



Australian Government
Rural Research and
and Development Council

National Strategic Rural Research and Development *Investment Plan*



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List of acronyms

ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ABS	Australian Bureau of Statistics
AFF	Agriculture, Fisheries and Forestry
ACIAR	Australian Centre for International Agricultural Research
ACDA	Australian Council of Deans of Agriculture
ARC	Australian Research Council
CGIAR	Consultative Group on International Agricultural Research
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Council	Rural Research and Development Council
DAFF	Department of Agriculture, Fisheries and Forestry
DCCEE	Department of Climate Change and Energy Efficiency
DEEWR	Department of Employment, Education and Workplace Relations
DFAT	Department of Foreign Affairs and Trade
DIISR	Department of Innovation, Industry, Science and Research
DRET	Department of Resources, Energy and Tourism
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
ERA	Excellence in Research for Australia
FAO	Food and Agriculture Organization of the United Nations
ICSU	International Council for Science
IIASA	International Institute for Applied Systems Analysis
OECD	Organisation for Economic Co-operation and Development
PIERD Act	<i>Primary Industries and Energy Research and Development Act 1989</i> (Commonwealth)
PIMC	Primary Industries Ministerial Council
PISC	Primary Industries Standing Committee
PMSEIC	Prime Minister's Science, Engineering and Innovation Council
R&D	Research and development
R&D Corporation	(rural) Research and Development Corporation
RD&E	Research, development and extension
UNESCO	United Nations Educational, Scientific and Cultural Organization

Glossary of terms

Bio-based products	Products derived from land, water and living systems
Bioindustry	Companies producing engineered biological products and their supporting businesses, classified by end market, such as for therapeutics, diagnostics and bio-products for agriculture and bioremediation
Blue-sky	Refers to scientific research in domains where 'real-world' applications are not immediately apparent
Ecosystem services	Benefits obtained by the whole community from the sustainable management and husbandry of natural, renewable resources
Expanded along the value chain	R&D expenditure related to food processing and the processing of non-food agricultural products, chemicals, machinery and equipment
Extension	Communication, information exchange and promotion of learning in order to build capability and change practice
Field of research	ABS classification for categorising R&D activity
Innovation	Implementation of new or significantly improved products (goods or services), operational processes, marketing methods or organisational methods in business practice, workplace organisation or external relations
Intergenerational	Refers to interaction between people of different generations
Levy-based policy instruments	Collection of levies from producers, and some processors, for undertaking rural RD&E
Millennium Development Goals	Eight international development goals that the United Nations (and at least 23 international organisations) have agreed to achieve by 2015, including eradicating extreme poverty, reducing child mortality rates, achieving universal primary education levels, promoting gender equality, fighting disease epidemics, reducing maternal mortality, ensuring environmental sustainability and developing a global partnership for development
National Strategic Rural R&D Investment Plan	A plan developed by the Rural R&D Council to recommend an appropriate balance for ongoing

	and new investment by the Australian Government in rural RD&E
Related to rural	R&D expenditure related to climate change, ecosystem management of land and marine resources, and the control of pests and diseases
Research and development (R&D)	Defined under OECD standards as creative work done systematically to increase the stock of knowledge—including knowledge of man, culture and society—and using this to devise new applications
Rural Research and Development Priorities	A set of priorities established in 1994 and reviewed in 2007 to complement the Australian Government’s National Research Priorities with the aim of fostering innovation and guiding rural R&D effort in the face of continuing economic, environmental and social change
Rural sector	Communities associated with agriculture, fisheries and forestry along the value chain
Socio-economic objective	ABS classification that allows R&D to be categorised according to its purpose or outcome as perceived by the data provider (researcher), consisting of discrete economic, social, technological or scientific domains
Transformational research	Research driven by ideas that stand a reasonable chance of radically changing the understanding of an important existing scientific concept or leading to the creation of a new paradigm or field of science and technology
Triple bottom line	Expanded spectrum of economic, environmental and social values used as a criterion for measuring organisational success over time

Preface

The Minister for Agriculture, Fisheries and Forestry appointed the Rural Research and Development Council (the Council) in 2009 to develop further, in consultation with stakeholders, Australia's research, development and extension (RD&E) vision for the rural sector.

The Council is the Australian Government's key advisory body to provide high-level advice and coordination to target and improve the effectiveness of the government's rural RD&E investment.

Terms of reference

The Council's terms of reference are to:

1. develop a National Strategic Rural Research and Development (R&D) Investment Plan based on an agreed list of national priorities for profitable, globally competitive, sustainable, innovative and adaptable primary industries
2. establish a performance measurement and reporting framework against an agreed list of national priorities¹ and key performance indicators
3. advise on enhancing cross-sectoral, cross-disciplinary, cross-jurisdictional and international cooperation and collaboration
4. advise on improving communication and uptake of new knowledge and technology across all rural industries and at all scales of enterprises
5. foster innovation as integral to the culture of rural communities and industries
6. foster the capacity building in the rural R&D sector to ensure Australia is prepared for challenges to global competitiveness, productivity, adaptability and sustainable development into the future; including challenges associated with climate change
7. advise on any other matters relating to rural R&D referred to it by the Minister.

This document pertains to the first two terms of reference. Terms of reference 3–7 are ongoing and are separately reported at www.daff.gov.au/agriculture-food/innovation/council.

Council members

Chair:	Dr Kate Fairley-Grenot
Members:	Professor Rob Clark AM
	Ms Cathy McGowan AO
	Mr Mark McHenry
	Professor Jim Pratley
	Dr Robert Rose
	Dr Frances Shapter
	Mrs Anne Stünzner
	Professor Beth Woods OAM
	Chief Scientist for Australia (ex-officio)

¹ To avoid confusion with the already established Rural Research and Development Priorities, the Council has developed a list of national goals rather than priorities. An explanation of how the Council's goals (distilled into five themes) interact with the Rural Research and Development Priorities is contained in Box 3.

Chair's introduction

Australia's globally-competitive, export-oriented rural sector has a short history and a long future.

The sector has been built on a foundation of strong technical performance.

Farm sector investment in research has been deliberate and sustained.

Rural value systems assign a high degree of importance to research and associated enterprise.

This is an enviable starting position for a Rural Research and Development Council.

However, no assumption should be made about the on-going competitiveness of Australian rural research and development in a rapidly changing global innovation environment.

Neither should any assumption be made about the adequacy of current investment relative to the cost of addressing long-term challenges for rural Australia that require technically-derived solutions.

Rather, every effort should be made to better secure and enhance the substantial capability that enables our rural sector to develop, access and apply world-class, adaptive knowledge.

This Plan presents five thematic areas for on-going maintenance. It respects the high level of ownership that rural Australia has in 'it's system' and seeks to preserve this, placing traditional investment at the core of expansion.

I count it a privilege to have chaired Australia's first Rural Research and Development Council.

I gratefully acknowledge the support of the Minister, the work of my Council colleagues, our Secretariat and others at the Department of Agriculture, Fisheries and Forestry, and contributions to this Plan from the leadership community that surrounds us.



Dr Kate Fairley-Grenot
Chair
Rural Research and Development Council

Plan structure and development

The National Strategic Rural R&D Investment Plan outlines a rationale for balancing Australian Government investment in rural RD&E, details the current level of investment and offers a vision for the rural RD&E system. The Council asserts that strategic investment is required and the Plan identifies five themes against which investment should be determined. The Council suggests an initial investment balance, recognising the need for flexibility in the future. Finally, the Council presents a conceptual framework for monitoring and reporting on the performance of the rural RD&E system and discusses institutional arrangements that draw together its complex array of investors, research providers and stakeholders.

Key findings and recommendations highlight challenges for the current rural RD&E system and provide signposts to direct future Australian Government rural RD&E investment.

How the Plan has been developed

The Council notes that there are many existing processes and institutions delivering or assessing specific elements of the rural RD&E system. Recognising this, the Council has taken a high-level view of the rural RD&E system and has developed overarching investment themes for application to the system as a whole.

The Plan is underpinned by data gathered from a wide range of sources. The Council notes shortcomings in data availability and has consulted extensively to further inform its thinking on the future direction of Australian Government investment in rural RD&E.

During the Plan's development, the Council:

- commissioned three studies: a retrospective study of rural R&D policy in Australia; a review of international rural R&D drivers; and a report on productivity, R&D and innovation
- conducted a web-based stakeholder survey in January 2010. Seventy-two stakeholders responded with views about how best to encourage investment and allocation of resources to meet challenges such as climate change, food security, international competitiveness, and labour and skill shortages
- facilitated two stakeholder workshops in March and April 2010 on international and education issues
- hosted two rural R&D leadership discussions in August and November 2010 that included representatives from the Council of Rural Research and Development Corporations, the Primary Industries Standing Committee RD&E Sub-Committee (for its work on the National Primary Industries RD&E Framework), CSIRO, the Australian Centre for International Agricultural Research, the Rural Industries Research and Development Corporation, and the Department of Agriculture, Fisheries and Forestry
- presented at and participated in conferences, including the 2009 Australian Academy of Science Theo Murphy Forum, the 2009 - 2011 ABARE(S) Outlook conferences, the 2010 Australian Farm Institute conference and the 2011 Australian Agricultural and Resource Economics Society annual conference
- reviewed statutory and industry-owned R&D Corporations' Annual Operating Plans in 2009 and 2010, giving consideration to R&D Corporations' five-year strategic plans, the national Rural R&D Priorities and emerging themes at Council level

- made recommendations to the Minister for Agriculture, Fisheries and Forestry regarding projects funded under the FarmReady Industry Grants program, the Climate Change Research Program and the Forest Industries Climate Change Research Fund
- commissioned a consultant in July 2010 to assist in the early development of a performance measurement and reporting framework
- attended ten Council meetings and invited presentations from stakeholders such as the Australian Government Department of Innovation, Industry, Science and Research, the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) and the National Farmers' Federation.

Based on the processes described above, the Council produced a Draft Plan that was released for public consultation in January 2011. Thirty-two stakeholder submissions were received. The comments provided in these submissions have been valuable in finalising the Plan. The Council has addressed issues raised by stakeholders where possible, with a focus on the current and future state of the whole rural RD&E system.

Executive Summary

This National Strategic Rural R&D Investment Plan is intended to provide high-level strategic direction and coordination to a diverse rural RD&E system. The system is estimated to have an annual turnover of about \$2.9 billion across the agriculture, fisheries and forestry sector, its value chain, and in areas related to the rural sector more broadly. The Council emphasises that it is crucial to consider this wider system in determining priorities and areas of investment for rural RD&E. The wider system includes traditional agricultural research as well as research in other areas, for example new chemicals, technology improvements or more effective environmental management practices.

Rationale for change

In the coming decades, Australia's rural sector will face considerable challenges, including climate change and the need to concurrently increase productivity and sustainability to respond to rising global demand for food while maintaining the resource base for future generations.

Meeting these challenges will require long-term transformation of the rural sector, defined broadly to include communities associated with agriculture, fisheries and forestry as well as related industries along the value chain. Every effort should be made to better secure and enhance the substantial capability that enables our rural sector to develop, access and apply world-class, adaptive knowledge.

Rationale for change

Findings

1. Australia's rural RD&E system, defined broadly, has an annual turnover of about \$2.9 billion and represents about 10 per cent of the national innovation system. This comprises \$1.1 billion in the 'agricultural, fisheries and forestry' (AFF) component of the system, \$1 billion in the 'expanded along the value chain' component and a further \$0.8 billion in the 'related to rural' component.
2. The rural RD&E system's diversity is a strength, however, its complexity and fragmentation make cohesive responses to emerging opportunities and risks challenging.
3. There is evidence that rural sector productivity growth is slowing in Australia and other developed countries. Continued productivity growth in the rural sector will be an important source of economic growth for Australia in the future.
4. RD&E underpins productivity growth and sustainable development in the rural sector. Any slowdown in the growth of public funding for RD&E is of concern because of the time lag between research expenditure and desired outcomes, risking a contraction of benefits in the medium term.
5. With an ageing research workforce and evidence of an increasing skills deficit, there may already be insufficient capacity in the rural sector to develop and adopt innovations at the desired rate.

Vision

The Council proposes the following 'big vision' for rural RD&E: that the rural RD&E system will play an important role in:

- contributing to the national economy by enabling Australia to play its part in the global effort to double rural sector output over the next 30 years while utilising proportionally fewer resources
- developing a range of technologies and knowledge to contribute to healthy Australian lifestyles and global food security
- producing a wider product range, including food, fibre, energy and bio-based products, in addition to ecosystem services.

For the rural sector to achieve these outcomes, the Council believes the Australian Government's investment in rural RD&E must be better understood and targeted. The system will need further development and an increased focus on international collaboration to share knowledge. The Council recommends allocating resources to maximise opportunities and minimise the likelihood, or impact, of adverse events.

Vision
Recommendation 1. The Council recommends increased investment, including by the Australian Government, in rural RD&E to: enable Australia to play its part in the global effort to double rural sector output over the next 30 years while utilising proportionally fewer resources; develop a range of technologies and knowledge to contribute to healthy Australian lifestyles and global food security; and produce a wider product range, including food, fibre, energy and bio-based products, as well as ecosystem services.

Investment goals and key themes

The Council has determined the following investment goals:

- facilitate ongoing industry development and adaptation to change through RD&E
- leverage innovation for growth along value chains, with greater sharing-of-risk and reduced reliance on natural resources
- integrate natural resource management with production systems to use natural resources more efficiently
- use improved modelling and scenarios to analyse and plan for climate change, build understanding, and develop adaptation practices and resilient systems
- build capability through high quality education and training
- reward and retain world-class researchers through commitments above current investment levels
- develop social research and tools that enable rural communities to embrace change, adopt new technologies and manage the impact of change
- develop elite genetic resources, emerging technologies and multidisciplinary capability for application to rural problems and opportunities
- invest in, and in some cases accelerate the development of cross-sectoral RD&E strategies such as those relating to bioenergy, bio-based products, food and nutrition
- develop systematic links, and collaborate, with leading international groups to improve access to funds, markets and knowledge that can address common Australian and global needs.

Following consultation with stakeholders, these goals have been distilled into five RD&E investment themes.

Investment themes
Recommendation 2. The Australian Government should adopt five themes under which investment in rural RD&E will be made: industry development, sustainable production, transformational RD&E, capacity in people and international links.

Industry development and sustainable production are viewed as interdependent and influenced in the longer term by transformational RD&E. People are considered central to the system because it is through their initiative, innovation and motivation that rural RD&E will be relevant and effective in the long term. International links encompass the other themes, recognising that many challenges facing Australia's rural sector are global and that Australian researchers are, and must continue to be, active participants in international research networks.

Theme 1: Industry development
Findings 6. The rural R&D Corporation investment model is an essential element in the AFF component of the rural RD&E system with its strong focus on achieving productivity growth in established industries. 7. New and emerging industries in the AFF component of the rural RD&E system are mostly managed by the Rural Industries R&D Corporation and will continue to require core government funding. 8. The National Primary Industries RD&E Framework is central to improving the efficiency and effectiveness of rural RD&E across different levels of government, industry, CSIRO, CRCs and higher education institutions. 9. There is potential for business sector investment in Australia's rural RD&E system to grow; current levels are low compared with other OECD countries.
Recommendations 3. The Australian Government should continue its support for the rural R&D Corporations model as a critical component of the National Primary Industries RD&E Framework and commit to ongoing support for both of these elements in the transfer of system-wide knowledge to effective rural sector networks. Additional funding mechanisms should be developed with the private sector to support other rural industries in pursuit of the vision set out in this Plan. 4. The Australian Government should invest in conserving the genetic diversity of major socio-economically significant species and associated knowledge, in addition to continuing its support for international efforts to conserve germplasm, including in relation to biodiversity.

Theme 2: Sustainable production
<p>Finding</p> <p>10. Australia’s innovation system is responding to cross-industry issues relating to sustainability. The Agriculture, Fisheries and Forestry portfolio is well placed to foster active engagement by the rural RD&E system in these efforts.</p> <p>Recommendation</p> <p>5. The Australian Government should improve coordination of and collaboration in RD&E initiatives that inform the management of land, water, marine and other natural resources to achieve sustainable outcomes for current and future generations.</p>

Theme 3: Transformational RD&E
<p>Findings</p> <p>11. Growth in bio-based production will increase the flow of capital into the rural sector, creating significant opportunities.</p> <p>12. Australian Government involvement in transformational RD&E, including the development of emerging industries, will cross portfolios other than the Department of Agriculture, Fisheries and Forestry.</p> <p>Recommendation</p> <p>6. The Australian Government should ensure that policy settings encourage the rural sector to participate actively in new business opportunities, including those related to bio-based production.</p>

Theme 4: Capacity in people
<p>Finding</p> <p>13. There are generally lower levels of formal education and training in the rural sector than in other sectors of the economy, leading to the risk of skill underdevelopment and reduced capacity to develop, adapt to and implement innovation.</p> <p>Recommendations</p> <p>7. The Australian Government should apply its rural research funds in ways that value research excellence as well as research impact, and raise the profile of agriculture, fisheries and forestry within the broader research community.</p> <p>8. The Australian Government should invest in initiatives to increase the rural sector’s utilisation of technical knowledge, better equipping it for global competitiveness, productivity, adaptability and sustainable development.</p>

Theme 5: International links
<p>Finding</p> <p>14. While Australia's rural sector has struggled to attract R&D financing from abroad, our rural research community has significantly supported R&D in other, generally less developed, countries.</p> <p>Recommendations</p> <p>9. The Australian Government should build strategic international links and strengthen the capacity of existing networks to contribute to international efforts to address climate change and sustainably produce food, fibre and renewable energy.</p> <p>10. The Australian Government should encourage industry and researchers to strengthen links that increase the flow of international capital into Australia's rural RD&E system.</p>

The Council considers that these five investment themes are broadly consistent with the Australian Government's Rural Research and Development Priorities (2007): productivity and adding value; supply chain and markets; natural resource management; climate variability and climate change; biosecurity; innovation skills; and technology. The priorities are particularly important in guiding the research investments of the rural R&D Corporations. The Council's proposed investment themes are not intended to replace or duplicate these priorities. Rather, they are intended to guide strategic investment across the rural RD&E system as a whole, encompassing agriculture, fisheries and forestry RD&E, as well as RD&E in 'expanded along the value chain' and 'related to rural' areas.

Proposed investment balance

Based on analysis of the rural RD&E system and stakeholder feedback, the Council recognises the leading role that transformational RD&E will likely play in ensuring increased rural productivity and sustainability, while maintaining the resource base for future generations. The Council therefore proposes that 40 per cent of the investment should be directed to transformational RD&E. The Council proposes that 30 per cent of RD&E investment should be directed to industry development and sustainable production, reflecting the need for near-term adjustment to achieve mid-term outcomes including improved productivity growth and competitiveness. Ongoing RD&E investment in the enabling themes of 'capacity in people' and 'international links' (20 per cent and 10 per cent respectively) will support the achievement of both mid- and long-term outcomes.

Stimulus will be required when data indicate that the investment portfolio needs to be adjusted to achieve balance. As new information and data become available, further judgement should be applied in consultation with others.

Investment balance
<p>Finding</p> <p>15. The National Strategic Rural R&D Investment Plan will, in consultation with stakeholders, build an appropriate investment profile across the rural RD&E system.</p> <p>Recommendation</p> <p>11. To achieve the Council’s vision for rural RD&E, the initial balance of investment across the rural RD&E system should be:</p> <ul style="list-style-type: none"> • 40 per cent: transformational investment for long-term outcomes • 30 per cent: near-term adjustment for mid-term outcomes • 20 per cent: capacity building in people • 10 per cent: international linkage.

Performance measurement and reporting framework

The Council has commenced the development of a performance measurement and reporting framework for Australia’s rural RD&E system. The framework has four components:

- broad measures of rural R&D system achievement
- performance indicators for the five investment themes
- comparison with global rural and other Australian RD&E systems
- indicators of internal risks to which the rural RD&E system can respond.

Success of the performance measurement and reporting framework depends on data availability, governance and adequate resources. Evaluating the ‘triple bottom line’ returns from investment in rural RD&E will be critical to guiding future investments and meeting accountability requirements. Decision-support systems will be required to manage the variability associated with rural sector information.

Performance measurement and reporting
<p>Finding</p> <p>16. The availability of data for monitoring and reporting trends and performance of the rural RD&E system in Australia is severely limited.</p> <p>Recommendation</p> <p>12. The Australian Government should invest immediately in increased data collection to support the measurement of the rural RD&E system performance. This includes allocating resources to analyse data requirements and existing and new sources of data, and to communicate findings clearly. The first of a regular series of rural RD&E system reports should be prepared urgently using the Council’s proposed performance measurement and reporting framework.</p>

Institutional arrangements

Given the complexity of the rural RD&E system, many of the Plan's recommendations go beyond the direct influence of one minister and can only be addressed through collaboration with other Australian Government ministers and departments, state governments and the business sector.

The Council believes that system-wide leadership is required to provide focus and to help position rural RD&E investment within the broader national and international innovation system. Notwithstanding the importance of the business sector, a whole-of-government approach is required given the number of portfolios with an interest in rural RD&E.

There should be enduring provision for a system-wide entity to implement and oversee the Plan on behalf of the Australian Government, reporting in the first instance to the Minister for Agriculture, Fisheries and Forestry.

Institutional arrangements
Recommendations 13. The Australian Government should endorse the first National Strategic Rural R&D Investment Plan. 14. The Australian Government should ensure adequate provision for the maintenance and implementation of the Plan by endorsing a key advisory body to guide more effective multi-sector cooperation and the prioritisation of Australian Government investment in RD&E for Australia's rural industries.

Part 1 – Introduction

Part 1 sets the scene for the National Strategic Rural R&D Investment Plan. The Council notes the challenges and opportunities to be faced by the rural sector in coming decades and current levels of investment across the rural RD&E system in Australia, including activities along the value chain and in other areas that are relevant to the rural sector. Based on its assessment of the current situation and future challenges, the Council introduces a vision for rural RD&E and five themes against which investment should be made.

Part 2 of the Plan includes further detail about the investment themes, investment balance, and performance measurement and reporting framework proposed by the Council.

Rationale for change

Contributing to economic, social and environmental prosperity

The rural sector is defined broadly in the Plan to encompass the communities associated with agriculture, fisheries, forestry, and related industries along the value chain. It underpins the economic, social and environmental prosperity of Australia's rural and regional communities.

The sector generates considerable export revenue for Australia, valued in 2008–09 at more than \$34 billion and almost 20 per cent of total merchandise exports (ABARES 2010a). It supplies the bulk of Australia's fresh food.

The rural sector also makes a valuable contribution to the broader community through the production of fibre and renewable energy, the sustainable management of Australia's land, water and marine resources, and the generation of wealth (Box 1).

Box 1: Australia's rural sector

Management of environmental assets

- The rural sector manages about 60 per cent of Australia's 7.6 million square kilometres.
- The sector is responsible for the 10.2 million square kilometre exclusive economic zone for wild caught fisheries and a growing aquaculture industry.
- The agriculture, fisheries and forestry industry accounted for 7097GL (50 per cent) of total Australian water consumption in 2008–09.

Community

- 7.7 million people, about one-third of Australia's population, live in rural and regional Australia.
- 28 per cent of people in rural areas undertake voluntary work, compared with the national average of 20 per cent.
- The rural sector employs a culturally diverse workforce:
 - Indigenous Australians account for 1.3 per cent of employees in agriculture, fisheries and forestry
 - women are estimated to contribute almost half of the total value, including on-farm, off-farm, household and community work, of output attributed to farming communities.

Contribution to the Australian economy

- The farm-dependent economy accounts for about 12 per cent of gross domestic product.
- The farm-dependent economy accounts for about 17 per cent of national employment.
- Rural industries provided 14 per cent of exports of Australian goods and services in the drought-affected four-year period to 2008–09.
- Between 1974–75 and 2007–08, the AFF industries achieved 2.8 per cent annual productivity growth – double the national average of 1.4 per cent – accounting for 18 per cent of market sector productivity growth.

Sources: ABARES 2010b, ABS 2010a, ABS 2010c, ABS 2008, ABS 2007, BRS 2008, DAFF 2010, DAFF 2004, NFF 2009, Sheridan and McKenzie 2009, Symonds *et al* 2009.

Through a combination of trade and development assistance, rural sector activities also directly contribute to geopolitical stability in the region. This includes trade in agricultural commodities that can reduce short-term price volatility in neighbouring countries, as well as international aid in the form of collaborative agricultural systems research to improve regional food security and adaptation to climate change in the longer term.

Action is required now

In the coming decades, Australia's rural sector will face considerable challenges, including climate change and the need to concurrently increase productivity and sustainability to respond to rising global demand for food while maintaining the resource base for future generations. In the absence of significant and coordinated technological innovation to address this combination of challenges, there is a risk of Australia weakening its current position as a stable exporter of high-quality primary inputs.

Meeting these challenges will require long-term transformation of the rural sector, defined broadly to include communities associated with agriculture, fisheries and forestry as well as related industries along the value chain. Every effort should be made to better secure and enhance the substantial capability that enables our rural sector to develop, access and apply world-class, adaptive knowledge.

Climate change is projected to result in a range of impacts across the rural sector, including less water availability in many farming regions, hotter conditions across parts of the country, more extreme weather events, and changes in the prevalence of pests and diseases. Food and farming systems in Australia will need to be resilient in response to these challenges (PMSEIC 2010a, Campbell 2009). Domestically, water markets and plans to increase water allocated for environmental purposes, particularly in the Murray–Darling Basin, will carry significant implications for irrigated agriculture. There is also growing demand for water in urban centres, including for use in energy production (PMSEIC 2010a).

'The agriculture, fisheries and forestry industry' was the largest user of water in 2008–09, accounting for 50 per cent of total Australian water use² (ABS 2010c). This generated on average \$4 million in gross value for every gigalitre of water consumed—an increase of 16 per cent since 2004–05, but well below the average for all other industries as defined in the national water accounts.

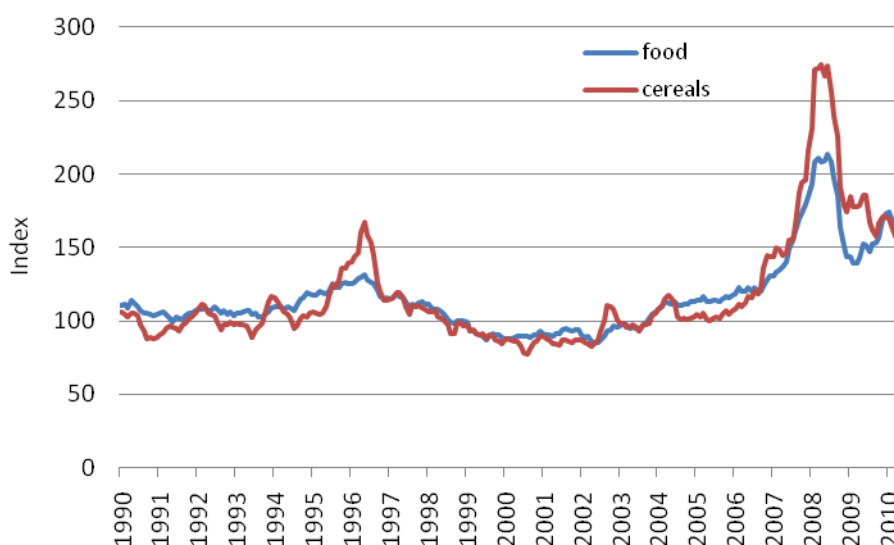
Agriculture is a significant source of greenhouse gas emissions and was responsible for an estimated 15 per cent of total greenhouse gas emissions in Australia in 2008. Land use, land use change and forestry are estimated to account for a further 5 per cent of national emissions (DCCEE 2010). Since 1990, emissions from land use, land use change and forestry have declined significantly, while emissions from agriculture and other sectors of the economy have continued to increase on average.

The rural sector may become a supplier of large carbon sinks through the management of terrestrial and marine resources. Opportunities include innovative management practices on cropped and grazed lands sequestering carbon in soils, afforestation for timber and to sequester carbon, and also the use of farmed algae (saline and non-saline) to convert carbon dioxide from the air into stable carbohydrates (ABS 2010a, Garnaut 2008).

² Excludes aquaculture

In recent years world food prices have become significantly volatile (Figure 1). Prices of cereal commodities, especially rice, have been particularly variable. Some governments have reduced the volume of food traded in international markets through export restrictions and this has recently been correlated with an increase in price volatility (Anderson 2010). The prices of some inputs have also increased significantly. Between 2007 and 2008, the price of phosphate and urea-based fertilisers roughly doubled and remained high throughout 2009 (ABARE 2009). Rapid income growth in Asia, together with biofuels subsidies and mandates, has increased demand for fibre, renewable fuel and food. These trends in both commodity prices and inputs are expected to continue into the medium term. Collectively, they raise serious questions about the long-term domestic affordability and security of food (PMSEIC 2010b).

Figure 1: Trends in world food prices



Source: Food and Agriculture Organization of the United Nations (www.fao.org)

Robust projections of future demand for, and supply of, food, fibre and renewable energy – including the FAO’s assertion that ‘expanding populations and changing eating habits will make a doubling of food output imperative within the next thirty years’ (Halwart *et al* 2003) – highlight the timeliness of a ‘big vision’ for rural RD&E. Notwithstanding the need to produce more from less in the coming decades, there will be physical limits to efficiency improvement.

The coming decades will present opportunities as well as challenges for Australia’s rural sector—for example, to expand into new high-value markets as consumer demands evolve globally. It remains feasible that if Australia invests in innovation today, it could lead the world in the productive and sustainable management of agriculture, fisheries and forestry resources and significantly contribute to increased global food, fibre and energy security.

Australians appear to have increasing expectations that food, fibre and renewable energy production will deliver broader benefits to society in terms of sustainable resource management and utilisation, the safety and nutritional value of food, animal welfare, and solutions to climate change.

Several changes are already occurring, including increased international attention to bio-based production³ in the energy and manufacturing sectors as a replacement for petrochemical inputs. In the fishing industry there are particular challenges due to limits on wild catch fisheries. Harvesting of low-trophic marine organisms which feed on renewable plant foods such as phytoplankton and seaweeds may become increasingly important to an industry geared to high-trophic species already at their maximum sustainable yield.

Going forward, the needs and contributions of producers and processors must be considered in parallel with those of the broader community so that RD&E can play a pivotal role in rural sector adjustment. Specifically, the Council asserts that:

- rural RD&E investment planning should take into account beneficiaries across the Australian community
- mechanisms that recognise the specific needs and contributions of rural value chain partners should be preserved
- greater recognition should be given to the role of social and international capital in Australia's rural RD&E future.

³ Bio-based production: Production derived from land, water and living systems.

Current levels of investment in rural research, development and extension

Australia's rural RD&E system has evolved since European settlement, when the country's natural resources were assessed as favourable to support migration. The first scientific institution in Australia was established in 1832 to catalogue collections, including specimens collected by Banks in the 1770s. A brief 100-year history of the Australian RD&E system is provided in Box 2.

Box 2: A century of rural RD&E

The importance of rural industries to generate wealth for a growing population has been recognised for some time in Australia. European settlement in Australia occurred on the basis of favourable assessments of natural resources to support migration and the country's first scientific institution was established in 1832 to catalogue collections.

Several state governments and universities established research programs during the 1800s. During this period, and into the early 1900s, there were also philanthropic commitments and precursors to the commodity councils that represented industry interests, including research interests.

National institutionalised RD&E began in Australia in 1916, when the Australian Government established the Advisory Council of Science and Industry, chaired by the Prime Minister, William Hughes. In 1920, the Council was replaced by the Commonwealth Institute of Science and Industry, and further changes were made in 1926 to create the Council for Scientific and Industrial Research, which became CSIRO in 1949. Today, CSIRO is Australia's largest national science agency, delivering science and innovative solutions for industry, society and the environment.

In 1945, the Bureau of Agricultural Economics was established. In 1987 it became the Australian Bureau of Agricultural and Resource Economics (ABARE), with a brief to undertake economic research and analysis for agriculture, resources and energy. In 2010, ABARE merged with the Bureau of Rural Sciences (becoming ABARES), with a brief to provide integrated economic and scientific analysis to address issues facing Australia's primary industries.

The Department of Agriculture, Fisheries and Forestry (established as the Ministry for Primary Industries and Energy in the 1950s) works with governments, nations, trading partners and industry sectors to develop and implement policies and programs that ensure Australia's agriculture, fisheries, food and forestry industries remain competitive, profitable and sustainable.

The Australian Centre for International Agricultural Research (ACIAR) is also a key provider in the rural RD&E system. ACIAR was established in 1982 to encourage research to identify, or find solutions to, agricultural problems in developing countries.

The Australian Government introduced the R&D Tax Concession in 1986 to increase industry research and development. It is broadly based and not industry specific, with companies deciding on the scope and timing of the R&D and then claiming deductions for eligible expenditure.

Established in 1989 under the *Primary Industries and Energy Research and Development Act 1989 (Cwlth)*, the rural R&D Corporations enable a joint industry-government approach to R&D and innovation to improve productivity and quality on behalf of producers and processors.

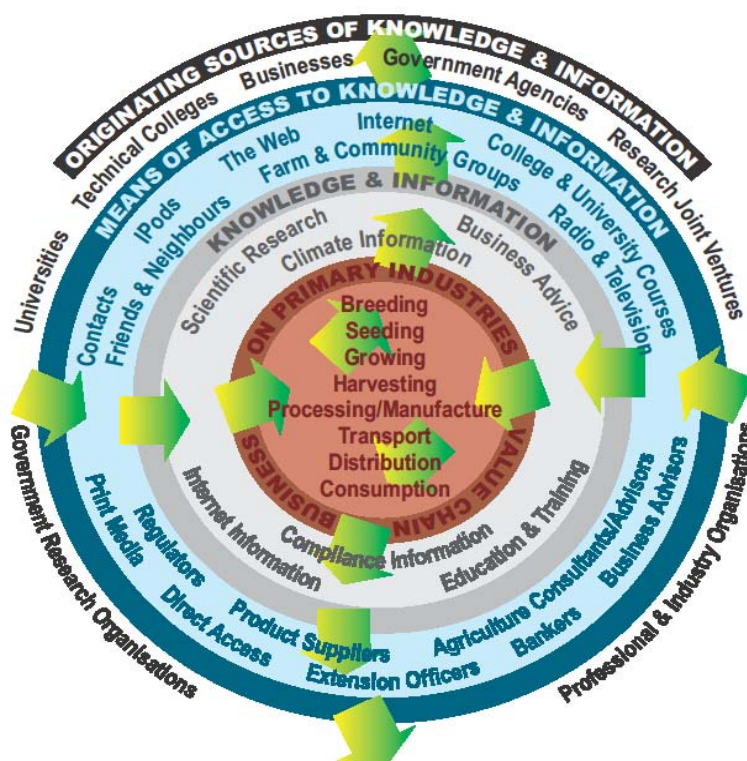
The National Primary Industries RD&E Framework was endorsed by the Primary Industries Ministerial Council in 2009 to improve rural RD&E efficiency and effectiveness across different levels of government, industry, CSIRO, Cooperative Research Centres (CRCs) and higher education institutions.

Other organisations, such as the Office of the Chief Scientist, the Australian Research Council (ARC) and the CRCs, have also contributed considerably to rural RD&E system-building activities.

A complex system

The rural RD&E system is now highly complex. There are many investors and research providers, making it difficult to specify the scope of the system. Figure 2 illustrates the complexity and the range of information sources that flow through the system.

Figure 2: Information sources in the rural RD&E system



Source: PISC RD&E Subcommittee Extension Working Party 2010

The Council believes that consideration of current and future levels of investment in rural RD&E must not only take into account the 'traditional' investment in agricultural research, but also

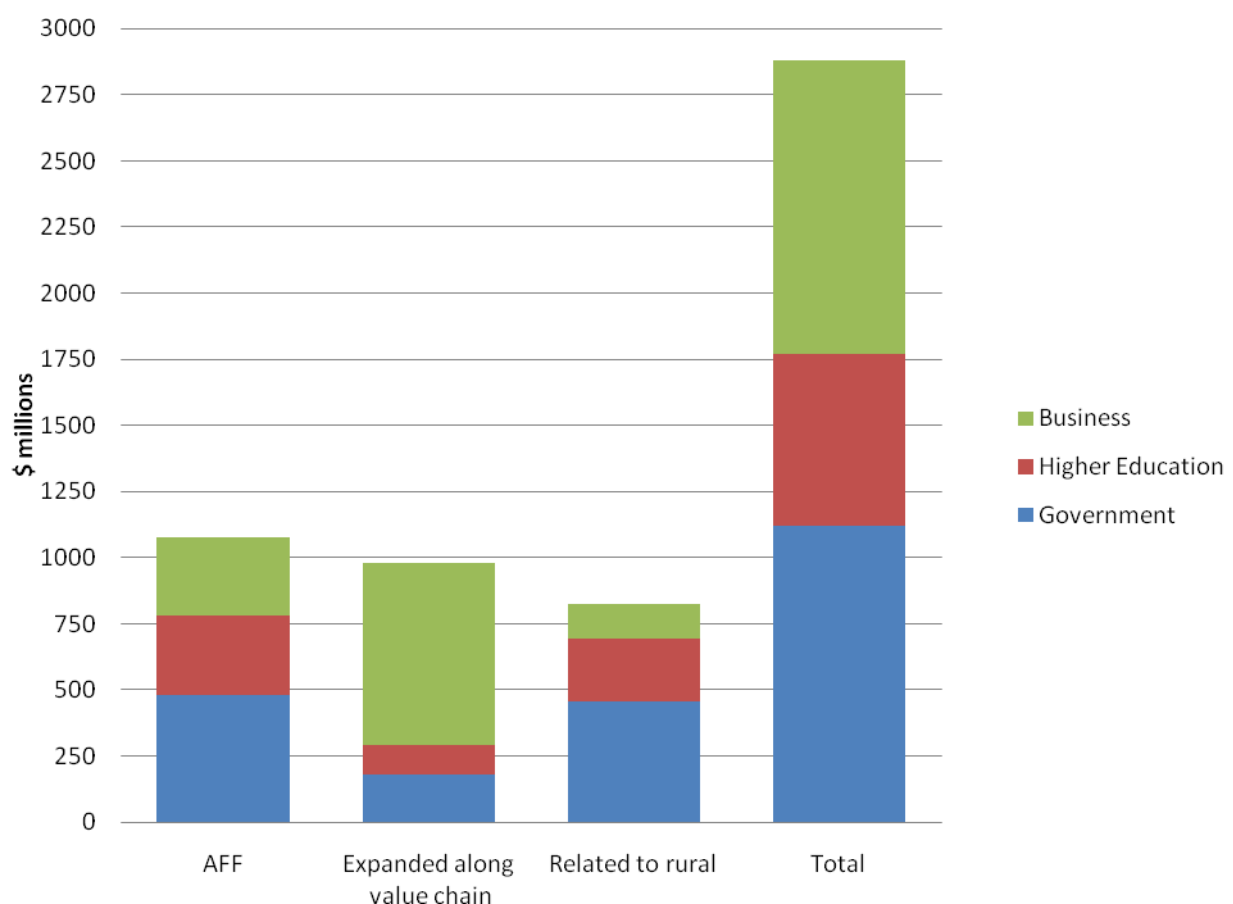
research that occurs in related areas, for example new chemicals, technology improvements or more effective environmental management practices.

Analysis of ABS data on research and experimental development suggests that expenditure in 2008–09 on R&D relating to the agricultural, fisheries and forestry (AFF) sector was \$1.1 billion, representing about 4 per cent of the \$27 billion expenditure on innovation across the entire Australian economy that year (Figure 3, Tables 1 and 2).

By defining the rural sector broadly to include rural industries along the value chain, it is estimated that further expenditure of about \$1 billion occurred in 2008–09 on R&D related to food processing; processing of non-food agricultural, fisheries and forestry products; agricultural chemicals; and machinery and equipment. These activities are included in the Council’s ‘expanded along the value chain’ definition of the rural RD&E system.

It is estimated that in 2008–09 a further \$0.8 billion expenditure occurred in R&D activities ‘related’ to the rural sector, principally in environmental sciences related to climate change, ecosystem management of land and marine resources, and control of pests and diseases.

Figure 3: Expenditure related to rural R&D, 2008–09



Source: ABS Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09 (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0)

Council finding 1

Australia's rural RD&E system, defined broadly, has an annual turnover of about \$2.9 billion and represents about 10 per cent of the national innovation system. This comprises \$1.1 billion in the 'agricultural, fisheries and forestry' (AFF) component of the system, \$1 billion in the 'expanded along the value chain' component and a further \$0.8 billion in the 'related to rural' component.

In the AFF component of the system, R&D expenditure is undertaken by all three sectors: business, government and higher education (Table 1). The government's contribution is especially significant in the 'related to rural' component, while the business sector dominates expenditure in the 'expanded along the value chain' component.

Table 1: Rural R&D expenditure in Australia, 2008–09

	Government	Higher education	Business	Total
	\$m	\$m	\$m	\$m
Agriculture, Fisheries and Forestry	479.7	301.8	294.9	1,076.4
Expanded along the value chain	180.8	110.2	688.9	979.9
Related to rural	457.6	237.1	130.0	824.8
Total expenditure	1,118.1	649.2	1,113.8	2,881.1

Source: ABS Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09 (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0)

From an Australian Government perspective, the categorisation of the rural RD&E system into these three components highlights the need for the Minister for Agriculture, Fisheries and Forestry and portfolio agencies to work collaboratively with other Australian Government ministers and departments, state governments and the business sector to achieve outcomes across the full spectrum of the system. From a practitioner's perspective, the complexity of the system presents both opportunity and the risk of inefficiency.

Council finding 2

The rural RD&E system's diversity is a strength, however, its complexity and fragmentation make cohesive responses to emerging opportunities and risks challenging.

Table 2 shows the breakdown of the \$27 billion spent by government, higher education and business on R&D across all socio-economic objectives in 2008-09.

Table 2: R&D expenditure in Australia, 2008–09

	Government	Higher education	Business	Total
	\$m	\$m	\$m	\$m
Rural ^a	1,118.0	649.2	1,113.8	2,881.1
Mineral and energy resources ^b	253.2	221.4	5222.5	5,697.1
Health ^b	543.7	2,347.4	436.8	3,327.9
Defence ^b	486.0	55.4	259.4	800.8
Information and communication services ^b	156.9	220.3	2,035.5	2,412.7
Other ^b	862.6	3,223.5	7,790.5	11,876.6
Total expenditure	3,420.5	6717.1	16,858.5	26,996.1

^a Rural sector expenditure as defined by the Rural R&D Council, including 'agriculture, fisheries and forestry', 'expanded along the value chain' and 'related to rural' components. Sources: ABS Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09 (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0).

^b Source of other data: ABS Research and experimental development, by socio-economic objective, all-sector summary, Australia, 2008–09 (cat. no. 8112.0).

RD&E underpins productivity growth

An estimated 65 per cent of per capita economic growth in Australia over the past four decades can be attributed to increased productivity (DIISR 2010). The *2010 Intergenerational Report* identifies productivity growth (the production of more output from the same or fewer inputs) as critical to Australia's long-term prosperity and security given the ageing and growing population living in an environment vulnerable to climate change (Commonwealth of Australia 2010).

The rural sector has made a significant contribution to this economic achievement. Its productivity growth has typically exceeded that achieved by most other market sectors and could play an increasingly important role following any downturn in the resources boom. The ABS estimates that the agriculture, fisheries and forestry industries achieved average annual productivity growth of 3 per cent between 1985–86 and 2005–06. In contrast, the average for the market sector in total was just 1.2 per cent over the same period (ABS 2007). Similar patterns have been observed in other developed countries, including the United States, Canada and the United Kingdom (EU KLEMS 2008).

However, there is evidence of a slowdown in the rate of this growth in Australia and in other developed countries (Sheng *et al* 2010). This is disturbing when a period of global abundance of agricultural products appears to be ending (James *et al* 2008). There is thus growing interest in confirming the extent of this slowdown and identifying the contributing factors.

There is concern that slowing productivity growth in agriculture is caused in part by a slowdown in the growth of public spending for RD&E in many countries (Pardey and Alston 2010). A decline in broadacre productivity growth in recent years has been linked to decreased investment in RD&E (Nossal and Sheng 2010).

Recent ABARES research has identified five enablers of productivity growth for Australian agriculture: development of new knowledge and technology; facilitating innovation by improving the incentives for, and capability of, industry to adopt new knowledge; removal of regulations or other impediments that stifle innovation; improvements to market access; and enabling expansion while minimising the use, and any degradation, of natural resources (Nossal and Gooday 2009).

At a minimum, there has been a clear shift in focus in public funding of rural R&D from productivity growth to the pursuit of broader objectives, such as environmental and biosecurity outcomes. In several developed countries there is evidence that public sector agricultural RD&E is being scaled back or is slowing down (James *et al* 2008).

Council finding 3

There is evidence that rural sector productivity growth is slowing in Australia and other developed countries. Continued productivity growth in the rural sector will be an important source of economic growth for Australia in the future.

Increased RD&E investment will improve agricultural productivity and equip the sector to deal with future challenges (PMSEIC 2010b). RD&E contributes to productivity growth by enabling high-performing rural businesses to adopt new technologies and more efficient farming systems and expand the production frontier. Over time, further productivity growth occurs through the second tier of rural businesses adopting currently available technology and ‘catching up’ to the best-performing businesses (Gray *et al* 2011). Given the established relationship between technological strength and industrial performance (Abramovitz 1986; Freeman and Louca, 2001; Ward and Devereux 2003), evidence of any reduction in expenditure on rural RD&E is a great concern if Australia wishes to remain a globally competitive producer of rural products.

Council finding 4

RD&E underpins productivity growth and sustainable development in the rural sector. Any slowdown in the growth of public funding for RD&E is of concern because of the time lag between research expenditure and desired outcomes, risking a contraction of benefits in the medium term.

The government has identified an expected shortfall in qualified researchers as a risk to achieving its vision for Australia’s innovation system, as set out in *Powering Ideas: an innovation agenda for the 21st Century* (DIISR 2009). The rural sector is not exempt from this trend, with analysis indicating an increasing skills deficit and an ageing rural research workforce (Allen Consulting Group 2010).

Council finding 5

With an ageing research workforce and evidence of an increasing skills deficit, there may already be insufficient capacity in the rural sector to develop and adopt innovations at the desired rate.

The ramifications of a decline in investment in rural RD&E and in training a research community are not expected to be fully felt in the short term. It is well established that considerable time—several decades in some cases—elapses between research expenditure and productivity outcomes for the rural sector.

A vision for the rural RD&E system

The Council sets out the following ‘big vision’ for rural RD&E: that the rural RD&E system will play an important role in:

- contributing to the national economy by enabling Australia to play its part in the global effort to double rural sector output over the next 30 years⁴ while utilising proportionally fewer resources
- developing a range of technologies and knowledge to contribute to healthy Australian lifestyles and global food security
- producing a wider product range including food, fibre, energy and bio-based products, in addition to ecosystem services.

The benefits of achieving this vision will include sustainable use of the environment into the long term, increased employment opportunities, production of healthier food, and a more knowledgeable and efficient rural sector. Major beneficiaries will be farming, fishing and forestry businesses, as well as businesses along the agricultural value chain and the wider Australian community. For the rural sector to achieve these outcomes, the Council believes the Australian Government’s investment in rural RD&E must be better understood and targeted. The system will need further development and an increased focus on international collaboration to share knowledge. The Council recommends allocating resources to maximise opportunities and minimise the likelihood, or impact, of adverse events.

Many of the challenges facing the rural sector are global in nature. The Council’s vision will have to be realised in a changing global rural RD&E environment. Australia is well-placed to deliver domestic benefits and to play a major role in global efforts. A historically significant public funder of rural RD&E in the world (Alston *et al* 2010), Australia has technologically-advanced industries and a record of international leadership dating back to Prime Minister Stanley Bruce’s role in establishing the Food and Agriculture Organization of the United Nations in the 1940s.

Achieving this rural RD&E vision will require a long-term commitment. The lag time between rural research expenditure and desired outcomes means that there is a role for government to ensure both the development and achievement of long-term goals for the benefit of the Australian community, and a stable environment for increased business investment in the rural sector. This Plan, together with related global initiatives, creates an opportunity for wealth-creating, sustainable, rural production systems to be prominent in Australia for decades to come.

Council recommendation 1

The Council recommends increased investment, including by the Australian Government, in rural RD&E to: enable Australia to play its part in the global effort to double rural sector output over the next 30 years while utilising proportionally fewer resources; develop a range of technologies and knowledge to contribute to healthy Australian lifestyles and global food security; and produce a wider product range including food, fibre, energy and bio-based products, as well as ecosystem services.

⁴ The FAO has asserted that ‘expanding populations and changing eating habits will make a doubling of food output imperative within the next thirty years’ (Halwart *et al* 2003).

Whole-of-system goals

Strategic investment in rural RD&E is required

Investment needs to be efficient and effective. Funding certainty is needed to develop the rural sector's capacity. Furthermore, taking a whole-of-system approach to managing the investment portfolio considers other policy initiatives and private sector interests.

The Council has determined the following RD&E investment goals:

- facilitate ongoing industry development and adaptation to change through RD&E
- leverage innovation for growth along value chains, with greater sharing of risk and reduced reliance on natural resources
- integrate natural resource management with production systems to use natural resources more efficiently
- use improved modelling and scenarios to analyse and plan for climate change, build understanding, and develop adaptation practices and resilient systems
- build capability through high quality education and training
- reward and retain world-class researchers through commitments above current investment levels
- develop social research and tools that enable rural communities to embrace change, adopt new technologies and manage the impact of change
- develop elite genetic resources, emerging technologies and multidisciplinary capability for application to rural problems and opportunities
- invest in, and in some cases accelerate the development of cross-sectoral RD&E strategies such as those relating to bioenergy, bio-based products, food and nutrition
- develop systematic links, and collaborate, with leading international groups to improve access to funds, markets and knowledge that can address common Australian and global needs.

Following stakeholder consultation and Council consideration, these goals have been distilled into five RD&E investment themes:

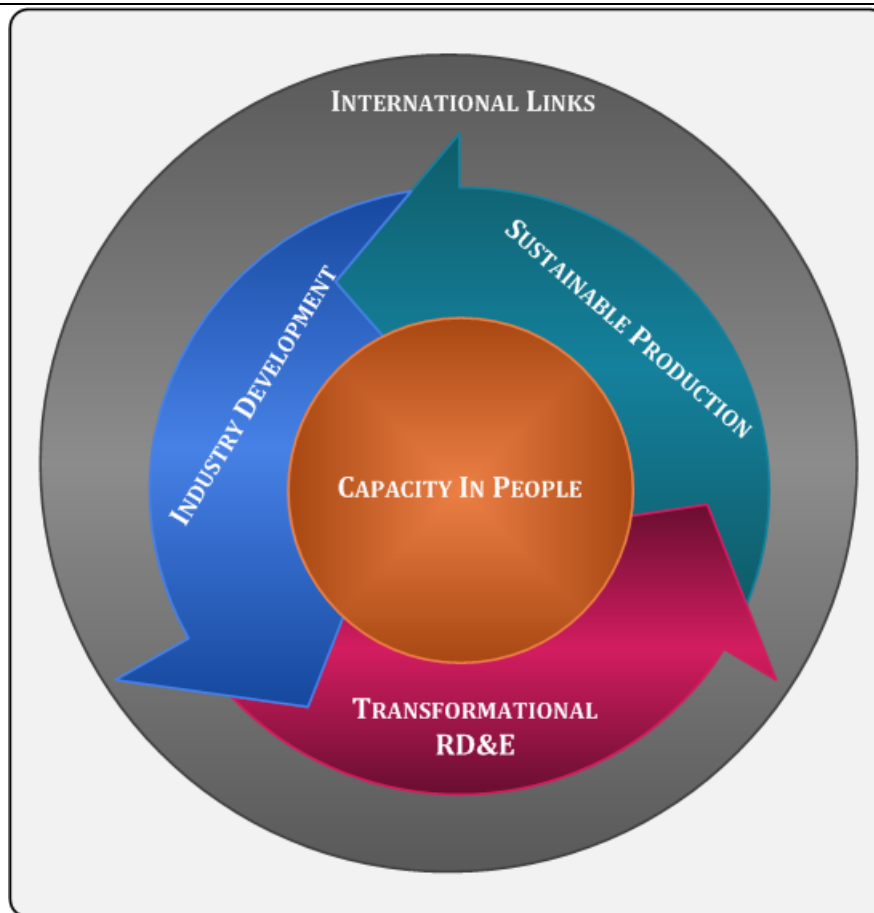
Underpinning themes

- Industry development
- Sustainable production
- Transformational RD&E

Enabling themes

- Capacity in people
- International links.

Industry development and sustainable production are viewed as interdependent and influenced in the longer term by transformational RD&E. People are considered central to the system because it is through their initiative, innovation and motivation that rural RD&E will be relevant and effective in the long term. International links encompass the other themes, recognising that many challenges facing Australia's rural sector are global and that Australian researchers are, and must continue to be, active participants in international research networks. Figure 4 highlights the relationship between the five investment themes.

Figure 4: Investment themes

The five themes identified by the Council provide a basis for strategic investment in RD&E by both the public and private sectors to meet the challenges facing Australia's agriculture, fisheries and forestry industries now and in the future. The Council argues that if its vision for rural RD&E is to be achieved, an increase in overall investment will be necessary.

Council recommendation 2

The Australian Government should adopt five themes under which investment in rural RD&E will be made: industry development, sustainable production, transformational RD&E, capacity in people and international links.

Investment themes are consistent with the Rural Research and Development Priorities

The Council considers that these five investment themes are broadly consistent with the Australian Government's Rural Research and Development Priorities (2007): productivity and adding value; supply chain and markets; natural resource management; climate variability and climate change; biosecurity; innovation skills; and technology. The priorities are particularly important in guiding the research investments of the rural R&D Corporations. The Council's proposed investment themes are not intended to replace or duplicate these priorities. Rather, they are intended to guide strategic investment across the rural RD&E system as a whole, encompassing agriculture, fisheries and forestry RD&E, as well as RD&E in 'expanded along the value chain' and 'related to rural' areas.

Box 3 demonstrates how the Council's investment themes interact with the Rural Research and Development Priorities.

Box 3: Interaction between Council investment themes and the Rural Research and Development Priorities

In 1994, the Australian Government established a set of Rural Research and Development Priorities to guide R&D investment within the rural sector.

The government reviewed the priorities in 2007 to better target agriculture, fisheries, forestry and food industry R&D efforts. These priorities complement the National Research Priorities developed in 2002 and the National Innovation Priorities developed in 2009.

As a condition of receiving funding, the rural R&D Corporations are required to consider the Rural Research and Development Priorities when making research investment decisions, and to report on expenditure against the priorities. Table 3 shows the R&D Corporations' program alignment against the Rural Research and Development Priorities in 2008-09.

The Council believes its investment themes are broadly consistent with the government's Rural Research and Development Priorities:

Theme	Rural Research and Development Priority
Industry development	Productivity and adding value Supply chain and markets
Sustainable production	Natural resource management Climate variability and climate change Biosecurity
Transformational RD&E	Technology (supporting the Rural R&D Priorities)
Capacity in people	Innovation skills (supporting the Rural R&D Priorities)

Table 3 shows the breakdown of R&D Corporations' expenditure in 2008-09 against the Rural Research and Development Priorities. The differing levels of expenditure against each priority are an indication of industries' different market profiles and products.

While this table is useful in illustrating the key areas of expenditure for different industries, the Council emphasises that this is just one part of the \$2.9 billion rural RD&E system, and the table should not be used to extrapolate priority areas of expenditure for the system as a whole or for industries collectively.

Table 3: R&D Corporation 2008–09 program alignment against the 2007 Rural Research and Development Priorities

Rural R&D Priorities	Productivity & Adding Value	Supply Chain & Markets	Natural Resource Management	Climate Variability & Climate Change	Biosecurity	Innovation Skills	Technology	Total Expenditure
Rural Research and Development Corporation	\$	\$	\$	\$	\$	\$	\$	\$
Australian Egg Corp Ltd	356,633	430,886	0	18,000	173,968	469,500	81,056	1,530,043
Australian Wool Innovation	15,685,000	31,580,000	2,600,000	508,000	733,000	4,960,000	5,581,000	61,647,000
Cotton Research Development Corp	370,000	220,000	2,550,000	200,000	2,130,000	900,000	670,000	7,040,000
Dairy Australia Ltd	10,441,730	5,726,110	2,357,810	1,010,490	1,347,320	4,378,400	3,705,130	33,683,000
Fisheries Research Development Corp	4,000,000	2,900,000	10,800,000	500,000	1,300,000	1,200,000	2,400,000	23,200,000
Forest and Wood Products Australia	1,452,799	1,210,666	1,331,733	786,933	363,199	907,999	0	6,053,332
Grains Research Development Corp	30,740,000	2,530,000	9,810,000	6,460,000	20,940,000	19,990,000	14,870,000	106,250,000
Grape & Wine Research Development Corp	10,521,000	2,776,000	4,496,000	965,000	209,000	4,151,000	3,045,000	26,163,000
Horticulture Australia Ltd	19,844,318	16,169,444	8,084,722	5,879,798	4,409,848	11,024,661	8,084,072	73,497,475
Land & Water Australia*	1,321,000	0	19,150,000	3,680,000	0	2,227,000	7,960,000	27,174,000
Meat & Livestock Australia	17,835,200	9,106,000	5,275,200	2,826,000	6,594,000	6,845,200	14,067,200	62,800,000
Rural Industries Research Development Corp	7,913,000	903,000	2,096,000	250,000	671,000	1,190,000	2,834,000	15,857,000
Sugar Research Development Corp	3,500,000	286,000	1,577,000	384,000	682,000	984,000	878,000	8,292,000
TOTAL	123,980,680	73,838,106	70,128,465	23,468,221	39,553,335	59,227,760	64,175,458	453,186,850

Source: Data taken from tables published by rural R&D Corporations in their 2008–09 annual reports.

Note: Information about Australian Pork Limited, Australian Livestock Export Corporation and Australian Meat Processors Corporation program alignment against the rural Research and Development Priorities was not provided in their annual reports in a form that would translate into this table and has therefore not been included.

*Land & Water Australia was wound up in 2009.

Part 2 – The way forward

The following sections of the Plan discuss the Council's five investment themes and recommendations for future Australian Government investment and policy settings. An investment balance that focuses on mid- and long-term outcomes is proposed, along with a performance measurement and reporting framework and institutional arrangements to underpin the achievement of these outcomes.

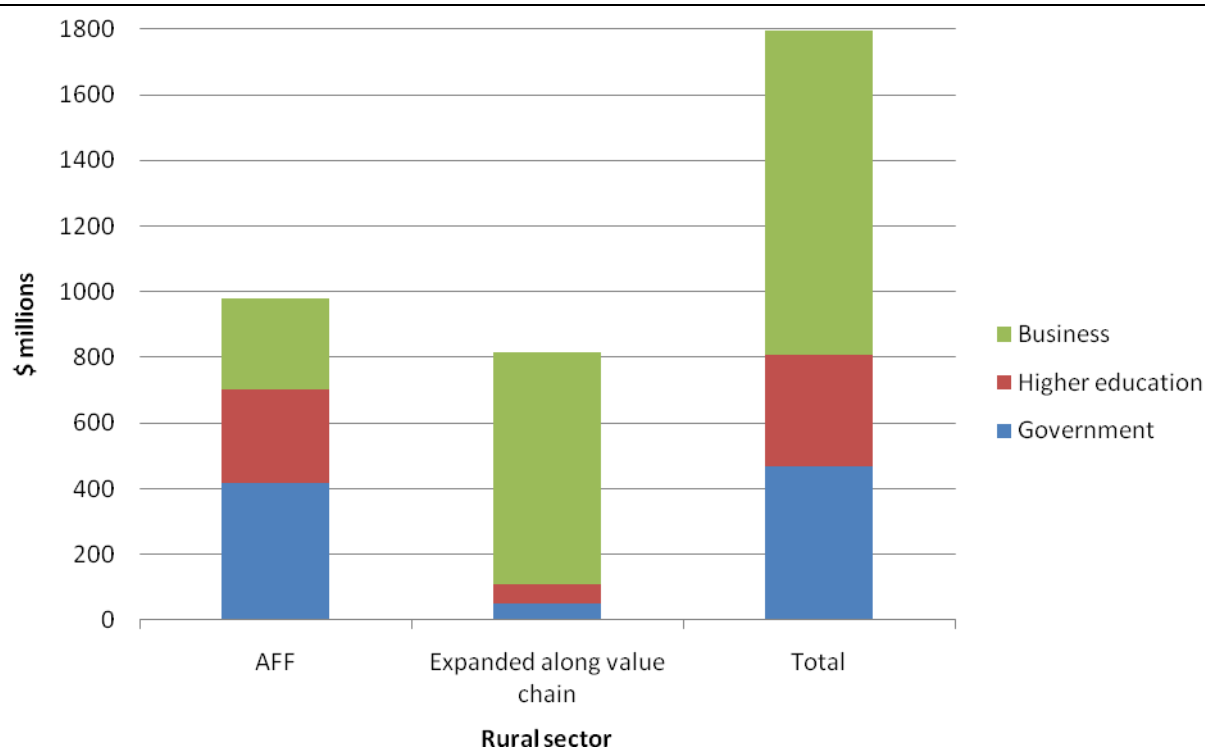
The Council's discussion and recommendations should be viewed in the context of the \$2.9 billion rural RD&E system, recognising the significant current and future impacts on the rural sector of RD&E in the 'expanded along the value chain' and 'related to rural' parts of the system.

Theme 1: Industry development

This section highlights the importance of investment in RD&E to assist industry to continue to achieve improvements in productivity and competitiveness. The Council notes the key roles played by the R&D Corporation model and the National Primary Industries RD&E Framework, and the importance of leveraging RD&E investment along the value chain.

An estimated \$1.8 billion was spent on rural R&D related to industry development in 2008–09 (Figure 5, Table 4). About 55 per cent of this expenditure occurred in the AFF component of the rural R&D system, across all three sectors (business, government and higher education). The remaining 45 per cent of this expenditure occurred in the ‘expanded along the value chain’ component of the system and was undertaken principally by the business sector.

Figure 5: Rural R&D expenditure related to Investment Theme 1: industry development, 2008–09



Source: ABS, Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09 (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0). Note: This is likely to include some expenditure on R&D fields which the council would regard as transformational R&D but which cannot be disaggregated due to the classification system used when the data was collected.

Table 4: Rural R&D expenditure related to Investment Theme 1: industry development, 2008–09

	Government	Higher education	Business	Total
	\$m	\$m	\$m	\$m
Agriculture, Fisheries and Forestry	416.9	284.3	279.0	980.2
Expanded along value chain	50.5	56.7	709.0	816.2
Related to rural	0	0	0	0
All three components	467.4	341.0	988.0	1,796.4

Source: ABS, Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09, (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0).
Note: This is likely to include some expenditure on R&D fields which the council would regard as transformational R&D but which cannot be disaggregated due to the classification system used when the data was collected.

Production of food and fibre is the rural sector’s engine of wealth creation and provides the basis for rural sector participants to meet Australia’s food, fibre and renewable fuel requirements, and maintain and improve natural resources for use by future generations. Economically viable businesses are the cornerstone of the rural sector, and the rural RD&E system must engage with them directly.

Aquaculture is one example of an industry that has significant potential to meet, sustainably, growing demand for protein in Australia and around the world. Aquaculture is the fastest growing food production sub-sector in many countries (Halwart *et al* 2003). Global aquaculture production in 2010 exceeded wild harvest fisheries, which are generally becoming more expensive on a cost per unit basis (for example, Lovatelli *et al* 2004). Continued RD&E will be critical in enabling aquaculturists, many of whom in Australia belong to new and emerging industries, to sustainably expand or intensify production.

Government initiatives to promote industry self-reliance and preparedness for increased climate variability also contribute to improved productivity growth. In other areas, investment is needed simply to maintain previous improvements in productivity. For example, pests and diseases require the sector to continue investing in RD&E simply to hold previous gains and to maintain access to international markets. Similarly, Australia’s livestock industries are relatively free of diseases that affect livestock industries overseas, but remain vulnerable to incursions. Continued research in biosecurity is thus necessary to maintain the clean status of Australia’s livestock industries, which support international trade.

Focus on productivity growth

The Council acknowledges that the productivity growth achieved by the rural sector reflects a foundation of strong technical performance. Farm sector investment in research has been deliberate and sustained. The trend in more recent times has been for RD&E investments to be dispersed between productivity-enhancing activities and broader community objectives such as environmental sustainability (Core 2009). The challenges presented by climate change and other environmental issues require a refocus of investments—both government and private—on productivity-enhancing activities.

The rural R&D Corporation investment model reflects a long history of industry development and has direct links to producers. It has in-built mechanisms to ensure that industry views guide research priorities in partnership with the Australian Government, and can direct and deliver outcomes focused on productivity growth. It is estimated that the rural R&D Corporations

collectively invested almost \$200 million in 2008–09 on RD&E related to industry development, representing more than 40 per cent of the total R&D Corporation RD&E investment⁵.

It should be noted that the R&D Corporations model is neither comprehensive nor treated consistently. Not every industry contributes levies and not all levies are matched with government investment. The Council acknowledges the Productivity Commission review of rural R&D Corporations that is occurring in parallel with the development of this Plan. The Council agrees with the Productivity Commission's draft findings that the R&D Corporation model should be maintained and enhanced (Productivity Commission 2010).

The Council believes that R&D Corporations should continue to focus on increasing productivity and responding to aspects of sustainability that relate to productivity growth. Existing entities should continue to receive matching funds where they are supported by their levy payers and respond in an industry-appropriate manner to the government's Rural R&D Priorities (as shown in Table 3). The Council believes that public and private dollars should continue to be co-invested on behalf of the Australian Government by R&D Corporation boards at the point where a particular industry's priorities meet broader national objectives.

The additional investment required to address 'expanded along the value chain' and 'related to rural' RD&E should not be confused with the Australian Government's commitment to the R&D Corporations model. The rural RD&E system as a whole needs to continue to respond to these broader challenges in a manner that takes into account the range of beneficiaries across these areas.

All industries should be encouraged to run their course. The Council acknowledges that the duration and scope of the current 14 courses may vary and understands that this will have long-term funding implications for the Australian Government.

Council finding 6

The rural R&D Corporation investment model is an essential element in the AFF component of the rural RD&E system with its strong focus on achieving productivity growth in established industries.

New and emerging industries should be separately considered for Australian Government support, regardless of the 'fostering portfolio' - for example, DIISR, DRET or DAFF. RD&E in areas such as bioenergy, ecosystem services and other knowledge-based industries may require additional support.

The Rural Industries R&D Corporation provides services for smaller, established industries and new industries, with and without levies. A range of measures will be required to stimulate the growth of these industries in the future, including investment in RD&E. Such investment could be short- or long-term and could in the first instance be guided by the overarching rural R&D public funding principles espoused in the Productivity Commission's draft report. Funding mechanisms should recognise industry maturation patterns and be developed jointly with the private sector.

⁵ Based on investments in the rural research priorities 'productivity and adding value' and 'supply chain and markets' as reported by each RDC (excluding Australian Pork Limited, Australian Meat Processors Corporation and Australian Livestock Export Corporation) in their 2008–09 annual reports. See Table 3 for the complete data.

Council finding 7

New and emerging industries in the AFF component of the rural RD&E system are mostly managed by the Rural Industries R&D Corporation and will continue to require core government funding.

The National Primary Industries RD&E Framework is tailoring investment across stakeholder priorities and contributing to improved efficiency by developing industry-oriented RD&E strategies. The framework mediates the RD&E commitments of the Australian and state governments, universities, R&D Corporations and CSIRO. This collaborative effort, coupled with the long-term co-investment by the Australian Government and levy-payers through the R&D Corporations model, constitutes an increasingly well-organised 'central capability' that can articulate with the related and expanded activities of the broader rural innovation system. The establishment of the framework has reduced fragmentation and resulted in some rationalisation as lead areas are distributed nationally based on production profiles.

To date, RD&E strategies for the beef, dairy, fisheries and aquaculture, forest and wood products, grains, horticulture, pork, poultry, sheep meat, sugar cane and wine industries, plus new and emerging industries, have been finalised. Cross-sectoral strategies are also being developed under the framework, of which the animal welfare strategy has so far been finalised. Some of these strategies fall primarily under the agriculture, fisheries and forestry portfolio (for example, animal biosecurity), while others require a high level of consultation and collaboration with other portfolios across Australian and state governments (for example, water use in agriculture).

The Council believes that the framework will be flexible enough to accommodate variations in sector and cross-sectoral RD&E strategies as industries evolve and new risks and opportunities become apparent. However, investments in infrastructure are likely to be required for these strategies to realise their full potential over coming years, and the institutional arrangements supporting the development of these strategies may need to evolve to support their implementation.

Council finding 8

The National Primary Industries RD&E Framework is central to improving the efficiency and effectiveness of rural RD&E across different levels of government, industry, CSIRO, CRCs and higher education institutions.

The Council notes that the Australian Government's National Collaborative Research Infrastructure Strategy and the Education Investment Fund Regional Priorities Round may also provide an opportunity to fund required investments in infrastructure, including for information and communications technologies, to support world-class rural RD&E.

Government and industry investment partnerships should aim to leverage rural RD&E investment by participants along the value chain to: manage risks arising from innovation, and target productivity gains for the benefit of all. There needs to be a focus on increased export earnings, a competitive business environment and long-term sustainable growth. This includes encouraging expansion of business sector investment in RD&E beyond the levy-paying AFF sector. Historically, Australia has had relatively low levels of business sector investment in rural RD&E compared with others in the OECD (Alston *et al* 2010). Expansion in export-focused production along the value chain and emerging bio-based industries is expected to drive increased future investment in the 'expanded along the value chain' component of the rural RD&E system.

Council finding 9

There is potential for business sector investment in Australia's rural RD&E system to grow; current levels are low compared with other OECD countries.

Council recommendation 3

The Australian Government should continue its support for the rural R&D Corporations model as a critical component of the National Primary Industries RD&E Framework and commit to ongoing support for both of these elements in the transfer of system-wide knowledge to effective rural sector networks. Additional funding mechanisms should be developed with the private sector to support other rural industries in pursuit of the vision set out in this Plan.

Preservation of germplasm to support productivity growth

Improvements in crop yields, new plant varieties, carcass weights and other sources of productivity growth in the rural sector have been achieved through the collection of germplasm from overseas and its adaptation to Australian conditions. The development of new plant varieties and breeds of livestock suited to an increasingly variable climate will be important for Australia's rural sector in the coming decades.

There are collaborative international efforts to preserve germplasm, including through the Global Strategy for Plant Conservation, which may be an effective way to share the cost of international public goods. Gene banks for many crop species are maintained through the International Agricultural Research Centres of the CGIAR and their partners. There is likely to be a need for Australia to undertake targeted preservation of rural related germplasm that is more important to us than to other countries contributing to international preservation efforts.

Council recommendation 4

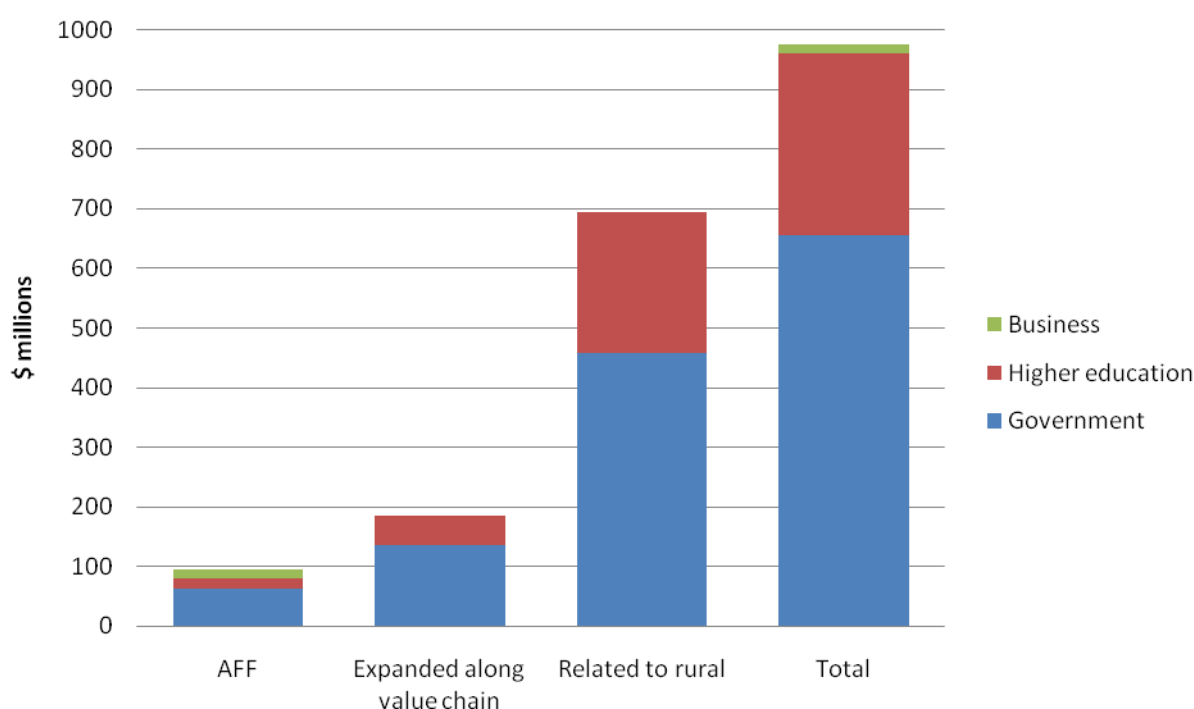
The Australian Government should invest in conserving the genetic diversity of major socio-economically significant species and associated knowledge, in addition to continuing its support for international efforts to conserve germplasm, including in relation to biodiversity.

Theme 2: Sustainable production

This section covers the crucial role played by the natural environment in agricultural, fisheries and forestry production. The Council acknowledges that natural resources have wide benefits for the economy and the whole community. Further, that conflict may arise at times between the short-term profitability goals of individual producers and the longer-term needs of the environment. Rural RD&E has the potential to help industries to meet both prosperity and sustainability objectives, and there is a need for coordination and collaboration on RD&E initiatives across the several government portfolios that address natural resource issues.

It is estimated that in 2008–09, \$1 billion was spent on rural R&D related to sustainable production. The research was principally conducted by the government and higher education sectors (Figure 6, Table 5). More than 70 per cent of this expenditure occurred in the ‘related to rural’ component of the rural R&D system.

Figure 6: Rural R&D expenditure related to Investment Theme 2: sustainable production, 2008–09



Source: ABS, Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09, (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0). Note: This is likely to include some expenditure on R&D fields which the council would regard as transformational R&D but which cannot be disaggregated due to the classification system used when the data was collected.

Table 5: Rural R&D expenditure related to Investment Theme 2: sustainable production, 2008–09

	Government	Higher education	Business	Total
	\$m	\$m	\$m	\$m
Agriculture, Fisheries and Forestry	62.8	17.5	15.8	96.1
Expanded along value chain	134.8	50.2	0	185.0
Related to rural	457.6	237.1	0	694.7
All three components	655.2	304.8	15.8	975.8

Source: ABS, Rural expenditure on research and experimental development—government, higher education and business sectors, by socio-economic objective, 2008–09 (special extraction from cat. nos. 8109.0, 8111.0 and 8104.0). Note: This is likely to include some expenditure on R&D fields which the council would regard as transformational R&D but which cannot be disaggregated due to the classification system used when the data was collected.

It is estimated that the rural R&D Corporations collectively invested \$133 million in 2008–09 in RD&E related to sustainable production, representing about 30 per cent of total investment⁶.

Notwithstanding these attempts to estimate levels of investment and expenditure in rural RD&E related to sustainable production, the Council notes that the investment themes ‘industry development’ and ‘sustainable production’ are inextricably linked, with many RD&E outcomes delivering joint benefits to the rural sector and the broader community. RD&E relating to managing pests and diseases is one example of this. RD&E is also vital in assisting the fishing industry to meet its obligations under ecologically sustainable development legislative frameworks and the Commonwealth Fisheries Harvest Strategy Policy, to ensure that the industry can remain both sustainable and profitable into the future.

Australia’s vast and valuable natural resources, including land, forests, water, marine and germplasm, underpin not only the success of the rural sector but also much of the broader economy. There is a particular role for government in facilitating a transition to a less emissions-intensive economy, particularly through support for RD&E to generate new knowledge and innovations that improve water and energy use efficiency and reduce waste. The *2010 Intergenerational Report* outlines several areas for government involvement, including the establishment of a carbon-trading market, water governance arrangements and environmental stewardship agreements with landholders (Commonwealth of Australia 2010). All of these areas will require RD&E investment.

Collaboration is required to improve leverage efforts

There is significant investment in the maintenance and rehabilitation of Australia’s natural resource assets, some of which is devoted to RD&E activities. From a rural sector perspective, government investment has become dispersed with the expansion of departments addressing these natural resource issues. DCCEE, DSEWPC, DIISR and DAFF all play some role, often with differing objectives. Future increases in government investment in natural resources are likely to remain fragmented and outside direct remit of the Minister for Agriculture, Fisheries and Forestry, thereby increasing the risk of duplication or gaps in this area of rural RD&E.

⁶ Based on investments in the rural research priorities ‘natural resource management’, ‘climate variability and climate change’ and ‘biosecurity’ as reported by each RDC (excluding Australian Pork Limited, Australian Meat Processor Corporation and Australian Livestock Export Corporation) in their 2008–09 annual reports. See Table 3 for the complete data.

Council finding 10

Australia's innovation system is responding to cross-industry issues relating to sustainability. The Agriculture, Fisheries and Forestry portfolio is well placed to foster active engagement by the rural RD&E system in these efforts.

Sustainable resource management is complex, with new practices and technologies delivering a combination of private and broader community benefits. While the Council does not believe it is possible to clearly separate public and private benefits, a better understanding of the likely public-private nature of new technologies and practices could improve returns on investment. In particular, the potential to leverage private and other non-government investment to achieve common objectives should be explored. For example, the Great Barrier Reef Sustainable Freshwater Revitalisation project – a joint initiative of the Coca-Cola Foundation, the World Wildlife Fund and cane farmers – implements agronomic innovations to reduce sediment and damaging pollutants in run-off into the Great Barrier Reef.

The Council notes that some of the cross-sectoral RD&E strategies being developed under the National Primary Industries RD&E Framework will be important for targeting investment efficiently and effectively, including the RD&E strategies for climate change adaptation, bioenergy and biofuels, and water use efficiency. The Prime Minister's Science, Engineering and Innovation Council (PMSEIC) can also assist by providing a robust scientific evidence base.

Council recommendation 5

The Australian Government should improve coordination of and collaboration in RD&E initiatives that inform the management of land, water, marine and other natural resources to achieve sustainable outcomes for current and future generations.

Theme 3: Transformational RD&E

The Council has defined transformational research as research driven by ideas that stand a reasonable chance of radically changing the understanding of an important existing scientific concept, or leading to the creation of a new paradigm or field of research. This section examines Australian and overseas expenditure on transformational RD&E in a range of fields, and discusses opportunities for Australia in the area of bio-based production.⁷

Transformational RD&E in the rural sector can result in an industry developing a new approach to production, creation of new technologies or the emergence of an entirely new industry. It thus has the potential to dramatically improve productivity of Australia's rural industries.

A system-wide approach to transformational RD&E considers that various components of the rural RD&E system are mandated to operate at various points along the basic/strategic/applied research/experimental development continuum, and that a range of technological frontiers exist across this spectrum. Transformational change like this requires innovation at the local level, with support from government at the national scale. It moves the system from one that needs change, to one that has the support necessary to undertake change (PMSEIC 2010a).

Expanding the scientific knowledge base creates opportunities to transform the economy. Innovative enabling technologies such as biotechnology, and information and communications technologies, are already altering approaches to industry development and sustainable production. Blue-sky research is expected to play an important role in: environmental issues; food, fibre and energy security; improving health outcomes; and facilitating development (OECD 2009).

Comprehensive estimates of rural sector investment in transformational RD&E in Australia are difficult to collate. The ABS R&D expenditure data provide some immediate indication of transformational research expenditure, for example, in fields of research such as agricultural and environmental biotechnology, agro-ecosystem function and prediction, and carbon sequestration science. It is estimated that about \$124 million of rural research expenditure occurred in these Fields in 2008–09. Further transformational expenditure would be identifiable only by further data collection and is likely to be reported under expenditure on industry development and sustainable production (as noted in Figures 5 and 6). For example, domestically, DIISR reports significant growth in industry-led eco-innovations such as low-carbon and renewable energy (DIISR 2010). Another indicator is the \$64 million expenditure reported by rural R&D Corporations against the Rural Research and Development Priority 'Technology' in 2008–09 (Table 3).

Meanwhile, public expenditure within the OECD for all types of biotechnology R&D in 2005 was estimated at US\$28.7 billion (data are incomplete). Expenditure was dominated by the United States, with rapid increases in large developing countries including Brazil, China and India (OECD 2009). Total private sector R&D expenditure within the OECD for all types of biotechnology R&D in 2003 was estimated at US\$21.5 billion, again dominated by the United States (OECD 2009).

Analysis of ARC grants also provides an indication of the extent of transformational RD&E. The ARC uses a competitive process to fund high-quality fundamental and applied research, and research training, across all disciplines except clinical medicine and dentistry. It is estimated that the ARC

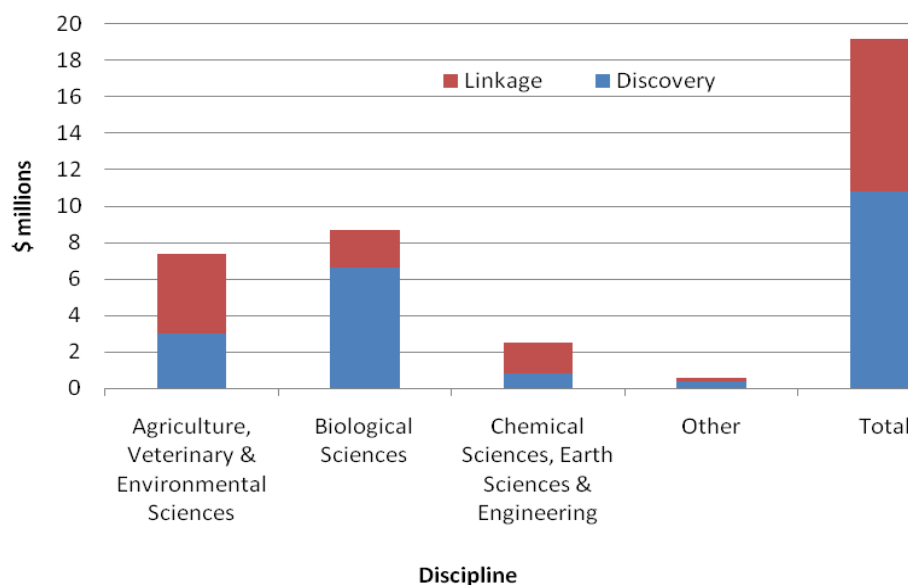
⁷ Bio-based production: production derived from land, water and living systems.

provided \$19.2 million in grants to rural sector projects in 2008, representing about 4 per cent of all ARC funding for that year. Only about one-third of this funding was directed to projects classified within the ‘agriculture, veterinary and environmental sciences’ field of research. The remainder supported rural projects classified within other fields of research, principally biological sciences, chemical sciences, earth sciences and engineering (Figure 7).

An estimated \$11.7 million was provided by DIISR to bio-based production-related research in 2008–09 (Figure 8). The bulk of this funding was from the Climate Ready Program. The Commercial Ready Program⁸, International Science Linkages Program and the Australia–India Strategic Research Fund are also important sources of funding. Additional funding will be available from the DIISR Grand Challenge Fund, with Australian Government and matching Indian Government funding for research projects related to food and water security, sustainable farming and climate change (Minister Carr 2010).

Several other Australian Government departments are also funding related research, including \$15 million from DRET for the Second Generation Biofuels Research and Development Program. DCCEE is providing funding for the Climate Change Adaptation Research Grants Program (\$30 million), the Australian Climate Change Science Program, and support for the National Climate Change Adaptation Research Facility (\$20 million).

Figure 7: ARC funding provided to rural-related projects by reported research field, 2008

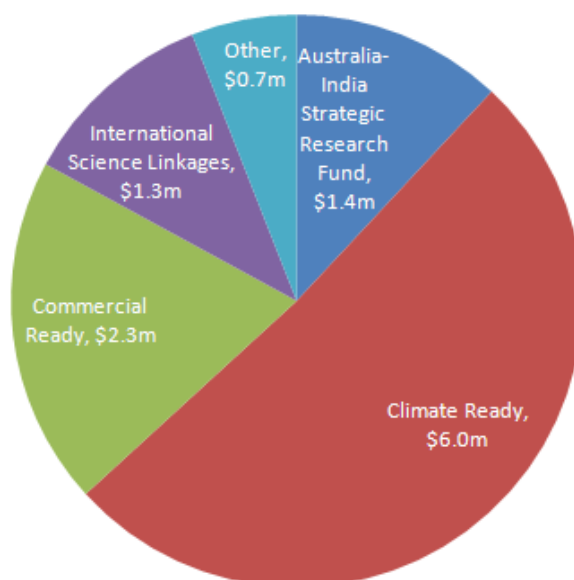


Source: ARC discovery and linkage grants by field of research code spreadsheets, 2003 to 2008 (www.arc.gov.au).

Note: These data do not include ARC funding for centres of excellence with a rural focus.

⁸ The Commercial Ready Program ceased in 2009

Figure 8: DIISR grant funding for rural bio-economy related research, 2008–09



Source: DIISR grant funding spreadsheets 2008–09, (www.innovation.gov.au)

Council finding 11

Growth in bio-based production will increase the flow of capital into the rural sector, creating significant opportunities.

Council finding 12

Australian Government involvement in transformational RD&E, including the development of emerging industries, will cross portfolios other than the Department of Agriculture, Fisheries and Forestry.

Embracing new opportunities and new challenges

A low-emissions economy is likely to create new opportunities for Australia's rural sector, which is likely to have a natural competitive advantage as a significant supplier of bio-based products to replace petrochemical inputs in the energy and manufacturing sectors. Biotechnology and other enabling technologies may also create openings for marginal rural production systems in new energy products, materials and other industrial feedstock economies. The developments need to be underpinned by basic research and may provide opportunities to expand traditional production systems and increase productivity growth. Small-to-medium size enterprises across all components of the RD&E system are expected to play a significant role in the near- to mid-term.

The increased interface between primary production and industries that rely on similar research capabilities will create opportunities for increased collaboration with other disciplines and sectors. For example, growing interest in the health properties of food is likely to create new opportunities for jointly-funded collaborative research between the health and rural sectors. The incidence, and associated economic and social burden, of chronic diseases can be significantly reduced through the development of preventative health products. RD&E investigating foods and other agents that

can protect against cancer, neurodegenerative disease, heart disease and diabetes could reduce higher health care costs expected as Australia's population ages. Significant opportunities to collaborate with researchers in countries facing similar issues are also likely.

Exploration of Australia's biological resources and the development of sustainable new production practices require a combination of technical and local knowledge. Unprecedented innovation will be required from multidisciplinary research teams to encourage new uses of land, including in arid and saline environments, while maintaining the ecological integrity of complex landscapes.

Invest in underlying capacity to adapt and respond

A primary goal of rural RD&E is to invest in underlying capacity so that the sector is prepared to respond and adapt to opportunities and challenges that have not been anticipated. This involves creating an attractive setting for private and foreign rural investment to supplement government funding and maximise the value of Australia's land, water, marine and germplasm resources.

Council recommendation 6

The Australian Government should ensure that policy settings encourage the rural sector to participate actively in new business opportunities, including those related to bio-based production.

Theme 4: Capacity in people

The Council has identified capacity in people as an enabling theme that requires RD&E investment in its own right, but also supports achievement of industry development, sustainable production and transformational RD&E goals.

The capacity of Australia's rural sector to respond to the challenges of global competitiveness, productivity, adaptability and sustainable development depends largely on investments being made now in its people. This is a recognised challenge (House of Representatives Standing Committee on Agriculture, Fisheries and Forestry 2007; Agrifood Skills Australia 2010). The Council highlights the need to reinvigorate the rural research workforce, and the role of scientists in impartially evaluating and communicating potential risks and benefits of new technologies.

It is difficult to estimate how much has been invested in the rural sector's research workforce or in ensuring that rural sector participants are equipped to adopt innovations generated by researchers, adapting them where necessary to suit their production or business systems. Reporting against the Rural Research and Development Priorities, the rural R&D Corporations declared an investment of about \$60 million in 2008–09 in skill improvement to undertake research and apply its findings⁹.

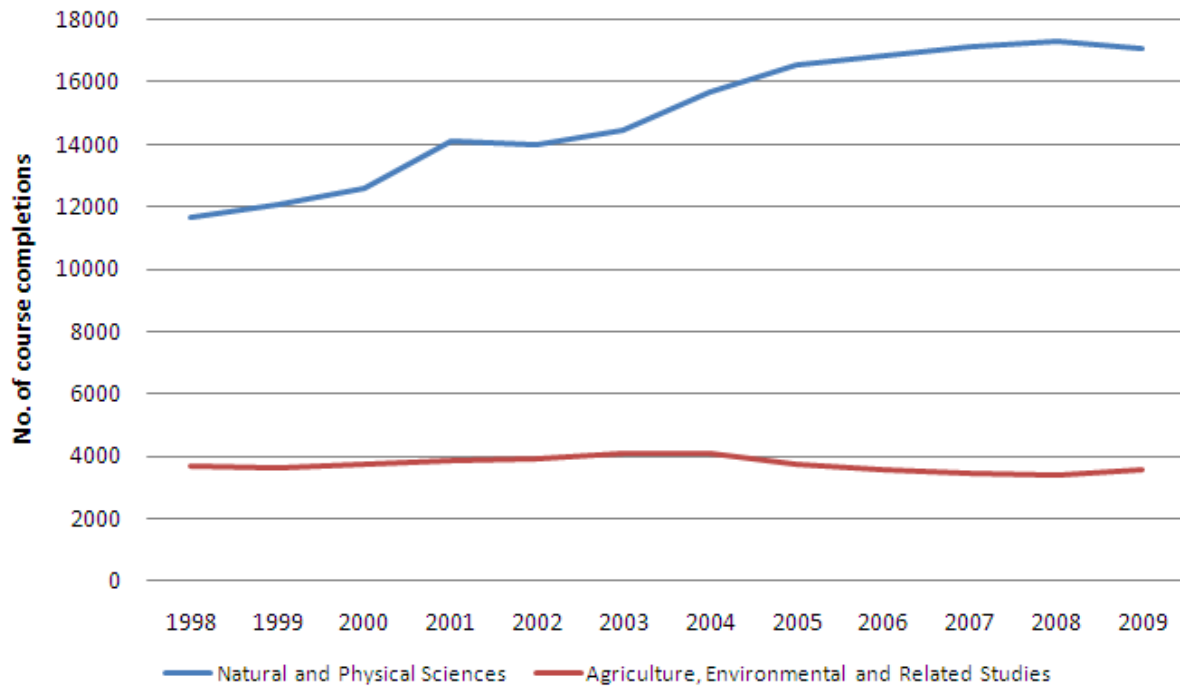
Against a national trend of increasing award course completions, DEEWR reports a decline in agricultural, environmental and related studies between 2003 and 2008 (Figure 9; see also Pratley and Copeland, 2008). This occurred despite growth in international student numbers, which masked a greater decline in completions by domestic students. The Council notes that this may be partially offset by strong growth in course completions in the natural and physical sciences.

The number of students completing PhDs and masters by research studies in agricultural, environmental and related areas is also low relative to the number of completions in other fields of education, although completions in the natural and physical sciences remain high (Figure 10).

These trends in undergraduate and postgraduate completions in the rural disciplines, together with evidence of the ageing profile of the academic workforce, underpin assessments that the demand for rural sector researchers is likely to outstrip supply in the coming decades (Allen Consulting Group 2010, ACDA 2008).

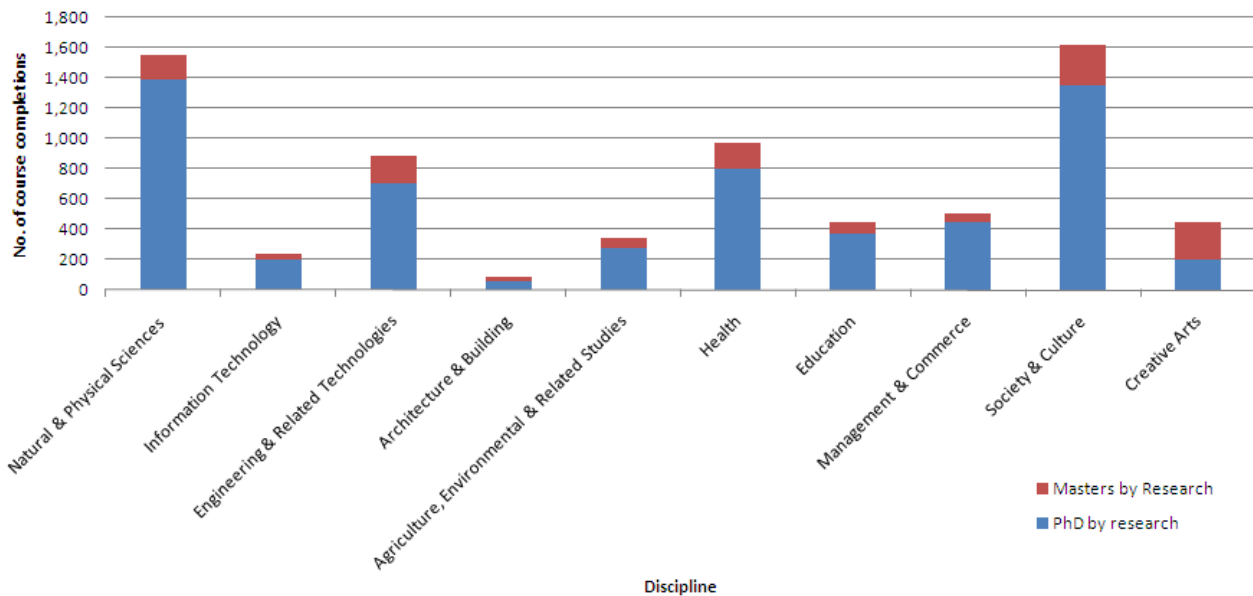
⁹ Excludes investments in innovation skills by Australian Pork Limited, Australian Meat Processors Corporation and Australian Livestock Export Corporation. See Table 3 for the complete data.

Figure 9: Award course completions for selected fields of education, 1998 to 2009



Source: DEEWR 2010, Award course completions 2009: selected higher education statistics tables, 1998 to 2009 (www.deewr.gov.au)

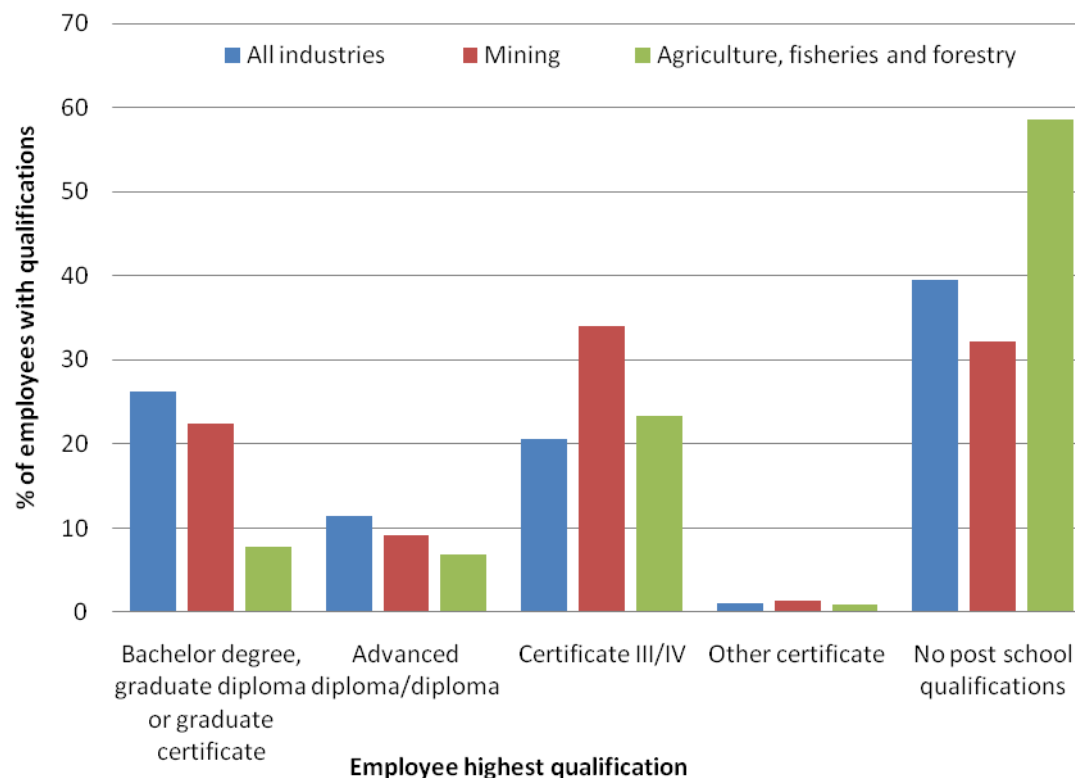
Figure 10: PhD and masters by research completions by discipline, 2009



Source: DEEWR 2010, Award course completions 2009: selected higher education statistics tables, 1998 to 2009 (www.deewr.gov.au)

The rural sector has a generally lower level of formal post-school qualifications compared with the rest of the economy (Figure 11). Further, those in the rural sector generally have relatively limited access to new information on the Internet and lower rates of broadband use in the home (ABS 2010b). Given the time lag between investing in R&D and resulting productivity growth, efforts to increase adoption of new technologies and practices by investing in people could generate significant returns. Such efforts include exploring options to influence school curricula and building a 'pipeline' to improve capacity and skills over the long term.

Figure 11: Post-school educational attainment by industry, 2009



Source: ABS 2010, *Education and training experience, 2009* (cat. no. 6278.0)

Council finding 13

There are generally lower levels of formal education and training in the rural sector than in other sectors of the economy, leading to the risk of skill underdevelopment and reduced capacity to develop, adapt to and implement innovation.

Develop a culture of excellence in research

Investment in researchers begins with the development of a world-class research culture. Existing and new researchers need to work in an environment where publications are peer-reviewed. This provides a quality assurance mechanism as well as a permanent public record of achievement. Research funders, including rural R&D Corporations, have to incorporate this requirement into their plans. In recent years, an emphasis on industry uptake has taken precedence over scientific quality and has the potential to erode scientific quality in the longer term.

International recognition of high-quality Australian research can be increased through improved relationships between Australian researchers and those doing related work internationally. It is estimated that Australia contributes about 6 per cent of the world's agricultural research papers and Australian research is often cited in papers published by non-Australian researchers (Butler 2001). Analysis of publications output between 1991 and 2005 shows that about a quarter of Australian-authored papers in the agricultural, veterinary and environmental sciences had international collaborators and that these papers were generally cited more often in other research than papers without international collaborators (Matthews *et al* 2009). It is important that support for international collaborative research is a specific priority in RD&E funding. Placing Australian researchers in institutions overseas, sending more PhD students abroad as part of their studies and seconding overseas researchers to Australian research institutions is likely to generate a higher rate of innovation and adoption of new productivity-enhancing technologies.

Establishing a vibrant rural research community that is well connected to researchers in related fields through organisations such as the Australian Academy of Science, the Australian Academy of Technological Sciences and Engineering, and the Federation of Australian Scientific and Technological Societies will open up new opportunities to secure research funding. For example, knowledge on cell membranes could be derived from plant physiology or neurobiology research and funded from various sources, and nutrition issues also span medical and agricultural research funding systems. While generic and peripheral research findings will be increasingly relevant to rural RD&E, it is important to retain a core scientific capacity that relates to rural research issues, maintains continuity, and enables a 'systems' approach to research and analysis.

The ARC's Excellence in Research for Australia (ERA) initiative, a key element of *Powering Ideas: an innovation agenda for the 21st Century* (DIISR 2009), is one mechanism for building recognition of Australia's strength in rural research. Several Australian universities were rated at or above world standard in rural or related research fields in the 2010 ERA evaluation (Excellence in Research for Australia Initiative 2011).

The ERA initiative assesses research quality within Australia's higher education institutions using a combination of indicators and expert review by committees comprising experienced, internationally-recognised experts. Leading researchers evaluate research in eight discipline clusters including: physical, chemical and earth sciences; humanities and creative arts; engineering and environmental sciences; social, behavioural and economic sciences; mathematical, information and computing sciences; biological and biotechnological sciences; biomedical and clinical health sciences; and public and allied health sciences (Excellence in Research for Australia Initiative 2011).

Outputs from the first full ERA evaluation in 2010 will inform the allocation of government funding through the Sustainable Research Excellence program, and will be included as a key measure of research performance in the government's negotiations with universities (Minister Carr 2011,).

Building and retaining expertise is critical to addressing long-term challenges. Better funded scholarships and an increase in research support funds may be required to boost the supply of rural researchers. Improving security in tenure, and reducing upheaval created through ongoing restructuring, may also assist. Ensuring that some funding is longer-term with a program rather than a project focus will provide more attractive career paths for young scientists who will lead rural RD&E in future decades. The Council anticipates the Australian Government's Research Workforce Strategy will identify mechanisms to address some of these challenges.

The challenges presented by climate change will make increased collaboration and multi-disciplinary integrated research necessary. For example, integrated multidisciplinary teams will be required to answer scientific questions regarding plant interactions within the environment and rural production systems. The CSIRO National Research Flagships Program is one initiative that draws together large-scale multidisciplinary teams to address national research priorities. An increased focus on research areas that address resilience at the regional, community and business levels could assist responses to cross-industry challenges and implementation of changes needed for international competitiveness. The establishment of ARC centres of excellence in strategic fields where there is interest in addressing global needs, particularly those relating to sustainable food production in a changing climate, would create further opportunities for researchers from different disciplines to interact and build critical mass.

Information and communication technologies have dramatically changed some aspects of research methodology over the decade, including timely access to published research findings. Those working in RD&E disciplines will need ongoing training to capture the full benefits of advances in these technologies. Future growth in scientific output from non-English speaking countries is likely to present an additional challenge. The Education Investment Fund Regional Priorities Round, announced in September 2010, may be a source of funds for infrastructure investments to support the development and growth of the rural research workforce.

Council recommendation 7

The Australian Government should apply its rural research funds in ways that value research excellence as well as research impact, and raise the profile of agriculture, fisheries and forestry within the broader research community.

Increase the penetration of technical knowledge to rural sector participants

Investment in, and the active involvement of, rural sector participants is required to ensure uptake of technology and innovation. The rural R&D Corporations and CRCs are examples of entities that enable cooperation between researchers and industry. Greater collaboration that leads to a better understanding of rural sector participants by those involved in rural RD&E is likely to improve the rate and magnitude of technology adoption. For example, drawing on the unique and detailed knowledge of land and other natural resources of many rural people - Indigenous and non-Indigenous - could improve the relevance and uptake of RD&E. The Council sees the low number of Indigenous people completing tertiary courses in agricultural, environmental and related studies (DEEWR 2010) as an area of untapped potential.

The rural sector is culturally diverse and there is likely to be practical value in segmenting and targeting participants to increase technology adoption. Younger people may have different concerns to those of older people, and gender may influence interest in different technologies and practices. Ongoing research is required to ensure that delivery mechanisms are targeted to maximise adoption. The extension project being developed under the National Primary Industries RD&E Framework is an example of one investment aiming to increase innovation adoption and implementation.

Council recommendation 8

The Australian Government should invest in initiatives to increase the rural sector's utilisation of technical knowledge, better equipping it for global competitiveness, productivity, adaptability and sustainable development.

Build understanding and ownership in the broader community

The broader Australian community and overseas consumers of Australian products should also be considered. The rural RD&E system needs to be well informed about the views of the wider community. Some technological innovations—for example, those involving genetic modification—have proven controversial, limiting the commercialisation of some biotechnologies. The outcomes of community consultation on water-sharing in the Murray–Darling Basin, sustainable population levels and the development of a national food plan are all relevant to the rural sector. There is an ongoing role for scientists to evaluate impartially the potential risks and benefits of new technologies in order to inform policy makers and the community, and to contribute to public debate. The Council emphasises the importance of a scientifically sound, evidence-based approach to new developments in the rural sector.

Theme 5: International links

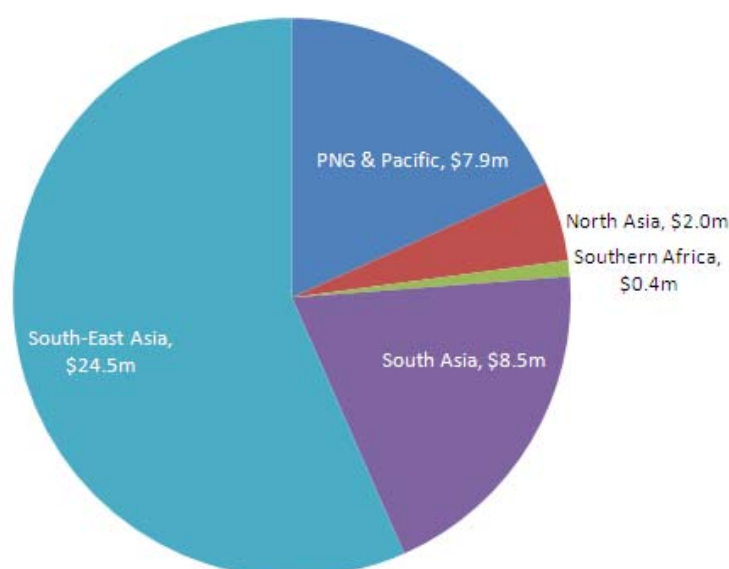
As with the ‘capacity in people’ theme, ‘international links’ facilitate achievement of RD&E goals in the areas of industry development, sustainable production and transformational RD&E.

International knowledge is an important source of new technological innovation given Australia’s comparatively small population, and its openness to trade in goods and services (Productivity Commission 2007, DIISR 2010). It is not efficient for Australia to undertake rural sector RD&E in isolation when many of the relevant skills, expertise and capital are based overseas.

Australia has a long history of participation in international rural RD&E collaboration including participation in the *Strategy and Results Framework* developed by CGIAR, which seeks to reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality international agricultural research, partnership and leadership.

Australia’s international agricultural research agency, ACIAR, provided about \$60 million in RD&E funding in 2008–09 to 15 international agricultural research centres and projects across Papua New Guinea and the Pacific, South-East Asia, South Asia, North Asia and Southern Africa (Table 6, Figure 12).

Figure 12: ACIAR research expenditure by region, 2008–09



Source: ACIAR 2008–09 annual report (www.aciar.gov.au).

Table 6: Australian Government funding to international agricultural research centres in 2008-09

Centre		Total funding (\$m)
BI	Bioversity International, Italy	0.34
CIAT	International Center for Tropical Agriculture, Colombia	0.38
CIFOR	Center for International Forestry Research, Indonesia	0.67
CIMMYT	International Maize and Wheat Improvement Center, Mexico	1.87
CIP	International Potato Center, Peru	0.60
ICARDA	International Center for Agricultural Research in Dry Areas, Syria	0.42
ICRAF	World Agroforestry Centre, Kenya	0.25
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India	1.03
IFPRI	International Food Policy Research Institute, USA	0.87
ILRI	International Livestock Research Institute, Kenya	0.48
IRRI	International Rice Research Institute, the Philippines	0.95
IWMI	International Water Management Institute, Sri Lanka	0.68
WORLD FISH	World Fish Center, Malaysia	1.02
AVRDC*	The World Vegetable Center, Chinese Taipei	0.47
CABI*	CAB International, UK	0.75
Total		10.8

* Centres not associated with CGIAR, but working in areas of agricultural development of interest to Australia's regional developing country partners

Source: ACIAR 2008–09 annual report, (www.aciar.gov.au)

As a developed country with knowledge and skills in agriculture, fisheries, forestry and rural development, Australia is well placed to play a significant role in the call for international efforts to reverse the decline in public RD&E investment in order to address climate change and provide food, fibre and renewable energy for a growing global population (Beddow *et al* 2009).

Council finding 14

While Australia's rural sector has struggled to attract R&D financing from abroad, our rural research community has significantly supported R&D in other, generally less developed, countries.

Build strategic international links

International RD&E interactions must be strategic to maximise benefits to the rural sector and broader Australian community. Existing scientific, trade and aid networks, such as the Australian Academy of Science, and associated links with ICSU, Austrade, AusAID and ACIAR, as well as Australian Government membership of UNESCO, provide a strong basis for further international collaboration.

Participation in international research groups provides a mechanism for monitoring overseas developments that could be relevant and useful in Australia. In some cases, there may be value in paying to secure involvement in selected research communities.

In recent times, the Australian Government has considered the adequacy of current patterns of investment to support international collaboration in RD&E, generally (House of Representatives Standing Committee on Industry, Science and Innovation, 2010). Less than 3 per cent of total Australian RD&E is financed *from* abroad, compared with 17 per cent in the United Kingdom and 8 per cent across the European Union (DIISR 2010, OECD 2008).

From a rural sector perspective, recent ABARES research examines the contribution to Australian broadacre productivity growth of research conducted overseas, whether through new ideas or adaptation of research to suit local conditions. It suggests that the relative contributions of foreign and domestic research activities (including extension) to broadacre productivity growth have been roughly equal, and that foreign research is particularly important for small, open economies like Australia (Sheng *et al* 2011). This underlines the importance of Australia's continued interaction with the international research community, and the need to ensure that access to relevant foreign research is available to local RD&E providers.

Australia itself is positioned to become a major contributor to global rural research in areas where it has a comparative international advantage. For example, RD&E improvements in the production of beef, wheat and horticulture are likely to be of interest to many countries and could be a focus of international collaboration for some of the rural R&D Corporations. Similarly, RD&E in water use efficiency in semi-arid environments is likely to be of interest to producers in the Middle East and parts of Africa. At the same time, Australia may benefit from RD&E related to water use efficiency being undertaken by countries such as Israel. Australia is a founding member of the Global Plant Sciences Council and the Global Research Alliance on Agricultural Greenhouse Gases, both established in 2009 through world-wide scientific and policy networks respectively. Such alliances bring countries, organisations and individuals together to enhance international cooperation and collaboration. The Alliance is focused on RD&E that will help deliver ways to grow more food (and more climate-resilient food systems) without increasing greenhouse gas emissions.

The Council notes that the results of research developed overseas are not always directly transferable. It is important that Australia maintains adequate RD&E investment in key areas of interest, either to adapt overseas results or conduct research specific to the Australian environment.

Notwithstanding the importance of international links, Australia needs to be self-reliant in areas of RD&E that are not a priority to other countries. For example, as a major producer of fine wool, opportunities for international collaboration with other research groups may be limited. However, this does not preclude international RD&E links with processors and others along the value chain, with a focus on customer requirements for fabric and clothing.

Council recommendation 9

The Australian Government should build strategic international links and strengthen the capacity of existing networks to contribute to international efforts to address climate change and sustainably produce food, fibre and renewable energy.

Increase private investment through international links

Improved international links can create significant opportunities to increase private investment in rural RD&E in Australia. Stable legal and government institutions and large regional landscapes with good infrastructure make for an attractive investment environment.

The identification of a commercial path to market that is broader than just the Australian context will be essential for securing private foreign investment. Austrade, and many research organisations, are identifying these opportunities and helping to tailor research to address both global needs and commercial markets, as are.

Intellectual property arrangements are important for securing private sector investment. Analysis of trends in plant breeders' rights applications and patent applications for plant-related innovations in Australia shows gradual growth in the number of plant innovations being protected by intellectual property provisions (Hubicki and Sanderson 2009).

Researchers and policy makers need to consider and negotiate intellectual property rights. They should not be a barrier to collaboration.

Council recommendation 10

The Australian Government should encourage industry and researchers to strengthen links that increase the flow of international capital into Australia's rural RD&E system.

There is an increasing number of philanthropic organisations funding RD&E to address food security and climate change challenges in a bid to meet Millennium Development Goals. Australian researchers are well placed to access this funding through collaborative RD&E that could deliver benefits both in Australia and to regions with similar agro-ecological climates, such as parts of Africa and Asia. The Council notes the growing trend for philanthropic organisations to require matched investment by partner governments to leverage funds for greater and faster impacts.

Proposed investment balance

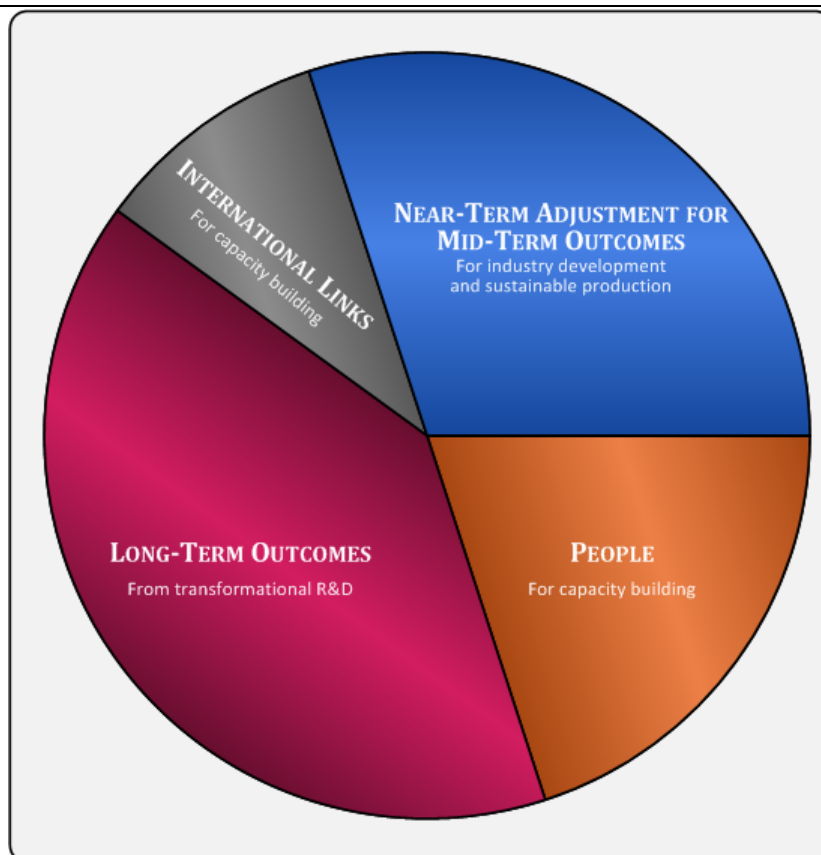
The desired balance of investment across the five themes identified by the Council has been considered in several stakeholder consultation processes.

Based on analysis of the rural RD&E system and stakeholder feedback, the Council recognises the leading role that transformational RD&E will likely play in ensuring increased rural productivity and sustainability, while maintaining the resource base for future generations. The Council therefore proposes that 40 per cent of the investment should be directed to transformational RD&E. The Council proposes that 30 per cent of RD&E investment should be directed to industry development and sustainable production, reflecting the need for near-term adjustment to achieve mid-term outcomes including improved productivity growth and competitiveness. Ongoing RD&E investment in the enabling themes of 'capacity in people' and 'international links' (20 per cent and 10 per cent respectively) will support the achievement of both mid- and long-term outcomes.

The Council's proposed investment balance recognises the long lag time between investment and return for RD&E.

Figure 13 illustrates how the investment balance covers the Council's five investment themes of industry development, sustainable production, transformational RD&E, capacity in people and international links.

Figure 13: Investment balance across the five themes



The Council has refrained from recommending a dollar value for rural RD&E investment, although the proposed investment balance should be considered in light of the Council's recommendation

for increased overall investment in rural RD&E, including by the Australian Government. The investment balance is not necessarily intended to divert funding away from existing activities, but to provide a high level indication of how overall RD&E investment should be distributed. The Council also acknowledges that while its vision and proposed investment balance are broadly applicable to rural industries and the rural RD&E system as a whole, there are certain sub-sectors whose goals may not align with the Council's proposals.

Council finding 15

The National Strategic Rural R&D Investment Plan will, in consultation with stakeholders, build an appropriate investment profile across the rural RD&E system.

Council recommendation 11

To achieve the Council's vision for rural RD&E, the initial balance of investment across the rural RD&E system should be:

- 40 per cent: transformational investment for long-term outcomes
- 30 per cent: near-term adjustment for mid-term outcomes
- 20 per cent: capacity-building in people
- 10 per cent: international linkage.

The Council believes its investment profile moves towards 'triple bottom line' (economic, social and environmental) outcomes that balance long-term needs with short-term priorities, establishing strategic capability to support research into rural issues while being linked to larger, national 'grand challenges'.

Stimulus will be required when data indicate that the investment portfolio needs to be adjusted to achieve the desired balance. As new information and data become available, further judgement should be applied in consultation with others.

Performance measurement and reporting

Evaluating the triple bottom line return on investment in rural RD&E, though difficult, is essential for guiding future investment. The use of business metrics, including net present value and rate of return, is well established for estimating economic outcomes. Methods for assessing the return on public funds invested to achieve environmental and social outcomes are less developed. There is a need to build on existing whole-of-government RD&E monitoring initiatives such as the DIISR Innovation Metrics Framework (DIISR 2010) and to consider broader and global developments in integrated (rural) systems analysis (for example, IIASA, Austria; see also PMSEIC 2010a).

The Council has commenced the design of a performance measurement and reporting framework for Australia's rural RD&E system (GHD 2010). It is anticipated that the primary audience for this framework will be the entity responsible for the implementation of the investment plan¹⁰. The framework should also support a secondary audience consisting of stakeholders who influence or benefit from the rural RD&E system. This audience is also interested in monitoring progress and in many cases has its own process of evaluation (Table 7).

Table 7: Primary and secondary audiences for the measurement and reporting framework

Primary audience	Secondary audience
<ul style="list-style-type: none">▪ Australian Government Minister for Agriculture, Fisheries and Forestry▪ Entity responsible for monitoring the overall rural RD&E system on the Minister's behalf	<ul style="list-style-type: none">▪ Inter-governmental councils and committees related to rural RD&E (e.g. PIMC, PISC, RD&E Framework)▪ Federal and state government RD&E organisations and ministers▪ CSIRO▪ Rural R&D Corporations (including Council of R&D Corporations)▪ Universities▪ Agribusiness and multinational corporations▪ Peak industry groups▪ Peak environmental groups▪ Rural sector participants

¹⁰ See the Institutional Arrangements section of the plan for a discussion of the need for a system-wide approach to monitoring the rural RD&E system.

Table 8 summarises the uses for the framework.

Table 8: Uses for the measurement and reporting framework

Uses	
	<ul style="list-style-type: none"> ▪ Understand opportunities, drivers and gaps in the rural RD&E system ▪ Allocate resources in the context of the overall system ▪ Design and implement RD&E ▪ Build RD&E capabilities ▪ Support collaboration ▪ Develop investment business cases ▪ Evaluate spread of investment and capability against priorities ▪ Determine impact of RD&E, including economic return, environmental improvement and social benefits ▪ Justify continued and new investment

Preliminary measures

The framework has four components:

- broad measures of rural R&D system achievement
- performance indicators for the five investment themes
- comparison with global rural and other Australian RD&E systems
- indicators of internal risks to which the rural RD&E system can respond.

Preliminary measures and indicators are provided for each of the four components. Refinement of these measures and indicators is an area of ongoing work for the Council in its third year. The Council is mindful of the opportunity to do this in a manner that increases the return on investment in existing measurement and reporting frameworks. Reporting should enable the rural RD&E system to demonstrate achievements and identify areas for improvement.

Broad measures of achievement cover inputs as well as what has been produced (outputs) and the resulting outcomes (Table 9):

Table 9: Broad measures for rural RD&E system achievement

Inputs	<ul style="list-style-type: none"> ▪ Government policies, strategies and coordination efforts ▪ Levels of investment (direct financial investments and investments in people through education)
Outputs	<ul style="list-style-type: none"> ▪ Participation in public and private sector extension services ▪ Improvements in skills and capacity ▪ Scientific publications ▪ Patent registrations and plant breeders' rights ▪ Investment/uptake in innovative capital, plant/animal varieties, products and practices

Outcomes	<ul style="list-style-type: none"> ▪ Condition and use of natural resources ▪ Economic performance of the rural sector ▪ Improved social welfare in rural Australia
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Over time, the level of investment in inputs can be adjusted. Feedback through evaluation is critical to achieving a resilient system that is ‘internally aware’ and can redirect itself as needed.

The indicators reported in Table 10 are specific to the investment themes in the Plan:

Table 10: Preliminary indicators for system-wide investment goals

Goal	Preliminary indicator
Industry development	
Facilitate ongoing industry development and adaptation to change through RD&E	<ul style="list-style-type: none"> ▪ Emerging technologies, platforms and production systems created ▪ Trends in total and partial factor productivity
Leverage innovation for growth along the value chain, with greater sharing of risk and reduced reliance on natural resources	<ul style="list-style-type: none"> ▪ RD&E investment along the value chain and relative to gross domestic product ▪ Returns from RD&E investment along the value chain (benefit–cost ratios, internal rates of return, net present value etc.)
Sustainable production	
Integrate natural resource management with production systems to use natural resources more efficiently	<ul style="list-style-type: none"> ▪ Trends in natural resource use efficiency and condition for AFF systems ▪ Number and area of rural businesses with environmental accreditation
Analyse and plan for climate change with improved modelling and scenarios to build understanding and develop adaptation practices and resilient systems	<ul style="list-style-type: none"> ▪ Climate change RD&E strategies, investment and knowledge created ▪ Number of businesses/industries with life cycle analysis/accreditation
Transformational RD&E	
Develop elite genetic resources, emerging technology platforms and multidisciplinary capability for application to rural problems and opportunities	<ul style="list-style-type: none"> ▪ Trends in multidisciplinary RD&E investment and capability clustering ▪ Trends in appropriately maintained genetic registers and collections
Invest in and, in some cases, accelerate cross-sectoral RD&E strategies, such as those relating to bioenergy/biofuels/ bio-based	<ul style="list-style-type: none"> ▪ Trends in cross-sectoral RD&E strategies, governance structures and levels of investment

products, food and nutrition

Develop social research and tools that enable rural communities to embrace change, enhance adoption and manage the impact of change

- Implementation of knowledge created by rural communities to manage climate and other drivers

International links

Systematically link, and collaborate, with leading international groups to access funds, markets and knowledge to address common Australian and global needs

- International investment in Australian rural RD&E
- Australian investment in rural RD&E overseas
- Co-patents, co-publication and citation trends and proportions with international researchers

The Council believes there is significant value in comparing the performance of Australia's rural RD&E system performance with global and other benchmarks (Table 11):

Table 11: Preliminary benchmarks

Inputs	<ul style="list-style-type: none">▪ Comparison of public and private investment in rural RD&E with other sectors and countries▪ Comparison of trends in completions of tertiary qualifications in relevant fields with other sectors and countries▪ Comparison of trends in other investments in the capacity of rural sector participants
Outputs	<ul style="list-style-type: none">▪ Comparison of trends in patent registration and plant breeders' rights with those in other countries▪ Comparison of trends in scientific publications with those in other disciplines and countries▪ Comparison of trends in field trials
Outcomes	<ul style="list-style-type: none">▪ Comparison of trends in productivity growth in the rural sector with those in other sectors and countries▪ Comparison of trends in gross value added per natural resource (water, land etc.) with those in other countries▪ Comparison of trends in environmental measures (soil, water quality, biodiversity, pests, weeds, waste etc.)

Internal risk should also be monitored (Table 12):

Table 12: Preliminary measures for monitoring rural RD&E system risk

Category	Components
Infrastructure	<p>Does the rural RD&E system have the required infrastructure to achieve its goals?</p> <ul style="list-style-type: none"> ▪ Quality of RD&E professionals from education ▪ Distribution and quality of science and technology disciplines ▪ Distribution and quality of physical infrastructure ▪ Distribution and variability of rural RD&E finance
Institutional	<p>Do the institutional settings support public and private sector investment and participation in rural RD&E?</p> <ul style="list-style-type: none"> ▪ Legal and regulatory framework ▪ Social and cultural norms
RD&E participant capability	<p>Do the rural RD&E firms have the required capability?</p> <ul style="list-style-type: none"> ▪ Alignment of strategy and investment with industry needs ▪ Capability, culture and systems sufficient and aligned ▪ Adaptability
Interactions	<p>Do interactions between participants optimise rural RD&E performance?</p> <ul style="list-style-type: none"> ▪ Industry-science links ▪ Co-innovation along value chains ▪ Collaboration between rural RD&E firms ▪ Open innovation at the sector level
Exogenous drivers	<p>What external risks influence the ability of businesses to participate in rural RD&E and capture value from knowledge created?</p> <ul style="list-style-type: none"> ▪ Market forces on rural industries ▪ Environmental impacts (e.g. climate change) ▪ Structural change in rural industries and commodities ▪ Science and technology development

Issues relating to implementation

Successful performance measurement and reporting depends on data availability and quality, governance and adequate resources.

Data relating to public sector RD&E investment are available. Publicly available data related to private RD&E investment are limited. Primary producer innovation data are severely limited; the ABS does not currently collect innovation data for the rural sector as part of its Business Characteristics Survey.

In relation to ‘triple bottom line’ measures, the ABS and ABARES produce data relating to employment, income, exports, profit, water and energy use, greenhouse gas emissions, and partial and total productivity measures. However, these data are not available for all components of the rural sector. ABS data on the structure and nature of society cannot always be disaggregated to just the rural sector. For the environment, monitoring condition and trend of the natural resource base used by the rural sector, the data are currently variable in coverage and frequency, although this is an area of ongoing improvement.

Council finding 16

The availability of data for monitoring and reporting trends and performance of the rural RD&E system in Australia is severely limited.

Maintenance and implementation of information systems

There are timing and resource implications associated with implementing the performance management framework. The economic and science research bureau within DAFF is well positioned to assemble and maintain relevant databases and to couple system-wide performance analysis with other AFF knowledge. Associated cyber-infrastructure should enable data curation and modelling and be sufficient to enable a systems approach to the variability associated with rural sector information.

Where possible, the rural RD&E system performance measurement framework should articulate with the monitoring activities of the National Primary Industries RD&E Framework, rural R&D Corporations and DAFF grants programs. For example, the Framework requires the maintenance of industry-specific capability audits and the Council of Rural R&D Corporations has advanced rural R&D program evaluation. The framework should not add to the compliance burden or administration costs already facing rural RD&E providers – rather, such arrangements should aim to increase reporting efficiency.

Council recommendation 12

The Australian Government should invest immediately in increased data collection to support the measurement of the rural RD&E system performance. This includes allocating resources to analyse data requirements and existing and new sources of data, and to communicate findings clearly. The first of a regular series of rural RD&E system reports should be prepared urgently using the Council’s proposed performance measurement and reporting framework.

Institutional arrangements

This section discusses the Council's proposal for overarching institutional arrangements.

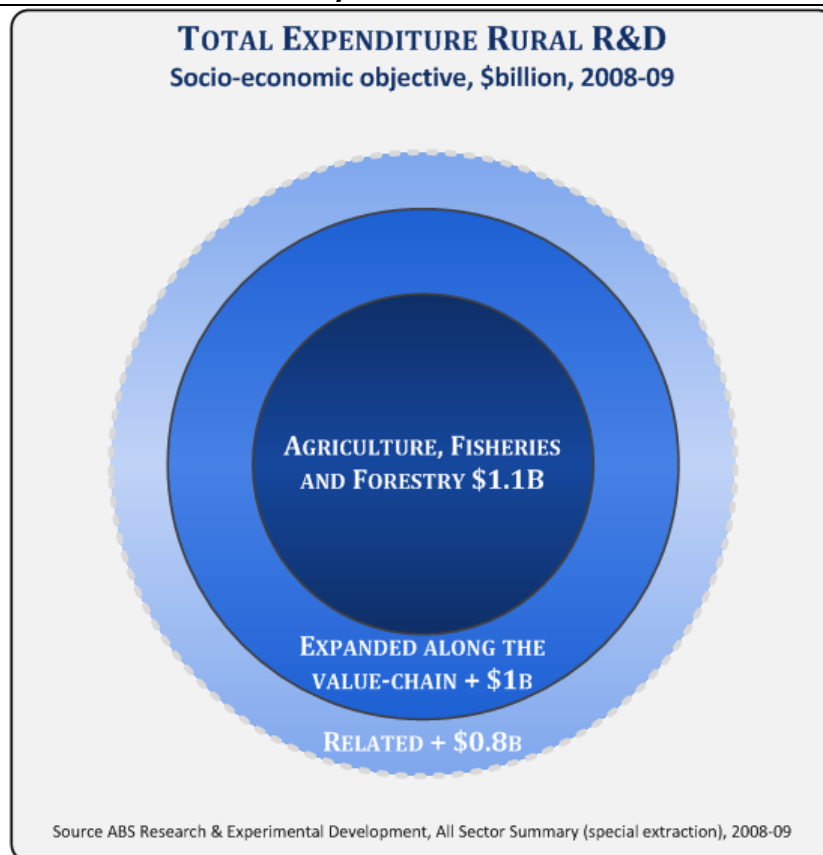
The need for a system-wide approach

The complex range of investors and research providers in the rural RD&E system is not likely to be simplified in the future. It reflects the diversity inherent to the rural sector and offers depth to rural RD&E investment in Australia through a system of distributed responsibilities. The Council believes that a system-wide approach is required to provide focus and to position rural RD&E investment relative to the broader national, and international, innovation systems.

Governance arrangements

Stakeholder consultation has indicated strong support for the notion of viewing this complex system in terms of three concentric circles representing the 'AFF', 'expanded along the value chain' and 'related to rural' components of rural RD&E as a useful and robust lens through which to view this complex system (Figure 14). In such an analysis, approximately 40 per cent of gross expenditure on R&D nationally is 'farm sector-led'. More than half of the rural RD&E system is outside of this, with funding coming from other sources and non-primary industries focused government departments. From an Australian Government perspective, DEEWR, DFAT, DIISR, DRET, DCCEE and DSEWPC are all active participants.

Figure 14: Components of the rural R&D system



Notwithstanding the importance of the private sector, a whole-of-government approach is required given the number of portfolios with interests in rural RD&E (Table 13):

Table 13: Government agency interests in Council-identified goals

Goal	Agency
Facilitate ongoing industry development and adaptation to change through RD&E	PIMC's Commonwealth and state jurisdictions, DAFF, CSIRO, R&D Corporations
Leverage innovation for growth along the value chain, with greater sharing of risk and reduced reliance on natural resources	PIMC's Commonwealth and state jurisdictions, DAFF, DSEWPC, CSIRO, R&D Corporations
Integrate natural resource management with production systems to use natural resources more efficiently	PIMC's Commonwealth and state jurisdictions, DAFF, DSEWPC, CSIRO, R&D Corporations
Analyse and plan for climate change with sophisticated modelling to: build understanding, and develop adaptation practices and resilient systems	DAFF, DCCEE, CSIRO, RIRDC
Build capability through high-quality education and training	DEEWR and state counterparts, DIISR
Reward and retain world-class researchers through commitments above current investment levels	DEEWR and state counterparts, DIISR
Develop social research tools that enable rural communities to embrace change, enhance adoption and manage the impact of change	DEEWR and state counterparts, DIISR, RIRDC
Develop elite genetic resources, emerging technology platforms and multi-disciplinary capability for application to rural problems and opportunities	PIMC's Commonwealth and state jurisdictions, DAFF, CSIRO
Invest in, and in some cases accelerate, cross-sectoral RD&E strategies, such as those relating to bioenergy/biofuels/bio-based products, food and nutrition	PIMC's Commonwealth and state jurisdictions, DAFF, CSIRO, RIRDC
Systematically link, and collaborate, with leading international groups to access funds, markets and knowledge to address shared Australian and global needs	ACIAR, Austrade, AusAID, ARC, DAFF, CSIRO, state agencies

In considering institutional arrangements, the Council has also taken into account changes to the Administrative Arrangements Orders since Federation, the history of rural research leadership in Australia, nation-building precedents, structures used in other parts of the innovation system, overseas comparators and legislative options.

While it is essential that mechanisms exist to link rural industries to broader developments, the Council believes that responsibility for implementing and overseeing the investment plan and associated performance management system should be vested in a diverse key advisory body that reports to the Australian Government Minister for Agriculture, Fisheries and Forestry. Implementation of the Council's vision for rural RD&E will also require DAFF to be well-resourced.

Day-to-day, those with responsibility for a system-wide approach should:

- focus on building resilience by ensuring that the system is ‘internally aware’ and can redirect itself as needed
- use world-class information management, analysis and interpretation
- respond to identified performance deficits, working within agreed terms of reference to effect change
- work to short-, medium- and long-term objectives across economic, environmental and social domains
- promote efficiency
- contribute to and, at times, facilitate discussion among thought leaders
- pursue ongoing development and adjustment through the supply of information and facilitation of change-management processes
- elevate and celebrate system achievement, critiquing specific developments through the lens of an overarching plan
- work across a federated structure and in a market-based economy
- take into account the specific needs of rural stakeholders and broader Australian interests
- assist those responsible for the positioning of domestic capability in a global context
- promote exchange between domestic components of the rural R&D system in the context of aggregate data and overarching objectives
- enable a response to ‘national conversations’ about population, food, carbon, water and energy, guiding the national rural R&D system towards agreed objectives in these fields
- work to preserve Australia’s world-class rural R&D reputation in a rapidly changing global research environment.

Council recommendation 13

The Australian Government should endorse the first National Strategic Rural R&D Investment Plan.

Council recommendation 14

The Australian Government should ensure adequate provision for the maintenance and implementation of the Plan by endorsing a key advisory body to guide more effective multi-sector cooperation and the prioritisation of Australian Government investment in RD&E for Australia’s rural industries.

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