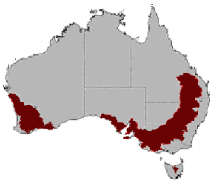
CONSULTATION DRAFT

GRAINS INDUSTRY

NATIONAL RESEARCH, DEVELOPMENT AND EXTENSION STRATEGY

20TH JULY 2010



EXECUTIVE SUMMARY

The Australian grains industry produces approximately 35 million tonnes of grain (subject to seasonal variation) grown over an area of about 20 million hectares. The industry has an annual GVP of greater than $9 billion of which 45% (value approximately $4 billion), is exported. Grains production also underpins Australia's growing food processing sector including the milling, malting and brewing industries (annual gross revenue in excess of $6.6 billion); and the feed compounding industry that services Australia's $14.6 billon GVP intensive animal production sector (beef, dairy, pig and poultry).

The Australian grains industry has grown significantly over the past 30 years driven by market forces and rates of growth in total factor productivity (TFP) that benchmark well by national and international comparison. Research, development and extension (RD&E) has been broadly recognised as a significant contributor to TFP performance, but recent declines in TFP growth are a major concern for the industry and highlight the importance of a re-evaluation and renewal of the resources, structures and processes used to prioritise, fund and undertake RD&E.

The industry operates in a rapidly changing production and market environment and the outlook for the next 20 years is considered positive with increasing global demand, diverse profit opportunities and increasing land values for grain producers. The industry is characterised by rapid adoption of advanced science and technology, deregulated marketing, and a mix of public and private sector service providers.

Rapid change in both the international and national environment is driving change across the grains industry. Key international drivers include:

- global food security issues (world population growth, competing uses for available arable farmland, biofuels demand, water availability, water quality and climate change);
- the impact of new participants in the international grain trade, in particular the 'Black Sea' countries and, potentially, South America; and
- growing market opportunities for Australian grain in Asia and the Middle-East.

Nationally, there is continuing change driven by deregulation of grain marketing and the consolidation taking place across the entire grains industry value chain from grower to end user. This change has made the business environment more complex for some stakeholders, but equally is opening new opportunities through the entire grains supply/value chain.

By its nature RD&E is complex, requiring investment over variable, often extended, time periods to deliver results to industry and the community. Growers, industry and government, whilst appreciating this, are seeking the timely delivery of research outcomes to provide short term enterprise prosperity and business security. The challenge is to balance the RD&E investment portfolio across the short-term and longer-terms needs of growers, industry, and government. The Strategy is not intended to reduce RD&E funding, to the contrary, but is a framework to encourage greater transparency in investment decisions, continuity of investment, and improvement in the effectiveness and efficiency of RD&E to deliver better outcomes to industry, government, and the broader Australian community.

The diverse, and geographically widely dispersed, grains industry has been historically well served by a consortium of mainly public sector RD&E providers (state agencies, universities, CSIRO) strategically co-investing with GRDC in national and regional programs. Successful as this has been, RD&E is now being affected by a range of new challenges:

- total factor productivity appears to be in decline in the grains sector;

- access to public funding is facing increased competition from other government sectors such as health;
- privatisation and globalisation are increasing across the grains industry, with greater involvement of private capital in grains RD&E;
- climate variability and longer-term climate change have become new priorities for research;
- private sector involvement in biotechnology is increasing, as barriers for technology uptake are reduced in the Australian and international grains market; and
- demographic factors and competition for RD&E skills from other sectors of the economy threaten the grains industry's human capital, particularly in regionally-based RD&E centres.

In responding to these changes it is recognised that the existing RD&E system can be improved by greater national collaboration in RD&E planning and delivery, and by greater stakeholder engagement in the RD&E prioritisation and investment processes.

The process of aligning grower, industry and government priorities has commenced, with public agencies identifying their future 'Major', 'Support' or 'Link' roles based on the PISC R&D Sub-committee definitions for agency commitments to the National RD&E Framework

Agency contributions in Major-Support-Link roles will be coordinated through a RD&E system of National Research Programs, National Centres of Research Capability, and Regional Development and Extension Networks, supported by a number of cross-program national 'Enabling Functions'.

National Research Programs form the core of the grains RD&E Strategy and will formalise and extend the existing national research effort across four priority areas (better varieties, improved practices, supply chain innovation and building farm business and industry capability – see Section 4.7). The National Research Programs will be supported and delivered through five National Centres of Research Capability, the universities, the Regional Networks, and other research providers. Under the Strategy, the Regional Development and Extension Networks have a primary role in regional and local farming systems R&D, NRM, and extension. Science staff employed within the Regional Networks will also be contributors to National Research Programs across a range of areas.

To drive and execute the Strategy, a National Grains RD&E Implementation Committee will be established with senior representation from the relevant PISC agencies, the university sector, CSIRO, GRDC and industry. The Implementation Committee will be supported by an Executive Officer and will oversight working groups appointed to implement the five key strategies outlined in Figure 1. To build ownership, the Committee will undertake extensive industry and research-provider consultation over the next 12 months.

Included in the Implementation Committee's role is the task of convening an annual National Grains RD&E Forum to gather broad cross-industry and government input to RD&E needs and priorities, with the goal of developing a comprehensive National Five Year RD&E Plan for the grains industry.

It is also recognised that the National Grains RD&E Strategy will need to be integrated with other agricultural RD&E sectoral and cross-sectoral plans. The Implementation Committee will draw on the work being done under the PISC R&D Sub-Committee on the harmonisation of performance evaluation, intellectual property management, administrative systems and new approaches to extension. It is anticipated that organisations will reconfigure their investment to support areas in which they have greater capability, and can make significant impact, whilst drawing on research from other jurisdictions in areas of lesser need.

A grains industry vision for RD&E, national priorities, and a delivery plan are shown in Figure 1.

The National Grains RD&E Strategic Plan

VISION

A *profitable*, *competitive* and *sustainable* grains industry with spill-over benefits to the broader agricultural sector, the food manufacturing industry and the Australian community.

To achieve the above:

A highly efficient national grains RD&E sector which fosters world-class innovation, industry-focused development, and influential extension.

CORE OUTCOME

Grains industry Total Factor Productivity growth of greater than 2.5% per annum (within a decade) whilst sustaining the resource base and improving market position.

STRATEGIES

1. **Build on existing national collaboration by developing improved processes for:**
   - **identifying and prioritising issues for RD&E investment**
   - **ensuring effective stakeholder engagement (growers, industry and RD&E partners)**
   - **agreeing common definitions and common impact evaluation assessments**
   - **reducing transactional costs in managing RD&E.**

2. **Devise more effective relationship models for engagement between public and private sector investment in RD&E to foster:**
   - **investment by multinational bioscience companies in strategic research in Australia;**
   - **the efficient delivery of extension through arrangements with consultants, agribusiness, and farming systems and grower groups;**
   - **value-adding opportunities for domestic and export grains.**

3. **Implement agency roles within PIMC's 'Major - Support - Link' national RD&E framework to develop:**
   - **national research programs to create critical mass to address national priorities and to deliver national and regional outcomes;**
   - **national centres of research capability to maintain critical infrastructure and critical science disciplines; and to establish links to access international research outputs;**
   - **regional networks of applied RD&E which support farming systems, improved practices, and adoption of national research outcomes.**

4. **Develop a national capability building plan to secure the intellectual and human capital and physical resources required to underpin future RD&E and industry innovation.**

5. **Develop a mechanism for regular review and alignment of government and industry objectives and agreement on priorities and resource allocation under the National Grains RD&E Strategy.**

Figure 1. National Grains Industry RD&E Priorities and Delivery Plan

Industry Vision	**A PROFITABLE. COMPETITIVE AND SUSTAINABLE GRAINS INDUSTRY** **↑Yield ↑Value ↓Costs ↑Sustainability**
Industry Outcome	**Total Factor Productivity Growth of Greater than 2.5% per annum over the Next Decade whilst Sustaining the Productive Capacity of the Resource base.**

PIMC/PISC Outcome	**Highly Efficient National Grains RD&E Sector** **National Centres of Research Capability, National Research Programs, Regional Networks of RD&E**				
RD&E Strategies **Partners** DAFF State Departments CSIRO Universities GRDC GCA (or successor)	**Build on Existing National Collaboration**	**Develop Effective Relationship Models for Private - Public coexistence**	**National Research Programs, National Centres of Research Capability and Regional Networks of Applied RD&E under the "major-support-link" Framework**	**National capability planning for human and physical infrastructure**	**Better & on-going alignment of Stakeholder Priorities and RD&E Resource Allocation**

RD&E Priorities	**Improved Varieties to Lift Productivity & Product Value**	**Improved Practices to Enhance Productivity & Sustainability**	**Supply Chain Innovation & Market Competitiveness**	**Building Farm Business & Industry Capability**
Investors Australian Government State Governments Industry	Growers and industry have ongoing access to improved genetics and varieties with better on-farm performance, reduced cost of production and grain qualities that are competitive in global markets	Improved on-farm practices that increase productivity and profitability whilst maintaining or improving the natural resource base and product integrity	Advance industry knowledge throughout the supply chain to improve the competitiveness and profitability of the sector	Accelerate adoption of new technologies and practice change across all segments of the grains industry

CONTENTS

DEFINITIONS

Agribusiness
In agriculture, agribusiness is a generic term for the various businesses involved in food production, including farming and contract farming, seed supply, agrichemicals, farm machinery, wholesale and distribution, processing, marketing, and retail sales.

Biometrics
Biometrics (or biostatistics) encompasses experimental design, statistical analysis and interpretation of biological data.

Bioinformatics
In this document the term bioinformatics is interpreted as the application of statistics and computational techniques to the field of molecular biology such as manipulation, analysis and storage of large quantities of DNA or protein sequence data.

Extension ("E")
Extension is concerned with communication, information exchange and promotion of learning in order to build capability and change practice. It includes a wide range of communication and promotion tools and activities, and in this context particularly includes the roles of direct advisory or consultant services, field days and update events. Extension includes the development of practice change methodologies required to achieve high levels of adoption of research outcomes. It is recognized that the tools and delivery mechanisms will by nature be diverse and vary according to the intended outcome sought, the target segment of the industry, and the local situation.

Experimental Development ("D")
Experimental Development is systematic work, drawing on existing knowledge gained from research and/or practical experience which is directed to producing new materials, products or devices, or to substantially improve those that already exist. It is taken to include application, adaptation and validation of 'known' technologies to suit regional/local environments, varieties and practices. At one end it may overlap with 'applied R' and at the other 'demonstration trials' – which verges upon 'E'. By definition, a significant proportion of 'D' must occur at regional/local level.

Industry, Grains Industry
The terms 'industry' and 'grains industry', depending on context, are used in the document. For the purpose of the Strategy, 'industry/grains industry' includes growers, input suppliers, providers of storage, handling and transport services, processors and exporters. The phrase 'growers and industry' is used in some places for emphasis, but is not intended to indicate a separation of the two.

Major-Support-Link
These terms have a special meaning in the Strategy based on the definitions developed by the PISC R&D Sub-Committee for the role of agencies and jurisdictions under the National RD&E Framework.

Major: take a lead role by providing significant R&D effort through maintenance of capability and leadership to deliver national R&D outcomes.

Support: contribute to R&D in partnership but the major role will be taken by another agency.

Link: undertake little or no R&D but access information and resources from other agencies (E only).

Pre-breeding
Pre-breeding is R&D intended to contribute to genetic improvement for a trait or traits of economic value. It is often undertaken outside a commercial breeding program, but with the intent of providing

breeding programs with improved germplasm, screening technology or breeding methods. Pre-breeding may include gene discovery, trait identification, developing markers, phenotypic screens and information generation. Whilst not strictly a scientific term, it serves a useful purpose in the grains industry and it is recommended that the definition above be adopted:

RD&E

The continuum that extends from 'research' (R), through 'experimental development' (D) to 'extension' (E) of the regionally interpreted and validated research. The Strategy uses the terms as defined here, and recommends they be agreed and consistently applied in the grains industry.

Research ("R")

Research encompasses the following definitions adopted by the Productivity Commission (Productivity Commission 2007*, Public Support for Science and Innovation*, Research Report, Productivity Commission, Canberra):

> **Basic research** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application of use in view. Basic research is sometimes divided into pure basic research and strategic basic research, with the latter directed at acquiring knowledge towards specified broad areas in the expectation of useful discoveries.
>
> **Applied research** is also original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.

Supply chain / Value chain

Supply chains are the set of entities directly linked by the upstream and downstream flows of products, services, finances, and information from a source to a customer. The concept of a 'value chain' puts the emphasis on the set of activities within a supply chain that add value to the end product that is ultimately presented to the consumer. Identifying the value chain allows a business to refine its operations in an effort to improve quality, add efficiencies, and increase profits.

Total Factor Productivity

Total Factor Productivity is the ratio of the total quantity of output to the total quantity of input.

Productivity growth may be measured[1] as 'partial productivity' (output relative to a single input such as land or labour) or as total factor productivity (TFP) which compares total output with total inputs used in production. For ABARE's TFP estimates for agricultural industries, these inputs include land, labour, capital, materials and services. TFP is also sometimes called multifactor productivity (MFP). TFP, while a determinant of profitability, is not measure profitability as the inputs are measured by quantity and not market value.

Terms of Trade

Farmers' terms of trade is defined as the ratio of prices received to prices paid[2]. A long-term characteristic of Australian agriculture has been that prices received for farm products have trended down relative to the prices paid for inputs – a decline in the terms of trade. Farmers' response to this decline in their terms of trade has been to rely heavily on increasing productivity to maintain profitability.

---

1 Nossal, K., & Gooday, P. (2009). Raising productivity growth in Australian agriculture. ABARE, Issues, insights 09.7.

2 Roberts, I, Haseltine, C., & Maliyasena, A. (2009). Factors affecting Australia's agricultural exports. ABARE, Issues, insights 09.5.

ACRONYMS

AAAC	Australian Association of Agricultural Consultants
ACDA	Australian Council of Deans of Agriculture
ACAS	Australian Crop Accreditation System Ltd
ACNFP	Australian Centre for Necrotrophic Fungal Pathogens
ABARE	Australian Bureau of Agricultural and Resource Economics
ACPFG	Australian Centre for Plant Functional Genomics
ACRCP	Australian Cereal Rust Control Program
AEGIC	Australian Export Grain Innovation Centre
AGT	Australian Grain Technologies Pty Ltd
ADWIP	Australian Durum Wheat Improvement Program
AgriBio	Centre for AgriBioscience, Victoria
APPF	Australian Plant Phenomics Facility, Adelaide and Canberra
ARWA	Agricultural Research Western Australia
AWB	AWB Ltd
AWCC	Australian Winter Cereals Collection
AWCPA	Australian Winter Cereal Pre-breeding Alliance
AWI	Australian Wool Innovation Ltd
BBA	Barley Breeding Australia
BoM	Bureau of Meteorology
BRI	BRI Research Ltd
CANFA	Conservation Agriculture and No-till Farming Association
CBH	Cooperative Bulk Handling Ltd
CBWA	Canola Breeders Western Australia Pty Ltd
CMA	Catchment Management Authority
CPRS	Carbon Pollution Reduction Scheme
CSIRO	Commonwealth Scientific and Industrial Research Organisation (PI – Plant Industry, FFF – Food Futures Flagship)
CCRSPI	Climate Change Research Strategy for Primary Industries
CGFI	Centre for Grain Food Innovation
CGIAR	Consultative Group for International Agricultural Research
CRC	Cooperative Research Centre
CSU	Charles Sturt University
CUT	Curtin University of Technology
CWFS	Central West Farming Systems Inc.
DA	Dairy Australia
D&E	Development and Extension
DAFF	Department of Agriculture, Fisheries and Forestry
DAFWA	Department of Agriculture and Food, Western Australia
DPIV	Department of Primary Industries, Victoria
DEEDI	Department of Employment, Economic Development and Innovation, Queensland
DIISR	Department of Innovation, Industry, Science and Research
EHGC	E. H. Graham Centre, Wagga Wagga

FTE	Full time equivalent
FFICRC	Future Farm Industries Cooperative Research Centre, Perth
FSG	Farming Systems Group
GAQ	Good Average Quality
GCA	Grains Council of Australia
GHG	Greenhouse Gas
GM	Genetic Manipulation, Genetically Manipulated
GOA	Grain Orana Alliance
GoGrains	Go Grains Health & Nutrition Ltd
GRDC	Grains Research and Development Corporation
GVP	Gross Value of Production
IDM	Integrated Disease Management
I&I NSW	Department of Industry and Investment, New South Wales
ICPBER	International Centre for Plant Breeding Education and Research
IP	Intellectual Property
IPM	Integrated Pest Management
IWM	Integrated Weed Management
LaTrobe	LaTrobe University
MLA	Meat and Livestock Australia
MPBCRC	Molecular Plant Breeding Cooperative Research Centre
NRM	Natural Resource Management
NUE	Nitrogen Use Efficiency
NVT	National Variety Trials
PBA	Pulse Breeding Australia
PIERD	Primary Industries & Energy Research and Development
PIIC	Primary Industries Innovation Centre
PIMC	Primary Industries Ministerial Council
PIRSA	Department of Primary Industries and Resources SA
PISC	Primary Industries Standing Committee
PUE	Phosphorus Use Efficiency
QAAFI	Queensland Alliance for Agriculture and Food Innovation
QFAB	Queensland Facility for Advanced Bioinformatics
RDC	Research and Development Corporation
R&D	Research and Development
RD&E	Research, Development and Extension
RIRDC	Rural Industries Research and Development Corporation
SABC	State Agricultural Biotechnology Centre, Murdoch University
SARDI	South Australian Research and Development Institute
SCU	Southern Cross University
SunRice	Ricegrowers Ltd
TFP	Total Factor Productivity
TIAR	Tasmanian Institute of Agricultural Research
UA	The University of Adelaide
UM	The University of Melbourne

UNE	The University of New England
UQ	The University of Queensland
UniSA	The University of South Australia
UNSW	The University of New South Wales
USQ	The University of Southern Queensland
US	The University of Sydney
UMU	Murdoch University
UWA	The University of Western Australia
WANTFA	Western Australian No-Till Farming Association
WCC	Wheat Classification Council
WEA	Wheat Exports Australia
WAHRI	Western Australian Herbicide Resistance Initiative
WUE	Water Use Efficiency

1 INTRODUCTION

1.1 CONTEXT

Research, Development and Extension (RD&E) is a major driver of the innovation required to ensure the productivity, sustainability and competitiveness of Australia's primary industries. Australia's global competitive position and future sustainability will rely on its industries continuing to have access to new technology and management practices. This will require Australia's finite science, technology and extension resources, with appropriate global partners, to efficiently and effectively identify industry and public needs (throughout the value chain) and then act strategically and collaboratively in finding solutions.

In April 2005, the Primary Industries Ministerial Council (PIMC) endorsed a concept of national research with regional development and local extension, recognising that research (both strategic and applied) can be provided from a distance, with regional adaptive development and local extension also critical to ensure cost-effective innovation across the industry.

Subsequently, PIMC and the RDCs signed a Statement of Intent containing a set of principles to facilitate further cooperation between agencies and industry to improve the efficiency and effectiveness of the national RD&E capability. The principles emphasised collaboration, information sharing, continuity of funding, access to capability and reporting. The agreed principles were:

i. The Parties will cooperate to encourage the establishment of a more efficient and effective RD&E system nationally;

ii. Recognising that the Parties will be subject to budget fluctuations, the Parties will endeavour to at least maintain RD&E funding levels for primary industries; and investments, including from savings, should be re-directed to improve the capability of the national system in priority areas;

iii. The Parties will share information, plans and priorities for investment in RD&E to facilitate development and implementation of the Framework and underpinning sector and cross sector strategies;

iv. The Parties will facilitate access to national research capability (people, infrastructure and information) by industry and R&D partners across Australia;

v. The Parties will support processes to refresh the rural R&D priorities and to encourage more consistent and rigorous monitoring of performance of R&D targeting and delivery;

vi. The Parties recognise the importance of investing in extension of R&D to facilitate rapid uptake of research and innovation;

vii. The Parties agree to work cooperatively to improve the administrative processes and effectiveness of information sharing and management;

viii. The Parties agree to freely share the knowledge generated through the primary industries National RD&E Framework, including minimising barriers to RD&E created by intellectual property protection;

ix. The Parties will monitor, evaluate and report on the performance of the National RD&E Framework and the sector and cross-sector strategies developed and implemented under the Framework.

In April 2007 PIMC further agreed to develop a national RD&E framework to provide a more formal and comprehensive structured approach within an agreed timeframe. This National RD&E

Framework aims to facilitate greater collaboration and coordination between the Commonwealth, State Governments, CSIRO, universities and RDCs with industry to:

- harness the necessary capability (people, infrastructure and information) for present and future RD&E needs;
- provide shared strategic directions and priorities planning;
- overcome capability gaps, create critical mass and reduce fragmentation and unnecessary duplication of effort across the nation.

Fourteen sector strategies will form schedules to the Framework: beef, cotton, dairy, fisheries & aquaculture, forestry, grains, horticulture, pork, poultry, sheep meat, sugar, wine, wool, and new and emerging industries. In addition seven cross-sector strategies are being developed covering climate change, food and nutrition, animal biosecurity, plant biosecurity, animal welfare, biofuels & bioenergy, and water use in agriculture. The Grains Strategy has significant allied interests and alignment with a number of these strategies; including beef, dairy, pork, poultry, sheep meat and aquaculture (feedstock), food and nutrition, animal and plant biosecurity, biofuels and climate change. In addition there are a number of additional specific areas where grains has allied interest with others; these include pastures, genetic resource centres and water use and management.

All agencies and stakeholders are subject to a tight budgetary environment and are compelled to seek the best possible returns from their RD&E investment. It is the intention that agencies will build and retain capability in fields that are strategically important to their jurisdiction, leading to the development and maintenance of a nationally coordinated network of RD&E capability.

1.2 PROCESS & STAKEHOLDER CONSULTATION

The National Grains Industry RD&E Strategy has been developed through a Steering Committee involving PISC agencies, GRDC, grain producers and the agriculture-related universities. The Steering Committee comprised representation from Western Australia (DAFWA), South Australia (SARDI), Victoria (DPIV), New South Wales (I&I NSW), Queensland (DEEDI), the universities (ACDA), CSIRO, the Australian Government (DAFF) and GRDC. Initial industry input was provided by the Grains Council of Australia through grower representatives from the northern, southern and western grains regions.

Development of the Strategy involved preparation of an initial consultation paper plus a consultant's sector overview report. The consultant reviewed the many recent grains industry reviews and jurisdiction/agency strategic plans, and held interviews with a wide range of research providers and industry participants from across the supply chain. Additional inputs were provided by individual agencies.

The Strategy provides detailed sections on:

- a situation analysis for the grains industry, including a 20-year outlook;
- current RD&E capability (investment, infrastructure and people);
- current and future RD&E priorities;
- key strategies for RD&E delivery;
- a change plan based on opportunities for partners to take "Major", "Support" or "Link" roles in driving national RD&E;
- proposed implementation plans; and
- critical success factors and KPIs.

The Strategy is built on a substantial body of background material either collected or commissioned. This material has been collated and is referred to throughout the Strategy as the 'Grains Industry Strategy – Supporting Documents'. More concise underpinning information is provided in the Appendices attached to this document. The members of the Steering Committee and others involved in the preparation of the Strategy are listed in Appendix 1.

1.3 SCOPE

The grains industry in Australia consists of numerous individuals, small businesses and large corporations engaged in a diverse range of activities, including primary production, processing, trading and transport and serviced by an equally diverse range of public and private service providers and investors. Information relating to the traditional public sector RD&E inputs is readily available. Currently, however, there are no formal mechanisms to capture information from the private sector. It is recommended that as the Strategy is implemented, and other cross sector strategies are developed as part of the National RD&E Framework, a mechanism be established to better integrate RD&E investments made by the post-farm-gate and private sector elements of the grains industry.

2 GRAINS INDUSTRY SITUATION ANALYSIS

2.1 PRODUCTION

The Australian grains industry (subject to seasonal variation) produces approximately 35 million tonnes of grain from an area of about 20 million hectares with an annual GVP of greater than A$9 billion. The industry is characterised by a predominance of winter cereals produced over a wide geography and in a number of distinct agro-ecological zones with unique climate/soil characteristics and diverse management requirements. Pulses and oilseed crops are significant both in their own right and as rotation-break crops in the dominant cereal rotation.

National crop production statistics for the most recent available decade (1999/2000 to 2008/09) are shown in Table 1. Production (44.5 million tonnes) in 2005/06 (the 2005 cropping season) illustrates the potential productivity of the sector in a 'good year'. In contrast, in 2006/07 total grain crop production was only 19 million tonnes—the impact of widespread drought. More detailed statistics (production x region x crop) are included in Appendix 2 and additional background information on production is held in the Strategy's supporting documents.

Table 1. Grain production in Australia (million tonnes)

Crop	2005/06	2006/07	10-year Average (1999/00 to 2008/09)
Wheat	25.2	10.8	20.0
Barley	9.5	4.2	7.0
Coarse grains (sorghum, oats, triticale, maize)	4.7	2.3	4.3
Pulses (lupins, field peas, chickpeas, faba bean, lentil)	2.5	1.0	1.9
Oilseeds (canola, soybean, sunflower, other oilseeds)	1.6	0.6	1.7
Rice	1.0	0.1	0.7
TOTAL	**44.5**	**19.0**	**35.6**

Geographically the industry is defined by three broad agro-ecological regions:

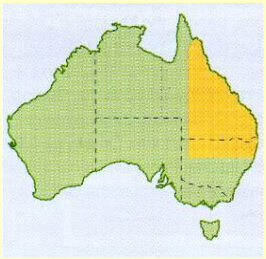
- Northern sub-tropical, summer rainfall dominant;
- South-eastern/southern temperate, uniform to winter dominant rainfall; and
- Western, mediterranean-type with a strongly winter rainfall dominance.

These differences are reflected in the regional differences in mix of crops and associated farming systems between regions. Most marked of these differences is the production of summer-growing cereals, primarily sorghum and maize in the northern region with smaller areas of summer-growing

pulses (peanut, mungbean) and oilseeds (sunflower, safflower). Small areas of highly productive summer crops are also produced under irrigation in the Murray-Darling region of south-eastern Australia, but total production is still small. Crop composition across the south-eastern/southern region and the western region is similar with the notable exceptions of triticale in the south-east produced for dairy cattle feed, and production of lupins in the western region.

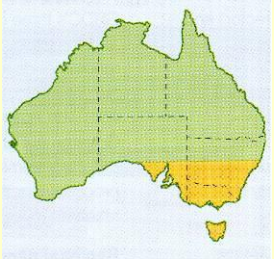
2.1.1 NORTHERN REGION

The Northern region encompasses Queensland and northern NSW. The region is characterised by summer-dominant rainfall and high inherent soil fertility. Both summer and winter crops are important and yield depends to a significant degree on conservation of soil moisture from summer dominant rainfall. The region has the highest diversity of crop production including maize, sorghum and tropical pulses, plus wheat, barley, winter-growing pulses and oilseeds. The region is the largest source of Australia's premium hard high protein wheat for export and domestic use. The region has relatively high seasonal rainfall and production variability compared with the southern and western regions. Demand for feed grains from the region's important livestock industries is a driver of grain production in the region.

Northern Region	Crop	Average Production (t) (2001/02–2008/09	National %
	Wheat	3,668,000	19
	Sorghum	2,040,000	98
	Barley	843,000	12
	Maize	363,300	98
	Chickpea	219,500	90

2.1.2 SOUTHERN REGION

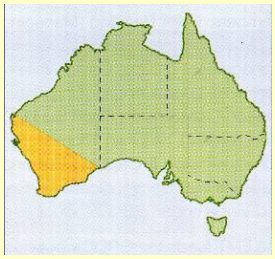
The region encompasses south-eastern Australia, including central and southern NSW, Victoria, Tasmania and South Australia. The climate is temperate with uniform or winter-dominant rainfall and diverse soils of generally low fertility. Yield potential is dependent on seasonal, especially autumn and spring, rainfall and there is lesser dependence on stored soil moisture. Production patterns are diverse and include many mixed farming enterprises with significant livestock and cropping activities.

Southern Region	Crop	Average Production (t) (2001/02–2008/09)	National %
	Wheat	7,836,000	41
	Barley	3,933,000	55
	Canola	679,400	52
	Oats	641,000	48
	Triticale	487,000	89
	Rice	471,825	100

Appendix 2 identifies the Southern Region as a major national producer of wheat, barley, rice, oats, canola, triticale, field pea, faba bean and lentil. The majority of the South Australian production is export focussed whilst production in southern NSW, Victoria and south-eastern SA is increasingly focused on the domestic milling and feed markets.

2.1.3 WESTERN REGION

The Western region has a Mediterranean climate with hot summers and cool, wet winters. Soil fertility is low to very low. Wheat, barley, canola and lupins are the dominant crops with livestock enterprises in mixed farming systems of lesser importance. Yields depend on winter and spring rainfall and are low by world standards. However, this is compensated for by the large scale and degree of mechanisation of the enterprises. Long-term variability in seasonal rainfall and production is lower than the northern and southern regions. The western region has a small population and feed industry and exports more than 80% of its production. Japan, Indonesia, Saudi Arabia and South Korea are the main export markets.

Western Region	Crop	Average Production (t) (2001/02–2008/09	National %
	Wheat	7,538,000	40
	Barley	2,352,000	33
	Lupin	699,900	82
	Oats	574,000	43
	Canola	565,300	44

2.2 CHANGING INDUSTRY DYNAMICS

An assessment of the situation facing the grains industry has identified the following key trends, opportunities and threats:

2.2.1 INTERNATIONAL GRAIN ENVIRONMENT

The main potential impacts on the Australian grains sector with regard to the global grains industry and international markets are:

- Deregulation in both the purchase and supply of agricultural products. There has been a major change over the past 15 years from ‘single desk’ buyers to multiple buyers (e.g. significantly increased container trade/markets), and from government-backed statutory marketing bodies to a free market;
- Intensifying global competition: the emergence of the ‘Black Sea’ countries (e.g. Ukraine) and potentially South America as major grain exporters (In 2008/09 some traditional Australian markets in Asia sourced Black Sea-origin grain for $A90 per tonne less than the Australian equivalent);
- Increasing consumption in China, India and other Asian markets;
- North America adopting a more aggressive approach to growth markets in Asia;

- The adoption of GM crops (corn, soybean and canola) leading to major change in the relative production of wheat in North America;
- Projected long-term grain shortages and volatility of supply leading to high prices and potential food shortages (but recently offset by increased world production levels);
- Diversion of grains into biofuels production and away from human or animal consumption, particularly in North America;
- Decreasing land available for grains production through degradation and urbanisation;
- Increasing regulatory and customer requirements in international markets including low chemical residues, traceability, carbon footprints, unintended GM presence etc;
- Potential incursions of diseases prevalent overseas and their likely consequence to Australia;
- Increased globalisation and consolidation of the grains industry supply/value chains.

2.2.2 AUSTRALIAN GRAINS ENVIRONMENT

Major trends within the Australian grains industry include:

- Consolidation across the grains industry supply chain leading to a reduction in the number of large grain accumulators/marketers. There are currently four major participants: Viterra (formerly ABB Ltd); Cooperative Bulk Handling Ltd, Grain Corp and AWB Ltd;
- Increased vertical and horizontal integration, for example CBH and GrainCorp have forward integration in flour milling; Viterra and GrainCorp in barley malting, and AWB Ltd into rural services through their Landmark business;
- Increased overseas ownership/involvement in the grains industry supply chain with the recent examples of Viterra's acquisition of ABB; the joint venture of AWB and the US-based Gavilon; and the purchase of grain infrastructure facilities by Sumitomo;
- Deregulation of the bulk wheat export market enabling the entry of international grain traders and expansion of local traders;
- Continued rationalisation of suppliers of the major grain production inputs - fertilisers and chemicals – and matching rationalisation in rural distribution;
- The emergence of the north-eastern and south-eastern regions as a predominantly domestic market with processing, human consumption and livestock feed markets growing rapidly. In excess of 50% of grain produced on Australia's eastern seaboard is now consumed domestically; with up to 90% in years of livestock feed shortage. The Western region and south-western South Australia in contrast is growing in significance as the industry's major grains exporter;
- Current perceived conflicts between growers and grain marketing company needs and expectations as previously grower-controlled organisations convert to public companies.

2.2.3 GOVERNMENT

Government continues to have a major impact on the grains industry through investment in RD&E, regulation and evolving policy issues. These include:

- The recent deregulation of bulk wheat exports and the establishment of Wheat Exports Australia (WEA) as the industry's wheat export regulator;
- The end of state-based grain marketing regulation (e.g. barley, canola, lupins);

- Ongoing State government review of their primary industry policy agencies, particularly their role in RD&E;
- A previous Productivity Commission review that questioned the role of government in funding industry-good R&D;
- An increased focus on impact assessment, cross-RDC collaboration, and harmonisation across state and federal agencies.
- Formation of the Rural R&D Council in February 2009 to develop a National Strategic Rural R&D Investment Plan and a framework for performance measurement and reporting;
- The Australian government's ratification of the Kyoto Protocol and the government's intention to introduce a Carbon Pollution Reduction Scheme; and strong government emphasis on climate change impacts on productivity;
- The 2008 Australian Government review of the National Innovation System and state and Australian government support for the development of a National Primary Industries RD&E framework.
- The Australian Government's recently announced terms of reference for a Productivity Commission review of the R&D Corporations.

2.2.4 GROWERS

The following current trends for grain growers have been considered:

- Farm consolidation continues, the number of grain enterprises declined from 40,000 to 27,000 over the period 1980 to 2010 – and the decline is expected to continue with farms becoming larger and with an increased business focus;
- Increased corporate involvement in grain production driven by both capital gain opportunities and the expectation of productivity growth;
- A change in growers' approach to grain marketing post deregulation – including widespread use of price risk management tools, on-farm storage, and direct marketing both individually-locally and group-internationally;
- A changing ownership profile - the average age of grain growers is 57 years, but a younger, proactive generation of farmers is emerging with a more global orientation to both science and marketing. Nevertheless, shortage of skilled labour remains a problem for the grains industry and drives investment in labour saving machinery and technology;
- Increased membership of grower groups often with developing interests in self-managed R&D.

2.2.5 FARM ADVISORS/CONSULTANTS

The farm advisor/consultant sector is characterised by the following trends and issues:

- Growers are increasingly using consultants with the current national estimate around 47%. Consultants provide primarily agronomic and farm business advice, but increasingly also include areas of marketing, finance and price risk management;
- Underdeveloped linkages between consultants and the originators of grains R&D (as the former replace the older 'linear' state agency integrated RD&E model in some states);
- Unclear training and succession for existing advisors/consultants;

- Increased influence of rural merchandisers and input suppliers in providing agronomic advice.

2.2.6 *GM TECHNOLOGIES/ACCESS*

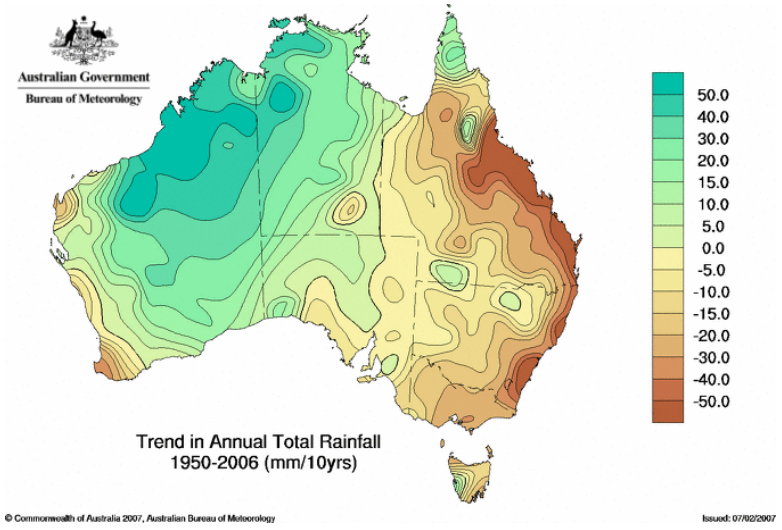
Current issues facing introduction of GM technology in grains are:

- Introduction of the first commercial GM canola in NSW and Victoria in 2008 and the 2010 approval for GM canola in WA. A GM crop moratorium still exists in SA and Tasmania;
- Multi-national bioscience companies are now actively involved in cereals (particularly wheat) biotechnology and are looking to partner with entities with germplasm assets (including in Australia) to provide a platform to deliver breeding technologies including GM varieties in the future;
- Cost of GM technology development and regulatory approval is high and requires partnership with large private businesses with sufficient capacity to invest. These companies will also seek to protect their investment through partnership arrangements to manage IP.
- Timelines for industry and consumer acceptance of GM cereals remains unclear (US, Canadian and Australian grains industries believe GM wheat and barley are probably still 10 years from market).

2.2.7 *CLIMATE CHANGE*

There is increasing acceptance that climate change is occurring and that average rainfall has been declining for some time over much of the Australian grain-belt (Figure 2).

Figure 2. Change in annual rainfall (1950-2006) illustrating a significant decline over much of the Australian grainbelt.



The following climate issues are important considerations for the grains business environment:

- Predictions that rainfall will decrease by up to 15% and surface runoff by 25-30% across significant areas of southern temperate Australia by 2030;
- Understanding that season-to-season rainfall and temperature variability will remain far greater than the long term trends due to increased atmospheric greenhouse gas levels;

- Increased recognition that the capability needs to exist for grain growers to adapt through technology change, for example new varieties, reduced tillage, etc;
- Increased focus of RD&E programs on climate change; mitigation, adaptation and carbon economy market opportunity for farmers;
- The introduction of carbon offset markets could provide opportunities for agriculture to find more efficient ways of producing food and fibre AND reduce emissions, without reducing productivity. The challenge is to identify opportunities that reduce waste in the sector, thus reducing emissions and leading to increases in productivity.
- Mitigation and adaptation responses are a strong Australian government priority and PISC agencies, Universities and RDCs are taking a national approach to dealing with climate change issues.

2.2.8 AGRI-POLITICAL ORGANISATIONS

The grains industry's agri-political organisations are undergoing a significant evolution as their representational and funding bases change. Declining membership and diverse views on the future of grain marketing have caused internal difficulties and the sector is in the process of regrouping to determine future roles in changed market conditions and where they can or should add value. Recent developments include proposals for a producers association and discussion on formation of a national grains alliance.

Significant issues are:

- the lack of a national grains whole-of-supply-chain representative body;
- lack of a united voice with which to approach government, research investors, research providers, and the grains industry supply chain, to address grains industry issues including RD&E;

Implications for Grains RD&E

Continued rapid changes in global production and market environments are creating both new opportunities and significant risks for the Australian grains industry. How the Australian industry, including the RD&E sector, responds to these changes will ultimately determine the level of competiveness, profitability and sustainability the industry will attain. Ongoing innovation throughout the grains industry supply/value chain will be critical.

2.3 GRAINS INDUSTRY 20-YEAR OUTLOOK

Industry assessment has identified the following factors as major influences in the 20 year projection for the Australian grains industry.

2.3.1 INTERNATIONAL

- Increasing global demand for food and feed grain due to population growth, changing consumption patterns, challenges to supply due to climate change/variability, the loss of productive land due to degradation and urbanisation and reduced availability and quality of water;

- Increasing demand from China, the Indian sub-continent and the Middle East associated with a growing and increasingly affluent middle class;
- Increasing global competition from the Black Sea region and potentially from South American countries both in quantity and quality of grain products;
- Development and acceptance of GM traits in most grain crops;
- A plateau or decline in North American wheat production as area is diverted to alternative crops (primarily GM-enhanced corn and soybean) and for bio-fuels.

2.3.2 NATIONAL

- The major grain crop by volume will remain wheat, followed by barley in the southern and western regions and sorghum in the north;
- Although cereals will continue to dominate grain production, there will be increased emphasis on broad leaf (pulse and canola) genetic improvement and cropping systems to underpin the productivity of cereal rotations;
- Niche value added opportunities are likely to emerge. However, it is unlikely that speciality production for individual niche markets will exceed 500,000t from a national crop that has averaged 35.6 mt over ten years;
- Western Australia, and a significant proportion of South Australia will continue to be export orientated whilst the northern, eastern and south-eastern regions will increasingly produce for domestic human consumption and animal feed markets with niche opportunities for on-shore processing;
- Climate variability will continue to be a factor impacting production, requiring continued innovation and resilience in farming systems, including risk management;
- Longer-term climate change will increase the pressure on marginal cropping areas providing opportunities for diversification (including as part of the global "carbon economy") and will increase the focus of production on the higher rainfall areas;
- A Carbon Pollution Reduction Scheme, if introduced, will create an incentive to use carbon intensive inputs more efficiently. The development of robust abatement methodologies will help enable the cropping sector to contribute to the transition to a low carbon economy, such as pulses for cheaper sustainable sources of nitrogen;
- Rationalisation and internationalisation of the grains industry supply chain will continue;
- GM technologies will be commercialised and accepted and increase productivity and profitability. However, for cereals the timeframe to commercialisation is still uncertain and unlikely within the next 10 years;
- Markets will increasingly demand traceability and quality assurance on grain and grain products;
- The number of grain farms in Australia will continue to decline but the average size per farm will increase; and
- Second generation bio-fuels may present opportunities for grain crops in specific localised areas based on feed stock availability and proximity to market.

2.4 INDUSTRY CHALLENGES

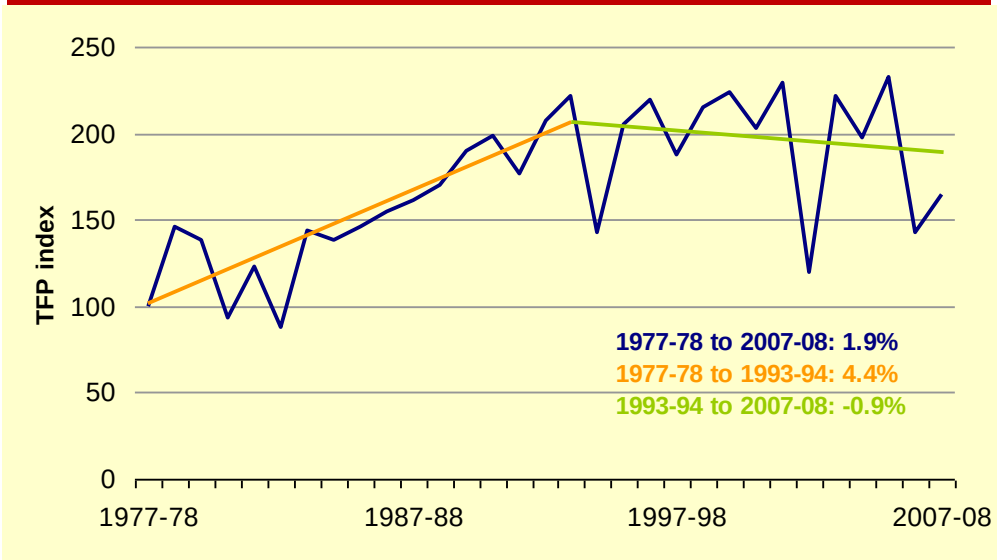
2.4.1 *GRAINS INDUSTRY PRODUCTIVITY*

Productivity growth and the ability to respond quickly to changing economic conditions are essential to maintaining industry competitiveness. From the late-1970s through to 2007/08 the Australian broadacre grains industry experienced an average annual rate of total factor productivity (TFP) growth of 1.9% per annum, well above other commodity sector groups and Australian industry as a whole. Annual productivity growth was even higher in the 1980s and early 1990s, with this period of stronger productivity performance linked to the period of growing investment in Australian grains R&D, in the 1950s-1970s, together with the development and adoption of technology inputs including those from overseas R&D in the form of new agrochemicals and larger and innovative machinery. Specific drivers of TFP growth have included:

- Better farm management (both the quality of management and work skills, and the ability to access and take advantage of information flows);
- More productive varieties;
- Improved crop rotations;
- Better disease, weed and pest control, particularly new herbicides and the use of low-cost off-patent products;
- Development and adoption of minimum tillage;
- More efficient fertiliser use, notably optimising application rates;
- Increased scale through farm amalgamation and the use of larger, more efficient tractors and machinery.

Of the contribution of R&D to productivity growth, about one third has been attributed to genetics (varieties) and two thirds to farm management systems (practices); and productivity growth has been greater in the Western region.

Figure 3. Grains sector total factor productivity growth over time
(source ABARE)



The overall figure of 1.9% average TFP growth per annum referred to above masks an apparent decline in productivity growth from the mid-1990s to the present. Productivity growth averaged 4.4% a year for the period 1977-78 to 1993-94, but productivity growth was negative, falling by an average 0.9% year for the period 1993-94 to 2007-08 (Figure 3). This represents a major challenge for the industry.

Reasons for the apparent decline in productivity over the recent past are believed to be:

- The adverse impact of recent droughts –output has been reduced directly by the dry seasons, but also due to the secondary effects of drought as growers have reduced inputs (fertilisers, chemicals), have experienced reduced confidence levels and deferred expenditure on adoption of new capital-intensive technologies;
- The decline in RD&E expenditure both in terms of dollars invested and the re-direction of R&D investment toward natural resource management (NRM) and biosecurity. Pardey *et. al.* (2006) and others[3] have shown that since the early 1980s there has been steady decline in the share of R&D expenditure directed to enhancing farm productivity. The recent GRDC-funded ABARE studies on productivity are pointing towards a similar trend in Australia.
- A slowing of technology outputs from the R&D pipeline as the 'low-hanging fruit' has been picked. New chemical groups with new modes of action are more difficult to find and more expensive to commercialise; the step changes such as the introduction of semi-dwarf cereal varieties and new pulse crops are more difficult to find; remaining problems such as crown rot, drought and frost are inherently more complex and difficult problems to solve;
- A plateauing of agronomic and business capability at the grower level is impacting the rate of adoption of newer, more complex technologies;
- Other factors may include the changing regulatory environment (for example the state bans on GM crops), reduced spill-in of technology from other countries and CGIAR centres, and a gradual degradation of the natural resource base (e.g. chronic acidification, nutrient depletion, salinity etc).

In summary:

- Grains industry productivity growth for the past 30 years has averaged around 1.9% per annum - well above that of other commodity sectors and Australia's market sector industries;
- RD&E and innovation are recognised across the grains industry as underpinning productivity gains;
- Productivity needs are a key driver of RD&E priorities;
- Public and private RD&E investment has been a significant contributor to increased farm productivity growth;
- However, there are indications of a slowing of grains productivity growth in the last decade due to the reasons listed earlier;

[3] Pardey, PG, Alston, JM & Beintema, NM 2006, Agricultural R&D spending at a critical crossroads. *Farm Policy Journal* 3: 1-9

Mullen, J and Cox, T 1995, 'The Returns from Research in Australian Broadacre Agriculture', *Australian Journal of Agricultural Economics*, vol. 29, no. 2, pp.105-128.

Nossal, K and Sheng, Y, 2010, 'Productivity growth: trends, drivers and opportunities for broadacre and dairy industries', *Australian commodities*, vol. 17, no. 1, pp.216-230.

- Farm productivity needs to grow at a minimum of 2% per annum to offset the long-term decline in growers' terms of trade. However, productivity growth needs to be considerably greater if the Australian grains industry is to remain competitive in the medium to long term.

These issues highlight the importance of Total Factor Productivity growth to the future viability of the grains industry and the need for the National Grains RD&E Strategy to sharpen the focus on the critical drivers and barriers to improving TFP growth through RD&E.

2.4.2 THE LINK BETWEEN PRODUCTIVITY AND PROFITABILITY

There is wide acceptance of a strong relationship between productivity and farm profit. Observations by Mullen indicate that grower terms of trade have steadily declined since the mid 1950s but have been offset by increased TFP in broadacre agriculture (Figure 4). Furthermore, an analysis of GVP with and without productivity growth highlights the positive impact of advances in TFP on agricultural GVP (Figure 5) that would otherwise have declined from a high of $36b in 1952-53 to around $13b in 2007-08.

.

Figure 4. .Trends in TFP and growers' Terms of Trade[4]

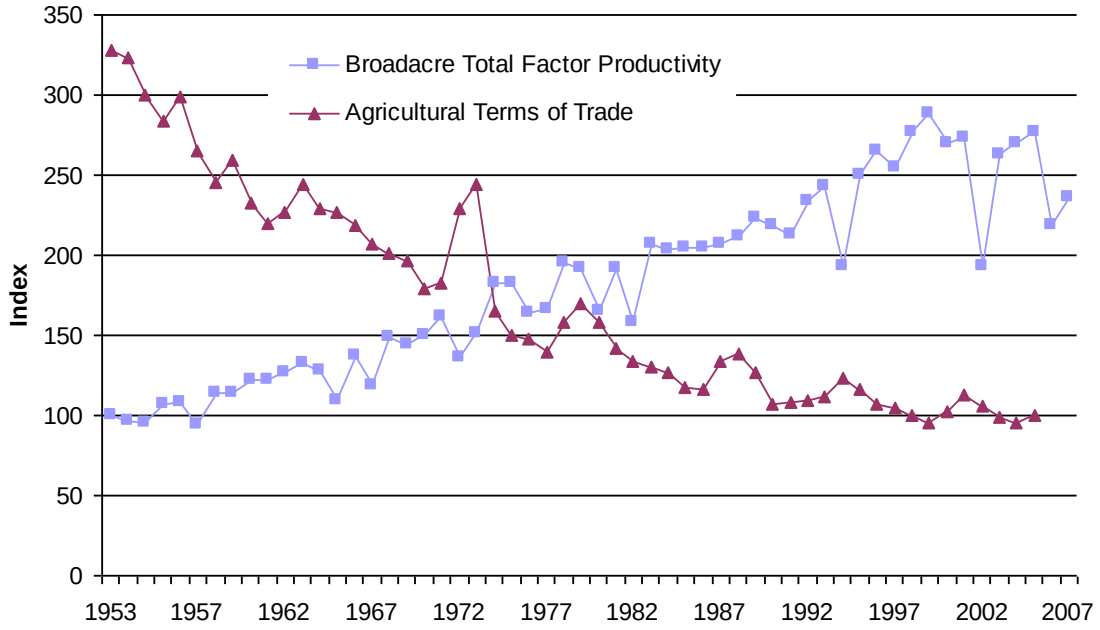
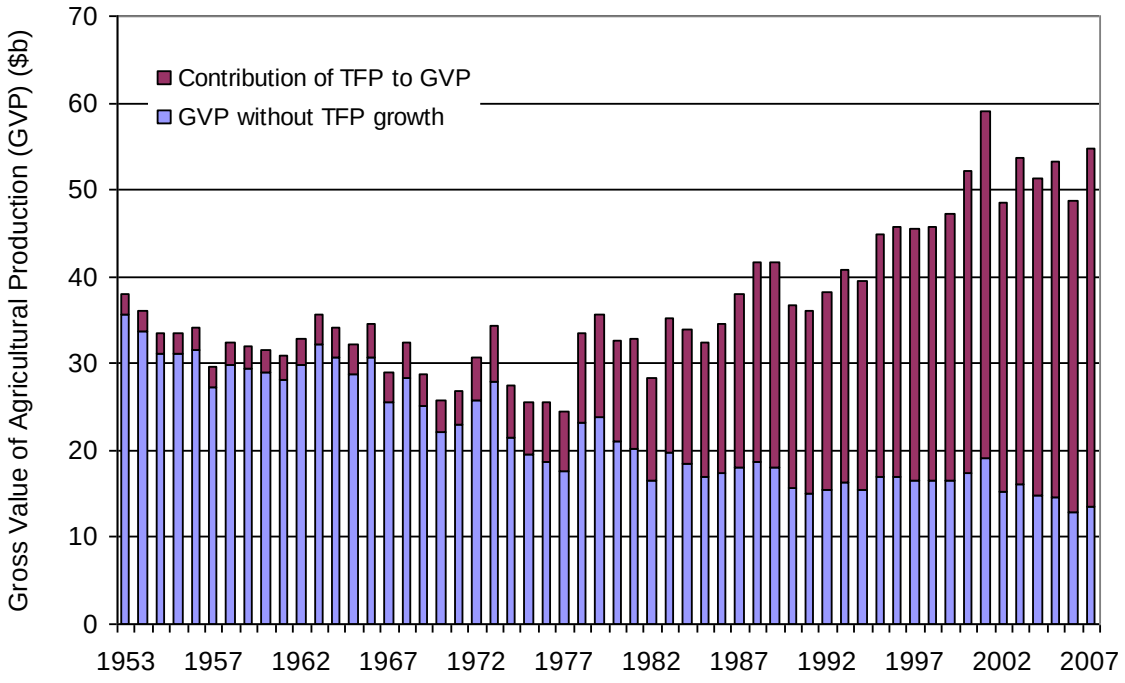


Figure 5. Impact of productivity growth on real GVP[4].



[4] Mullen, J. and Crean, J. (2007), *Productivity Growth in Australian Agriculture: Trends, Sources, Performance*, Australian Farm Institute, Surry Hills.

2.4.3 *BUSINESS & MARKET COMPETITIVENESS*

The ability of grain farmers to anticipate and respond to change, rapidly adopt improved business practices and make well-informed decisions is essential to realise productivity improvements from R&D. Improving business competitiveness is thus fundamental to the well-being of grain businesses, their industries and communities. Competitiveness incorporates the full range of issues that impact on the business operating environment, including efficiency of production, managing environmental risks, increasing net value, flexible labour, efficient regulatory structures, effective access to markets and other macro and micro-economic factors.

A key challenge is to enable grain growers to meet local and international market and community expectations with respect to the quality and safety of grain products. It is important that the grains industry successfully identifies and manages biosecurity risks and other impediments to trade, so that it can maintain access to existing markets as well as secure new markets.

In order to thrive in competitive markets, along with improving on-farm productivity, the grains industry will need to differentiate grain commodities to capture higher value markets where the opportunities exist. Similar to realising productivity improvements, the capability of grain farmers to anticipate risks and respond to markets will be critical to improving competitiveness in markets.

2.4.4 *SUSTAINING THE PRODUCTIVE CAPACITY OF THE NATURAL RESOURCE BASE OF THE GRAINS INDUSTRY*

Over the last fifteen years there has been a strengthening of public investment in environmental issues to the detriment of agronomic research in agricultural R&D across all developed countries. Australia is no exception and this trend is reflected in government agency priorities for investment. The decline in world food stocks in 2007 and 2008 and sharp rise in grain commodity prices refocussed attention on the need to maintain or increase productivity-related research. With TFP growth showing signs of decline, there is now an urgent need for government and agribusiness to increase investment and improve the effectiveness of productivity research. A key challenge will be to improve productivity while maintaining the productive capacity of the natural resource base, as access to natural resources (including arable land and water) becomes more difficult.

Changes in the natural assets on which the grains industry depends, such as availability and quality of water, soil condition, salinity, weeds and pests, affect the productive capacity of the industry. Thus, in addition to productivity growth, the long term future of the grains industry will rely on sustainable management of the natural resource base. This will require the industry to build knowledge and capability, adapt practices, effectively manage risks and maintain and improve fundamental natural resources such as soils, water and biodiversity through better management. Managing environmental risks and adopting more sustainable practices is not only an essential ingredient to productivity, it is also a clear expectation of government and the wider non-rural community. Many science disciplines underpin both environmental values and productivity (for example land capability assessment, soil constraints, water and nutrient use efficiency, carbon sequestration and greenhouse gas emissions, etc) and offer the opportunity to develop mutually beneficial and sustainable farming systems which balance the dual requirements of state agencies to improve productivity growth for growers and industry, whilst achieving the environmental policy goals and services required by the wider community.

3 CURRENT RD&E INVESTMENT AND CAPABILITY

The Steering Committee undertook an extensive "audit" of the national investment in grains RD&E. The audit covered all of the state jurisdictions, CSIRO, GRDC and the agricultural universities through the President of the Australian Council of Deans of Agriculture Universities (ACDA). The audit, however, was unable to gather data of the same detail on private (national and international) enterprise investment in Australian grains RD&E. Details are included in the supporting documents[5].

3.1 INVESTMENT

It is estimated that the total expenditure on grains RD&E in Australia (2007-08) was of the order of $325 million. The comparative breakdown is shown in Table 2, below.

Table 2. Australian grains RD&E investment in 2007-08

Organisation	$ million	%
State Departments	123	37
CSIRO	45	14
Universities	39	12
GRDC	88[6]	28
Private Investment (Estimate)	30	9
TOTAL	325	100
Grower contribution (5-year average)	60	21

Based on an average annual gross value of production of $9 billion, the RD&E expenditure of $325 million represents 3.7% of the GVP, equivalent to $9.40 per tonne of grain based on an assumed production of 35 million tonnes.

Of this figure, it is estimated that direct grower contributions average $60 million or $1.86 per tonne of grain produced. Thus, growers' investments are leveraged 5-fold through contributions from other organisations.

Approximately 75% of Australian grains RD&E investment is sourced from public funds (federal and state), whereas in the United States of America 53% of total RD&E investment comes from private sources and 47% from the public sector.

[5] National Grains RD&E Strategy – Supporting Documents (GRDC, 2010)

[6] GRDC investments outside PISC agencies (other RDCs; grower groups/farming systems groups; CRCs; international collaboration and private industry totalled approximately $30m in 2007/08.

3.2 INFRASTRUCTURE

The grains industry is serviced by a very large and dispersed RD&E infrastructure base constructed over the period from the 1950s post-war expansion of the land area devoted to agriculture to the 1980s. Much of this capability was replicated state by state. Table 3 is a summary of the main centres or clusters of infrastructure currently servicing the grains industry. Many of these sites are also bases for RD&E for other agri-industries.

Table 3. Current centres with significant grains RD&E capability

Centre	Major Activities	Agencies
Northern Region		
Emerald / Biloela	Tropical crop and pastures genetic resource collection, farming systems	DEEDI
Toowoomba / Warwick / Gatton	Sorghum breeding, tropical/subtropical pathology, entomology, farming systems, barley breeding, winter cereal pre-breeding, weed science and herbicide resistance, biometrics, crop and farm systems modelling	DEEDI, CSIRO, UQ, USQ
Brisbane	Soybean genetics, climate change, entomology, wheat pre-breeding (yield, biotic stress), grain protection, WUE, bioinformatics	CSIRO, UQ, DEEDI
Narrabri / Myall Vale	Irrigated soybean, wheat and faba beans, crop rotations Pre-breeding – wheat, faba bean breeding and field pea evaluation	US, I&I NSW
Tamworth	Chickpea and durum breeding, farming systems, grain pathology, integrated weed management, AWCC, lucerne and subtropical grass breeding and legumes agronomy, soil health and greenhouse gas emissions, cereal chemistry (durum)	I&I NSW
Southern Region		
Wagga Wagga (Condobolin, Yanco)	Farming systems, plant pathology, soil health, entomology, weed science, canola pre-breeding, biometrics, cereal and oil science; temperate pastures, rice improvement (Yanco).	I&I NSW, CSU
Canberra (Black Mountain)	Wheat pre-breeding (abiotic and biotic stress, molecular genetics platforms, nutrient efficiencies, WUE, yield, quality, phenomics)	CSIRO
Cobbitty	Australian Cereal Rust Control Program	US, CSIRO
Bundoora (AgriBio)	Germplasm improvement (mainly transgenic wheat and barley) and pulses (chickpea, lentils, field pea) and canola. Linked to the centre at Horsham for delivery through private and public partnerships.	La Trobe, DPIV
Horsham (Grains Innovation Centre)	PBA lentil, field pea and kabuli chickpea breeding/pre-breeding, Temperate Crops Genetic Resource Collection (temperate cereals, pulses), oilseed pre-breeding, GM wheat and canola, plant pathology, nematology, climate change research, crop physiology, modelling, biosecurity, grain quality, farming systems, soil science	DPIV, co located with MU & private companies and service providers

Table 3. Current centres with significant grains RD&E capability (continued)

Centre	Major Activities	Agencies
Southern Region (continued)		
Waite Campus	Wheat, barley and durum pre-breeding (abiotic stress, nutrient-use efficiency, pathology and quality), Molecular genetics platforms; BBA Barley, Oat, Vetch, Durum & PBA faba breeding, WUE, Root disease testing service, Pulse pre-breeding, Weed science and herbicide resistance, Biometrics and Plant Pathology, phenomics platform, soil science and plant nutrition (filed and molecular aspects). Increasing attention to the relationships between grain quality, food and health	SARDI, UA, ACPFG
Minnipa	Farming systems (low rainfall, alkaline soils)	SARDI
Hamilton	Farming systems for high rainfall zone with grains	DPIV
Western Region		
Perth	Wheat and barley pre-breeding (quality, biotic stress), BBA barley breeding, PBA lupin breeding, legume pre-breeding and genetic resource collections, ICPBER, plant pathology including nematology & virology (UMU, DAFWA), ACNFP, grain food processing (CGFI), soil fertility and plant nutrition, pasture productivity, canola pre-breeding, climate and weather, biometrics, bioinformatics & molecular genetics (UMU)	DAFWA UWA UMU CSIRO CUT
Geraldton	Sand plain cropping systems, crop protection	DAFWA
Northam/Merredin	Wheatbelt farming systems, modelling, weed science	DAFWA
Albany/Esperance	High rainfall farming systems, soil constraints, crop protection	DAFWA

3.3 HUMAN RESOURCE

In addition to investment data, the Steering Committee's audit provided data for a national grains capability assessment, incorporating information on human resources and infrastructure. The audit was based on a snapshot of the 2007/08 financial year and is summarised in Table 4 as full-time equivalent staff by region.

Key human resource statistics for the grains industry are:

- approximately 1,400 full time equivalent staff (FTEs) are involved in grains related RD&E in the PISC agencies and universities; and a very approximate estimate for the total grains RD&E effort, including private participation of approximately 300, is 2,000 FTEs;
- the two principal classifications are scientist (52%) and technician (34%), other (13%) includes administrative and support staff;
- the balance in personnel between regions is approximately 24% north (334), 47% south (660), and 29% west (392);

- about 25% of national capability (350 FTE) is dedicated to pre-breeding and breeding programs, another 195 FTE are classified as 'molecular biology', 113 as 'cereal chemistry/NIR testing' and 32 as biometrics/bioinformatics. If the assumption is made that the majority of these people also contribute to breeding/pre-breeding, then variety development accounts for close to 50% of the total national RD&E effort.
- Plant protection disciplines (pathology, entomology, nematology) account for approximately 130 FTE. However, as discussed in Appendix 3, these disciplines are at risk of rapid attrition in numbers as experienced personnel retire and are not replaced;
- Farming systems areas including agronomy, modelling, weed management, soil science, nutrition, climate science, engineering, irrigation and precision agriculture account for approximately 340 FTE or 25% of national capability. Many of these disciplines are also under threat as long-serving scientists and technical support staff retire;
- Extension and capability building accounts for only 6% (76 FTE) of national RD&E capability, and other key areas such as agricultural economics, end product quality, grain storage and biometrics/bioinfomatics are at critically low levels.

3.1.1 FUTURE INDUSTRY NEEDS, TECHNOLOGY TRENDS AND CHALLENGES FOR PUBLIC AND PRIVATE RD&E PROVIDERS

A separate analysis of the RD&E human resource supporting the grains industry is provided in Appendix 3. In the appendix, the current human resource status, trends and future industry need is analysed for key discipline areas.

Table 4. National Grains RD&E Expertise/Discipline Capability (2007/08) (Numbers include professional technical and administrative staff)							
Key Area of Expertise	TOTAL	North		South		West	
		Prof	Technical	Prof	Technical	Prof	Technical
Administration	36.9	11.6	-	13.2	-	12.1	-
Plant breeding	242.0	33.8	43.6	24.2	63.8	30.4	46.2
Plant genetics	111.3	10.1	6.0	55.9	36.1	3.2	-
Molecular biology	194.6	16.4	5.5	79.8	54.5	28.5	9.9
Bioinformatics / biometrics	31.7	18.4	1.0	3.0	2.0	5.5	1.8
Cereal/Grain Chemistry, NIR testing,	112.7	5.0	14.0	23.7	40.5	14.9	14.6
Plant physiology	49.5	8.6	10.0	6.0	12.0	10.9	2.0
Plant pathology (fungal, viral)	99.2	10.7	11.0	30.8	19.5	16.6	10.6
Plant nematology	9.5	3.0	2.0	1.2	1.0	0.9	1.4
Entomology	25.7	7.0	5.0	4.0	2.7	3.0	4.0
Grain storage	22.5	7.0	4.0	2.6	6.6	0.3	2.0

Table 4. National Grains RD&E Expertise/Discipline Capability (2007/08) (Numbers include professional technical and administrative staff)							
Key Area of Expertise	TOTAL	North		South		West	
		Prof	Technical	Prof	Technical	Prof	Technical
Weed management / science	36.9	5.0	5.5	6.2	0.5	13.3	6.4
Agronomy	183.5	14.0	18.8	29.3	38.0	29.1	54.3
Ag systems development and integration	19.7	6.1	2.4	4.8	1.3	4.1	1.0
Ag engineering, incl. irrigation	12.9	7.6	0.5	2.8	-	2.0	-
Precision Ag technologies	9.4	3.0	-	4.8	-	1.6	-
Modelling / Decision support	28.2	11.3	5.0	0.9	2.2	7.5	1.3
Soil science (chemistry, physics, biology, fertility)	46.0	4.7	1.0	19.6	9.5 (8.3)	16.1	4.6
Crop nutrition	15.7	1.8	0.0	7.3	2.6 (2.0)	4.9	1.7
Climate science, variability	10.5	0.3	-	0.7	0.5	7.5	1.5
Extension / capability building	75.7	14.8	-	53.1	-	7.8	-
Agricultural Economics	15.3	2.5	-	4.6	-	8.2	-
TOTAL	1385.4	198.7	135.3	378.5	281.2	228.4	163.3
REGIONAL TOTAL			334.0		659.7		391.7

4 ALIGNING INDUSTRY AND GOVERNMENT RD&E PRIORITIES

Setting priorities in a national context is an imperative for the National Grains RD&E Strategy if it is to be effective. The modest size of the Australian grains RD&E budget in the global context dictates that investment decisions must be strategic to achieve best impact on industry innovation.

Given the multi-level governance framework and the diversity of the grains industry, it is inevitable that there have been competing priorities around RD&E. Nevertheless, there is consistency among higher level industry-wide objectives, priorities and strategies that provides an over-arching national framework which can be augmented by more detailed regional and commodity based plans.

4.1 NATIONAL RESEARCH PRIORITIES (AUSTRALIAN GOVERNMENT)

National research priorities (Australia's National Research Priorities, DIISR, 2010) relevant to the agricultural sector are:

- An environmentally sustainable Australia;
- Promoting and maintaining good health;
- Frontier technologies for building and transforming Australian industries; and
- Safeguarding Australia.

The Australian Government has established a set of Rural Research and Development Priorities to guide its new and ongoing R&D investment to support the primary production sector, and to ensure R&D objectives of the Australian Government are met. The priorities were reviewed in 2007 in order to refresh the national understanding of current critical R&D investment needs and to better target agricultural, fisheries, forestry and food industry R&D efforts.

The new Rural R&D Priorities were developed in consultation with state and territory governments, industry, research funders and providers, with the shared approach to priority setting among the players helping to focus R&D efforts on issues of major importance. These Priorities complement the National Research Priorities listed earlier.

The Australian Government's Rural R&D priorities (May 2007) define the Government's objectives for its investment in rural R&D, of which the grains industry is a significant part. These priorities are:

Productivity and Adding Value

Improve the productivity and profitability of existing industries and support the development of viable new industries.

Supply Chain and Markets

Better understand and respond to domestic and international market and consumer requirements and improve the flow of such information through the whole supply chain, including to consumers.

Natural Resource Management

Support effective management of Australia's natural resources to ensure primary industries are both economically and environmentally sustainable.

Climate Variability and Climate Change

Build resilience to climate variability and adapt to and mitigate the effects of climate change.

Biosecurity

Protect Australia's community, primary industries and environment from biosecurity threats.

Supporting the Rural Research and Development Priorities

Improve the skills to undertake research and apply its findings [and] promote the development of new and existing technologies.

4.2 STATE AGENCY GRAINS SECTOR PRIORITIES

State governments describe their primary industries objectives in terms of driving state economic and regional development objectives and in protecting the natural resource base. The States maintain a very diverse RD&E capability that underpins these priorities. The States remain the largest investors in primary industries RD&E in Australia. Whilst varying slightly in emphasis, State government priorities for the grains sector include:

- Providing RD&E capabilities, infrastructure and programs to address regional needs and opportunities, complementing and partnering national programs;
- Improving the long term productivity and net value of the agriculture and food sectors in a variable climate;
- Diversifying and growing markets and improving market access for agricultural products;
- Enhancing natural resource management policy to maintain productive capacity of the natural resource base;
- Developing technologies that enable better productivity from the natural resource base while protecting that base to enable long term sustainable use;
- Ensuring effective biosecurity measures to minimise risks to productivity and market access;
- Assisting regional and rural communities and industries to respond, adapt and capture opportunities in response to future climate change scenarios;
- Building the capability of the industry sector to adapt and grow and increase jobs and investment in regional areas.

Detailed investment plans aligned to these priorities are developed through consultation with relevant state based industry stakeholders and are regularly reviewed and updated.

4.3 CSIRO GRAINS SECTOR PRIORITIES

Over the past decade CSIRO has drawn increasing strength and greater focus in its R&D through its National Research Flagship program to better respond to Australia's most significant challenges and opportunities. The Flagships comprise large scale multi-discipline research groups that seek to apply world-class research in partnership with the private and public sectors, both in Australia and internationally. In relation to the grains industry there are three particularly relevant Flagships:

- '**Food Futures'** is researching ways to develop novel high value grains to provide substantial health benefits to consumers;
- '**Sustainable Agriculture'** has an emphasis on increasing total factor productivity growth whilst reducing the sector's carbon footprint;
- '**Climate Adaptation'** looks to provide new management techniques to enable agricultural industries to minimise risks and capitalise on opportunities resulting from climate change.

In addition, CSIRO makes a considerable investment in cereal germplasm enhancement, pre-breeding and breeding through a major portfolio of work under the direction of the Division of Plant Industry.

CSIRO has a robust process to review and prioritise investments in research—the Science Investment Process—which allocates specific levels of investment to research themes. In the CSIRO agribusiness portfolio there has been a redirection of investment away from near-market and incremental research to issues affecting the longer term competitiveness of the agriculture and food sectors.

4.4 UNIVERSITIES

Universities have two priorities – the provision of education and training and the conduct of high quality research. In the context of the grains industry, university priorities lie in the provision of education and training in agriculture and related disciplines, and as significant suppliers of research, as well as some D&E services to rural industries. The science excellence profiles of universities drive their research directions. In recent years they have received higher levels of GRDC funding and have been developing stronger partnerships with state agricultural agencies in grains R&D.

The Australian Council of Deans of Agriculture represents twelve universities that offer a degree course in agriculture or related agriculture areas. It was formed in 2007 in response to declining enrolments in agriculture and aims to collaborate to turn this situation around to support the future needs of industry. The Council provides a new opportunity for the grains industry and PISC agencies to engage collectively with these universities in national research priority and capability building strategies.

4.5 GRDC

GRDC, since its establishment under the PIERD Act 1989, has coordinated a national strategy and allocated funds via a series of Five Year Strategic R&D Plans. The most recent plan *"Prosperity through Innovation 2007-12"* sets out a series of high-level strategies with the core objective of supporting the competitive position of Australian grain growers in global grain markets through enhanced profitability and sustainability.

It supports this objective through four strategies;

- Coordinate a national Grains RD&E agenda and portfolio;
- Deliver against Australian Government priorities;
- Grow and leverage the total investment in grains RD&E;
- Ensure that all RD&E is market driven and that the outputs deliver products and services that improve the productivity, profitability and sustainability of the Australian grains industry.

GRDC develops investment plans based on broad consultation with its stakeholders – growers, research partners and the Australian Government.

In addition, GRDC in consultation with its partners, develops specific plans to respond and address specific issues such as the development of an Environmental Plan for the Australian grains industry.

4.6 GRAINS INDUSTRY PRIORITIES

4.6.1 GROWER PRIORITIES

Australian grain growers' R&D priorities are regularly reviewed through industry-wide consultations with regional research advisory committees, grower groups, grower representative organisations and individual grain growers. The most recent high level priorities identified by GCA are:

- **Environmental**

  - responses to climate change
  - improving water use efficiency
  - sustainability and resource management
  - soil health and biology
- **Farm management**
  - integrated farming practices and technologies
  - integrated management of weeds, diseases and pests
  - herbicide resistance management
- **Variety development**
  - biotechnology for improving genetic gain
  - superior new varieties
- **New and innovative product development**
- **Capability building**
  - improving skills training and education in agriculture
  - farm business management.

4.6.2 POST-FARM-GATE PRIORITIES

R&D priorities for the grains industry's post-farm-gate value chains are determined through the activities of a number of industry-wide organisations and industry groups. Current issues identified by stakeholders include wheat classification for export grade, grain receival standards, post-AWB access to international market signals (notably informing breeding targets) and phyto-sanitary standards (particularly relating to grain storage pests).

Currently there are a number of post-farm gate investments including GoGrains which promotes the nutritional value of grains in the diet, and stored grain protection involving GRDC, CBH, Viterra and GrainCorp. These investments involve both industry and GRDC funding and are based more on individual issues than on a broad overall post-farm-gate RD&E strategic plan. The Grain Foods CRC, BRI and the recently opened Centre for Grain Food Innovation in Perth (a joint venture between CSIRO, Curtin University of Technology and DAFWA) also have investments in this area.

A key issue identified in developing this Strategy has been a lack of structure and clear analysis of the RD&E needs of the post-farm-gate value chain of the grains industry. This area would benefit from:

- much greater consideration and involvement of the marketing and processing industry in prioritisation and co-funding of RD&E
- greater clarity and understanding by the private sector of the role and capability of government agencies in relation to marketing and trade issues.

4.7 PRIORITIES – OVERVIEW

The following boxes summarise priority actions under four pillars of RD&E activity consistent with the objectives and priorities of government and industry. Specific RD&E priority issues are covered in more detail in the proposed R&D responsibility matrix in Table 5.

BETTER VARIETIES - TO LIFT PRODUCTIVITY & PRODUCT VALUE	
Desired Outcome:	Growers and industry have ongoing access to improved genetics and varieties with better in-paddock performance and grain qualities that enhance competitiveness in global markets
Priority Action Areas:	• build and sustain breeding and pre-breeding programs with capability to respond to evolving grower and market needs • develop international and public-private partnerships to expand access to global gene banks, genomic platforms and transformation technologies • focus gene discovery and germplasm enhancement on key traits • facilitate independent and effective variety evaluation and faster adoption of superior varieties • facilitate a whole of breeding chain approach to variety development and commercialisation

IMPROVED PRACTICES – TO ENHANCE PRODUCTIVITY & SUSTAINABILITY	
Desired Outcome:	Improved on-farm practices that increase productivity and profitability whilst maintaining or improving the natural resource base and product integrity
Priority Action Areas:	• identify and facilitate adoption of technology (sourced nationally and internationally) and inputs relevant to Australian grain growers • optimise agronomic systems for each of the major agro-ecological zones • develop tools to improve seasonal decision-making and to enable industry to adapt to an increasingly variable climate • Risk management • promote practices and systems that reduce the environmental footprint including off-site impacts of grain growing • undertake targeted extension through appropriate delivery channels • demonstrate industry environmental credentials to promote a respected and sustainable grains industry

SUPPLY CHAIN INNOVATION AND MARKET COMPETITIVENESS

Desired Outcome: Advance industry knowledge throughout the supply chain to improve the competitiveness and profitability of the whole sector

Priority Action Areas:

- capture and assess market intelligence which can be used to promote the utility and attributes of Australian grain in key export markets
- understand processing requirements in terms of grain characteristics
- support the ongoing development of better storage, transport, quality assurance and identity preservation processes
- support grain variety classification and grading requirements to meet market requirements
- facilitate pre-competitive information flows to assist all participants throughout the value chain to improve their risk assessment and decision-making
- develop and support information systems to allow validation of pest and disease status for market access purposes
- support disease surveillance measures, the development of diagnostic tools and disease management protocols for priority biosecurity threats to the grains industry

BUILDING FARM BUSINESS & INDUSTRY CAPABILITY

Desired Outcome: Accelerate adoption of new technologies and practice change across all segments of the grains industry to increase farm business and sector viability

Priority Action Areas:

- strengthen capability to communicate accurate and consistent information between the public and private sector across the grains industry
- enhance delivery through appropriate and effective partnerships
- coordinate a national approach to building and maintaining industry and research capability, including education and training, extension, and technology transfer
- develop a National Five Year RD&E Plan and a forum to annually overview performance, review priorities and gain broad industry, GRDC, government and RD&E partner ownership
- provide environmental leadership through provision of credible and trusted communication

5 STRATEGIC FOCUS FOR GRAINS INDUSTRY RD&E

VISION

A *profitable*, *competitive* and *sustainable* grains industry with spill-over benefits to the broader agricultural sector, the food manufacturing industry and the Australian community.

To achieve the above:

A highly efficient national grains RD&E sector which fosters world-class innovation, industry-focused development, and influential extension.

CORE OUTCOME

Grains industry Total Factor Productivity growth of greater than 2.5% per annum (within a decade) whilst sustaining the resource base and improving market position.

STRATEGIES

1. **Build on existing national collaboration by developing improved processes for:**
   - **identifying and prioritising issues for RD&E investment**
   - **ensuring effective stakeholder engagement (growers, industry and RD&E partners)**
   - **agreeing common definitions and common impact evaluation assessments**
   - **reducing transactional costs in managing RD&E.**
2. **Devise more effective relationship models for engagement between public and private sector investment in RD&E to foster:**
   - **investment by multinational bioscience companies in strategic research in Australia;**
   - **the efficient delivery of extension through arrangements with consultants, agribusiness, and farming systems and grower groups;**
   - **value-adding opportunities for domestic and export grains.**
3. **Implement agency roles within PIMC's 'Major - Support - Link' national RD&E framework to develop:**
   - **national research programs to create critical mass to address a national priority and to deliver national and regional outcomes;**
   - **national centres of research capability to maintain critical infrastructure and critical science disciplines; and to establish links to access international research outputs;**
   - **regional networks of applied RD&E which support farming systems and improved practices, and adoption of national research outcomes.**
4. **Develop a national capability building plan to secure the intellectual and human capital and physical resources required to underpin future RD&E and industry innovation.**
5. **Develop a mechanism for regular review and alignment of government and industry objectives and agreement on priorities and resource allocation under the National Grains RD&E Strategy.**

5.1 BUILDING ON EXISTING NATIONAL COLLABORATION

A high level of national coordination already exists in the grains industry. Agencies are also realigning their RD&E capability to prepare for the future in ways that are compatible with the Major-Support-Link framework (discussed later) through formation of partnerships and the clustering of related activities. Examples are:

- The AgriBio centre based at Bundoora formed by joined investment of the Victorian Government, through DPIV, and LaTrobe University. AgriBio will accommodate up to 400 staff , undertaking research in plant and animal genomics, plant pathology and physiology, animal health and agricultural sustainability;
- State Agricultural Biotechnology Centre, Murdoch University. Includes DAFWA, UMU, plus start-up biotechnology companies Saturn Biotech (diagnostics) and NemGenix.
- Grains Innovation Park, Horsham, Victoria, combining the expertise of 100 agricultural scientists from DPIV, UM, and from 14 private businesses (including four plant breeding companies) to provide applied RD&E regionally, including delivery of strategic research developed by AgriBio;
- the E. H. Graham Centre formed in 2005 by I&I NSW and CSU at Wagga to fill a gap in applied regional RD&E. The Centre combines the expertise of over 100 agricultural scientists, applied scientists, biometricians, post-doctoral researchers, undergraduate and post-graduate students;
- the I A Watson Centre, Narrabri, which brings together the University of Sydney, the Wheat Research Foundation, major wheat breeding companies and a range of other universities, focused on providing strategic-basic research for the northern region;
- the Plant Biosciences Cluster under the SA government's 'Constellation SA' initiative incorporating UA, SARDI, CSIRO Plant Industry, Flinders University, UniSA, SA Museum and the SA Department of Environment and Heritage, focussed on the Waite Campus of UA;
- the Australian Plant Phenomics Facility (APPF), being established in Canberra and Adelaide by partners UA, CSIRO, ANU, the SA and ACT governments and ACPFG; and
- the Centre for Grain Food Innovation at Curtin University of Technology recently formed by DAFWA, CSIRO and CUT.

New partnerships under active development are:

- Agri-Science Queensland's (a business group of DEEDI) discussions with industry regarding establishing a centre for applied grains RD&E on the Darling Downs, and its planned strengthened research presence in collaboration with UQ through joint investment in the Queensland Alliance for Agriculture and Food Innovation (QAAFI);
- a collaborative public-private partnership being developed between I&I NSW, Sunrice, RIRDC and the Ricegrower's Association of Australia; and
- the pledging of Western Australian government support to build a new Australian Export Grain Innovation Centre on the Murdoch University campus in Western Australia.

Areas for improvement include:

- improved identification and prioritisation of issues to be addressed by RD&E investment;
- effective stakeholder (growers, industry, RD&E partners and Australian government) engagement and ownership;

- adoption of common definitions of RD&E and agreed impact evaluation assessment processes;
- improved transactional cost efficiency including harmonised research and IP management principles;
- improved assessments of the benefits to industry, community and environment from grains R&D.
- development of truly National Centres with national governance arrangements and increased transparency and active management of the research portfolio.

5.2 MORE EFFECTIVE RELATIONSHIP MODELS FOR ENGAGEMENT BETWEEN PUBLIC AND PRIVATE SECTOR INVESTMENT IN GRAINS RD&E

5.2.1 PLANT IMPROVEMENT RESEARCH

In Australia, grains R&D is currently dominated by public sector investment (86% public, 14% private). This is not the case internationally. In the United States where grains-related R&D is increasingly through the large, multi-national bioscience companies, 53% of investment in agricultural R&D is private and 47% public.

In both the United States and Canada, where the presence of international bioscience companies is increasingly dominating the breeding of the major GM crops such as corn and soybean, publicly funded R&D is moving towards the basic end of the research spectrum where the private sector is less likely to invest. The diagram below provides an example related to variety improvement under the current North American model.

Basic Research →	Pre-competitive Research →	Commercialisation (D&E)
Public sector	Public-Private partnerships	Private sector
e.g. genome sequencing	*e.g. gene mining & discovery*	*e.g. GM varieties and seed*

A similar situation is starting to evolve in Australia, particularly for wheat and canola where molecular breeding techniques are of increasing significance (and, in the case of canola, includes the use of proprietary GM traits).

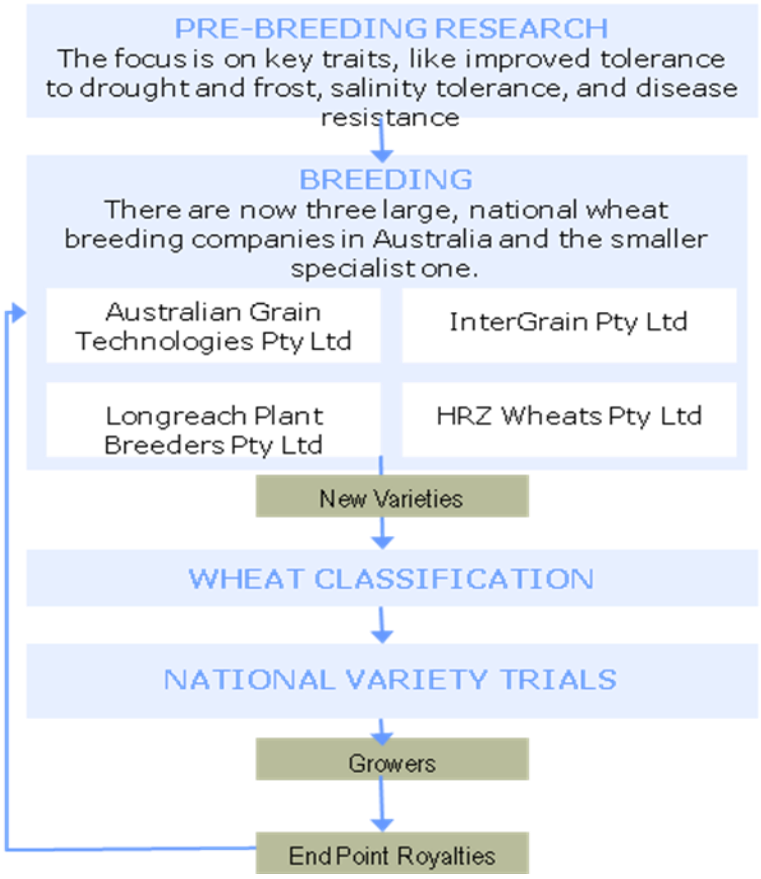
Wheat breeding has evolved rapidly over the last decade from exclusively state-based breeding programs owned by state agencies, to the present dynamic private sector model with four competing breeding companies (two with significant international company shareholders)[7]. The relationships among pre-breeding, breeding, and post-breeding activities in wheat are illustrated in Figure 6.

As in North America, public investment is increasingly orientated toward pre-competitive pre-breeding, and to logistic investments in evaluation and classification that deliver broad industry benefit. Barley breeding is on the cusp of commercial viability and it is likely that it will operate on a fully commercial basis within five years.

Breeding in crops with smaller production such as pulses, oats and triticale, has been less attractive to private investors and is still predominantly undertaken through public sector programs. However, given that grains biotechnology will continue to be dominated by the international private sector players, Australian breeding entities and pre-breeding research in all crops will need mechanisms to effectively interface with them.

[7] It is understood that DOW Agrosciences is considering forming an Australian wheat breeding company

Figure 6. Wheat breeding in Australia 2010



The issues for breeding and pre-breeding R&D include:

- partnering with multi-national companies to integrate their advance breeding technologies including GM traits into Australian genetic backgrounds, evaluate the performance of these traits and manage their introduction in the Australian grains industry and our target markets;
- deciding which technologies and traits Australia should focus on:
  a) developing in Australia
  b) adapting from elsewhere;
- effective commercialisation of technology invented in Australia, both in Australia and internationally;
- consideration and development of structures to facilitate commercial implementation of innovative biotechnology, particularly GM traits, which will require public/private partnerships, implicitly on a national or international scale;
- commercial and legal skills to support Australian researchers entering into complex commercial agreements;
- equitable access by private and public breeding programs to public sector pre-breeding outputs;

- appropriate governance and management structures for the major "R" entities to:
  a) minimise overlap and duplication
  b) ensure appropriate responses to agreed national and regional priorities.

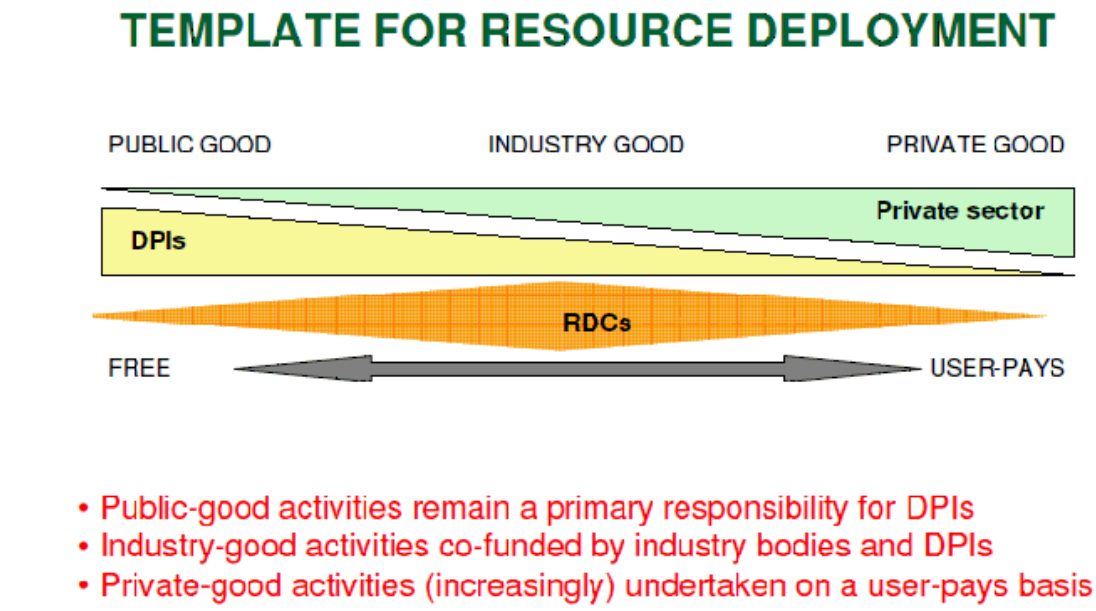
For winter cereals, the existing winter cereals pre-breeders alliance could fulfil this function.
For farming systems and practices the issues include:

- ensuring efficient delivery and appropriate branding of the contribution of public sector investors in R&D through increasingly private sector channels;
- defining the basic research questions in agronomy and farming systems that should be underpinned in the national context;
- developing effective delivery channels to provide research information to public and private D&E providers.

5.2.1.1 Guidelines for Investment in Plant Breeding and Related Research

In the context of the changing commercial environment for investment in plant breeding, some guidelines are proposed to guide future investment of public monies in plant breeding and pre-breeding. The principles will need to be considered against the situations of different crops and pasture species, taking into account the stage of industry development. The guidelines are intended to provide a framework for further industry and private sector involvement in breeding and related activities; and the underlying principles are illustrated in Figure 7.

Figure 7. Principles for resource deployment



Guidelines for future investment include:

- Testing for commercial viability
- public funding for RD&E is increasingly based on 'market failure' principles that generate 'public goods' or 'spill-over' benefits;
- market failure in plant breeding generally exists in the 'pre-breeding' phases of technology discovery and germplasm development;
- industry and private investment is more appropriate for cultivar development and commercialisation;
- new technologies and enhanced germplasm produced with public funds should be made available for breeding and research purposes on a non-exclusive basis;
- 'near market germplasm' (potential cultivars) developed from public funding can be commercialised through exclusive licenses following an open expression of interest and equitable selection process;
- agencies which negotiate fee for service with private industry which result in private good outcomes should charge a price that reflects the full cost of delivery. This could include special traits where closed loop arrangements are desirable or outcomes are constrained by contractual agreements;
- the conservation of national germplasm collections is a public good and should be maintained in accordance with international treaties on the safe exchange of germplasm.

These principles are consistent with the guidance provided to researchers, prebreeding and breeding entities associated with the Australian Winter Cereal Pre-Breeding Alliance.

5.2.2 INTERFACING TO THE NEW EXTENSION PARADIGM

Arguably the greatest change in the grains RD&E landscape has occurred in the extension sector. Historically RD&E was conducted and delivered via a linear hierarchy of public sector scientist-district agronomist-extension officer-grower. This has now changed into a complex matrix, still involving public sector entities, but increasingly also a mixture of private sector relationships through grower groups, consultants and agribusiness. This is illustrated in Figure 8. Of particular significance is the role of grower groups and farming systems groups that now occupy an important niche in the pathway from basic research to adoption of new practices. Their numbers have continued to increase as state governments have moved away from traditional extension models.

Although grower groups differ widely in their size and structure, they share several important characteristics - strong and committed ownership from their grower members and local businesses, and proficiency at identifying local issues constraining farm businesses (and ranking those issues in priority order). The groups are also adept at capturing local agricultural community interest, and for this reason are excellent vehicles for enhancing the adoption of new practices. Many are now incorporated bodies which have boards of directors and business plans, employ staff and undertake contracts for extension delivery and provision of new outcomes from applied research.

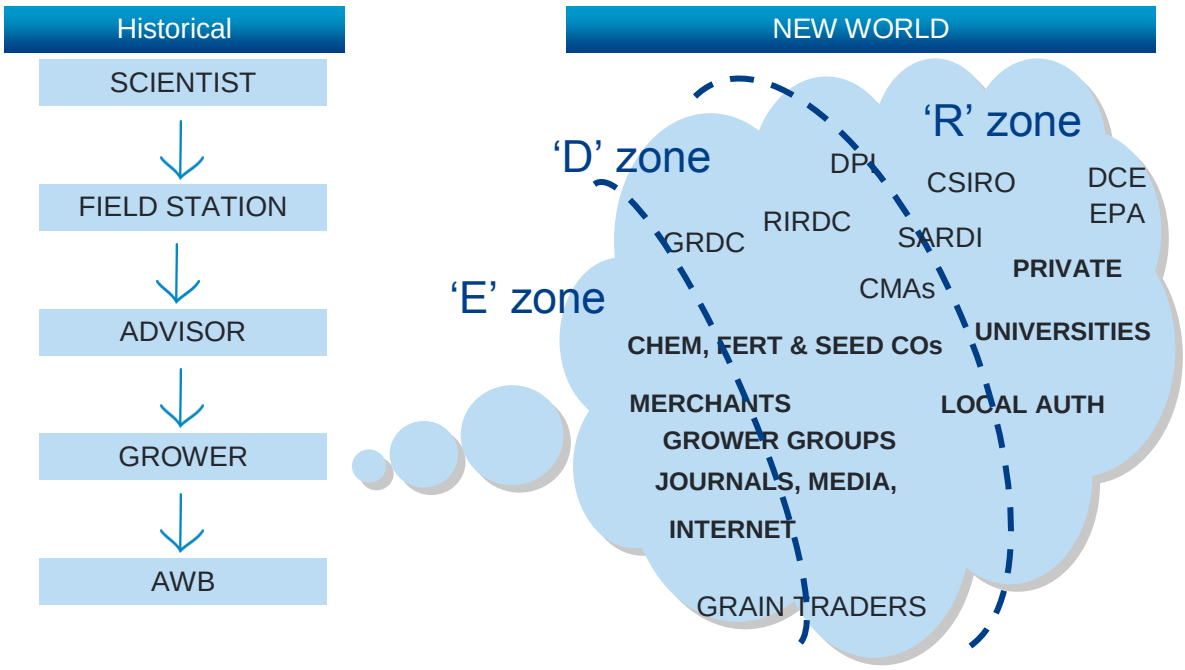
Larger grower groups increasingly undertake applied research and demonstration activities to fulfil their desire to speed the rate of adoption of new technologies under local conditions and demonstrate the results within their areas of influence.

The recognised needs include:

- Improved business models for better coordination and delivery of farming system practices D&E through farming system groups and consultants;
- ready access by agribusiness and consultants to the outputs of R&D to deliver these to growers in a way that results in the high uptake of profitable practice changes;
- more targeted packaging and delivery of the outputs of R&D in a way that maximises the opportunity for profitable adoption by different grower segments e.g. by farm size, age and location;
- enhancing the skills of farming system groups in conducting D&E and monitoring their effectiveness;
- collaborating with and leveraging off NRM and biosecurity investments and resources with public-good extension;
- establishing the ongoing viability of some grower groups, including identifying opportunities for consolidation and reducing their dependence on external funding.

Figure 8. The changing world of grains RD&E*

(Used with permission: Prof. P Phillips, UWA, 2009)



5.2.2.1 Guidelines for Investment in Extension

Given the changes in the extension sector already referred to, there has been increasing scrutiny (both public and private) on how funding is deployed across delivery organisations. Greater transparency and justification in the approach is needed and to address this in a formal sense, some guiding principles are proposed for investment of public monies in extension:

- extension is recognised as the process whereby our primary industries access, adopt and adapt new ideas, science, and technologies to boost their productivity, sustainability and competitiveness;

- extension is a non-linear process and involves a complex set of relationships and information flows provided by public, private and community organisations;
- there is no single extension model that fits all industry sectors, all growers and all situations, so extension must be tailored to meet the needs of the target audience. This will often mean using a variety of methods, multiple delivery channels, and various co-investment arrangements. For the grains industry, all sectors should explore the extension methodology that best suits the immediate and long term needs of program areas, and develop appropriate partnership or collaborative arrangements to achieve this;
- public funding will mainly focus on public benefit, with industry funding supporting industry-wide benefits;
- agencies should foster the progressive development of a user-pays culture for private-good activities, and user co-contribution for industry-good activities;
- coordinated delivery will focus on developing partnerships within and between delivery sector**s** (private, public, not-for-profit) to deliver extension services;
- all agencies will endeavour to foster the capability of their staff and/or other service providers as a whole.

5.3 DEVELOPING AND IMPLEMENTING A NATIONAL RD&E FRAMEWORK FOR THE GRAINS INDUSTRY

Central to the PIMC National Primary Industries RD&E Framework is the consolidation and better targeting of the nation's RD&E resources. This imperative forms the core of this Strategy and seeks to develop a more effectively managed collaborative national approach to grains industry RD&E using the Major-Support-Link Framework.

To provide a base for developing the Strategy, the PISC agencies considered their future roles in the light of the PISC Major-Support-Link framework. Agencies nominated their future 'Major' interests and indicated where they planned a 'Support' or 'Link' role (Table 5).

Given its importance, the proposed grains industry Framework for delivery of RD&E is addressed in detail in Sections 6 and 7 of this Strategy.

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Genetic resource			
Grains	DPIV, I&I NSW	DEEDI (tropical), DAFWA (lupins), UWA (barley)	
Pastures (Pasture genetic resources is a joint responsibility with the ruminant livestock industries including MLA, DA and AWI)	SARDI (*Medicago*)	DAFWA (*Trifolium*), DEEDI (tropical)	
Wheat genetic improvement			
Abiotic stress (Yield, drought, nutrient use efficiency, heat stress, frost, salinity/sodicity/boron-soil constraints)	ACPFG, UA, CSIRO, DPIV (Horsham & AgriBio)	I&I NSW, SARDI, DAFWA, UMU, DEEDI/QAAFI, CSU, UWA	
Biotic stress (rusts) (leaf, stem, and stripe rust)	US, UA (cytogenetics), DPIV, CSIRO	I&I NSW (stripe), DAFWA, DEEDI, UWA	SARDI
Biotic stress (other than rusts) (e.g. root and crown rots, yellow spot, septoria blotches, powdery mildew, viruses, nematodes)	UA, CSIRO, SARDI, DAFWA, UMU, DPIV (AgriBio & Horsham), DEEDI/QAAFI, ACNFP, I&I NSW (STB)	I&I NSW, UWA	
Durum improvement	I&I NSW, UA	DEEDI	DAFWA
Quality (classification, product functionality, grain defects, market development and support)	CSIRO, DAFWA, UMU, UA, BRI, QAAFI, I&I NSW (Durum)	I&I NSW, DEEDI, CGFI UA (Durum),	DPIV

[1]Major: Take a lead role by providing significant R&D effort through maintenance of capability and leadership to deliver national R&D outcomes;

[2]Support: Contribute R&D in partnership but major effort will fall within another state or agency;

[3]Link: Undertake little or no R&D, but access information and resources from other states or agencies (E only).

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Barley genetic improvement			
Abiotic stress (Yield, drought, frost, nutrient use efficiency, heat stress, soil acidity, salinity/sodicity/boron-soil)	UA/ACPFG, CSIRO, DAFWA, UMU	I&I NSW, SARDI, DEEDI, UWA	DPIV
Biotic stress (Rusts)	US	SARDI, DAFWA, DEEDI, I&I NSW, UWA	UA, DPIV
Biotic stress (other than rusts) (e.g. root rots, scald, powdery mildew, net blotches, viruses, nematodes)	SARDI, UA, DAFWA, UMU, ACNFP, DEEDI	I&I NSW (scald), UWA	DPIV
Quality (Malting quality, feed, new quality attributes and product functionality, market development etc)	UA, DAFWA	DEEDI/QAAFI, TIAR	I&I NSW, DPIV, SARDI
Coarse grains – genetic improvement			
Oats	SARDI	DAFWA, DEEDI (forage)	DEEDI (grain/hay), I&I NSW, DPIV
Triticale	US, AGT		DAFWA, DEEDI

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Winter pulse genetic improvement			
Lupin breeding	DAFWA	I&I NSW, SARDI	DPIV, DEEDI
Chickpea breeding	I&I NSW, DPIV (kabuli)	UWA/COGGO, DAFWA, DEEDI, SARDI	
Field pea breeding	DPIV	I&I NSW, SARDI, DAFWA	DEEDI
Lentil breeding	DPIV	I&I NSW, SARDI	DEEDI, DAFWA
Faba bean breeding	UA	I&I NSW, DPIV, SARDI,	DEEDI, DAFWA
Vetch breeding	SARDI	I&I NSW, DPIV	DEEDI, DAFWA
Pre-breeding and germplasm	SARDI, UWA, UA, DPIV	I&I NSW, CSIRO, DAFWA, UWA	DEEDI
Molecular and biotechnologies	DPIV, UWA	DAFWA, CSIRO, UWA	DEEDI
Oilseed genetic improvement			
Canola	DPIV, I&I NSW, UWA/CBWA	SARDI, CSU	DEEDI, DAFWA, CSIRO
Mustard	DPIV, I&I NSW	SARDI, UWA/CBWA	DEEDI, DAFWA
Summer crop genetic improvement			
Sorghum, maize, soybeans, mungbeans, peanuts, sunflower	DEEDI/QAAFI	I&I NSW, CSIRO, UQ	DPIV, SARDI, DAFWA
Rice	I&I NSW	CSU, US, SCU	DEEDI, DAFWA

•

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Crop protection			
Weed management weed ecology herbicides & crop tolerance herbicide resistance cultural control & IWM	UWA, UA, DAFWA, I&I NSW, CSU, DEEDI/QAAFI	CSIRO, SARDI, UM	
Disease management pathogen diagnostics etiology & epidemiology fungicide deployment cultural control, resistance & IDM	I&I NSW, CSU, DPIV, SARDI, DAFWA, DEEDI/QAAFI	CSIRO, UM, UWA, ACNFP, US	
Pest management invertebrate ecology & incidence insecticide deployment population thresholds & IPM	I&I NSW, SARDI DEEDI	CSIRO, UM, UQ, UA, UNE, UWA, DAFWA	

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Agronomy			
Varietal and paddock management packages & decision support	I&I NSW, SARDI, DEEDI/QAAFI	DAFWA, DPIV	
Water use efficiency	CSIRO, SARDI	DEEDI, I&I NSW, DPIV, DAFWA, UA, CSU, TIAR, UWA	
Tillage & seeding systems	UniSA	DAFWA, SARDI	DEEDI
Precision agriculture	US, UNSW, UNE, CSIRO	SARDI, I&I NSW, DAFWA, CUT, DEEDI	
Irrigation	CSIRO, DEEDI, I&I NSW (Rice based systems)	I&INSW, CSU, UQ, USQ	DAFWA
Farming systems			
Rotations, break crops, pastures & livestock integration	DAFWA, DPIV, I&I NSW, CSU, SARDI, UA, DEEDI/QAAFI, CSIRO	UWA, UMU, CUT	
Bio-economic modelling – system optimisation	DAFWA, UWA, CSIRO, DEEDI/QAAFI	SARDI, DPIV, I&I NSW	

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Soil science and crop nutrition			
Soil biology, chemical and physical fertility and constraints	SARDI, I&I NSW, CSU, UA, DEEDI/QAAFI, CSIRO, DPIV	DAFWA, UWA, USQ	
Crop nutrition & fertilizer management	DAFWA, UA, DEEDI/QAAFI, CSU	DPIV, UA, UWA, UMU, UNE, UQ, CSIRO, SARDI, I&I NSW	
Nitrogen fixation	UMU, SARDI	CSIRO, DAFWA, DPIV, US, DEEDI	
Climate change			
Greenhouse gas emissions	DPIV, I&I NSW, MU, QUT, CSIRO	DEEDI	DAFWA
Carbon sequestration	CSIRO, I&I NSW	DAFWA, UWA, UNE, SARDI, DPIV, DEEDI, CSU	
Prediction, forecasting	BoM, CSIRO	DEEDI/QAAFI, I&I NSW, DPIV, SARDI, DAFWA, UNE, UWA	
Adaptation	UM, DPIV, DEEDI/QAAFI, SARDI, CSIRO	DAFWA, UNE, I&I NSW, CSU, UWA	

Table 5. Proposed R&D responsibility matrix			
RD&E Priority Area	**Major[1]**	**Support[2]**	**Link[3]**
Farm business productivity			
Productivity drivers, technology adoption, management skills and market intelligence	ABARE, DAFWA, I&I NSW	UWA, CUT, SARDI, DPIV	DEEDI
Post-farm-gate & market competitiveness			
Export market access, support & market intelligence	BRI, DAFWA, DAFF, BBA	DEEDI, DPIV	
Grain quality assurance (storage, hygiene)	DAFWA, UMU, DEEDI	I&I NSW (grain storage)	SARDI
Variety classification	WEA, BRI	DAFWA, I&I NSW	DEEDI
Grain functionality & product development	CGFI, BRI, CSIRO,QAAFI	DAFWA, UA, I&I NSW, CSU, DEEDI	
Consumer education	GoGrains, BRI		DAFWA, DEEDI
Biometry / Bioinformatics			
Experimental design & statistical analysis and data interpretation	DEEDI, I&I NSW	DAFWA	
Molecular bioinformatics, computational techniques and data management and storage	ACPFG, UMU, AgriBio, DEEDI, UQ(QFAB), I&I NSW, CSIRO		DAFWA

5.4 NATIONAL CAPABILITY BUILDING FOR GRAINS INDUSTRY RD&E

5.4.1 HUMAN RESOURCES

A successful National Grains RD&E Strategy will depend on long-term access to a strong and committed scientific workforce. Rapid erosion of the skills base is occurring in many 'traditional' discipline areas such as agronomy, plant pathology (e.g. mycology, nematology and virology) and entomology as the large numbers of agricultural scientists trained and employed by State agencies during the expansion of agriculture in the 1950s and 1960s now retire. Compounding this problem has been the loss of training resources within the universities, also in part due to retirements, but also as the universities redirect teaching and training to meet demand in molecular sciences. The result of these trends is that the grains industry is now supported by a large number of molecular biologists, but a diminishing resource of field-orientated specialists in the core disciplines of pathology, nematology, entomology, plant physiology and crop nutrition required to underpin improved practices and conduct the specialist screening and phenotyping required to capitalise on the molecular genomics "revolution".

In planning to meet future industry needs, it is important to distinguish between disciplines where professional expertise can be drawn from the broader workforce, and more specialised disciplines where the skill sets are to a significant degree specific to the grains industry. Disciplines with broad application of skills beyond the grains sector include modelling, climate science, engineering, molecular biology, economics and extension and marketing. Areas requiring more specialised expertise of most concern include entomology, mycology, virology, nematology, grain chemistry, crop nutrition, weed science, plant breeding and plant pathology.

A further complicating factor is the PISC national RD&E framework concept of delivery of research nationally, development regionally and extension at the local level. Clearly a consolidation of research into a smaller number of nationally-coordinated programs will focus and may reduce the manpower requirement, but D&E delivered regionally and locally will still require relatively large numbers of personnel. Paradoxically the changes in teaching and training are delivering more molecular-trained scientists where there is overlap with the health and biotechnology industries, and fewer people trained in the traditional agricultural disciplines essential at the regional and local levels.

Highly trained molecular scientist will be needed to both link Australian science to international biotechnology and support local biotechnology research and development. Numbers however, are likely to be relatively small. Potentially more difficult will be ensuring the supply of field pathologists, entomologists and agronomists to fill regionally-based positions that have been perceived to carry lesser status and career flexibility. On the positive side, some plant breeders and their specialist support staff are being employed by new private or public-private breeding companies, and field-based agronomists by private agribusiness. In both cases, these scientists have access to benefits and incentives not previously available in the public sector. Nevertheless, the industry may have to look at novel approaches—for example 'fly-in, fly-out'—if it is to meet needs for regional and local expertise in key disciplines in the future.

5.4.2 PLANNING FUTURE RD&E SKILLS AND CAPABILITY

Predicting future skills needs in a sector with rapidly changing technology is difficult but essential. Table 6 defines at a broad level the future need for discipline expertise in grains RD&E. More detailed comment and analysis is provided in Appendix 3.

Table 6. Future Grains Industry Skills Needs	
Plant breeding/quantitative genetics	High priority, critical core discipline. Small numbers (breeders), but high levels of expertise and experience required to meet private and public sector demand. PhD level training opportunities critical.
Molecular sciences	Core discipline supporting breeding, diagnostics and biosecurity. Current and future need is likely to be met by recruiting from the broad generic training base in molecular sciences already available.
Crop protection (plant pathology, entomology, mycology, nematology, virology, bacteriology, weed science)	High priority, critical disciplines to support breeding, agronomy and biosecurity. Critical shortages looming, increasingly difficult to source expertise. Will transition to greater private delivery of services, but will need training to be maintained and enhanced. Significant additional on-the-job training at a laboratory (typically State government) is a continuing need.
Grain chemistry	Core discipline supporting breeding and product development. Critical shortages looming, increasingly difficult to source expertise, only small numbers required, but with high levels of expertise and experience.
Agronomy, agricultural systems	High priority, critical field-based disciplines. Increasingly difficult to source expertise, significant shortage looming, relatively large numbers required.
Agricultural economics	Important analytical discipline to support prioritisation of RD&E and farm management decision-making. Need likely to be met through generic training resources in economics, but difficult to recruit to the agricultural sector.
Extension	In transition to private sector provision as audience and role changes. PISC agencies will need to include specialists with capability to convert outputs of R&D to a form suitable for the expanded range of delivery channels.

5.5 ALIGNING PRIORITIES AND GAINING INDUSTRY CONSENSUS

Currently grains industry leadership is fragmented. The GRDC has had a *de facto* leadership role in relation to RD&E, but there is a need for the whole supply/value chain, from input suppliers to growers to marketers and end users, to assume greater responsibility for input into the planning and priority setting for RD&E conducted on their behalf through GRDC, the PISC agencies, the universities and other delivery agencies. An immediate goal is to develop a National Five-Year RD&E Plan for the grains industry, and to create collaborative processes to annually overview performance, review priorities and gain broad industry, GRDC and government ownership of the RD&E agenda for the industry. A National Grains Five-Year RD&E Plan would focus on the industry priorities in relation to RD&E (Section 4.7), and complement this Strategy which focuses on the efficient delivery of RD&E to support the grains industry.

6 CHANGE PLAN – A NATIONAL FRAMEWORK FOR DELIVERING GRAINS RD&E

6.1 BACKGROUND

PISC agencies and other organisations provide an enormous range of RD&E expertise to the grains industry across the nation, but this is in the form of multiple bases of expertise arising from the traditional geographically delimited mandates of the State agencies and the independent decision-making of the educational institutions, national research agencies and private organisations.

In the current climate all research providers and funders are subject to a tight budgetary environment and are compelled to seek the best possible returns from their RD&E investment. Thus there is a consensus for the grains industry to build better relationships and conduct R&D and associated extension through a coordinated set of fewer, larger centres with critical mass and truly national or regional roles and responsibilities. The intent is not to replace, but to build on the regional and local mandates of the state agricultural agencies, and to build a truly national RD&E network.

The PISC National Framework for RD&E is built on the key tenet that basic and strategic research can be done nationally, development should be done regionally and that extension would be delivered locally. The Framework also makes provision for agencies to agree on future roles under a 'Major-Support-Link' framework as defined below:

Major: ***Take a lead national role by providing significant R&D effort through maintenance of capability and leadership to deliver national R&D outcomes***

Support: ***Contribute to R&D in partnership but major effort will fall within another state or agency***

Link: ***Undertake little or no R&D, but access information and resources from other states or agencies.***

There are already many examples of a strongly collaborative national program approach to grains R&D, both inter-agency, including across State boundaries, and cross-sectoral. This has been facilitated by the GRDC's national mandate for strategic investment and the cooperation of the major research agencies. Some examples are:

Major cross-sectoral R&D collaborations	Multi-agency, multi-state R&D collaboration
Managing Climate Variability Program Natural resource management groups Healthy Soils Program Grain and Graze Program Co-operative Venture for Capacity Building Farm Health and Safety Climate Change Research Strategy for Primary Industries	Australian Centre for Plant Functional Genomics Australian Winter Cereals Pre-breeders Alliance Barley Breeding Australia / Pulse Breeding Australia National Oat Breeding Program Australian National Durum Wheat Improvement Program Australian Wheat and Barley Molecular Marker Program State Extension Leaders Network Australian Cereal Rust Control Program

6.2 OPTIONS FOR CHANGE

The Steering Committee considered in detail four options to progress the National Grains RD&E Strategy and these options are summarised below:

Option	Description
1	Continue collaboration, building on past successes but with an increased emphasis on the shared identification and evaluation of the RD&E issues to be addressed; improved strategies for public and private co-existence in grains RD&E; increased focus on impact assessment and communication with stakeholders and continuous improvement in identifying and implementing transactional efficiencies.
2	Option 1 plus progress the development of 'Major', 'Support' and 'Link' roles through building relationships (including increased emphasis on priority setting, evaluation and communication) that will then drive RD&E investment programs but within current capability (infrastructure and people) arrangements.
3	Option 2 plus fully develop the 'Major', 'Support' and 'Link' framework and realign capability investment including increased core and project funding in 'Major' jurisdictions and adjustments in capability investments in 'Support' and 'Link' jurisdictions. This option will depend on building relationships and could involve cross-jurisdictional investment.
4[8]	Option 3 plus development of alternative structures for delivering RD&E going forward, including options such as a USA Land Grant university model or NZ Crown Research Institute model.

The options build progressively on the existing base of inter-agency collaboration. Option 1 has the advantage that it could be implemented largely within existing capability (infrastructure and people) and could lay a foundation for more progressive options at a later date. Weaknesses, however, are that it does not acknowledge the 'Major-Support-Link' framework or encourage the move towards national programs, national centres of capability or regional networks for delivering against RD&E priorities. It would be seen as 'business as usual' and would not progress the development of a national framework for grains RD&E.

The second option builds on Option 1 and progresses the 'Major-Support-Link' framework. Under this option agencies would agree and finalise their proposed grains RD&E investment strategies under the 'Major', 'Support' and 'Link' categories and would agree a timetable for implementation. Potential national and regional centres would be agreed, and areas for increased and decreased investment would be identified, but implementation would be dependent upon capability and desire to implement.

Option 3 incorporates the progress embodied in Options 1 and 2, but takes this further through a commitment to full implementation of the 'Major-Support-Link' framework. This would include the establishment of national research programs, national centres of research capability and regional networks of applied RD&E based on future needs and existing competencies as defined by the 'Major-Support-Link' decisions by jurisdictions; and consequent commitment to significant changes

[8] 'Option 4 was discussed but received no support from the PISC agencies at this time and was not considered further

in the pattern of RD&E investment. The opportunities and risks inherent in this third option are listed below.

Opportunities and risks in implementing the Major-Support-Link framework	
Opportunities	**Risks**
Builds on existing collaboration Consistent with the PISC National Primary Industries RD&E framework. Ensures critical mass and development of 'world class' research capability to attract technology partnerships. National and regional centres provide on-going certainty of employment for researchers tied to achievement of key performance indicators. Better targeting of capability building and succession planning Establishes sustainable and better coordinated RD&E capability (people and infrastructure) particularly in D&E.	Varying ability of agencies to commit to and implement. Potential destabilisation and loss of commitment of existing researchers. Perception that the framework is an excuse to disinvest. Less contestable funding for RD&E leading to poorer performance outcomes Need to ensure national research facilities are resourced and committed to delivering effectively on national priorities

A number of agencies are already realigning their R&D capability in ways that are compatible with the Major-Support-Link framework through formation of partnerships and the clustering of related activities. Examples have been discussed in Section 5.1.

After due consideration, the Steering Committee unanimously supported Option 3 – full development of the 'Major -Support-Link' framework with realigned capability investment including increased core and program funding in 'major' jurisdictions and adjustment of capability investments in the 'support' and 'link' jurisdictions. This option is seen as the preferred approach to best deliver a truly national grains RD&E strategy for Australia.

Full adoption of the Major-Support-Link framework to drive major investments in key programs and enabling disciplines at the national or regional level would most likely involve 'block core' investments by the relevant partners for a significant period of time. The model would involve co-investment from the lead (major) agencies supported by GRDC and potential cross-jurisdictional or cross-agency investment at the in-kind level at a minimum.

The PISC agencies recognise that change to fully implement Option 3 will need to be staged. The basic elements of the Strategy (identified under Option 1) can be immediately progressed, whilst the major realignments in infrastructure, people and investment implicit in full implementation of the Major-Support-Link framework will require additional time to be put in place. Thus, the Steering Committee endorsed immediate implementation of:

- **Enhanced collaboration through stronger articulation of PISC agency RD&E plans with GRDC and industry participation;**
- **Agreed definitions, in relation to what is considered 'R' in contrast to D&E; and the roles of national, regional and local resources in addressing these aspects;**
- **A cross-jurisdictional approach to setting of RD&E priorities and ownership of the outcomes;**
- **A common approach and methodology to assess and measure the impact of RD&E;**
- **Improved communication among PISC agencies and other research agencies, and with stakeholders;**
- **A lowering of transaction costs through sharing of best practice in areas such as project design and reporting, standardised contracts, use of new information and communications technology (web and video conferencing, etc);**
- **A re-evaluation of extension delivery mechanisms to growers and agribusiness, including the future roles of the PISC agencies, the support needs of grower groups and of delivery channels to consultants, including mechanisms to ensure that consultants have access to the pipeline of R&D;**
- **Development of regional rather than State-based activities as well as investment to provide for national delivery through the national research programs, national centres and regional networks.**

It is noted that the PISC R&D Sub-committee has established cross-sector working groups to tackle the harmonisation of processes including RD&E impact and project evaluation, management of intellectual property, contracting of RD&E services and future approaches to extension. The learning from these working groups will assist with the implementation of the national grains RD&E strategy.

7 IMPLEMENTATION ARRANGEMENTS

7.1 MAJOR-SUPPORT-LINK – A NATIONAL GRAINS RD&E RESPONSIBILITY MATRIX

Whilst the examples of inter-agency collaboration listed in Section 5.1 demonstrate substantial progress in moving to more effective and efficient delivery of RD&E within a national framework, further gains are desirable and can be made. There is recognition that overlapping responsibilities between agencies and jurisdictions may be necessary in some cases, but unnecessary duplication and sub-optimal coordination and communication must be tackled to improve outcomes for the grains industry from the available investments in RD&E.

The Steering Committee has adopted the matrix (Table 5, Section 5.3) of provisional agency commitments to Major-Support-Link roles by RD&E priority area, taking into jurisdictional capability, track record, RD&E priorities, and regional industry importance. This matrix forms the basis for future provision of national RD&E and will underpin discussion during the implementation phase.

PISC agency and other research provider commitments to Major-Support-Link roles will be coordinated through an RD&E system of National Research Programs, National Centres of Research Capability, and Regional Development and Extension Networks. These will be supported by a number of national 'Enabling Functions' (for example biometry) required across Centres, Research Programs and Networks.

7.2 NATIONAL RESEARCH PROGRAMS

National Research Programs form the core of the grains RD&E Strategy and will formalise and extend the existing national research effort. National Research Programs will be supported through the National Centres of Research Capability, universities, other research providers and the Regional Networks. National Research Programs will have an agreed lead agency or coordinator which, in addition to committing to a 'Major' role, will assume responsibility for coordination of the national effort. For large programs with many participants, the coordination role will draw together multiple agencies/projects under the Program umbrella.

National Research Programs will encompass priority areas where national coordination is in the national interest and can lead to greater efficiency and impact. Crop genetic improvement and crop protection are two areas where a nationally coordinated approach to R&D has already been successful. Other research areas, particularly in agronomy, farming systems and resource management, may have some nationally coordinated research, but will also include much regionally and locally initiated R&D managed through the Regional Networks.

Characteristics of a National Research Program include:

- addresses an area of high national priority where critical mass is required, or synergies are expected;
- usually outcome, issue, or commodity specific,
- focussed on national rather than regional or local priorities or roles, although Research Programs will frequently include region-specific elements;
- often delivered through multiple projects/collaborating agencies with nominated 'Major' or 'Support' interests in the Research Program area recognising the value of existing infrastructure and expertise;

- larger Programs may be supported by a coordinator with Advisory Board support with the opportunity for grower and industry input (similar to PBA);

Agencies with a "Major" role investing in a National Research Program will:

- be responsible for engaging nationally (all agencies, industry, co-investors, research partners) to set research priorities;
- engage with all "Major" and 'Support' agencies to foster research collaboration and coordination to more efficiently and effectively use resources;
- engage with "Link" agencies to ensure regional priorities are considered in the development of research projects, and if appropriate, support the delivery of regional D&E programs by "Link" agencies;
- report on progress and communicate program activities and outputs to all regional networks, agencies and industry; and
- contribute to reviews and evaluations of the Research Program (as required)

For their part, "Support" and "Link" agencies will be expected to:

- openly discuss regional requirements and engage in setting research priorities; and
- undertake D&E activities appropriate to their regions.

Proposed National Research Programs are listed in Table 7.

7.2.1 ENABLING FUNCTIONS

Enabling functions are also nationally coordinated activities that provide critical support services for both National Research Programs and the R&D carried out through the Regional Networks. Proposed Enabling Functions are listed in Table 8.

Characteristics of Enabling Functions include:

- deliver to the full range of grains RD&E rather than to growers/industry;
- applicability to R&D across National Research Programs, National Centres and Regional Networks;
- smaller in scale and investment than National Research Programs;
- less need for industry/stakeholder direction; and
- user (e.g. breeder) input into management.

7.3 NATIONAL CENTRES OF RESEARCH CAPABILITY

It is recognised that although most research will be conducted through National Research Programs there will be some key research centres that warrant recognition as National Centres of Research Capability. Centres will deliver through contributions to both National Research Programs and Enabling Functions, and through linkages to the tertiary education sector, and will serve as major centres for high-level training in research disciplines for the grains industry.

Characteristics of a National Centre of Research Capability include:

- commitment—Centres are prepared to maintain or build new capability that is strategically relevant to the grains industry and can attract and retain high calibre staff;
- infrastructure—Significant investment in buildings and in capital intensive equipment;

- clustering—establishing 'research clusters' where government agencies, universities and private companies co-locate or co-mingle where possible;
- international recognition—Centres that are recognised internationally for excellence, are attractive to top scientists and international partners, and link Australia to international agricultural research;
- technology or discipline focussed—Centres will be technology or discipline focussed, bringing together platform technologies and disciplines in areas of national interest. They will endeavour not to duplicate infrastructure and capability unless it is agreed to be clearly in the national interest;
- inclusiveness—Centres are prepared to make research facilities and outputs available (for example, similar principles and guidelines to those adopted by AWCPA) and to support adoption of research through the National Research Programs and Regional Networks;
- governance—Centres incorporate governance arrangements to actively manage cross-institutional and cross-regional connections to National Research Programs and Regional Networks, and appropriate delivery channels to the public and private sectors.

Given these principles, The Waite Campus, AgriBio, CSIRO Black Mountain, the Australian Export Grain Innovation Centre[9], and the Queensland Alliance for Agriculture and Food Innovation at The University of Queensland are five nominated National Centres of Research Capability (Table 9).

[9] Funding for AEGIC has been pledged by the Western Australian Government with the Centre to be constructed on the Murdoch University campus, and the Centre to open in 2013.

Table 7. National Research Programs[1]			
Program	**Major**	**Support**	**Activities**
Crop genetic improvement			
Genetic Resources Management *Proposed* (Pasture genetic resources a joint responsibility with the ruminant livestock industries including MLA, DA and AWI)	DPIV (Grains)	I&I NSW (cereals), DAFWA (lupins), UWA (barley), DEEDI (tropical)	Germplasm seed collections and data curation; international treaty obligations.
	SARDI *(Medicago*)	DAFWA (*Trifolium*), DEEDI (tropical)	Germplasm seed collections and data curation; international treaty obligations.
Australian Wheat and Barley Molecular Marker Program *Existing*	UA	DEEDI/QAAFI, I&I NSW, DPIV, DAFWA	Development and distribution of molecular markers for defined traits in wheat and barley.
Wheat Quality Improvement Program *Proposed*	UMU, DAFWA, CSIRO, QAAFI	CGFI, BRI, SARDI, I&I NSW, DEEDI	Wheat quality and functionality pre-breeding for export and domestic milling markets
Australian Durum Wheat Improvement Program *Existing*	I&I NSW, UA	DEEDI	Durum wheat pre-breeding Durum wheat breeding
Barley Genetic Improvement *Proposed*	UA, DAFWA	SARDI, TIAR, DEEDI, UWA	Barley pre-breeding including malting and feed quality, abiotic and biotic stresses
National Oat Breeding Program *Existing*	SARDI	DAFWA	Oat pre-breeding Oat breeding

[1]Provisional list of National Research Programs with major and support roles based on the proposed R&D responsibility matrix (Table 5). See the text for a description of a 'National Research Program'.

Table 7. National Research Programs[1]			
Program	**Major**	**Support**	**Activities**
Crop genetic improvement (continued)			
Pulse Breeding Australia *Existing*	DPIV, I&INSW, UA, DAFWA	UWA, CSIRO, DEEDI, US, SARDI	Chickpea, field pea, lentil, faba bean and lupin breeding and variety commercialisation Pre-breeding (biotic and abiotic stress, grain quality)
Canola Genetic Improvement *Existing*	I&I NSW, CSU, DPIV,	UWA	Canola pre-breeding and breeding
Rice Improvement *Existing*	I&I NSW	RIRDC, SunRice, EHGC, UQ, CSU, US, SCU, CSIRO	Rice breeding and pre-breeding
Summer Crop Improvement *Proposed*	DEEDI/QAAFI	CSIRO	Breeding of summer crops – sorghum, maize, soybean, mungbean etc.
National Variety Trials	ACAS Ltd	DEEDI, I&I NSW, DPIV, SARDI, DAFWA	Management and operations of the NVT

[1]Provisional list of National Research Programs with major and support roles based on the proposed R&D responsibility matrix (Table 5). See the text for a description of a 'National Research Program'.

Table 7. National Research Programs[1]			
Programs	**Major**	**Support**	**Activities**
Crop protection			
Australian Cereal Rust Control Program *Existing*	US, CSIRO	CIMMYT, UA, DPIV, DEEDI, UWA	Cereal rust resistance gene characterisation and deployment, rust disease epidemiology.
Australian Centre for Necrotrophic Fungal Pathogens (ACNFP) *Existing*	CUT	ANU, CSIRO, I&I NSW, DAFWA, DEEDI/QAAFI, CSU	The ACNFP aims to generate the knowledge needed to develop novel genes that will confer crop plant resistance to necrotrophic fungi. Knowledge gained as a by-product is exploited to assist development of novel fungicides
National Diagnostic Centre for Root Diseases *Existing*	SARDI	DEEDI, DPIV	Provides national research capability, diagnostics and delivery of DNA based testing covering soil-borne pathogens, beneficial organisms and root growth in soil
National Integrated Weed Management Initiative (NIWMI) *Includes Australian Herbicide Resistance Initiative (AHRI)* *Existing*	UA, UWA, EH Graham Centre	UA, DAFWA, CSIRO, DEEDI/QAAFI, UM	The National Integrated Weed Management Initiative works to provide integrated weed management strategies for the major crop-weed threats to Australian grain production. AHRI (Previously WAHRI): management of herbicide resistance in in-crop weed species.

[1]Provisional list of National Research Programs with major and support roles based on the proposed R&D responsibility matrix (Table 5). See the text for a description of a 'National Research Program'.

Table 7. National Research Programs[1]			
Programs	**Major**	**Support**	**Activities**
Crop protection (continued)			
National Invertebrate Pest Initiative (NIPI) *Existing*	CSIRO	UM, I&I NSW, DEEDI, SARDI, DAFWA, UWA, CSU	NIPI brings together all major research providers with the aim of improving collaboration in invertebrate pest management.
Stored Grain Protection & Hygiene *Existing*	CSIRO, DEEDI, DAFWA	UMU, I&I NSW	The stored grain industry is heavily dependent on phosphine for stored grain pest control. This reliance on a single chemical is considered an unsustainable and alternative stored grain protection strategies are needed
Agronomy			
Harnessing Precision Agriculture *Proposed*	US, UNSW, UNE, CSIRO	CRC Spatial Information, DAFWA, UWA, AAAC, DEEDI, Grower Groups	Constraints and impediments to harnessing precision agriculture, electronics & mechatronics, GIS data capture and management systems for growers

[1]Provisional list of National Research Programs with major and support roles based on the proposed R&D responsibility matrix (Table 5). See the text for a description of a 'National Research Program'.

Table 7. National Research Programs[1]			
Program	**Major**	**Support**	**Activities**
Soil science and crop nutrition			
Soil Biology **(**Harnessing the Biological Potential of Our Soils) *Existing*	SARDI, I&I NSW, UA, DEEDI/QAAFI, DPIV, CSIRO, UWA, CSU	US, UNE, CSIRO	Supports investment that achieves efficient and sustainable grain production systems, improved measurement and interpretation of soil biological processes, and better engagement of the soil biology R&D community
National Rhizobium Program *Existing*	UMU	SARDI, I&I NSW	The Program investigates new inoculant strains, different types of inoculant carriers and the possibility of targeted plant breeding for better nodulation to improve the nitrogen fixation potential of pulse crops.
Soil Fertility and Crop Nutrition *Proposed*	DAFWA, UA, DEEDI/QAAFI, UWA	CSIRO, SARDI, DPIV, UNE, UA, I&I NSW, CSU	Maintenance of soil fertility is fundamental for sustainable farming systems. Removal of produce and erosion, runoff and leaching losses make nutrient replacement strategies essential to avoid long-term fertility decline
Climate adaptation			
Managing climate variability *Existing*	CSIRO, BoM, UM, DPIV, DEEDI/QAAFI, SARDI	I&I NSW, SARDI, UM, DAFWA, UWA, Grower Groups	Focuses on increasing forecasting accuracy, building predictive capability, and developing tools which translate climate forecasts and resource attributes into decision support tools for producers and natural resource managers

[1]Provisional list of National Research Programs with major and support roles based on the proposed R&D responsibility matrix (Table 5). See the text for a description of a 'National Research Program'.

Table 8. Enabling Functions			
	Major	**Support**	**Activities**
Biometrics	I&I NSW, DEEDI	DAFWA, SARDI, UA, DPIV	Statistical support for breeding entities and experimental research.
Bioinformatics	UMU (CCG), CSIRO, AgriBio, DEEDI, I&I NSW, ACPFG, UQ(QFAB)		Comparative genomics Genome sequence assembly Computational techniques, data management and storage (I&I NSW)
Systems modelling	CSIRO, DEEDI/QAAFI,	DAFWA, UQ, UWA, I&I NSW, DPIV	Whole farm and enterprise profitability Potential yield modelling Disease epidemiology, weed and insect population dynamics
Economic analysis	ABARE	DAFWA, UWA, UM, DPIV	Rural statistics, commodities outlook, farm business and TFP drivers, supply chain competitiveness

Table 9. National Centres of Research Capability		
Centre	**Location**	**Platform capabilities**
The Waite Campus	Adelaide	Gene discovery, Functional and comparative genomics, Phenomics, Metabolomics; Transgenesis (wheat, barley) Molecular pre-breeding Wheat and barley grain quality and biochemistry Soil fertility and plant nutrition (field to molecular aspects)
CSIRO Black Mountain	Canberra	Transgenesis (wheat, legumes, oilseeds) Wheat pre-breeding (quality and productivity traits including molecular rust pathology)
AgriBio	Melbourne	Gene discovery, functional and comparative genomics, phenomics, metabolomics, transgenesis (wheat, pasture species) Germplasm improvement (mainly transgenic wheat and barley) and pulses (chickpea, lentils, field pea) and canola.
Australian Export Grain Innovation Centre[1]	Perth	Wheat & barley grain quality/functionality (pre-breeding, processing and food technology), Bioinformatics Economic analysis (farm business profit drivers and industry competitiveness) Export market analysis Crop protection (cereal and legume pest and disease resistance, epidemiology and modelling)
QAAFI – an Institute of UQ	Brisbane	Systems research/modelling and platforms for farming systems optimisation Grain foods quality/functionality including gene discovery and deployment Genotype x management x environment integration in crop improvement systems (gene discovery, pre-breeding, adaptation, disease, pest and weed biology and management) including summer cereals, pulses and winter cereals and tropical and sub-tropical cropping systems

[1]Announced in the May 2010 WA State Government Budget

7.4 PROPOSED REGIONAL DEVELOPMENT AND EXTENSION NETWORKS IN FARMING SYSTEMS AND IMPROVED PRACTICES

Farming systems and related practices are essentially regional rather than national in nature and effective farming systems research (with its close links to natural resource management and farm business management) requires a close and continuous interaction with regional and local agribusiness and growers.

It is acknowledged that the role of PISC agencies in D&E is changing rapidly. However, they remain important providers of D&E services and are assuming an important role in support of grower groups, consultants and other private sector information providers. Maintaining regional and local expertise will be critical to the flow-through of RD&E and it will be important for the partners to maintain a network of expertise from which the broader agribusiness sector can draw.

Given the arguments above, under the Strategy the PISC agencies support the formation of Regional Development and Extension Networks focussed on regional and local farming systems and which integrate farming systems R&D and regional and local extension.

These Regional Networks will be important in retaining expertise and supporting PISC agency investments in productivity and natural resource management outcomes. PISC agencies are rationalising the number of regional sites they will maintain and are consolidating and modernising facilities and supporting staff in larger nodes at important regional locations.

The key characteristics of a Regional Network include:

- multi-location – a Regional Network is likely to encompass one or more major and smaller nodes that can efficiently service the relevant regional agro-ecological environments;
- multidisciplinary and focused on RD&E for regional benefit; and
- multi-agency.

Agencies participating in a Regional Network will:

- engage in regional priority setting for National Research Programs and adapting research outputs from these Programs through regional D&E;
- engage with grower groups, agribusinesses and consultants to develop priorities for regional and national RD&E programs and to deliver outputs from those programs;
- provide a "go to point" for the grains sector (e.g. growers, grower groups) wanting to access information and expertise (e.g. in surveillance diagnostics in pathology and entomology); and for D&E projects;
- interact with other Regional Networks to exchange ideas and outputs

For their part, grower groups which focus on short term D&E will be expected to:

- engage with the Regional Networks as appropriate to provide input in setting priorities for research activities, gather information on, and facilitate adoption of research outputs;
- engage with Regional Networks, other regional grower groups, agribusinesses and consultants to eliminate fragmentation of D&E activities; and
- extend information from Regional Networks, regional grower groups, agribusinesses and consultants to members to facilitate adoption.

It is expected that the staff located within the Regional Networks will be called upon to participate in, and in some cases lead, National Research Programs that support generic agronomic, crop protection

and farming systems issues (for example, precision agriculture, soil acidity, and plant growth and disease modelling).

Table 10 lists the proposed Regional D&E Networks.

7.5 INTER-RELATIONSHIP OF NATIONAL RESEARCH PROGRAMS, NATIONAL CENTRES OF RESEARCH CAPABILITY AND REGIONAL D&E NETWORKS

National Research Programs form the core of the grains RD&E Strategy and will be supported through the National Centres of Research Capability, universities, other research providers, and the Regional D&E Networks. Expertise and infrastructure for a particular program may be housed in a National Centre (especially so for capital intensive genomic research), but in general is likely to be drawn from a mix of National Centres, universities and major nodes in the Regional Networks. Similarly, scientific leadership of a particular National Research Program would be assigned to the most appropriate lead agency regardless of location. Thus, National Centres of Research Capability may have particular 'Major' roles, but may also fulfil 'Support' roles in other National Research Programs.

Regional Networks will also be important contributors to National Research Programs. In addition to their mandate for regional D&E, science staff within the Regional Networks are likely to be major contributors to National Research Programs where these contribute to farming systems and natural resource management RD&E.

Table 10. Regional Development and Extension Networks (Improved practices & farming systems)					
REGION	**Science focus**	**Name and/or Location of Major Node**	**Partners**	**Grower Group & Agribusiness Linkages**	**Other Nodes in the Network**
NORTHERN					
Tropical and Sub-tropical Farming Systems Network	Farming systems R&D, tropical & sub-tropical plant pathology, nematology, virology, crop protection, integrated weed management, industry development, irrigation systems, Barrier Reef impact, resource management, crop sequencing, variety management packages, remote sensing technology applications, precision agriculture	Toowoomba	DEEDI, I&I NSW CSIRO, UQ, UNE, USQ, US	South-East Queensland Farming Systems Group, Central Queensland FSG, Coastal FSG, Northern Grower Alliance, GOA. Regional agribusinesses and consultants	Emerald, Warwick, St Lucia, Gatton, Tamworth, Armidale, Myall Vale, PBI Narrabri
WESTERN					
Western Cropping Systems Network	Farming systems research, agronomy, grain disease pathology, nematology, virology, weed science, soils research (acidification, salinity, waterlogging, resource use issues, pasture/livestock/crop integration, precision agriculture All Western Region agro-ecological zones	Centre for Cropping Systems, Northam	DAFWA, CSIRO, UWA, CSIRO, CUT, UMU	Grower Group Alliance members, AAAC, WANTFA, Regional agribusinesses and consultants	Geraldton, Northam Merredin, Katanning Albany, Esperance

Table 10. Regional Development and Extension Networks (Improved practices & farming systems)					
REGION	**Science focus**	**Name and/or Location of Major Node**	**Partners**	**Grower Group & Agribusiness Linkages**	**Other Nodes in the Network**
SOUTHERN[1]					
Network for Mixed Farming Systems of NSW Central Zone & NSW-Vic slopes	Plant pathology, mixed farming systems, soil health, entomology, weed science, bioinformatics, biometrics, agricultural economics, modelling, irrigated crops, integration of pastures; climate change adaptation	E.H Graham Centre (Wagga Wagga)	I&I NSW, CSU, DPIV, CSIRO	Farmlink; CWFS; Riverine Plains; Murrumbidgee CMA; Lachlan CMA, Murray CMA, CANFA. Regional agribusinesses and consultants	Yanco, Condobolin, Rutherglen
Network for Mixed Farming Systems of SA Vic Bordertown – Wimmera & Vic High Rainfall Zone	Supports RD&E related to grain disease pathology, nematology, virology, pulse breeding, pre-breeding, climate change , Soil issues, agronomy, farming Systems, resource use efficiency.	Grains Innovation Park (Horsham)	DPIV, LaTrobe, UM	Regional farmer groups and catchment management authorities; Victorian Grower Group Alliance, CSIRO, National Research Centres Regional agribusinesses and consultants	Hamilton, Rutherglen, Adelaide, Agribio
Network for Mixed Farming Systems SA Vic Mallee & SA Mid-north – Lower Yorke, Eyre	Cereal and break crop agronomy, WUE, Herbicide tolerance. Farming systems. NVT	Minnipa Research Centre (Minnipa)	SARDI, UA CSIRO, DPIV	Regional Farmer Groups, Victorian Grower Group Alliance, National Research Centres, Minnipa Research Foundation Regional agribusinesses and consultants	Horsham, Adelaide, Minnipa

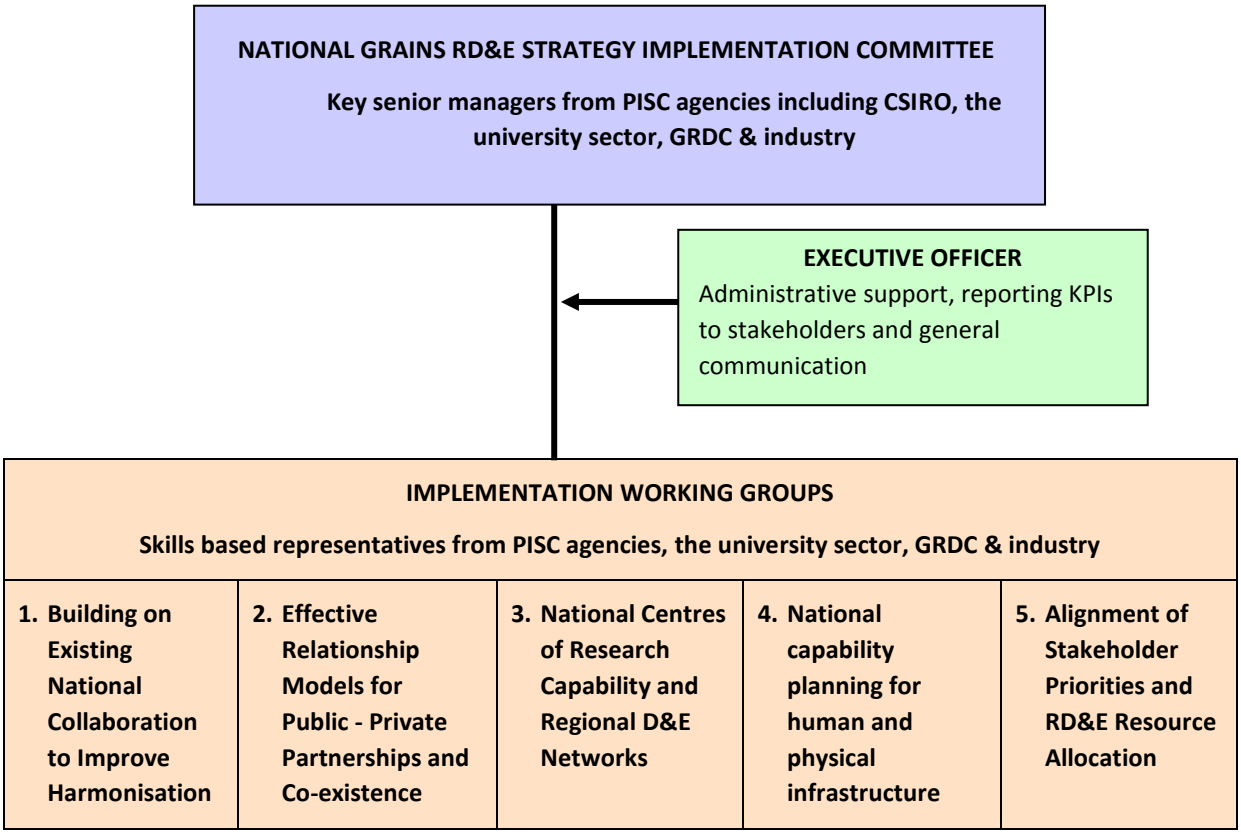
[1] The Southern Region networks are based on agri-climatic zones

8 NATIONAL GRAINS RD&E STRATEGY IMPLEMENTATION COMMITTEE AND WORKING GROUPS

8.1 IMPLEMENTATION OVERVIEW

To progress the implementation of the National Grains RD&E Strategy including the Major-Support-Link framework and the development of National Centres and Regional Networks, the Steering Committee proposes the formation of a high level 'National Grains RD&E Strategy Implementation Committee', and a set of five operational sub-committees responsible for the actions required to put in place different elements of the Strategy. The Implementation Committee would replace the current Steering Committee charged with the development of the RD&E Strategy. The proposal is summarised in Figure 9.

Figure 9. Proposed National Grains Industry RD&E Strategy Implementation Committee



8.1.1 NATIONAL GRAINS RD&E STRATEGY IMPLEMENTATION COMMITTEE

The National Grains RD&E Strategy Implementation Committee will provide strategic oversight and direction for implementation and further development of the National Grains RD&E Strategy and will consist of key senior managers from PISC agencies, including CSIRO, the university sector, GRDC and industry. It is proposed that a full-time Executive Officer support the Implementation Committee with the duties of administrative support, linkage to working groups, and stakeholder and general communication. Included in the Implementation Committee's role would be convening an annual National Grains RD&E Forum with the intention of gathering broad cross-industry and government input to RD&E needs and priorities.

Implementation Committee roles would include:

- Liaison/reporting to PIMC;
- oversight of working groups, including approval of working plans and monitoring of progress against agreed KPIs;
- initiating and convening an annual National Grains RD&E forum; and
- oversight of the development of a Five-Year National RD&E Plan.

8.1.2 STRATEGY IMPLEMENTATION WORKING GROUPS

Five working groups will be established to progress the implementation of the Strategy. The working groups will operate under the oversight of the National Grains RD&E Implementation Committee and with the following roles:

- foster a cooperative operating environment, including harmonisation of administrative processes and evaluation of RD&E impacts (Group 1);
- improve communication between RD&E providers and encourage sharing of resources to improve the efficiency of national and regional RD&E collaboration (Group 1);
- develop clear guidelines around governance and transparency in relation to use of public monies, and intellectual property in relation to public-private partnerships (Group 2)
- improve stakeholder understanding of issues surrounding 'market failure' and 'spill over' benefits and develop guidelines for who should pay for what (Group 2)
- improve the interfacing with the new extension paradigm, particularly connections between private consultants and R&D providers (Group 2)
- coordinate the preparation of business cases under the 'Major-Support-Link' framework for national programs proposed under the Strategy; (Group 3)
- facilitate the integration of the grains industry RD&E priorities with cross-sector and other sector strategies under the national primary industries RD&E framework; (Group 3)
- plan the education and training of future discipline and technology expertise to address the needs of the grains industry (Group 4)
- develop model succession plans for private consultants and advisors (Group 4)
- develop a consultative mechanism for review of national RD&E priorities for industry and government to develop of a 5-year plan to facilitate better coordination and alignment of investment and activities between RD&E providers; (Group 5)
- develop a communication plan to ensure ongoing connection of R&D outputs with public and private extension service providers. (Group 5)
- Reporting progress to agencies and industry (All)

Each working group will be skills-based and composed of senior staff from PISC agencies, the university sector and industry organisations.

8.2 TIMELINES, CRITICAL SUCCESS FACTORS AND KPIS

8.2.1 TIMELINES

To complete the National Grains RD&E Strategy, the Steering Committee has set the following timeline for consultation and final submission:

Date	Action
Mid-July	Agreement by agencies to the National Grains RD&E Strategy 'Consultation Draft'
2nd August	Submit the 'Consultation Draft' Strategy document to the PISC R&D Committee
12th August	Presentation on the Strategy to the PISC R&D Committee. Committee members to then 'walk' the Strategy through their jurisdictions and get sign off
27th August	Final Draft submitted to the PISC R&D Committee together with agency sign-off forms.
23rd September	Strategy presented to PISC
October	Further industry communication
4th November	Strategy presented to PIMC

8.2.2 CRITICAL SUCCESS FACTORS AND KPIS

The Steering Committee does not underestimate the scale of the task to advance the 'immediate steps' listed in Section 5 and then to move to full implementation of the Major-Support-Link framework. Establishment of the Strategy Implementation Committee, formation of the Working Groups and adoption of the 'Support' function will be critical. Critical success factors and associated KPIs for the process are listed in Table 11.

Table 11 Critical success factors and KPIs	
Critical Success Factor	**KPI**
Commitment by PISC agencies to the principles of the Strategy.	• Sign-off by all PISC agencies to the national Strategy (this document) (July 2010) • Presentation and acceptance of the Strategy by PISC (September 2010) and PIMC (November 2010)
Formation of a 'National Strategy Implementation Committee' with Executive Officer to drive the implementation of the Strategy	• Agreement to form a body to provide strategic direction and oversight (July 2010 • Appointment of an Executive Officer (December 2010)
Term commitment from PISC agencies, GRDC and relevant universities to fully implement the national RD&E Strategy.	• Appointment of senior executives from each organisation to the Strategy Implementation Committee with responsibility to drive Strategy implementation (October 2010) • Agreement on initial 12 months funding to be provided 50% by GRDC and 50% by the PISC agencies for an Executive Officer to support the Implementation Committee (January 2011) • Develop and agree to ongoing funding for year 2 onward • Develop the business cases for the existing and new national centres and programs (December 2011)
Buy-in of key industry groups to the implementation of the new national grains RD&E Strategy - growers and grower organisations -industry lead organisations - national and private investors in grains RD&E	• Develop a communication plan for major stakeholder groups by September 2010. • Appoint a communication specialist • Undertake ongoing communication/consultation with each of the interest groups (July 2010 to March 2011)
Establish Working Groups with responsibility for implementation of the components of the Strategy.	• Establish working groups (October 2010) • Implementation Committee approval of working group mandates and operating plans (March 2011)
Substantial implementation of the 'preliminary steps' (option 1) within 12 months (Strategy/Working Group 1)	• A formal sharing of agency RD&E plans annually through PISC. • Agreement to use common RD&E terminology and definitions and to a common approach to priority setting and impact assessment (June 2011) • A formal PISC sponsored review of the future extension delivery of R&D to the grains industry given the changing structures and role of the PISC agencies and the private sector.
Substantial implementation of the full major-support-link framework within three years (i.e. by June 2013)	• Independent review of progress in implementation (July 2012) • First National Grains RD&E Forum (July 2012) • Conduct of an inclusive national conference to produce a new Five Year National Grains RD&E Plan (by July 2013)

9 APPENDICES

9.1 NATIONAL GRAINS RD&E COMMITTEE MEMBERSHIP AND PROCESS

Appendix

Peter Reading	GRDC (Chair)
Dr Jeremy Burdon	CSIRO
Dr Bob Eisemann	DEEDI
Prof Roger Leigh	Universities
A/Prof Rob Lewis	SARDI
Ray Marshall	Western Region - GCA
Des Naughton	DAFF
Wayne Newton	Northern Region - GCA
John Oliver	I&I NSW
Dr Mark Sweetingham	DAFWA
Andrew Weidemann	Southern Region - GCA
Dr Ragini Wheatcroft	DPIVic

The Strategy was prepared by the National Grains RD&E Committee comprising industry Grains Council of Australia nominated representatives of the Northern, Southern and Western regions of the Australian grains industry, the Queensland Department of Employment, Economic Development and Innovation (DEEDI), Industry and Investment NSW (I&I NSW), Victorian Department of Primary Industries (DPIV), South Australian Research and Development Institute (SARDI), Western Australian Department of Agriculture and Food (DAFWA), Australian Council of Deans of Agriculture, Commonwealth Scientific and Industrial Research Organization (CSIRO), Commonwealth Department of Agriculture, Fisheries and Forestry (DAFF) and the Grains Research and Development Corporation (GRDC).

A consultant was engaged by GRDC to assist in developing a national grains sector overview. The consultant's research for the Strategy was based in part on a review of relevant documentation and on direct or telephone interviews with key personnel in state agencies, CSIRO, DAFF, GRDC, universities, relevant CRCs, NZ Crop Research – and with a wide range of industry participants including grower organisations, grower groups, consultants, rural merchandise companies, rural product/service providers (crop breeding, seeds, chemicals, fertilizers) and grain handlers.

The consultant sought information and views on qualitative and subjective issues of judgment – particularly *forward* judgments – which do not lend themselves to quantitative analysis or presentation.

The consultant's report emphasized a high level *national perspective*, recognizing that in many areas strategy implementation will require a balance of national and regional interests.

Other inputs for the development of the Strategy were provided by individual agencies. A desk top audit was also conducted on previous relevant grains industry reports and individual agency university and GRDC strategic plans.

The Committee would like to thank the large group of people within PISC agencies, universities and industry that contributed freely of their time and frankly of their opinions in an effort to build a better grains industry for Australia.

9.2 GRAINS PRODUCTION IN AUSTRALIA BY REGION

Australian Grain Production by Region (tonnes)				
Crop	**Northern**	**Southern**	**Western**	**TOTAL**
Wheat	3,668,000	7,836,000	7,538,000	19,042,000
Barley	843,000	3,933,000	2,352,000	7,129,000
Sorghum	2,040,000	42,500	700	2,084,000
Oats	112,300	641,000	574,000	1,328,000
Canola	50,800	679,400	565,300	1,296,000
Lupin	10,100	144,300	699,900	854,300
Triticale	9,900	487,000	50,800	547,700
Rice	0	471,825	0	471,825
Maize	363,300	6,000	1,200	370,500
Field pea	3,700	263,600	69,000	336,300
Chickpea	219,500	26,400	2,600	244,600
Faba bean	25,600	157,400	7,800	190,800
Lentil	40	117,800	2,700	120,500
Sunflower	73,100	*	*	73,100
Soybean	65,000	*		65,000
Mungbean	48,000			48,000
Peanut	37,000			37,000
TOTAL	7,569,340	14,806,225	11,864,000	34,238,625

Average of 8 seasons 2001-02 – 2008-09

9.3 National Grains RD&E Expertise and Discipline Analysis

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE[10]**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Plant breeding	197.5	Varieties	Wheat and barley breeding in the process of moving to the private sector or public-private partnerships. Smaller crops consolidating into larger more coordinated programs but remain in the public sector (e.g. pulses, durum, oats) Some strong regional specialisation (e.g. lupins – west; sorghum – north)	Traditional skills and ability to integrate new molecular technologies will remain a core requirement for public and private plant breeding entities. Technical support will require different skills with ongoing field and laboratory-based specialisation. IP management and commercialisation skills will increasingly need to engage with multinational companies to access new genes and germplasm.
Plant genetics / quantitative genetics	118.2	Varieties	Core discipline to support breeding and pre-breeding activity. Generic and crop specific specialisation. Spread of skills related to adaptation, yield and agronomic improvement and to specific abiotic and biotic stresses and to grain quality traits. Increasing private sector investment in R, some in D where directly involved in commercial breeding.	Scientists with a strong grounding in traditional plant genetics and a strong understanding of molecular genetics will remain in high demand to support private and public breeding and pre-breeding. Greater need for national and international linkages to remain at the forefront of the discipline and to have access to genomic platforms, rapid phenotyping technology, data management and bioinformatics. Ongoing access to genetic resource collections (seed banks with genotype and phenotype data) remains essential. Needs work with discipline specialists to ensure accurate phenotyping.

[10] Includes professional, technical and support staff

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Molecular biology	183.3	Varieties (mainly), Practices Biosecurity Supply chain	Core discipline to support genetic improvement and diagnostic tools for crop protection, quality assurance and identity preservation. Relatively small private sector investment in R in Australia. Increasing trend for private providers of routine biotech services to support R&D. Strongly represented by ACPFG, CSIRO, AgriBio and the SABC.	Will continue to be an area of rapidly evolving scientific discovery and automation of routine procedures as a result of massive global investment in medical and agricultural biotechnology. Australian science should remain globally competitive but with increasing need for strong international linkages to the public and private sectors. High growth in student enrolments over the past 20 years.
Bioinformatics	33.6	Varieties Practices NRM	This group include bio-statisticians involved in experimental design and analysis supporting agronomic and plant breeding activity; and computational biologists involved in managing and analysing large data sets (e.g. for comparative genomics or image analysis). Bio-statisticians currently have a high head-count in the northern region. Computational support is available at the Centre for Comparative Genomics in the Western region and QFAB in the Northern region. There are limited private sector service providers with relevant experience.	Biological and agricultural biostatistics is a declining specialist discipline group in academia. Universities with strong mathematics groups will be the source of new graduates to support the ongoing needs of grains RD&E. Increased computational power will enhance areas such as comparative genomics to support plant genetic improvement and image analysis to support areas such as precision agriculture.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Cereal/Grain Chemistry, NIR testing,	71.8	Varieties (mainly) Markets	Skills and knowledge are mostly aligned to wheat and barley and canola and evolved alongside the old public breeding programs. A handful of reputable private service providers meet commercial needs. State agencies still have skilled personnel but with limited scope for the future. No current wheat or canola breeding program has a dedicated cereal/ oil scientist as part of the breeding team.	Will remain a core discipline to support breeding and pre-breeding activity, but will be increasingly focussed on key traits of economic importance. The Australian skill base is under threat with no graduate training courses and fewer opportunities for on-the-job training with the consolidation of milling and malting companies and retraction of breeding from State agencies who also conducted adjunct research. Commercial breeding in wheat, barley and canola has separated the processor and cereal/oil scientist from the breeder. Skills will be needed for technical marketing of the crop in a deregulated arena. A national approach to underpin basic skill development is a priority.
Plant physiology	55.0	Varieties Practices	Core discipline that supports pre-breeding activity and agronomic research to alleviate abiotic and biotic stress factors.	Will remain a core discipline which becomes more integrated with molecular science and specialist phenotyping to support gene discovery and to benchmark water and nutrient use efficiency. Crop physiology is relatively weak and this is a medium-term issue as current experts approach retirement. A national approach to underpin basic skill development is a priority.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Plant pathology	97.8	Varieties Practices Biosecurity	Core discipline supporting disease resistance breeding and integrated disease management practices for all the major grain crops. Also supports biosecurity policy and compliance. Well developed regional networks (north, south and west) which specialise in regionally important diseases. Inter-Network interactions are effective but informal. Private sector has limited specialist skills in field based diagnostics and crop protection.	Will remain a core discipline with the need to ensure breadth of skills from across field and laboratory diagnostics, epidemiology and crop protection, resistance/susceptibility phenotyping through to molecular host-pathogen interactions. 'Field' plant pathology expertise critical to support biosecurity, farming systems specialists and grower groups. The number of Australian trained graduates has steadily declined over the past 20 years. Given the importance of this discipline a national approach to underpin specialist skill development is a priority. Diagnostics result from Research and Surveys and feed-back the next Research questions. Important to maintain the inter dependency between Research and (commercial) diagnostics
Plant nematology	9.5	Practices (mainly) Biosecurity Varieties	This discipline backs up agronomic packages for the different crops. Supports resistance breeding (e.g. CCN). Chemical control options not used in the grains industry. Probable area of under investment. Private sector has negligible specialist skills.	A small and specialist discipline group that must maintain strong international linkages to ensure critical mass. Increasing need for low cost identification and quantification tools. Greater interaction with field agronomists will be required.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Soil rhizobiology	?	Varieties Practices	Research capability currently at I&I NSW, Gosford, UWA, SARDI, DPIV. An important discipline supporting soil biology/ soil health. Current expertise derived from agricultural science and microbiology training.	Discipline based skill that has underpinned N fixation research that needs to be maintained in future as pressure on fertiliser prices (N & P) increases. Skills require agricultural science and microbiology training.
Entomology	25.8	Practices Supply chain Biosecurity Varieties (minor)	An important discipline supporting pest identification, integrated pest management and biosecurity policy and management. Opportunities to increase breeding for invertebrate pest resistance. Strong skills in the northern region linked to the cotton industry. Private sector has varying levels (across regions) of specialist skills in field based diagnostics and chemical control.	The number of specialist scientists is declining, particularly those with a strong crop protection and crop improvement orientation. 'Field' entomology expertise critical to support biosecurity, farming systems specialists and grower groups. Availability of tertiary training is declining. Increased training of field agronomists/consultants will be needed to maintain regional pest surveillance capability. Important to foster the research - diagnostics interdependency
Weed management / science	32.2	Practices Biosecurity Varieties	A core crop protection discipline that underpins viable agronomic management packages and systems. Current high head-count in the western region (herbicide resistance and integrated weed management). Private sector has substantial skills in the evaluation and deployment of chemical weed control.	Multinational company investment in new chemistry R&D has declined relative to investment in GM herbicide resistant crops. Herbicide resistance in key weeds will increasingly affect production cost and viability of some crops. Optimising the deployment of GM herbicide resistance traits and new chemistry in crop rotations will be needed to develop practical and effective stewardship and to maximise industry benefit from new technologies. Non chemical ecologically based control options also needed to enhance IWM.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Agronomy	126.5	Practices NRM	This integrative discipline considers varieties, crop protection, and soils, nutrition and machinery aspects to provide profitable production packages which are environmentally sustainable. Increasing private sector capability.	The private sector is likely to increase involvement in the development of agronomic packages with short time horizons (often variety specific recipes). Public sector research agronomists will need to be resourced to develop the understanding behind systems development with a longer term horizon, and to develop responses to challenges associated with climate change and variability. Public-private interface important to ensure information flow from R to D to E to adoption
Agricultural systems development and integration	28.4	Practices NRM	A multi-discipline group which integrates crop and livestock production into whole-farm systems. Investigates potential of new crops, pastures and mechanisation on system profitability and sustainability. Private sector is strongly involved in the financial and farm business elements but is generally less engaged in R&D with a longer term horizon.	There is a trend toward greater contracting of the private sector to work with public sector researchers to ground-truth assumptions and to strengthen the farm business context. A need to develop closer links/interaction with consultants and grower groups in the planning, experimental and extension phases of systems development.
Modelling / Decision support	28.7	Practices (mainly) Biosecurity NRM	Supports agronomic package and farming systems RD&E. Private sector utilises these tools but generally does not invest much in the development of new tools. Private sector sometimes develops decision support for use in marketing, notably in the area of fertilizer recommendation	Potential for more intensive use of larger amounts of data and *a priori* knowledge. Need for frameworks that can process data into a simple decision matrix. Likely to be progressively integrated with farm business and paddock performance record keeping and linkage to quality assurance. Stronger links to precision agriculture likely. NRM issues will need to be fully integrated into farm business productivity decisions.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Soil science	61.5	Practices NRM	This broad discipline contains a range of specialisations in soil chemistry, physics and biology. Contributes to agronomic and farming systems R&D and NRM outcomes. Soil biology has a high head-count in the southern region. Soil chemistry has a high head-count in the northern region. Rhizobium and N fixation strongly represented in the western region. Some specialist private providers for soil testing and mapping.	Strong links to agronomists, physiologists, plant nutritionists and pathologists needed to alleviate key soil constraints through farming practices and to support the development of phenotyping capability for genetic improvement programs. There is a long history of products being marketed with unsubstantiated claims of effects on soil processes. Maintaining expertise in this area is important in countering/validating these claims. Will be important contributors to GHG mitigation, carbon sequestration, and climate adaptation RDE
Crop nutrition	21.4	Practices (mainly) Varieties	Traditionally contributes to agronomic production packages. Private sector has substantial skills in the evaluation and deployment of fertilisers. Increasing effort going into breeding crops for increased nutrient use efficiency.	Future improvements in nutrient use efficiency will involve interactions between plant breeding, precision agriculture technology and improved timing of delivery linked to a better understanding of soil capability and seasonal forecasting. Nutrient delivery futures will increasingly interact with issues of energy cost, greenhouse gases, scarcity of raw materials (e.g. P, K) and water quality.
Climate science, variability	10.5	Practices (mainly) NRM Biosecurity	Application to the grains industry represented in all regions. Research is focussed on mitigation and impact; D & E on adaptation strategies. Generic climate science strong in the BoM and CSIRO (outside this audit).	Increasingly important in quantifying climate change in relation to natural variability. Ongoing international engagement with global circulation model refinement and de-convolution will be essential to increase the skills in local short to medium term forecasting required to improve agronomic decision making and support supply chain logistics planning.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
Agricultural engineering, including irrigation	11.2	Practices (mainly) NRM	Strongly represented in the northern region. Skill base in seeding, spraying and harvesting technology has moved to the private sector.	Technology advances increasingly reliant on international R&D.
Precision agriculture technologies	9.9	Practices (mainly) NRM	Involves the application of technology to deliver site-specific management based on spatial variation at a paddock scale. The University of Sydney hosts an Australian Centre for Precision Agriculture. The private sector has strong involvement both in terms of technology development and its deployment.	Dealing with the large amounts of data produced presents technological challenges and requires sophisticated diagnostic skills. Linking increasing technology capability to effective agronomic decision-making remains the challenge.
Grain storage and hygiene	22.6	Supply chain Markets Biosecurity	Specialists strongly represented in the northern region and lead the national program involving other agencies. Strong emphasis on control of storage insects and fumigation technology. CRC Plant Biosecurity involved. Export market standards demand freedom from pests. Increasing on-farm storage is increasing risks from stored insects and grain quality in general (e.g. malting barley). Grain handling companies have technical capability but have limited R&D focus at present.	Insect resistance to phosphine and protectant insecticides is a major concern with limited and expensive alternatives. Engineering solutions as well as chemical options likely to be required. Greater interaction with pathologists and grain quality research likely.
Extension / capability building	76.8	All	Agronomic support functions continue moving to the private sector. Most large producers engage one or more consultants. Grower group networks have strengthened over the past decade.	There will be a wider range of delivery partners and techniques. Public sector investment may contract further with the focus on the integration of biosecurity and NRM issues into farm business decision-making and a greater emphasis on risk management and the key drivers of productivity. The discipline will also continue to support government policy development.

Appendix 3. National grains RD&E expertise and discipline analysis				
Area of Expertise	**Current FTE**	**R&D streams supported**	**Current situation**	**Future industry needs, technology trends & challenges for public and private RD&E providers**
End-product quality, processing, food research	17.5	Markets Varieties	Strongly represented in the western region reflecting the export focus of this region. There is a limited number of grain food technologists trained in Australia.	Specific product development increasingly the domain of private company investment. Public sector focus will remain the genetic understanding of traits and processing technologies to increase the functionality and inherent value of Australian grain in a pre-competitive context. The challenge is to have accurate commercial signals to direct this research. Industry and the R&D community need a strategy to attract and retain small numbers of high quality grain food specialists.
Marketing options / market research (The capability in Austrade not captured in this audit.)	7.6	Markets Varieties Practices	Strongly represented in the western region reflecting the export focus of this region. Private sector has relevant knowledge but in the deregulated environment increasingly holds this in a proprietary context.	There is an ongoing need for accurate pre-competitive market intelligence. Signals need to be channelled back to breeding and pre-breeding and quality researchers but increasingly also to agronomic research groups, growers and supply chain participants.
Economics (The capability in ABARE is not captured in this audit.)	10.8	All	A critical discipline to support robust government policy, public and private RD&E investment strategy, supply chain innovation and farm business management. General trend towards transfer of capability from R&D divisions to policy divisions within PISC agencies. The private sector has more capability but limited groups with extensive agricultural expertise. Growing activity in supply chain economics and analysis at UA but not currently focussed on grains.	Increasing need for shared baseline data on industry productivity and farm business profitability between the public and private sector. Increasing need to identify RD&E investment priorities against the drivers of total factor productivity.