



# **Australian Agricultural Research: Institutional Changes, Performance and Measurement**

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# **Title: Australian Agricultural Research: Institutional Changes, Performance and Measurement**

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## Abstract

Changes to institutional structures and management of Australian agricultural R&D may have affected research performance. These changes have included shifts in institutional arrangements, increased focus on research management and accountability, integration of research effort, and greater involvement in research by producers.

We see these changes as generally beneficial to the delivery of more relevant outputs and improved impacts.

We make comment on measuring trends in the performance of R&D and the methods and findings of some Australian economic evaluations of research investment, using both top down and bottom up approaches. We then suggest a wider framework for evaluating R&D performance and agricultural R&D investment.

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## **1. Changes in Australian R&D Institutional Structures and Management**

Significant changes in institutional structures and management of Australian agricultural research and development (R&D) investment have occurred over the past 30 years. Particularly significant have been the formation of the Research and Development Councils in 1986 and Research and Development Corporations (RDCs) in 1990. A key principle driving the introduction of RDCs was the separation of research funding from research provision. The RDCs are funded by statutory producer levies and matched Australian Government funding.

The Australian Special Rural Research Council (ASRRC) was established in 1986 to fund research for small industries that had no levy structure, multi-industry research and national interest issues. In 1990 ASRRC was replaced by the Rural Industries Research and Development Corporation (RIRDC) that plays a similar but expanded role. Also in 1990, the Land and Water Resources RDC was established, later known as Land and Water Australia (LWA). This Corporation was wholly government funded. Its focus was on sustainable natural resource management (NRM). LWA drew additional funding from the commodity-focused RDCs to jointly address common productivity/NRM issues (e.g. an irrigation R&D program, a dryland salinity R&D program). The annual average level of investment by the 15 RDCs has been \$514 million over the period 2010-2015.

Cooperative Research Centres (CRCs) were also introduced in 1990 and are usually based at one or more universities. They are public/private sector joint ventures that require private sector involvement and funding. Universities, CSIRO and other researchers collaborate to produce research outputs that have strong prospects for commercialisation. CRCs operate in both agricultural and other industries as well as work for the public good.

The advent of RDCs and CRCs has generated research with a stronger focus on outcomes and end user benefits. RDC governing councils and boards are expertise based and generally include producers, researchers, extension personnel, an economist, and, for some years, an Australian Government representative. Emphasis is on strategic planning, assessment and scoring of research proposals, reporting to levy payer representatives and government, and evaluation and accountability.

### *The National Primary Industries RD&E Framework*

In 2005, the Primary Industries Ministerial Council (PIMC) (now known as the Standing Council on Primary Industries (SCoPI)) promoted the concept of a more collaborative national RD&E model, and endorsed the development of a National Primary Industries Research, Development & Extension Framework (the Framework).

The Framework was developed jointly between the Commonwealth, the State and Northern Territory Governments, RDCs, CSIRO, and universities. The Framework is one of the 'key issues of national significance' under the SCoPI terms of reference (Primary Industries Standing Committee: Research, Development & Extension Subcommittee, n.d.).

National RD&E strategies have been developed for the following primary industry and cross industry sectors:

- beef, cotton, dairy, fishing and aquaculture, forest and wood products, grains, horticulture, pork, poultry, sheep meat, sugarcane, wine, wool, and new and emerging industries;
- animal biosecurity, animal welfare, biofuels and bioenergy, climate change and variability, food and nutrition, plant biosecurity, soils, and water use in agriculture.

## **2. Impacts of these Changes**

The institutional, legal and management changes for Australian agricultural R&D over the past 30 years have produced various outcomes that will have impacted the performance of Australia's agricultural industries. Major examples have been the increased role of the private sector in plant breeding in response to Plant Variety Rights, and the growth of the private sector in extension.

### *Likely Positive Impacts of the Changes*

An increased focus on outcomes and end users has been positive for Australia and Australian primary industries. The increased relevance of R&D outputs to producer decision making has been beneficial. Also, increased uptake of planning, and monitoring and evaluation is likely to have improved efficiency and effectiveness of resource allocation by the funding bodies.

Improved processes for directing relevant R&D proposals and for selecting suitable R&D investments have improved efficiency of research funding through improved coordination and collaboration, communication and information flow, less duplication, and earlier exploitation of synergies and opportunities.

Other likely benefits of the changes include:

- Greater use by research managers of simpler methods of evaluating and prioritising alternative investment proposals (prospective unit cost change x quantity affected /adoption level). This has been partly due to economic expertise on most Councils/Boards and the gradual acceptance and value of both ex-ante and ex-post economic evaluations.
- More difficult-to-fund research into NRM and sustainability issues affecting agriculture due to the then LWA leverage of industry funds. Unfortunately, LWA, being 100% government funded, was terminated in the 2009 economic downturn. Sadly, the LWA website has been abandoned so there is limited access to 20 years of project information, research reports, reviews etc., many of which were unique and still highly relevant.
- An increase in both industry and research capacity through funding of scholarships and leadership courses by most RDCs and CRCs.

#### *Possible Negative Impacts*

The increased centralised management intensity and accountability requirements of the RDCs and CRCs have increased total costs of administration and management. The opportunity for growth of administrative structures and additional management services increased. It has been suggested that the RDCs have leaned towards incremental and applied research at the expense of strategic research. Unfortunately, most RDCs have not kept adequate records to allow the perception to be tested formally.

But has Australia's overall agricultural R&D performance increased or decreased over time? Sadly, we don't believe that question can be answered adequately or with any certainty. Improved understanding of the changing performance of Australia's agriculture R&D investment could better inform decision makers about the direction and future level of funding of agricultural R&D.

### **3. Measuring Performance of R&D Investment**

Various economic analyses and reviews carried out over the past 30 years show that agricultural R&D investment has been profitable for Australia and for Australian producers (e.g. Productivity Commission, 2011). Mullen (2007) confirmed earlier reported internal rates of return in Australian rural research and extension of between 15 and 40 per cent. However, most of the aggregated and program-level analyses have not been particularly consistent at measuring trends in performance over time and hence addressing the factors that have underpinned such trends. Both the estimated rates of return and the trends in these estimates are important in influencing whether greater or lower levels of R&D investment should be considered by investors.

Also, R&D managers have not been very good at monitoring investment in different categories of research and linking changes to performance. There has been scant effort applied by individual organisations to analysing trends in their investments or investment performance regarding riskiness and type of research so that their portfolio balance can be modified accordingly.

Economic analysis can take various approaches to measure performance. Here we discuss two such methods for evaluating research performance trends over time. We broadly categorise these approaches as 'top down' and 'bottom up'.

A top down approach takes observed performance changes (i.e. measures of productivity) and attempts to trace that performance, and attribute it, back to some past R&D investment. Alternatively, a bottom up approach starts with a past R&D investment, then attempts to map the R&D's activities and outputs through to measurable impacts compared with a counterfactual.

### *Top Down Approach for Measuring Performance*

The most frequently used top down approach to establish the value of agricultural R&D investment in Australia and elsewhere has relied on the link between annual research investment and total factor productivity (TFP) measures at the farm level. Productivity is assumed to be driven largely by R&D investment and, with appropriate lags, a relationship between annual research investment and farm productivity has been demonstrated in a number of studies worldwide, including some in Australia based on ABARES broadacre farm survey data.

Initially, the approach was rather simplistic and used a direct relationship. However, it has been recognised that Australian funded R&D is not the only factor driving farm productivity; other factors include farm structural and enterprise changes, improved inputs from overseas R&D, climatic factors, terms of trade, and improvements in farm management and adoption capacity. While the effect of some of these other factors may have been influenced by Australian R&D to an extent, until recently such relationships seem not to have been effectively elicited.

These top down, econometric, multi-period models have now become more sophisticated and generally point to a decline in TFP for Australian broadacre farms during the first decade of the 2000s (e.g. Sheng et al., 2011). Also, Sheng et al. (2011) reported that Australian R&D knowledge stocks contributed only 31% to the average annual TFP growth of 1.96% p.a. estimated for the period 1953 to 2007 with extension knowledge stocks contributing nearly half of the 31%.

In a 2006 report (Chudleigh and White, 2006), Agtrans used a partial top down approach in an economic analysis of lamb production R&D investment made over the period 1991 to 2008. The findings from this short analysis demonstrate that the trend coefficients are highly sensitive to the period of analysis chosen and particularly sensitive to data values at the start and end year of a data series. Further, the study showed that there was significant variation in TFP values between elements of the broadacre industries and even within subsectors of the specialist prime lamb farms; this issue was further explored in Villano et al. (2006) who concluded that understanding the nature of technical change in the Australian sheep industry is essential for estimating efficiency and productivity change accurately.

It may also follow that there are grounds for concern if trends estimated by TFP indices, that are derived from the broadacre industries, are then used to suggest trends in overall agricultural R&D performance. This issue is discussed in the 2011 Productivity Commission report (Appendix B, pp 327-328) and is part of the broader conclusion reached by the Commission that 'the available evidence is inconclusive about whether trend productivity growth across the entirety of the rural sector has actually slowed to any great extent' (Appendix B, p329). Globally, Fischer et al. (2014) have shown the global TFP growth rate has increased steadily from 0.2% p.a. in the 1960s to 1.8% p.a. in the most recent decade

The apparent declining rates of return estimated for Australian R&D investment could be distrusted by those who support increased R&D investment. On the other hand, much has been made of the apparently high internal rates of return reported for agricultural R&D investment and there has been some distrust of these high rates by policy makers.

#### *Bottom Up Approach for Measuring Performance*

The bottom up approach relies on ex-post cost-benefit analyses of sufficient representative research investments to be able to say something about performance trends over time. While this approach explicitly accounts for the counterfactual, there is difficulty achieving sufficient representation of research investment using a bottom up approach. Also, few research funding and management institutions have pursued tracking performance trends over time. This is despite a very large and growing interest in research impact accountability among RDCs, CRCs, State Government Departments, CSIRO and even Australian Universities.

The RDCs have collectively made some attempt at a collegiate approach through the Council of Rural RDCs (CRRDC) with aggregate performance reports produced in 2008, 2010, and 2016 (CRRDC, 2008; CRRDC, 2010; CRRDC, 2016).

Significant effort has been made by the RDCs in this reporting initiative. A standardised set of guidelines and procedures has been developed and used for investment selection within the 15 Corporations. This has been a dynamic process with the Modified Internal Rate of Return added in 2014 to the required set of investment criteria, after a review including input from economist Julian Alston.

The performance measures reported through this work are based on simple averages across RDC investments that were largely chosen using random sampling. As the individual cash flows from each investment were not always available to those compiling the aggregate reports, the only aggregate criteria possible to report was the benefit-cost ratio (BCR). In the 2008 report, only the simple average BCR was reported. However, in the 2010 CRRDC report, the aggregate weighted BCR was reported as 6:1.

In 2006, Agtrans made an attempt to track research investment performance over time using a bottom up approach based on economic evaluation of investment by LWA (Chudleigh et al., 2006) (Figure 1). Also, a similar attempt using an expanded data series was made in 2012 (Pearson et al., 2012) (Figure 2). The second analysis covered 39 project groups and included a total of 641 separate projects. These analyses produced a time series of estimates of aggregate investment criteria from LWA investments by apportioning the annual cash flow of benefits for an individual investment to a specific period based on the proportion of total investment occurring during that period. The rolling time series investment criteria could then be used to explore changes in performance.

Figure 1: Benefit-Cost Ratios for LWA Investments for Different Time Periods (Chudleigh et al., 2006)

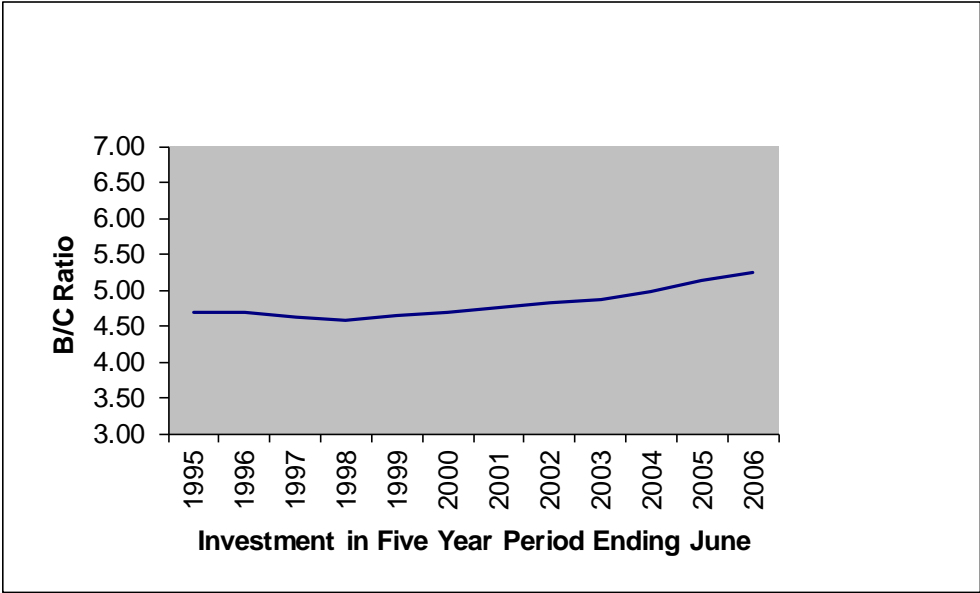
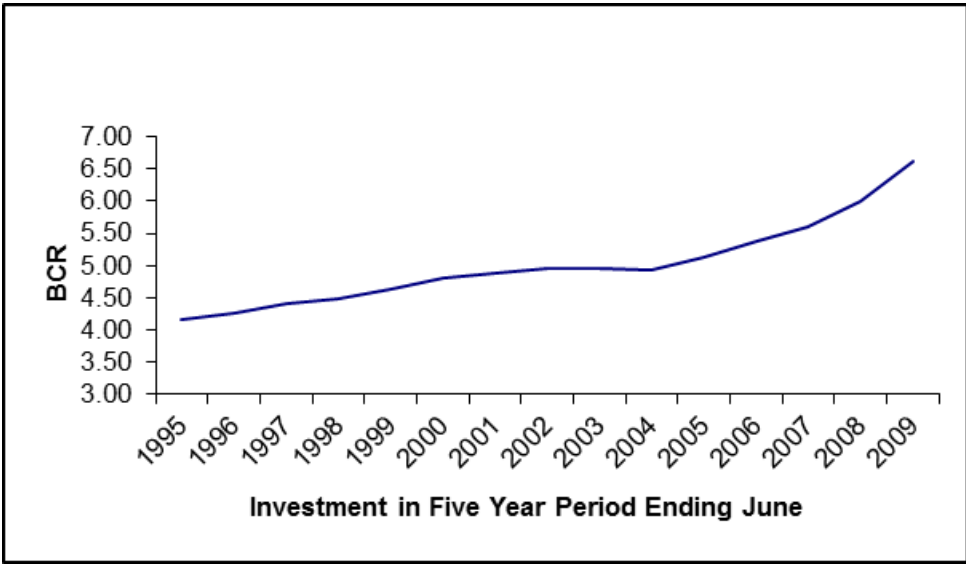


Figure 2: Benefit-Cost Ratios for LWA Investments for Different Time Periods (Pearson et al., 2012)



Another application of this approach was also attempted by Agrans for one commodity-specific RDC where up to 26% of the annual R&D investment was evaluated (see Figure 3) and a performance trend line estimated (see Figure 4). Figure 4 shows a declining rate of return to research investment from the early 2000s to 2009.

Figure 3: Proportion of the RDC’s R&D Portfolio Represented by the Evaluated Project Groups

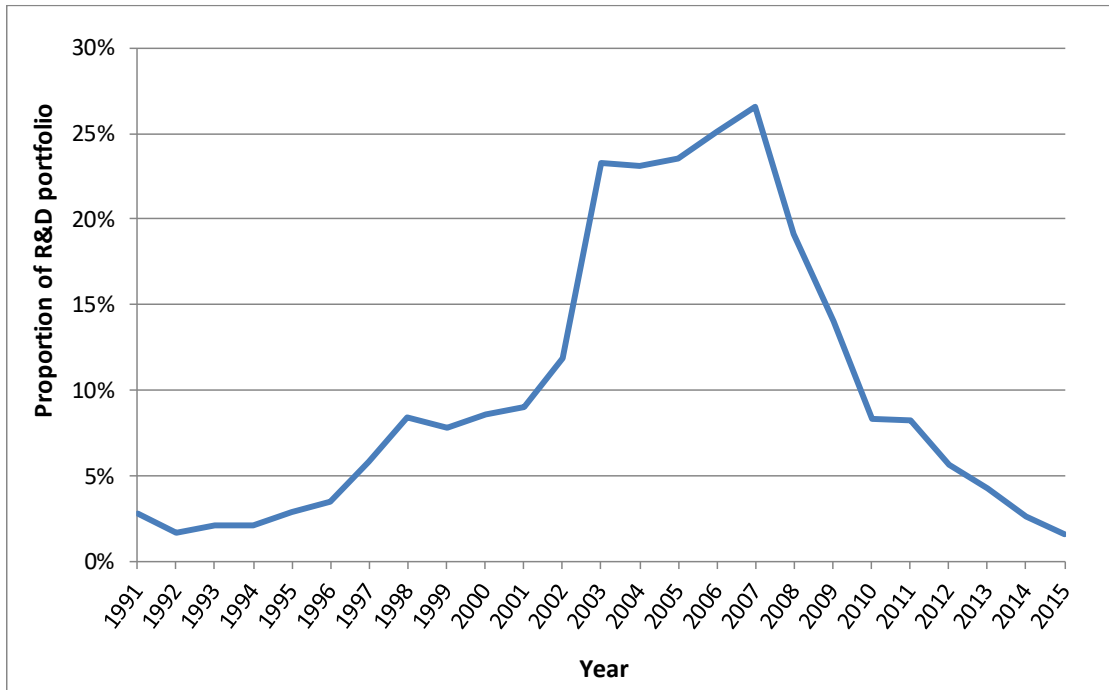
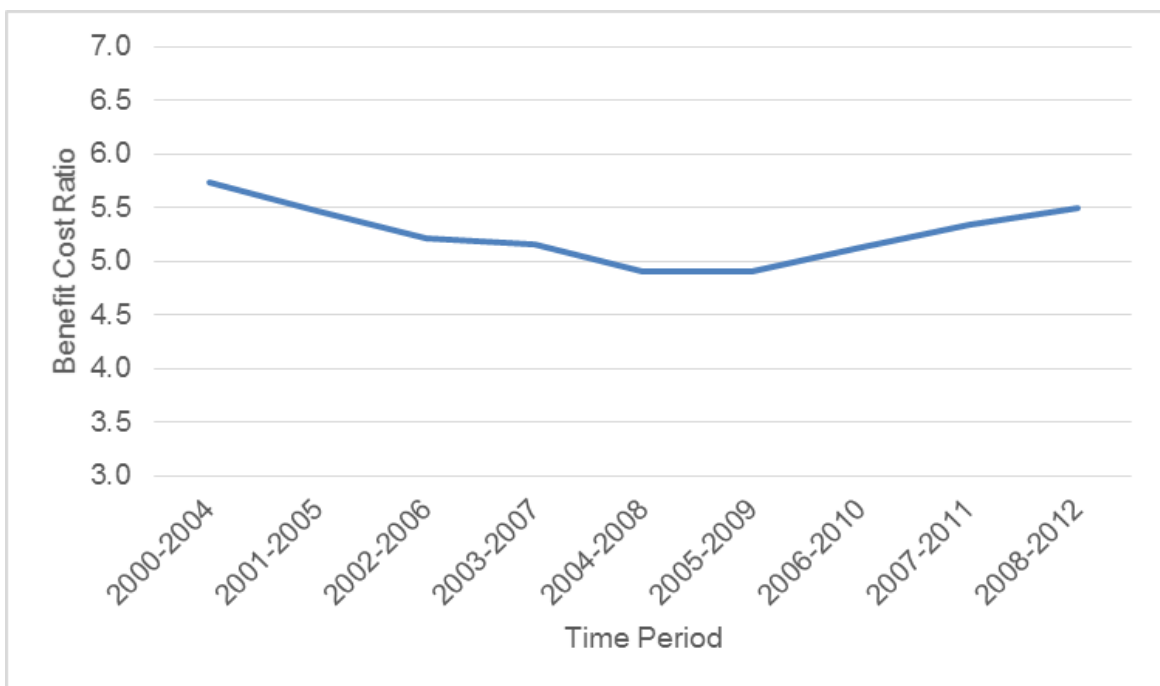


Figure 4: Benefit-Cost Ratio for ‘rolling five year periods’ Analysis





A strong institutional commitment over time is required to maintain useful time series data using a bottom up approach. Other constraints include the cost of carrying out enough evaluations to be meaningful. The commitment required makes the approach somewhat risky for individual R&D institutions as management priorities continuously change. To some extent, it would be preferable from a consistency and continuity perspective for such initiatives to be carried out 'in house', rather than externally. But this would clash with the objective of many research organisations where independent impact assessments are often required.

There are drawbacks to both approaches when used independently to measure agricultural R&D performance over time. The top down approach relies only on a subset of rural industries that may not be representative of the whole agricultural sector. Further, with a top down approach it is harder to make the linkages to the original R&D investment because of lag times and other factors that contribute to productivity changes. The bottom up approach lends itself to being industry specific and can cover all industries, but has struggled to cover sufficient R&D investment to provide confidence in the trend measurement. Also, some bottom up analyses are called ex-post but only in the sense that the research phase has been completed. This means that commercialisation and future adoption assumptions are necessary in some cases.

There is an argument for the development of the two approaches to be used in an integrated way to improve assessment of R&D performance over time. A bottom up approach could be used to supplement a top down evaluation. The bottom up results would provide additional information that either supports the top down trend findings or opposes the findings and provides some insight into the source of any discrepancy.

#### **4. A Wider Evaluation Framework**

Impact assessments of agricultural research investment are increasing. In 2015, CSIRO published its impact evaluation guide and advertised for analysts to register with the organisation. In 2016 the Australian Research Council (ARC) and the Department of Education and Training have been developing a framework for an engagement and impact assessment of universities to examine how they are translating their research into economic, social and other impacts. Also, State Government Departments appear to be undertaking more and more impact assessments of their research investments. Recently, one State Department required that impact assessments be undertaken in accord with the CRRDC guidelines. Although only a start, this request raises the question of whether a wider framework of research impact assessment/evaluation may be possible and desirable. Such an initiative could start at the RDC level as already the RDCs are performing much of the evaluation required via their cross-cutting RDC effort.

The authors note that research evaluation and/or impact assessment is not mentioned within the National RD&E Framework. Given the increasing interest in evaluation, there is potential for development of a common evaluation framework under the RD&E Framework. Already many agricultural research investments are made jointly between different research groups; one example has been the development of the 'lean and heavier lamb innovation' involving predominantly Meat & Livestock Australia (MLA) and six state governments (predominantly Vic, NSW and WA), with other input from some universities, CSIRO and some CRCs.

On the constraint side, impact assessment initiatives are currently driven by accountability to specific funding sources (e.g. State Department accountability to their Treasuries). Widening their current approaches to a national approach may be viewed as distracting. Furthermore, the element of competition for funding that can exist among research institutions may work against

the development of sharing a wider framework. Additional constraints may include the cost of building the framework and then maintaining the evaluations over time, and any additional costs incurred to carry out the evaluations.

A wider, improved bottom up framework could be advanced and serviced without compromising the existing individual institutional frameworks. An approach that could be nested within the existing National RD&E Framework would be for R&D investments in key national achievements for agricultural R&D to be identified jointly and subjected to impact assessments each year. Sets of lower and upper bound investment criteria could be produced where the value of benefits from the key investments valued are compared against the costs of only those investments (upper bound estimates) and then compared against the cost of all R&D investments made (lower bound estimates). The same analysis could be useful to all funders by using their own investment costs and attributing benefits according to relative investment costs

## **5. Conclusions**

There have been some significant changes in institutional structures and management of Australian agricultural R&D over the past 30 years. In general, these changes have been positive, with improved involvement of producers in decision making and improved business practices, especially regarding the RDCs and CRCs.

However, the measurement of the trends in performance of Australian agricultural R&D over this period has been insufficient and inconclusive. Top down approaches suggest rates of return to agricultural R&D investment are declining but this generalisation may be open to question depending on the time periods analysed and the rural industries included. We propose that a bottom up approach to estimating performance trends, while resource intensive, is more informative than the top down approach and warrants further consideration.

Within the National RD&E Framework, there is scope for the States, Universities, CSIRO, CRCs, and RDCs to work together to develop a National RD&E Evaluation Framework and to jointly conduct specific bottom up evaluations to produce more meaningful measurement of agricultural research performance trends. This also would generate more detailed information about both industry level and national agricultural research investment and its impact and may contribute to improved resource allocation for research funders for Australian agricultural R&D.

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