Economic Evaluation of Agricultural Research in Australia and New Zealand

A workshop held in conjunction with the 40th annual conference of the Australian Agricultural and Resource Economics Society 11–16 February 1996, Melbourne, Australia

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A workshop convened by:
Research Evaluation Group for Agricultural Economists (REGAE)

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Brennan, J.P. and Davis, J.S. 1996. Economic evaluation of agricultural research in Australia and New Zealand. ACIAR Monograph No. 39, 80 pp.

ISBN 1 86320 188 2

Production management: P.W. Lynch
Technical editing: P. Knight
Typeset and layout: Sun Photoset Pty Ltd, Brisbane
Printing: Watson Ferguson & Company, Brisbane

Contents

List of Acronyms and Abbreviations Used

AAES	Australian Agricultural Economics Society
AARES	Australian Agricultural and Resource Economics Society
ABARE	Australian Bureau of Agricultural and Resource Economics
ABS	Australian Bureau of Statistics
ACIAR	Australian Centre for International Agricultural Research
AgWA	Agriculture Western Australia
APPRAISAL	Spreadsheet for evaluating the returns to R&D
ARC	Australian Research Council
ARI	agricultural research intensity
BAF	benefit assessment framework
BCA	benefit–cost analysis
BCR	benefit:cost ratio
BIE	Bureau of Industry Economics
CRC	Cooperative Research Centre(s)
CRI	(NZ) Crown Research Institute
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPIE	(Commonwealth) Department of Primary Industries and Energy
DRDC	Dairy R&D Corporation
DSIR	(NZ) Department of Scientific and Industrial Research
DSTO	Defence Science and Technology Organisation
EEU	Economic Evaluation Unit
GDP	gross domestic product
GM	gross margin
GRDC	Grains R&D Corporation
GVP	gross value of production
IAC	Industries Assistance Commission
IC	Industry Commission
IPR	Intellectual Property Rights
IRR	internal rate of return
ISNAR	International Service for National Agricultural Reseach
IWS	International Wool Secretariat
LWRRDC	Land and Water Resources R&D Corporation
MoRST	(NZ) Ministry of Research Science and Technology
MRC	Meat Research Corporation
NHMRC	National Health and Medical Research Council
NPDP	National Procurement Development Program
NPV	net present value
OECD	Organisation for Economic Cooperation and Development
PGSF	(NZ) Public Good Science Fund
PRA	program resource allocation
PREVSYS	PRoject EValuation SYStem (Queensland)
QDPI	Queensland Department of Primary Industries
R&D	research and development
RADIS	R&D Investment Strategy Study
RDC	R&D corporation/council
REGAE	Research Evaluation Group for Agricultural Economists
REVS	Research EValuation Software (WA)
REXEV	Research and EXtension EValuation (spreadsheet package)
RIRC	rural industry research corporation/council
RIRDC	rural industries R&D corporation/council
SPEAR	Software for Project Evaluation of Agricultural Research (NSW)

Introduction to the Research Evaluation Workshop

John P. Brennan*

FOR years, individuals and small groups within organisations have worked to develop the use of research evaluation as a tool for research decision-making and priority-setting. It is apparent that there has been some progress as a result of those efforts. The early work was akin to making clearings in the jungle of ignorance and subjectivity, being based on isolated evaluations of individual research areas. Now it is as though economists have set out to make roads and pathways toward a world where economic evaluation of research would be used as a basis for research decision-making and priority-setting.

As they set out to make those roads and pathways, economists found that the equipment for the task, in the form of theoretical papers, turned out to be less than practical in the field. Much of that equipment was better suited to making freeways across fertile plains than to hacking pathways over rough and rugged terrain through the bush of ignorance, data scarcity and the antagonism of researchers and administrators. The pioneers needed to adapt and simplify many of the tools and equipment to enable them to carry out in the field analyses of practical projects. Largely working independently, research economists developed methods to enable them to make progress in that area.

Formation of REGAE

To enable more organised progress to be made across the board, an attempt was made to improve communication and information-sharing among organisations. In February 1995, those involved formed the Research Evaluation Group for Agricultural Economists (REGAE). REGAE was established to enable all those making the paths to learn from each other's experiences, to use common tools where appropriate, and to coordinate and cooperate to standardise the road surfaces, the road rules and sign posts, as far as possible.

After the first year of REGAE, it is timely to take stock of where we are and what we have achieved so far. Although our progress has been slower over the past 12 months than originally envisaged, I believe that we have made some useful gains:

(a) the formal recognition of REGAE as a special interest group of the Australian Agricultural and Resource Economics Society is a significant development for all involved;

(b) the development of REGAE News provides a means of communication that should improve the networking of those in this area, although only tentatively until there is a true two-way process of communication;

(c) the improved coordination that has taken place between some research organisations is encouraging, although there are still a number of gaps in the process, and still a number of organisations not included; and

(d) the interest from a wide range of economists in the REGAE group reveals an increasing commitment to this area of applied economics that encourages further efforts in this direction.

This workshop is a natural extension of REGAE's activities to date. It enables us to take stock of the current use of economic evaluation of research in Australia and New Zealand, and provide a basis for our future activities.

Aims of the Workshop

The aim of this workshop is to provide a review of three main aspects of the application of research evaluation methods, namely:

(a) the use of research evaluation in Australia and New Zealand;

(b) improving consistency in benefit–cost analyses across organisations; and

(c) implications for research evaluation activities of new directions in research policy.

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The first aspect is to examine the current status of the use of research evaluation in Australia and New Zealand (that is, a map of existing and planned roads). At present, the various organisations involved in the funding and provision of research in these countries are at different stages of development. Of particular interest is whether the application has been different between institutions with different roles in the research system, and whether, for example, these methods are used more by institutions undertaking the research than those providing the funding for the research. The key issue is to make it easier for those who are in the developmental stages to learn from organisations at a more advanced stage.

The second aspect considered in the workshop is the extent to which it is possible to develop consistency in applications across different organisations. To help in the task of more routine use of research economic evaluation, several organisations have developed specific software packages. Those software enable the nuts and bolts of the economic evaluations to be carried out relatively simply by even relatively inexperienced practitioners. In the workshop, we have an assessment of a selected set of those packages to ensure everyone is aware of what is available and what it features.

Despite the progress in software, the practitioner is still faced with a virtually blank sheet when estimating the benefits of the research. Among scientists and many research administrators with a science background, there is an impression that it is possible to obtain any result one might desire by adjusting the figures used in the benefit–cost analysis (BCA). Unfortunately, there is more than an element of truth in that. At this stage, I see very little consistency in how benefits are estimated for BCAs. Where funding organisations require a BCA to accompany project applications, that effort will *never* be worthwhile unless we can get consistency between organisations. While the economic merit of a project depends on which organisation does the BCA, or who within the organisation carried it out, the process will always be fatally flawed. Here we explore the possibility of developing guidelines for the estimation of benefits that will provide more consistent and more repeatable evaluations.

Third, while these developments have been taking place in the direct application of economic evaluation to research and priority-setting, the whole environment in which public sector research operates has been changing. The mix of funding for research is changing, as are the attitudes of governments to funding industry research. These changes are important not only for the work of economists in research organisations, but also for the role and type of research evaluations needed in the future. In our final session, the changes likely in the research policy arena are reviewed, along with the likely implications for research evaluation activities if these are implemented. Important issues are whether the possible changes will create a change in demand for research evaluation applications, and whether the changes will require developments to existing methods, the ways they are used, or the groups that are likely to undertake them.

Expected Workshop Outcomes

It is clear that REGAE has an important role to play in the development of such issues as those addressed in this workshop. No other organisation has the spread across research organisations, nor is one likely to; we have a unique opportunity to develop consistency in the economic evaluation of research. However, we are all faced with internal pressures from our own organisations, and will have difficulty achieving the progress that we would all see as desirable at a satisfyingly fast rate. Nevertheless, if we do not achieve some gains, the widespread use of economic evaluation of research will remain mortally wounded. We cannot expect a funding body or a research organisation to use the results of economic evaluations to make funding decisions or to move resources unless we have faith in the consistency and repeatability of the analysis. At this stage, I believe that we are not in that position.

However, I hope that the limited achievements of REGAE to date can be enduring and form a basis for future developments. For that, we need consistent efforts from a range of people, most of whom will have many more pressing calls on their time. I urge those of us who want to see REGAE succeed to make some physical input to the process rather than merely lend moral support. The extent to which we can report significant achievements by next year depends on the support of everyone here for the ongoing efforts of REGAE.

I expect that at the end of the workshop we will have made some direct progress towards a better understanding of the research evaluation processes in Australia and New Zealand. More importantly, we will be in a position to improve the efficiency and consistency of the processes, and to define where we are heading.

Use of Research Evaluation in Australia and New Zealand

Research Evaluation and Priority-setting in Research-providing Agencies in Australia

Neil Thomson* and David Morrison**

GOVERNMENT agricultural research and development (R&D) organisations are operating in an environment of increasing competition for funds where there are changing expectations from stakeholders and clients. While R&D organisations are expected to become more businesslike and generate greater returns to their R&D investment, they are facing declining real-term budgets.

It is difficult for R&D providers to cope with the rapid change. Strategies which have appeared to be good enough in the past are now clearly inappropriate. For example, reductions in budgets have often been dealt with by small cuts across the board, sometimes confined to operating costs only. With significant cuts to funding and demands to take on new activities, this strategy is now more inadequate than ever.

For example, in the 1995–96 budget allocation of Agriculture Western Australia (AgWA), 6% of State Government funds has been redirected into initiatives or new contingencies. This has come in the face of an unfunded component of an enterprise bargain agreement amounting to 2% for the financial year and no change to the nominal budget allocation. This excludes the effect of budget allocation changes within programs. To fund all changes by traditional means would have required an across-the-board cut to all programs of 7% in nominal terms. This paper outlines the analytical approach which influenced the budget allocation of AgWA, that targeted some programs for nominal budget increases while others received varying budget reductions, depending on their strategic and economic merit. For example, the budget allocation for the Pulse Program was unchanged from 1994, whereas the Wool Program received an 8% reduction in its budget.

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Analytical frameworks for evaluation of R&D and principles for allocation of scarce resources are being developed by agricultural economists throughout Australia. These frameworks should allow for a more meaningful interpretation of R&D priorities than other priority-setting systems such as scoring models. To date, however, the greatest challenge remains that of being able to influence the way R&D resource allocations are made within research providers.

Experience in the process of implementing analytical frameworks has shown that:

- transparent and credible evaluation methods must be applied;
- the clear and interesting communication of analysis results is important; and
- economists need to become involved in management processes beyond the analysis of benefits and costs.

The important question is posed, by a not-so-serious economic evaluation — does economic evaluation of R&D have a benefit:cost ratio greater than 1?

The Analytical Approach

The analytical approach outlined in *Step One* involves questions about the kind of project that the R&D provider should consider to include within its portfolio of activity. If this project is acceptable on the basis of the criteria outlined in this section, then it should be subjected to benefit–cost analysis (BCA), which is addressed in *Step Two.*

Step One: a simple set of decision rules

1. *Should it be done?*

   This is addressed by answering the subquestions: *are benefits likely to exceed costs?* and, where funds are scarce,
   are benefits likely to exceed the value of the alternative use of resources?

2. *If it should be done, who should do it?*
   The issue here is whether public R&D providers should do it (or at least arrange for it to be done), or whether it should be left to the private sector. The public sector should have a role only if there is market failure.

If the answer to both these questions is *yes*, the work should be undertaken by government or government should make arrangements to overcome market failure.

Step Two: Quantitative evaluation — benefit–cost analysis

Private-sector decisions to increase funding some activities and cut back on funding others are based largely on the returns received or expected on investments in the different activities. Planning in the private sector involves projections of revenues and costs of activities. *Non-performing* investments are phased out to fund potentially high return new areas. How well a firm performs depends to a very large degree on how well it chooses what to cut and what to expand.

Unlike the private sector, public R&D providers do not receive the revenue generated from most of their activities. Credible BCA, however, can provide information on the performing and non-performing investments of public R&D providers.

There are many differences in the detail of BCA for different projects; however, key information requirements for analyses are common to many different kinds of agricultural R&D. All analyses need to start with the question: what is the estimated difference in cost and revenue on the farm (or firm), with and without the R&D being conducted? The analyses should also include the elements of uncertainty, scale, adoption, R&D costs and the effects of supply and demand elasticities, where appropriate.

Critics of the BCA process are somewhat justified when they point to the speculation required to make some assumptions in analysis. However, strong arguments exist in support of BCA, including:

(i) it can provide a systematic framework to ensure the most important issues are considered both in how they relate to each other and how they will influence the result;

(ii) the process of BCA (particularly sensitivity analysis) highlights those variables with the greatest influence on outcomes, thereby identifying from the point of view of the analyst those variables deserving further scrutiny. Collection and estimation of and argument about these data are, in themselves, useful. The identification of important variables is also useful from the point of view of project planning and implementation. Armed with this information, a research manager may be stimulated to rethink the emphasis of a project, the directions of research or the processes of monitoring that should be in place. The importance of well-structured sensitivity analysis should not be understated as this information can also be the most compelling for managers and economists by demonstrating the robustness or otherwise of the results. The issue of structured and theoretically defensible sensitivity analysis is addressed by Pannell (1996);

(iii) BCA results are quantitative and adjusted to their present value, which means they can be compared where projects have benefits spanning different time periods.

The process of BCA can contribute to a cultural shift in an organisation by exposing managers to systematic decision-making processes. The analysts think as an investor, focusing on the outcomes of R&D and how much change within the industry can be claimed as a result. When this kind of thinking has developed, research managers have clearly gone beyond arguing for the status quo, and are contributing to a flexible and dynamic organisation.

It is vital that researchers feel they have a stake in this process. Without that they cannot be effective in influencing decisions or contributing to a cultural shift. Unambiguous leadership of organisations is also required.

Why the rigour of BCA analysis instead of *softer* alternatives? One alternative to BCA which can be used to support allocation decisions is a scoring system. By comparison with BCA, scoring systems have no well-established standards for parameters to be scored or weighted. Scoring is subjective, so that scores cannot be disputed and challenged in the way that the assumptions of BCA can. While it is concluded that BCA is a better support to decision-making, the two are not necessarily mutually exclusive.

Use of Benefit–cost Analysis

BCA is gaining recognition across R&D agencies in Australia although, for now, most are concentrating on supporting Rural Industry Research Corporations (RIRCs) funding submissions. Four State government agencies have now developed software for evaluation, and Victoria and Western Australia have or are implementing systematic processes of evaluation over their whole portfolios.

Experience in AgWA has shown that the evaluation process has developed in distinct stages in the following sequence:

(1) ad hoc evaluation for specific client needs;

(2) systematic evaluation processes (e.g. wall-to-wall or by random selection);

(3) reassessment of the reliability and efficiency of evaluations; and

(4) development of its strategic benefit by integrating it with the budget process.

In the case of AgWA, the first stage began in the mid-1980s with development of the Research Evaluation Spreadsheet (REVS), the second stage when AgWA's Executive in 1992 directed all programs to evaluate their portfolios. In the last year results from evaluation have made a major contribution to the resource allocation process. There is still an ongoing need to assess the reliability and efficiency of the evaluation process, especially as it has increasing demands placed on it. Recently performance measurement was added to the list of demands placed on BCA. This aspect of BCA is yet to be fully developed in AgWA, where the emphasis in the past has been on strategic planning.

Appropriate use of BCA

Adoption of BCA can be hampered by the perception that it provides unreliable information. It is therefore important that analysts and managers are aware of the limitations of the process, to avoid unreasonable expectations which lead to disappointment. A limitation is that the data are never perfect.

This limitation is not a case for discrediting BCA, but rather for using it properly. The responsibility to use public funds efficiently rests with managers; therefore a high degree of honesty is required when analyses are carried out. Reward systems for managers should reflect the public priority of efficiency rather than the priority some managers may have to increase their resource base.

The role of economists should also be developed so they are confident to challenge the assumptions R&D managers make. AgWA economists have been described as being 'feral' (as opposed to tame), in that they challenge the existing paradigms of R&D managers. Senior level support is vital if economists and their methodologies are to be accepted.

Where possible economists should utilise systematic methods to challenge the assumptions of R&D managers by, for example, testing for bias, or comparing assumptions with statistics. They should also consider using industry or other external experts to establish a wider set of views on assumptions. Well-designed economic models can be used very effectively in group sessions, where economists act as the facilitators, with managers or representatives from industry.

Analysis and presentation should make it easy for decision-makers to assess the credibility of the results. A minimum standard for this purpose is:

- transparency of input assumptions and outputs (if you cannot see in, put it in the bin);
- provision of break-even and sensitivity analysis for parameters which are uncertain and are likely to have a big impact on results.

It must also be clear to those using the results of BCA that the purpose of the analysis is to support a decision-maker's judgment, not to replace it.

Allocation Principles

Once analysis and judgment have identified existing low-return activities and opportunities for high-return new funding, reallocation of resources can proceed. Decisions should occur at different levels, for example, the allocation among projects that are nested within a program, or the allocation among programs that sit within an organisation. At each level the same principles apply, of freeing-up resources from low-return activities and reallocating to high-return activities.

The simple decision to fund or not fund is not usually appropriate at higher levels within the organisational structure. Take, for example, a case where two programs consist of a number of existing projects but also have opportunities for high returns to new activities. If one program has, on average, a benefit:cost ratio (BCR) of 4 and the other a BCR of 1, this does not mean the organisation should shut down the second program and allocate resources to the first. The average return information is not a good basis for decision-making. It is information on returns at the margin which is most important. Incremental allocation shifts not only seem more appropriate from the point of view of ensuring benefits are maximised, but they are easier to implement over time.

In the real world, the scarcity of resources available for BCA means that all activities cannot be analysed in a detailed way. Analyses should focus on providing information most relevant to decision-making. Thus it is important to screen analyses using the 'back of envelope' approach, then analysing only those activities thought to have low rates of return, or at least not obviously high rates of return. Proposed new activities requiring significant funding should also be analysed before decisions on major new strategic directions are made.

Decision-making at Different Levels

The following provides examples of BCA use at several levels in AgWA.

Individual research or research leader level. At this level it helps by strengthening and supporting applications for funding, screening ideas, deciding which existing areas of work to cut or increase, and helping achieve a cultural shift. Many of the good ideas for research projects come from researchers or are picked up by researchers through their involvement with industry. It is helpful for them to subject these ideas to the rigour of BCA and its way of thinking. Researchers familiar with BCA are likely to screen ideas more effectively before they become project proposals.

One of a number of examples of researcher-driven evaluation is pasture research by AgWA. Directions for research are based on a series of analyses using BCA and farm models to help clarify on which soil classes the pasture breeding and development work should take place, and which pasture characteristics are most valuable (Abadi Ghadim and Morrison 1992; Ewing and Pannell 1987). This analysis has been influential because the research leaders see it as theirs rather than as undertaken by an external group of economists.

At present, in some rural industry research corporations (RIRCs) it may not yet make much difference whether an application has a BCA or not, or whether the analysis is done well or not. However, RIRCs are gradually gaining a better understanding of how to use BCA and its importance. Increasingly panels and boards are seen as decision-makers investing millions of dollars in R&D, so that in future some members of each panel or board may be expected to have skills in interpreting analyses as a basic tool of trade.

Program Manager level. BCA supports decisions on resource allocation within and between subprograms. The appropriate principles are as described in the previous section.

For example, in the case of AgWA's wool program, low-return activities such as the lice eradication program (Thomson 1994) and some sheep reproduction research were identified, while high-return opportunities for developing higher quality wool were also identified and resources reallocated accordingly. On the basis of judgment by the program leader and the results of analysis, a major reallocation of resources occurred within the program, the shift within the wool program since 1992 in the order of $2 million of an annual base budget of about $6 million.

Program managers need to be more than passive recipients of BCA results. They should be thinking about the strategic directions of their programs and asking for analyses relating to that aspect. To assist managers in this process, AgWA has developed 'tiered' reporting that incorporates tables and charts and allows program managers to interrogate BCA reports quickly to the required level of detail (Thomson et al. 1994). The 'beach ball' pie charts (see Appendix) have been found a very useful tool in explaining expected returns to the R&D portfolio, as well as highlighting the need to change resource allocation at the margin.

Executive and Chief Executive Officer (CEO) level. Information provided here includes charts (showing BCRs) aggregated to program level, and notes to supplement them. Key assumptions and sensitivity analyses are available if required. Other strategic indicators such as projected industry growth, productivity estimates, estimates of current and future funding and industry congruence are also presented, along with arguments supporting funding shifts.

There appears to be a growing number of consultants marketing strategic planning concepts to senior managers in R&D provider organisations. It is a challenge to economists who, more than any group, are equipped with the analytical tools necessary for strategic planning, to compete with other professionals who may be less likely to apply the same degree of rigour to their analysis.

Agency level. BCA information is also presented to government inquiries and central agencies to make the case that agricultural R&D is a good investment. BCRs are a new part of AgWA's standard reporting to Parliament and the Auditor-General. Understandably, the Auditor-General requires that projects are selected for analysis in a systematic way and that they are analysed *ex post.* Using BCA as a performance indicator is not always consistent with the needs of strategic planning and resource allocation processes, though the two approaches can be complementary.

BCA is also a part of the key argument put to several recent State and Commonwealth inquiries for retaining the levels of government funding. The principal line of argument is that agricultural R&D is a good investment, yielding on average a BCR conservatively estimated to be above 3. Examples of such high-return activities as the development of the lupin industry (yielding net benefits greater than $25 million per year), the development of two new apple varieties (BCR = 7), and prevention of the spread of pests (BCR = 10) are used to illustrate potential returns. This line of argument is of critical importance to agriculture, which is perceived in some quarters as a poor investment.

BCA needs to be part of an integrated decision-making process which involves input from industry and Ministers for Agriculture and which also brings in strategic planning.

If industry and the Minister are a part of the process, they are much more likely to have a common view with the organisation's leadership on the directions it should take. In the case of BCA analyses for major decisions, industry and the Minister should have access to key assumptions. They may challenge and question assumptions, leading to more credible analysis and improved decision-making.

Implications for Analysts Beyond the Analysis

One of the greatest challenges facing analysts is taking BCA beyond the point of merely estimating results, to the point where it influences resource allocations within R&D providers. Limitations to implementation may have nothing to do with unwillingness on the part of management to adopt benefit–cost frameworks. The limitation may relate, for example, to the way financial control is maintained within the organisation, although this line can often also be an excuse for inaction.

Economists can take the view that this is a problem for management. However, in the case of AgWA, necessity has been the mother of invention. Opportunities exist for economists because they have numeracy skills and in-depth knowledge of management structures as they relate to R&D projects. AgWA has invested heavily over the last 12 months in new financial methods of control. The attribution of costs to projects has become a greater preoccupation within the Agency, and economists have made a substantial contribution to this process.

October 1995 was significant in that it was the first time in the organisation's history when:

- budgets were handed down to programs (based on industry outcomes), not, as had happened in the past, to operational discipline groups; and
- significant differences existed in the degree of cuts or increases to program budgets when compared with the estimate of previous costs.

This budget allocation was made possible only by the development of an integrated program resource allocation system (PRA) that was designed to link program expenditure on human resources, capital and operating to operational groups within the Agency.

The Challenge for the Profession

Do benefits of evaluation outweigh their costs? This question is answered by a not-so-serious analysis using the BCA framework.

Assumptions

- This considers the costs from 1985 until the present.
- It assumes that an increasing number of economists are being employed to carry out research evaluation in an increasing number of organisations across Australia.
- Average salary of an economist, $50 000 per year.
- On-costs and overheads of 100%.
- Additional management costs relating to this effort are minimal, until recently.
- Present value of costs = $14 million.
- Units of scale are the value of resources allocated to agricultural R&D every year by provider organisations, assumed to equal $700 million.
- Potential benefit is estimated by value-adding 10% to R&D expenditure.
- Adoption rate:
  - — no-one took any notice until 1990;
  - — maximum 20% at 1998;
  - — end of benefits in 2000, assuming, of course, all evaluation ceases tomorrow.
- Discount rate = 8%.

Results

Net present value (NPV) — $4 million, BCR 0.7.

Sensitivities

The possible range of returns is very great. Key factors determining success include how much value-adding economists contribute to decision-making through evaluation, and how much of this information is adopted by managers. Economists' salaries can be assumed to increase — this has little effect on the BCR.

Conclusion

A changing environment and changing expectations require that R&D providers become more like private-sector enterprises. BCA can contribute by supporting decisions on the allocation of resources, helping achieve a cultural shift in the organisations, and helping to win or maintain funds. In order to deliver these benefits, some simple standard practices, including transparency of analysis and sensitivity analysis, must be met. Decision-makers should be trained in interpreting results so that they understand BCA strengths and limitations and how to use it, with their judgment, to support decisions.

Researchers in a position to influence or propose the direction that their work takes should conduct BCAs to screen ideas and support major funding submissions. They must be able to use BCA as an integral part of the case they are making, rather than simply as an appendix. Most researchers already consider, informally, aspects of the benefits and costs of what they do or propose to do, so that the additional rigour of a BCA simply builds on this attitude.

Those in positions to set broader directions in R&D-providing organisations must be able to interpret BCA findings and understand principles of resource allocation. These skills should be part of R&D leaders in the new environment.

In spite of the case for BCA, its effective adoption in some R&D-providing institutions is slow. Recent discussions with providers around Australia indicate a great increase in evaluation activity, but that this is yet to influence decision-making in these organisations.

In recent years, Queensland Department of Primary Industries (QDPI), Agriculture Victoria, AgWA and NSW Agriculture have all developed tools for evaluation and increased their staff skills base in the process of evaluation. AgWA appears to have relied more heavily on economic analysis than other research providers in the process of budget allocations. This is partly reflective of AgWA's history of research evaluation effort and the fact that it has undergone a major restructure. In 1995–96 a new model of operating (termed the Funder Purchaser Provider (FPP)*) was implemented.

Each State R&D provider has unique obstacles to the implementation of processes similar to those outlined here, for example, QDPI appears to have the most regionalised management structure when compared with other state R&D providers. It is likely, therefore, that adoption will vary between regions unless there is a strong push from central offices to see it implemented.

Each organisation must identify and address constraints to adoption which may include:

- a limited understanding of how it should be used;
- lack of drive from the top of the organisation;
- inertia and comfort with the status quo within the organisation;
- scarce resources available to deliver the analysis;
- lack of a client focus among those able to deliver the analysis; and
- evaluators limited to evaluation where constraints exist in management structures.

(*FPP attempts to create a market between the purchasers of research (program managers) and the providers of research (researchers). In effect each researcher becomes a consultant to one or more programs.)

BCA needs to be seen in perspective, as part of a prioritisation and planning system. Its optimal use also needs to be considered. Although many R&D providers now appear to be underinvesting in it, the quality of the BCA and its use is a more sensible goal than quantity. Users need to consider the 'with' and the 'without' for BCA. It could be argued that to date most evaluation has a benefit:cost ratio less than 1, although future prospects for evaluation appear to be brighter.

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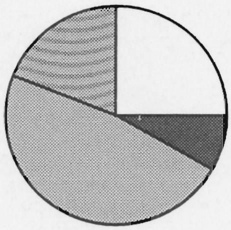
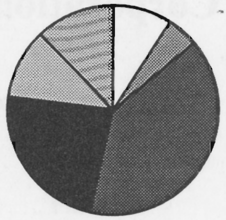
Appendix

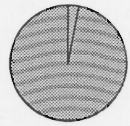
An example of the pie charts referred to as the 'beach balls'.
The size represents their relative budgets while the shading represents their benefit:cost ratio.



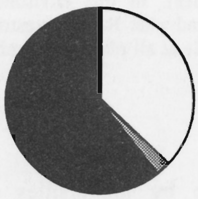
Wheat Program



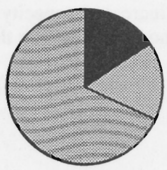
Fruit Program



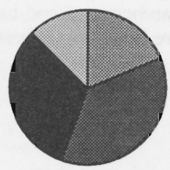
Oilseeds Program



Barley Program



Dairy Program



Pig Program

No analysis		BCR < 1		BCR 1–1.5	
BCR 1.5–3.0		BCR 3–5		BCR >5	

Use of Research Evaluation in Decision-making in R&D Corporations

Steven Lack*

Abstract

State governments and the Commonwealth are pursuing policies to focus research and development (R&D) resources on high priority areas and to improve the effectiveness of R&D delivery. An important aspect of improving the allocation of research resources is the establishment of an efficient system for evaluating the impact of completed research (*ex-post* studies) and assessing the likely returns from prospective research investments (*ex-ante* studies). In this environment, researchers and end-users require an increased capacity to evaluate and plan R&D investments. There is no single 'best solution' and no one technique that is applicable at all planning levels.

Institutional Framework

In 1992–93, $698 million or 11% of Australia's total expenditure on R&D was invested in the agricultural sector. Rural R&D performed by business enterprises represented only 10% of this effort. The majority, 90%, of rural research was performed in State departments of agriculture, Commonwealth Government agencies and higher education institutions. The break-up was:

- State Government agencies (approximately 50%)
  - — NSW Agriculture, Queensland Department of Primary Industries, Victorian Department of Agriculture, Agriculture Western Australia, South Australian R&D Institute, and Tasmanian Department of Primary Industry and Fisheries;
- Commonwealth Government agencies (approximately 26%)
  - — mostly rural research within Commonwealth Scientific and Industrial Research Organisation (CSIRO) which represents approximately half CSIRO's expenditure; and
- the higher education sector (approximately 14%)
  - — expenditure by universities on agricultural research in 1992–93 was about $97 million (Industry Commission 1995).

An historical feature of agricultural research in Australia is the significant role of the public sector. Taxpayers are the funders of this research with the majority of the resources being made available to government providers. Consolidated revenue is used to support:

- infrastructure and salary costs for State Departments of Agriculture, CSIRO and universities;
- research grants to universities through the Australian Research Council;
- taxation concessions for private companies in the processing sector; and
- in the case of the rural industries, legislation for the collection of industry research levies which are matched by the Commonwealth Government.

R&D corporations (RDCs)

In the rural sector, Australia is unique in that primary producers in the chicken meat, cotton, dairy, dried fruits, egg, fishing, forest, grains, grape and wine, honeybee, horticultural, meat, pig, sugar, tobacco and wool industries participate directly in financing their own research. The instrument used to achieve this is agreement by:

- members of the industry to impose a levy on output to provide funds for research into industry problems; and

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- the Commonwealth Government to match industry contributions on a dollar-for-dollar basis up to the maximum of 0.5% of the gross value of production (GVP) of the commodity (different matching arrangements apply for the fishing and forest industries).[1]

These funds are administered through R&D Corporations and Councils (RDCs) which are accountable to their industry as well as to the Commonwealth Parliament. Research expenditure undertaken through these bodies in 1994–95 was $282 million, of which approximately half was collected from industry levies (Table 1). The RDC model was developed with three broad objectives in mind:

- a clearer assignment of responsibility for priority-setting or investment (the demand side) and research delivery (the supply side);
- providing an incentive for industry participation in investment and priority-setting to maximise the potential for adoption of the outcomes of R&D investment; and
- improving accountability for expenditure upon R&D activities in relation to primary industries.

The funds available through the RDCs have doubled in real terms since the early 1980s, and approximately 30% of the nation's rural research funds for which the research providers compete is now invested through the RDCs.

The Changing Research Environment

Since the resources allocated to research could be used to produce other goods and services, the cost of research can be measured as the value of foregone alternatives. Principles of public accountability therefore require that research programs, like any other investment programs, should have built-in procedures to ensure regular reviews of their efficiency and the system of allocating research resources. Recurring themes during reviews are:

- what is an appropriate level of support?
- in which areas should the money be invested?
- who should pay?

The principles to address these questions are relatively straightforward. The difficulty is in determining its practical application:

[1] Based on the IC report, the Government announced new arrangements for funding R&D Corporations in the 1995 Innovation Statement. As from 1 July 1996, the Government will match industry contributions to all RDCs, dollar-for-dollar up to 0.4 per cent of GVP of each industry that contributes to the RDCs. Beyond that point, the Commonwealth will provide one dollar for every two dollars contributed by industry, with no ceiling. The Government has also determined that downstream processors will be allowed to contribute to the levy on a voluntary basis.

Table 1. RDC research investment 1994–95.

R&D Corporation/Council	Basic (%)	Strategic (%)	Applied (%)	1994–95 budget ($m)
Cotton R&D Corporation	25	28	47	6.06
Dairy R&D Corporation	13	32	55	18.36
Dried Fruits Research Council	4	13	83	1.50
Energy R&D Corporation	0	0	100	17.12
Fisheries R&D Corporation	15	45	40	14.00
Forest and Wood Products R&D Corporation	2	13	85	3.20
Grains R&D Corporation	13	22	65	51.00
Grape and Wine R&D Corporation	19	44	37	3.80
Horticultural R&D Corporation	5	20	75	21.48
International Wool Secretariat	0	22	78	32.82
Land and Water Resources R&D Corporation	15	65	20	21.98
Meat Research Corporation	15	20	65	52.73
Pig R&D Corporation	38	20	42	7.90
Rural Industries R&D Corporation	5	22	73	15.63
Chicken Meat	15	35	50	1.66
Egg	16	37	47	1.23
Honey	0	60	40	0.32
Sugar R&D Corporation	7	50	43	9.44
Tobacco Research Corporation	7	41	52	1.29
Total ($m)				**281.52**
Per cent	11	27	62	100.00

- the aggregate level of spending for R&D should continue to expand as long as the expected social benefits of further investment are greater than or equal to the additional costs;
- resources for research should be allocated to those areas and projects where the expected pay-off is greatest; and
- the beneficiaries from research should pay for the research in roughly the proportion to the benefits received — the 'user-pays' principle.

Until recently these issues did not assume a prominent role in national and State research policy as additional resources were generally available to meet the research requirements of most newly defined priority areas. And the administrative processes for dividing up research resources produced little conflict, since there were ample funds available for all users.

This climate is changing. Over recent years, with diminishing resources available from State Governments, some State departments of agriculture have been reviewing their priority-setting procedures. Recommendations have focused on an increased need to demonstrate the benefits that will flow to the State along with a greater emphasis on attracting external investment. Some traditional roles of State departments, including extension, are being questioned, while other fields are having to compete more aggressively for outside investment.

Stakeholder influence

A critical element in the RDC model is the role of each board in fulfilling its 'dual' accountability requirements to the Commonwealth Parliament and to its industry.

Formal industry input into the priorities financed by an RDC is achieved through the requirement that it consults with its 'representative' organisation (usually the industry's peak body) when developing five-year and annual operational plans. RDCs are also required to report annually to their representative organisation. These meetings allow the RDC to report on its performance and, based on that information, for the industry to determine the level of the research levy. A further link is the industry's role in the selection of RDC Boards.

To maximise potential for adoption of the outcomes of R&D investment, RDCs do not rely solely on formal reporting mechanisms. At the operational level, RDCs maintain strong connections with industry bodies by involving their representatives in the RDC decision-making processes. The linkages that form part of RDC networks occur at many levels including among producers, merchants, processors and marketers.

Recent Commonwealth Government interest in RDC performance has focused on accountability and the extent to which RDCs are addressing government objectives. For example, the recent review undertaken by the Auditor-General (1993–94) recommended that RDCs:

- introduce investment analysis techniques to develop better information about the commercial and financial results achieved through R&D; and
- submitting plans for Ministerial approval also provide strategies supported by economic analysis of the expected effects of successful R&D.

The Review of Rural Research undertaken by the Commonwealth Department of Finance (1993–94) recommended that RDCs develop:

- performance indicators that capture Government objectives for public-good research.

The Commonwealth Authorities and Companies (CAC) Bill, one of three Bills replacing the *Audit Act 1901*, provides for the establishment of a new system of accountability and reporting for directors, including those on the various RDC Boards.[2] The Bill's provisions impose a range of new and direct responsibilities, with corresponding potential liability of considerable magnitude, on individual directors. The CAC legislation will require a 'Report of Operations' to be included in an RDC's annual report. This report must include:

- quantitative performance indicators, including performance against another entity;
- an analysis of the economic outlook for the industry; and
- an assessment of how the R&D projects that the RDC invested in during the reporting period are expected to contribute to improving the efficiency and competitiveness of the industry.

RDC Approach to Evaluation and Priority-setting

Government and industry guidelines for assessing RDC performance and accountability are becoming more demanding. Common themes include greater use of investment analysis techniques to assist evaluation and priority-setting, milestones, performance indicators and risk assessment.

The effect of these 'incentives' on RDCs has been a push toward greater selectivity in research investment and increasing emphasis on regular and systematic evaluations of program objectives and

[2] The most likely commencement date for this new legislation is 1 July 1997. The package comprises the Financial Management and Accountability (FMA) Act, the Commonwealth Authorities and Companies (CAC) Act and the Auditor-General Act.

priorities. This is best analysed at three levels of decision-making where both quantitative and qualitative evaluation techniques are used:

- corporate level;
- program and/or subprogram level; and
- project level.

RDC approach at corporate level

Research priority-setting at corporate level is a decision-making process where optimal solutions regarding the allocation of resources are sought within a political, social and institutional framework.

At this level the Board of an RDC is concerned with:

- the role of the RDC and its relationships to other participants in its operating environment;
- linkages with stakeholders, e.g. the appointment of technical committees and others involved in the decision-making process; and
- performance against stakeholder expectations.

RDC approach at program and/or subprogram level

The general process for the establishment and development of a program is to identify a clear industry or community objective, the actions needed to meet this objective, the resources required to deliver the R&D, the outcomes (milestones) at agreed times, and component subprograms and projects that allow for the development of skills and their application. Programs should be of sufficient size to warrant discrete management.

Broadly, the options for evaluation at program and subprogram level are:

- the use of a mathematical model to represent an agricultural production system, with agricultural productivity estimated as a function of research inputs (data demanding);
- congruence between the research investment in a particular commodity and the relative economic significance of that commodity to national, State or regional production (limited applicability to non-commodity or multi-commodity research);
- to rely on historical precedence and adjust annual budgets across programs at the same rate as the total budget (ensures continuity in investment across programs, but promising areas of new research activity may have little chance of attracting resources).

At its program/subprogram level, the Meat Research Corporation (MRC) uses the R&D Investment Strategy Study (RADIS) to provide an outline of priority areas. The first component involves analysing, monitoring and evaluating changes to the evolution of the macro-environment and the changes to the evolution of the industry. It identifies trends, threats and opportunities affecting the profitability of the Australian meat and livestock industry.

The second component includes the development of a model that enables scenarios to be developed to assess the impact of R&D. One model is a combination of existing national and international livestock trade models, and the other is a value-chain model of the meat industry. It is in the form of a spreadsheet which describes and quantifies the inputs, product transformations, outputs and value added for the meat industry over a 12-month period.

The third component comprises a series of think-tanks which identifies researchable opportunities and R&D programs. For each priority area or program the MRC then develops a five-year business plan by consulting with industry and researchers. Each program business plan consists of about 25 projects. These are then either fully or selectively tendered (Prinsley 1992).

The International Wool Secretariat (IWS) has developed a model that estimates the net returns to Australian woolgrowers for different levels of R&D investment in each of the major research areas funded by the IWS, for example, pastures vs. animal health. The model is based on three key elements: a research production function, an equilibrium displacement model for the relevant input and product markets, and a discounted cash flow model. A research portfolio is selected by maximising the net present value of returns to R&D subject to a budget constraint (Prinsley 1992).

Since 1992 the Dairy R&D Corporation (DRDC) has used an economic model of the dairy industry known as the Benefit Assessment Framework (BAF). Data obtained from portfolio balance workshops include information on the values of key variables affected by R&D.

When allocating research resources the Grains R&D Corporation (GRDC) uses historical precedence, modified to take into account changes in its operating environment. Within the GRDC portfolio there are, at present, 25 leviable crops spanning temperate and tropical cereals, oilseeds and grain legumes.[3] Priority setting requires choices across regional and between research investments in the industry's primary, processing and marketing sectors. The program structure within GRDC is illustrated on page 22.

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[3] Wheat
Coarse grains: barley, oats, sorghum, maize, triticale, millets/panicums, cereal rye, canary seed
Grain legumes: lupins, field peas, chickpeas, faba beans, vetch, peanuts, mung beans, navy beans, pigeon peas, cowpeas, lentils
Oilseeds: Canola, sunflower, soybean, safflower, linseed

GRDC goal
⇑
4 research objectives
⇑
25 programs (30% national, 70% regional)
⇑
54 subprograms
⇑
690 projects

At program and subprogram levels within GRDC the previous year's investment is regarded as a base at the beginning of each budget cycle. Hence investments across programs and subprograms are initially tied to historical precedence. While this approach allows for continuity of investment, there is the potential to continue to support research which has lost its relevance. Over time, GRDC's operating environment changes as a result of:

- its own research initiatives, e.g. research outcomes, market analysis, and benchmarking studies; and
- external processes, e.g. new information and skills, new markets, regulation and deregulation, and changing commitments from other 'players'.

Generally, this information is not contained within any one body but dispersed among different groups — producers, merchants, processors, marketers, scientists, research administrators, economists and others within the general community. The GRDC has a role to facilitate interaction across industry sectors and among researchers. Coordination processes range from local workshops through to cross-sectoral groups with the support of peak industry bodies. This information is used by GRDC to make judgments about increasing or decreasing investments from historical levels.

RDC approach at project level

At project level, RDCs evaluate R&D through the usual mechanisms associated with monitoring any investment portfolio. They use also *ex-post* benefit-cost analysis (BCA) and *ex-ante* BCA.

Monitoring ongoing research

The most substantial element of an RDC budget is its investment in continuing R&D activities. In the case of GRDC, its continuing commitment in 1996–97 will be $27 million within a total budget of $65 million. For example, GRDC maintains a substantial number of major long-term investments in plant breeding programs. Although the emphasis varies, RDCs monitor their ongoing research by way of Progress Reports, Milestone Reports, Technical and Financial Audits and Final Reports. The steps are outlined below.

New directions (project and program level)
⇑
Final reports
⇑
Audits (financial and technical)
⇑
Achievement of milestones
⇑
Progress reports

Progress reports. RDCs require the submission of a Progress Report, either annually or mid-term. Among other things the report identifies progress against the aims of the project and the milestone(s) scheduled to occur in the period under report.

Achievement of milestones. Most RDCs use a system of milestones within projects and require workers to identify the expected outcomes of projects. Progress against milestones is usually the basis for making periodical payments to research providers.

Audits (technical and financial). The MRC, for example, carries out a technical audit of at least 10–12 projects per year. While the initial list is random, projects with investment of under $100,000 are rejected, as are those in their first or last year. During this process there is also an attempt to spread selected projects across agencies. Once the list has been prepared there is provision for a poorly performing project to be 'swapped' for one that has been randomly selected.

The MRC initiates financial audits on projects selected at random, but also includes those where technical progress is slow (e.g. milestones not met). GRDC also undertakes an audit of selected projects for financial accountability based on an analysis of the relative risks.

Final reports. All RDCs require a Final Report. These reports generally focus on:

- an assessment of the results and the outcomes for industry;
- the benefit and cost implications of the research results to the industry; and
- activities or steps to further develop, disseminate or commercially exploit research results.

Ex-post benefit–cost analysis

Increasing accountability requirements and demands on funds available for research have led to most RDCs undertaking *ex-post* BCA on selected projects. Examples include Stephens (1995) and Johnston

Table 2. Economic benefits from 16 grains industry research projects.

Project number and name		NPV ($m) at 10% as at 1991	B:C ratio at 10% discount rate	IRR (%)
1	National Chickpea Breeding	7	12:1	65
2	Suppression of Grain Dust	14	54:1	143
3	Disease Resistance in Faba Beans and Peas	35	28:1	68
4	Fertilizer Application at Sowing	61	76:1	113
5	Lupin Breeding and Evaluation	331	10:1	51
6	Brown Spot Control in Lupins	6	8:1	209
7	Oat Breeding for Cereal Cyst Nematode	36	34:1	57
8	Storage of Oilseeds	na	na	na
9	Nitrogen Use on Wheat	na	na	na
10	Decision Support Systems	na	na	na
11	Breeding Resistance to Yellow Spot	126	36:1	42
12	High-yielding Agronomic Packages	30	29:1	205
13	Noodle Quality of Wheat	12	7:1	38
14	Quality of Wheat for Middle East	na	na	na
15	Wheat Variety Improvement	4	3:1	84
16	Quality Assessment of Breeding Programs	1	4:1	40
17	Enhanced Evaluation of CIMMYT Germplasm	15	21:1	52
18	Central West Wheat Variety Trials	1	4:1	34
19	Molecular Mapping Program	na	na	na
20	Increasing Crop Production on Acidic and Compacted Soils	121	297:1	561
21	Disease-resistant Barley Varieties	176	129:1	64

Note: na, not available.
Source: *Gains for Grain*, Grains R&D Corporation Occasional Paper Series, Vol. 1, Canberra, 1992.

(1992). During 1991–92 GRDC commissioned an independent economic analysis of selected grains R&D projects undertaken over the past 15 years. The benefit-cost analyses suggest that over the life of 16 of the projects, benefits are expected to exceed costs by $1010 million in present value terms, using a 10% discount rate (Table 2) (GRDC 1992).

Overall, these studies indicate that R&D for the primary industries can yield high rates of return. Their main value to the RDCs has been in demonstrating the returns to both industry and government from RDC activity.

Ex-ante benefit–cost analysis

More difficult to measure is the likely return from prospective research. At the project level, four RDCs require researchers to undertake an *ex-ante* BCA: the Meat Research Corporation, the International Wool Secretariat, the Dairy R&D Corporation and the Grains R&D Corporation. In assessing projects these RDCs have adopted the approach of viewing research proposals as investment options. Like most investments, they are characterised by up-front costs, risks and the expectation of sufficient benefits to make the costs and risks acceptable.

While each of these RDCs requires an *ex-ante* BCA, cut-off levels and frequency of the BCA vary:

- the MRC requests researchers to undertake a BCA on all new projects but allows researchers to use a BCA model and/or software of their choice;
- all new projects to the DRDC require an *ex-ante* BCA using DRDC software. For selected large projects a mid-term BCA is also required;
- from 1995–96, the IWS requires all new proposals greater than $300,000 to be accompanied by an *ex-ante* BCA.

Historically, project scores were used by the GRDC to produce an ordinal ranking of individual projects based on the scoring of research proposals from 1 to 5. In 1995–96, the GRDC sought a more refined approach based on BCA. Three main goals were to:

- focus researchers on the value side of the work as well as its technical merit;
- increase the interaction between scientists and evaluators at the initiation and development stages of project proposals; and
- build up a BCA profile of GRDC research programs along with an ability to compare marginal projects across programs and subprograms.

From 1995–96 *ex-ante* BCA were required for all new GRDC project applications. In 1996–97 the GRDC introduced standardised software to improve consistency. The current benefit estimation framework is summarised on page 24.

Benefit/unit — this is usually a cost saving or additional profit, \$/ha, for example.

Scale (number of units) — a description and measure of the target for the likely impact of the research, often a geographic area or region with a specified area of crop likely to benefit from the research. Scale usually refers to the potential, the extent to which that is achieved defined by the rate of adoption.

Adoption pattern (the per cent of units to which benefits apply each year) — the rate at which potential as defined by scale is likely to be achieved. The adoption pattern for a new variety, for example, often reaches a maximum value after a number of years and then declines if superseded by a newer improved variety.

For example:

> **Impact** — this research is likely to result in increased benefits of \$6/ha;
>
> **Scale** — the research will be most relevant to the *x* ha of crop region *z*;
>
> **Adoption** — based on experience with similar research and technology, adoption should begin by about 2000 and reach a maximum of about 40% of the potential area of *x* ha by 2010.

To date, the main benefit to GRDC of introducing *ex-ante* BCA has been the increased discipline which a formal approach demands. Unresolved issues include:

- the lack of knowledge of adoption rates;
- estimating benefits resulting from improved quality attributes;
- estimating benefits resulting from research at the basic end of the spectrum; and
- targeting GRDC software to the right level — economists regard it as too simple, scientists believe it is too difficult.

Conclusion

There is no simple formula for determining research priorities and no one technique applicable at all planning levels. The RDCs use a variety of approaches to set priorities and to allocate research resources. At corporate level, industry commitments to invest funds and government policy directions are key influences in the decision-making. At program and subprogram level the use of models, congruence and historical precedence are common approaches to assessing the adequacy of resources being devoted to broad activity areas. Increasingly, RDCs are making greater use of formal *ex-ante* evaluation at project level as an additional tool to rank research projects more systematically and quantitatively.

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Research Evaluation in New Zealand

Johanna Radford*

New Zealand's Science System

BETWEEN 1989 and 1992, successive New Zealand governments undertook fundamental reforms of the public science and technology system. Prior to this, most public scientific research was conducted in government departments, particularly the Department of Scientific and Industrial Research (DSIR), which combined the roles of providing advice on science policy, and funding and conducting research.

New Zealand currently invests about 0.9% of GDP in research, science and technology, which is low among comparable small OECD economies. There now are political commitments to grow public expenditure from 0.6% to 0.8% GDP over the next 15 years, and new measures to encourage growth in private expenditure. In contrast to many OECD and Asian countries, New Zealand's expenditure is predominantly from public sources (approximately 60%).

As with most of New Zealand's public administration, policy advice, purchase (funding allocation) and provision (conduct of research) are separated, through:

- a Ministry of Research, Science and Technology (MoRST) that provides policy advice;
- a Foundation for Research, Science and Technology that allocates funding for 'public good science' and provides alternative policy advice. Its Public Good Science Fund (PGSF) was created from monies previously appropriated directly to various departments, including DSIR;
- nine Crown Research Institutes (CRIs), which are Government-owned research companies formed by reassembling the DSIR and research arms of various government departments (agriculture, forestry, etc.).

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The CRIs are not the only providers: universities, private sector-based research associations, trusts, private companies and individuals can apply for research funding for public good science.

The research, science and technology system is designed to:

- concentrate resources and effort in selected areas;
- shift the national portfolio of research toward downstream value-adding activities;
- encourage collaboration among research providers; and
- build partnerships between public and private investment.

Foundation for Research, Science and Technology

The Foundation for Research Science and Technology manages the major part of New Zealand's public funding for research, science and technology. It allocates approximately $310 million for research and development programs through a suite of complementary funding schemes. The funding schemes cover the spectrum of basic, strategic and applied research and are designed to yield, in different measure, the benefits of knowledge creation, human resource development and innovation by industry.

Key differences between New Zealand's research, science and technology system and those in most other countries are that:

- most funding is provided on a full-cost basis; marginal funding is uncommon. A corollary is that few public research institutions have block funding: all funding is contestable. The exceptions are the universities, which are block-funded on a formula linked to student numbers. However, the universities also can contest for additional research funding from the Foundation;
- funding is awarded on the basis of outputs, not inputs; and

- contracts are used to determine the accountability of, for example, research providers to the Foundation, or the Foundation to the Government.

Public investment in research, science and technology is planned to grow strongly over the next 15 years. Both public and private investment are low, however, by OECD standards, and the balance between them is the reverse of most advanced economies. Public expenditure is currently nearly twice private expenditure.

Expectations

The Government provides clear guidance on the purpose of the various public funding schemes and their expected outcomes. The Public Good Science Fund is by far the largest scheme, and allocations from it are made in accordance with a *Statement of Science Priorities,* released by the Government on the advice of an independent panel comprising users and providers of science. The Statement expresses priorities and dollars available over a five-year period for each of 17 socioeconomically defined sectors (or output classes) of research activity. It also makes qualitative statements of expectations on matters such as collaboration, linkages with users, leverage on other funding sources, and strategic partnerships between providers and users. The Statement is legally binding on the Foundation and is implemented through Research Strategies prepared by the Foundation on 5-year horizons for each of the 17 output classes.

The Foundation is required to report on programs, and specifically to evaluate the returns on investment in research and development. Similar expectations of the Foundation are set out annually in the Purchase Agreement, which is a performance contract between the Foundation and the Minister for Research, Science and Technology.

Assessment of Research Performance

The Foundation is presently moving from a situation in which its culture and resources were directed predominantly toward allocation activities to one in which there is balance and continuity between allocation and evaluation activities.

Evaluation by the Foundation

An Evaluation and Review group monitors and evaluates the outputs and outcomes of the Foundation's investments in research. A framework for evaluation and review sets out the range of activities undertaken by the Foundation, identifying three main purposes:

- meeting accountability obligations — a set of monitoring and audit activities to determine progress toward and achievement of contracted outputs. External consultants (scientists) are used to conduct audits selected mainly on a sampling basis but also on an exceptions basis;
- contributing to funding decision-making — comprising program and topic reviews by visiting expert panels to assess scientific performance and provide recommendations on future directions and funding. Peer review by expert panels, which has a large *ex-post* or performance component, will significantly displace peer review by referees. This is particularly apposite to large research programs that are frequently multidisciplinary and multi-objective;
- contributing to science policy and priorities — science area, sector and special purpose reviews to determine the extent to which strategic goals for science are being met, and to identify economic, social and environmental benefits of the investment.

The framework is in its first year of implementation and will continue to evolve in response to need and to incorporate new approaches developed by counterpart agencies elsewhere in the world. At present it addresses mainly the PGSF, but other funding schemes will be subject to more systematic evaluation from 1995–96 onwards.

In the current year, the range of activities includes:

- approximately 50 program and topic reviews;
- two projects of 12–18 months duration evaluating outcomes of investment in research in the aquaculture and meat sectors, each trialing methodologies derived from new growth theory and evolutionary economics as well as traditional neoclassical economics; details of one project are provided in the following section;
- a review of participation by New Zealand's universities in the PGSF (they have had a staged entry into the PGSF, becoming eligible to participate on an unrestricted basis from 1995–96);
- case studies of programs; and
- evaluation of methodologies for technology transfer.

Evaluation by other agencies

MoRST is charged with a general system-wide monitoring and evaluation role. In particular, it monitors on behalf of the Minister the performance of the Foundation against the requirements of the Statement of Science Priorities, the Ministerial Instructions and the Purchase Agreement.

To evaluate broad outcomes of the Government's investment in research, MoRST has proposed a cooperative program involving other stakeholding departments like Treasury and Commerce, as well as the Foundation. This program is currently embryonic.

Project on Economic Evaluation of R&D in New Zealand Meat Industry

Most economic evaluations of the benefits of research have sought to quantify benefits using measures of economic surplus. While quantitative analysis of benefits is an important aspect of the economic evaluation of research, it is not sufficient in itself, because research also creates other benefits such as the development of human capital and increasing the ability to interpret and adopt new ideas and new technology which must be considered.

The Foundation has initiated a case study-based project to evaluate the wider benefits of meat research. The project uses multiple levels of analysis and will measure the qualitative as well as quantitative benefits of research. The research encompasses a wide spectrum of the meat and related industries, including evaluation of meat packaging, software developments, product and process developments, vaccines, biochemicals and environmental aspects of the meat industry. It draws on evolutionary economics, new growth theory and grounded case-study theory as part of its theoretical and conceptual framework.

The inclusion of qualitative outcomes — human capital, technical platform effects, spillovers and interrelationships — will allow a more complete picture of the return from investing in meat research and development.

The Foundation's research project began in March 1995 by building a detailed micro-level picture of the processes by which outcomes from research and development are delivered. This was done using case study examples of innovations successfully commercialised in the New Zealand meat industry.

A wide range of case studies, in terms of time frames, technology, scale, etc., is being used to enable contrasts and comparisons to be made. The writing of 27 case studies, based on published literature and interviews, is currently underway. As each case study is written, it is sent to interviewees for comment. Their verification or correction of interpretation is particularly vital, as it is from these that key variables will be generated to form the basis for data analysis.

The project will be completed in August 1996 and has three objectives:

- to evaluate the contribution R&D and science activity make to New Zealand — the comprehensive evaluation of final outcomes provides stakeholders with a fuller understanding of the economic benefits of R&D and the processes and interactions that embody research outputs in economic outcomes;
- to provide an insight into the outcomes of past investment in R&D in the New Zealand meat industry, offering the possibility for the meat industry, after assessing the findings, to adjust investment decisions accordingly; and
- to develop a rigorous methodology for economic evaluation, based on a respected theoretical approach, that will be integrated into the Foundation's current evaluation activities. New growth theory has in recent years gained prominence among economists, but studies incorporating this approach are rare, despite the fact it has the capability to include important qualitative variables and to provide opportunity to develop robust theories and models of learning.

Concluding Comments

The public sector and microeconomic reforms since 1984 in New Zealand, leading to the new research, science and technology system and the establishment of the Foundation, were not uniquely New Zealand phenomena. Similar thinking and actions are evident, to a greater or lesser degree, in many countries around the world.

Similarly, the growing emphasis on and, in fact, imperative for evaluation of research funding are evident in most science systems. New Zealand is neither significantly ahead of nor behind international developments in this area except, perhaps, in its proposals to establish performance targets for the funding agency itself.

Developing Consistency in Benefit–cost Analyses across Organisations

Software Developments for Economic Evaluation of Research

T.D. Wilson*

In material circulated prior to this workshop, the organisers noted that research evaluation has received considerable attention from agricultural economists for nearly half a century. However, it is only recently that the methods developed in the past have begun to be applied in research organisations as part of their ongoing activities.

There are possibly two reasons for the increased use of research evaluation techniques. Firstly, there is the need for research funders and providers to be more accountable for the funds under their control. Secondly, computer technology, particularly the use of spreadsheets, has greatly facilitated the computations required to arrive at criteria such as Benefit–cost Ratio (BCR), Net Present Value (NPV) and Internal Rate of Return (IRR).

The recent interest by agricultural economists in research evaluation centres mainly on the use of benefit–cost analysis (BCA). The last three to five years have seen the development of a number of BCA computer applications. These have been mainly developed by, or on behalf of, research and development (R&D) corporations and State departments of agriculture.

At present, there are roughly 18 R&D corporations that provide research funds to rural industries. To gain some idea of the likely need for further development of BCA research packages, all corporations were contacted to assess their current and likely future use of BCA in research project selection.

The objectives of this paper are to:

- present data collected from R&D corporations about their current and future use of BCA;
- discuss some of the features of a number of the BCA templates recently developed in Australia; and
- discuss the need for greater standardisation of BCA packages for use by research funders and providers.

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Use of BCA by R&D Corporations

Brief one-page questionnaires were sent to the senior project officers of 18 R&D corporations (Attachment A). Replies were received from all 18 corporations. Three corporations are managed within the Rural Industries Research and Development Corporation (RIRDC), and said they followed RIRDC guidelines. Fifteen replies were analysed. The major findings follow.

(1) Eight respondents said they currently request BCA information with funding applications. These eight corporations represented the following industries — grains, meat, dairy, dried fruits, fisheries, grapes and wine. In addition, the Land and Water Resource Research and Development Corporation (LWRRDC) in 1995 asked for BCA details for the first time. The RIRDC asks for BCA information for projects costing more than $100 000 per year, or a total cost in excess of $250 000.

(2) In response to the question 'How useful has the BCA information been in project selection?', these eight respondents gave these ratings:

Very useful	1
Moderately useful	5
Slightly useful	2
No use	0

(3) The corporations were asked whether they would request (or continue to request) BCA information over the next 2–3 years. Eleven respondents said they would. In addition to the eight corporations rated above, respondents from the wool, tobacco and cotton industries believed their corporations were likely to request BCA data.

(4) There was only one respondent (from cotton) who felt his corporation would develop its own

computer package. (The dairy, meat and grains corporations already have developed packages.) Six respondents were unsure about this.

(5) In response to a question about the importance of developing a standard package for use by R&D corporations, State departments and other bodies, respondents gave these ratings:

Very important	0
Moderately important	11
Slightly important	4
Not important	0

Benefit–cost Templates

One of the objectives of this paper is to discuss a number of features of BCA templates developed in Australia. To assist in evaluating the various packages, a meeting was held in Brisbane on 25 January 1996. This was attended by agricultural economists from Queensland Department of Primary Industries (QDPI). Each package was perused for half-an-hour or so with the use of an electronic projector. The good and not-so-good features were noted.

The packages reviewed were:

State Departments of Agriculture
- REVS (Western Australia)
- APPRAISAL (Victoria)
- SPEAR (New South Wales)
- PREVSYS and REXEV (Queensland)

R&D Corporations
- Dairy (DRDC)
- Grains (GRDC)
- Meat (MRC)

Each of these packages is briefly discussed here. Some comments draw heavily on the paper prepared by Antony and Culpitt (1995) for the Research Evaluation Seminar held in Perth in February, 1995.

The packages are all similar in that they allow for the estimation of project benefits and project costs over time. The BCR can be represented broadly:

$$\text{BC Ratio} = \frac{\text{Unit productivity change (\$)} \times \text{Probability of success} \times \text{Industry size} \times \text{Adoption rate}}{\text{Project costs (\$)}}$$

with benefits and costs measured in discounted terms. Within this broad framework there are a number of differences between the applications developed.

REVS, PREVSYS, SPEAR

Three of the State department packages are very similar. REVS from Western Australia was developed first. PREVSYS from Queensland is based largely on REVS and includes a number of modifications. SPEAR from New South Wales, in turn, is based on PREVSYS and has a number of further modifications. They are therefore discussed in that order.

REVS (Research EValuation Software)

REVS has been developed on Microsoft Excel for Windows. There are eight main menu items.

(1) Research project details (project title, names of supervisor and researchers, project ID number, the year the research begins and the year all research and extension ends.)

(2) External funds (research salaries, extension salaries, on-costs, operating costs and capital costs).
These are all entered on a yearly basis. The program has an option which allows the user to nominate a percentage for on-costs and also to specify whether they are internally or externally funded. If funded from both sources, the breakup has to be done manually.

(3) Internal funds — identical headings to external funds.

(4) Unit benefits and costs (on-farm).
These have to be calculated separately before data are entered. There is the option of entering benefits per unit or in total, e.g. to the State. The user can choose units appropriate to the method of benefit estimation being used. For example, if the cost reduction method is being used, i.e. output is fixed, benefits per tonne would be appropriate. If the incremental profit method is being used, then benefits per hectare or per farm could be used.
If unit benefits are specified, the following data are entered — units used, number of affected units, on-farm benefits per unit, and on-farm costs per unit. The percentage of benefits which apply to that project or departmental activity is also specified.

(5) Probability-weighted benefit scenarios.
The user has the option of specifying the proportion of full benefits which would apply for each of five different scenarios — project fails, project partially succeeds (two levels of success), project achieves goal, and project exceeds goal. Probabilities are then specified for each scenario.

(6) Adoption of innovations.
The user specifies the year adoption begins, the percentage of farmers who will eventually adopt, the year when maximum adoption occurs and the year when the innovation no longer provides benefits. There is the option of showing these data graphically.

(7) Discount rate.
The option of selecting the discount rate.

(8) Results — NPV, IRR and BCR.
These criteria are shown calculated in two ways — with all costs included, and with internal funding excluded. In addition, a DCF graph and cash flow summary are provided. There is also a comprehensive sensitivity table where the values of key parameters can be viewed, and a dialogue box where some parameter values can be directly varied without going back to the main menu.

PREVSYS (PRoject EValuation SYStem)

Also developed on Microsoft Excel for Windows. There are six main menu items.

(1) Research project details.
Similar to REVS except that a research period is specified, e.g. 1995 to 1997; and also a project period, e.g. 1995 to 2030.

(2) Project costs.
Similar to REVS. In addition to departmental and external costs, there is also an option to enter any other costs. Again, a percentage for on-costs can be specified, but this is directly applied to a particular type of funding, e.g. external or departmental.

(3) Project benefits.
Again, these have to be calculated before data are entered. Benefits per unit are entered, as with REVS. There are two major differences:
(a) There is the option of specifying benefits for two production systems. For example, research might be applicable to two geographical regions and have different per-unit benefits in each, or have two distinct types of benefits (e.g. production and environmental). This option removes the problem of having to calculate some type of weighted average benefit. It is not necessary to work in the same unit for each production system.
(b) Three different levels of per-unit project benefits can be specified — minimum, most likely and maximum. Probabilities for each of these outcomes are specified.

(4) Adoption details.
These are entered separately for each production system. The user specifies the year adoption commences, the number of years to maximum adoption, the number of years maximum adoption persists, and the year benefits are expected to cease.
One major difference from REVS is that the user can specify the level of maximum adoption appropriate to the level of per-unit benefit, i.e. the minimum, most likely, and maximum per-unit benefit levels can have different maximum adoption levels. Again, adoption graphs are provided. In PREVSYS, adoption lines for each production system are shown.
A further difference relates to adoption costs. Where adoption results in significant one-off adoption costs, this can be allowed for by inserting the per-unit adoption cost for each benefit level.

(5) Evaluation results.
The NPV, BCR and IRR are shown. However, only one set of figures is calculated, i.e. internal funding is not excluded. Cash flow graphs and tables are provided.

(6) Sensitivity analysis.
Again, a comprehensive sensitivity table is required. The user can rename each sensitivity run.

SPEAR (Software for Project Evaluation of Agricultural Research)

The main menu items are identical to PREVSYS.

(1) Research project details.
Identical to PREVSYS.

(2) Project costs.
Similar to PREVSYS. Again, there is provision for departmental and external funding and other costs. Another component relating specifically to extension costs has been added. There is provision to apportion departmental salaries to particular projects. A major addition is the option to show the proportionate project contributions (equity shares) from various sources.

(3) Project benefits.
Project benefits at full adoption are first calculated. These are again based on benefits per unit, and with the option of two production systems. As for REVS, there is also the option of entering total benefits without first entering unit benefits.
The package makes allowance for four different project outcomes — project fails, i.e. zero benefit, estimated benefits as described above (presumably the most likely), together with two other outcome situations which the user can nominate. The user puts probabilities against these outcomes for the two production systems. It is not possible to enter different unit benefits for the 'with' and 'without' scenarios, limiting the use of this option to adoption patterns.

(4) Adoption details.
For each production system and under 'with' and 'without' scenarios, the user nominates the following information — the first year of adoption, the year of peak adoption, the number of years peak adoption persists, the last year of adoption,

and the percentage adoption at the peak. Adoption graphs are provided which show adoption details for each production system under 'with' and 'without' scenarios. As for PREVSYS, there is the option of allowing for one-off adoption costs for each production system (and under 'with' and 'without' scenarios).

(5) Evaluation results.

This is practically identical to PREVSYS. However, the cash flow graph shows both discounted and undiscounted figures.

(6) Sensitivity analysis.

Similar to PREVSYS. However, the sensitivity tables are considerably larger because both 'with' and 'without' scenarios are included.

Discussion

All three packages are well laid out and are easy to follow. Navigation through them is easy. It is not the intent here to compare the finer points of the packages. The following broad comments are offered.

- In common with most other packages, the user must do considerable calculation beforehand to estimate unit benefits.
- All three packages allow the user to select the method of benefit estimation to be used.
- The PREVSYS and SPEAR modifications of allowing more than one production system are advantageous.
- Similarly, the provision in these packages to allow 'one-off' adoption costs is useful.
- The PREVSYS modification of allowing adoption rates to vary with research pay-off is also useful.
- The layout for estimation of project costs in SPEAR is superior.
- All three packages incorporate outcome probabilities but in slightly different ways.
- The 'with' and 'without' scenarios available with SPEAR are necessary in the analysis of some projects.

REXEV (Research and EXtension EValuation)

The Brisbane meeting referred to previously also discussed a spreadsheet package developed by Mr J.R. Page, Agricultural Economist, currently based at Nambour. The package was developed specifically to estimate the profitability of crop research proposals in a research station setting. It is different from the previous packages discussed in that unit benefits do not have to be calculated separately. In broad terms, the spreadsheet has the following headings in which data are entered:

Current average gross margin
Average expected grain yield
Percentage of grain yield achieved each year
Average expected price gains/losses
Expected change in variable costs
Gain in gross margin (GM) per ha and in total each year on established area
Gain in GM per ha and in total on any expanded area
Costs of research and extension
Producer adoption costs.

The package shows net yearly cash flows and profitability criteria (NPV, BCR and IRR).

Each year's data have to be entered separately. Benefits can therefore be varied over time, offering superior flexibility to the other packages. The user can nominate the years when capital replacements come in and can insert terminal values in the analysis. The package calculates unit benefits but from more explicit data than the packages previously discussed. The package explicitly recognises only on-farm benefits.

The package handles only one production system. More than one run is needed if more than one system needs to be used.

The package has been well accepted in a research station setting because of the explicit nature of the data that are entered. Researchers are able to discuss and debate the technical assumptions underlying different analyses. This has led to group decisions on research projects to be undertaken.

APPRAISAL, DRDC

The APPRAISAL package developed within the Victorian Department and the software used by DRDC are very similar and are discussed together.

APPRAISAL (Spreadsheet for evaluating the returns to research and development)

(1) Project benefits.

Project benefits are entered into a benefits table as maximum benefits, i.e. as if there was a 100% adoption and a 100% success rate. A table is provided to facilitate these calculations. Benefits are not calculated as unit benefits. There is no facility to attach probabilities to different outcomes. Project risk is allowed for by a number of dilution factors (described below). Benefit calculation appears to rely on the incremental profit method.

(2) Farm capital costs.

There is an allowance for on-farm capital costs. These are entered on an aggregate basis, i.e. industry basis, according to the years in the adoption phase when they occur.

(3) Project costs.
A table is provided to enter yearly research and extension costs. There is also provision to split up the funding by source, internal or external. On-costs and overheads have to be calculated manually before data entry. A funding source summary table is provided.
(4) Adoption.
Under 'with' and 'without' scenarios, the following details are entered — the year (from beginning of the project) when adoption begins, the percentage maximum adoption, the number of years to obtain maximum adoption, and the number of years for technology use to fall to zero. Adoption curves are provided.
(5) Dilution of benefits.
Potential maximum benefits are diluted by:
- depreciation levy rate which is used where the value of a product or innovation declines over time for biological reasons;
- adoption factor;
- probability of research success, i.e. probability of the research attaining its predefined objectives;
- probability of successful implementation of results — this allows for the fact that laboratory results are not always translated completely when the new technology is applied in farmers' paddocks.

(6) Results.
Results printed out are NPV, BCR, IRR and NPV/$ invested.

DRDC

The DRDC project evaluation model is very similar to APPRAISAL.
(1) Benefits.
Identical to APPRAISAL except that benefits are explicitly calculated for both the dairy industry and for other industries.
(2) Capital cost incurred with full adoption.
As for APPRAISAL.
(3) Costs.
Entered on a yearly basis and split up by research, development, extension, other capital costs and research maintenance costs.
(4) Adoption.
Adoption is specified by the year when adoption begins, maximum adoption level, the years to obtain maximum adoption, and the adoption profile. A drop-down edit box allows the user to select the adoption profile from four alternatives — exponential, S-shaped, straight-line increase or, as with a new variety, where adoption and disadoption occur rapidly.
(5) Potential maximum benefits.
These are diluted by:
- calibre of resources (%) — this reflects skills and abilities;
- probability of research success (%);
- probability of successful implementation (%);
- decline in product prices;
- depreciation decay rate (%);
- obsolescence (%) — decline in benefits as a result of other alternative solutions becoming available.

(6) Results.
Results printed out are similar to those of APPRAISAL and also include the PV of benefits to the dairy industries and to other industries. (There is no inclusion of consumer benefits.)

The Brisbane meeting referred to had a number of queries about the DRDC model. Some of these also apply to APPRAISAL. The major comments were:
- the separation of 'probability of success' and 'calibre of resources' is unusual;
- benefits and costs associated with 'research maintenance' could be treated as a separate project;
- consumer benefits should not be excluded from the analysis;
- strange terminology like 'depreciation decay rate' should be avoided;
- the calculation of NPV/$ invested is superfluous;
- the sensitivity analysis is overdone;
- on the positive side, the user must provide details of how benefits were calculated. This is a deficiency in the models from the other State departments.

GRDC

The GRDC last year introduced a standard BCA package integrated with the rest of the project application (project description, budget, project details and milestones). Cost data are automatically extracted from the project budgets (for the first five years) and reset in the BCA. The total package requires four floppy disks, with the graphics taking up a lot of the memory required.

Some of the features of the BCA:
- choice of units in which to express per-unit benefits;
- the options of analysing up to three scenarios (e.g. success, partial success and failure) *or* three different subsystems (e.g. geographical areas). In the case of scenarios, probabilities can be attached to the outcomes;
- the option of 'with' and 'without' data;
- provision for year-by-year entry of any benefits not captured by the benefit/cost and adoption curve approach;

- the adoption percentages and years for the starting point of adoption, when maximum is reached and the end point of the project;
- BCR and NPV figures are calculated for each scenario and subsystem separately.

MRC

Applicants invited to submit final applications are asked to supply the following information yearly in written form.

(1) Research costs (regardless of funding source).
(2) Development costs.
(3) Commercialisation costs (regardless of funding source).
(4) Maximum benefits:
  - how benefit was achieved (increase in volume, reduction in costs, increase in product price);
  - cost of achieving benefit (presumably on-farm);
  - net benefit;
  - scope (e.g. hectares, animals).
(5) Adoption level:
  - adoption lag;
  - maximum number of end users;
  - market potential; and
  - rate of adoption.
(6) Net realised benefits (multiply (4) by (5)).
(7) Success determined by:
  - research success (%),
  - developmental success (%),
  - commercialisation success (%).

Conclusions

The following conclusions are based on feedback from R&D corporations and from an examination of a number of packages at the Brisbane workshop.

(1) Eight corporations currently request BCA data with project applications, this number likely to rise to around 11 over the next couple of years. Although eight corporations currently request the information, only one corporation representative said it had been 'very useful'. It therefore seemed that there was progress to be made in making maximum use of the BCA data. It could be that there is a need to have a fresh look at the way information is provided. Nonetheless, a lot of corporations will be asking for BCA data in future.
(2) There was limited support for the development of a standard BCA package. In fact, no corporation representative saw this as being "very important". On the other hand, only one representative said his/her corporation would be developing its own package. It seemed that others would rely on packages developed elsewhere.
(3) Most templates reviewed suffer from these limitations:
  - they do not allow for changes in real costs and returns;
  - it is often difficult to allow for uneven benefit flows;
  - the adoption rate is not clearly defined in any of the packages. Most packages imply that the adoption rate refers to the percentage of farmers adopting the practice or technology. Of course, in calculating the worth of the project, the adoption rate is the percentage of units, e.g. ha or t affected by the research activity. These two meanings give the same result only if all farms have the same level of output or area.
(4) The practice of excluding consumer benefits from the analysis (as in the DRDC) is not recommended. It should be remembered that as much of this research is funded by the general community as by dairy farmers.
(5) In terms of being user-friendly, the packages developed within the State departments are generally superior to the R&D corporation packages. In particular, the implementation of the REVS, PREVSYS and SPEAR packages is much more straightforward. Non-economists, e.g. researchers, are likely to find them easier to use.
(6) Designers of BCA packages must present the results of the analysis in a simple form. In particular, there is a need in sensitivity analysis to carry out analysis using the key parameters only. There is a danger that sensitivity analysis can become so complicated and involved as to be virtually useless.
(7) There is some scope to incorporate some of the features of the REXEV package into other compiled packages. In particular, REXEV requires input of farm management data so that benefits per unit are calculated. The inclusion of this option as a 'front end' on other packages would be very useful.
(8) There is some opportunity for current template designers to cooperate to introduce some level of standardisation. Further, it would be very inefficient if any new applications were developed without reference to a number of packages which are already available and which have open copyright.

Acknowledgments

The author acknowledges the contribution of a number of colleagues — George Antony, Blair Bartholomew, George Passmore, James Gaffney, Jim Page, Peter Hardman and Russ Reynolds — in the preparation of this paper.

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ATTACHMENT A

QUESTIONNAIRE TO R&D CORPORATIONS ON THE USE OF BENEFIT–COST ANALYSIS IN RESEARCH EVALUATION

CURRENT USE

Does your Corporation currently request BCA information in project proposals?

☐ Yes (Tick one)
☐ No

If **yes**, how useful has the information been in project selection?

☐ Very useful (Tick one)
☐ Moderately useful
☐ Slightly useful
☐ No use

FUTURE USE

Do you think it likely that your Corporation will request (or continue to request) BCA information with project proposals over the next 2–3 years?

☐ Yes (Tick one)
☐ Don't know/Unsure
☐ No

If **yes**, is it likely that your Corporation will develop its own BCA computer package?

☐ Yes (Tick one)
☐ Don't know/Unsure
☐ No

If **no,** please give reason(s) ....

....

STANDARDISATION

How important is it that a BCA package be developed which can be used by a number of R&D corporations, state departments of agriculture and other bodies?

☐ Very important (Tick one)
☐ Moderately important
☐ Slightly important
☐ Not important

Please complete the following

Corporation: ....

Contact name: ....
and return by Friday 19 January, 1996 to:

Trevor Wilson
Queensland Department of Primary Industries
PO Box 46 BRISBANE QLD 4001

Ph. (07) 3239 3856
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Developing Consistent Benefit–cost Analyses across Research Organisations

Bill Fisher,* Gary Stoneham* and Peter Daniel*

Abstract

This paper discusses a number of practical issues which need attention if the quality and value of benefit-cost analysis (BCA) is to be improved. Consistency issues are discussed as part of an overall approach to improving quality.

Consistency is important for two reasons. First, the potential value and usefulness of BCA in decision-making will be improved and, related to this, decision-makers will place greater emphasis on BCA if the studies have credibility.

Sources of inconsistency are: the availability of accurate and consistent data; differences in benefit estimation; poor knowledge about key variables such as the adoption of technology; the importance of considering what might have happened in the absence of the technology; and differences in defining the target population. The last section discusses a number of general issues important for the quality of BCA to be improved. Stress is placed on the need for *ex ante* studies on large work areas, and on *ex post* studies. The authors believe the present emphasis of some Rural Industry Research Corporations (RIRCs) on BCA for small projects is misplaced. Priorities for improving the quality and consistency of BCA are discussed in the final section.

THIS paper explains and discusses a number of practical issues concerned with consistency. First, the importance of consistency is discussed. Second, sources of inconsistency in benefit–cost analysis (BCA) are listed, followed by some general issues concerning the quality of benefit–cost studies and priorities for improving quality.

In this paper consistency issues are discussed as part of an overall approach to improving the quality and value of BCA.

Why Consistency is Important

Consistent approaches to the estimation of benefits and costs are needed for several reasons. First, they ensure the maximum possible value and use of BCA in decision-making by scientists and research administrators. For example, an *ex ante* study can provide powerful insights about variables which have a major impact on the profitability of a project; this information can direct scientists to those areas of science which will improve pay-off from the work. Second, economists and research administrators will place greater reliance on BCAs if the work has credibility. For example, the Rural Industry Research Corporations (RIRCs) which request BCA must have faith in the consistency of the analyses being prepared by research providers. If there are doubts, then the value of BCA will be diminished, with decision-makers placing less emphasis on economic considerations.

As expected, the smaller the work group or organisation, the easier it is to develop processes to ensure consistency in BCA. The task becomes more difficult as organisational size and the number of organisations involved increases. This is the case for BCA being prepared by research providers for the RIRCs.

Sources of Inconsistency

A full list of possible sources of inconsistency is shown as the Appendix, and is briefly discussed here.

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Adequate, consistent and accurate data are not available. This covers prices, quantities, areas, farm and stock numbers. It is particularly an issue for smaller industries.

Large workloads over short time frames may limit the ability of individuals and organisations to search out data.

Differences in methodology to benefit estimation. This should be thought of in terms of supply or demand shifts. Estimation issues which can lead to differences are: price effects and elasticities, often ignored; some projects often comprise several discrete subprojects; many projects require on-farm capital expenditure for the results to be adopted; using the same annual benefit each year may not accurately reflect the economic effect of some new technologies; some improvements such as genetic improvement may lead to an exponential increase in benefits over time; and there are difficulties in estimating what would have happened in the absence of the project.

Little evidence about the probability of research success and adoption rates. There is a dearth of published studies. Guesses have to be made for use in BCA.

Disadoption and research lead time. These issues need to be considered.

Adoption 'with' and 'without' the technology. This is particularly important when assessing extension projects. Adoption may occur without the project's help.

The target area or population must be tightly defined in terms of soil types, farm incomes, farm size, etc. These types of data can be hard to find.

Improving the Quality of Benefit–cost Analyses

Academic training, the use of reference material and experience in completing studies are the means by which economists develop BCA skills. Professional meetings and workshops will enhance skills once they have been developed. This knowledge has to be applied in a careful way to each problem.

It is not possible to develop overall guidelines for the estimation of benefits. The goal (of improved estimation) is best handled at workshops where specific projects and issues can be discussed. Out of this might come some generally agreed approaches to the estimation of benefits for different types of projects.

A checklist of questions can assist an economist consider how a study might be undertaken. However, there are too many issues involved that can influence the approach taken for a particular study and prevent general guidelines from being developed. Study purpose, data limitations and time constraints all have a bearing on such decisions.

A number of general issues of quality and the usefulness of BCA should be discussed.

Ex ante BCAs of 'broad work areas'. The most useful BCAs are those which examine the economics of broad areas of work activity. For example, in the grains industry it would be useful to have studies which show the benefits and costs of particular plant breeding programs, crop agronomy, plant disease and farming systems. The aim should be to have BCA studies of broad work areas, both within and between industries. At the moment few contemporary studies exist.

Ex ante BCAs for specific projects which fall within 'broad work areas'. This type of BCA should not take long to complete where benefits and costs have already been estimated for a larger study, as suggested above.

At present many RIRCs are insisting on BCAs as part of submissions for all projects. There are doubts about the value of this process. Concerns are that there are serious data limitations in attempting studies of small projects. Second, time constraints often prevent thorough analysis, which can mean that some benefits are omitted or are not estimated in a satisfactory way. These two concerns mean that the value of this type of study for decision-making and reporting to stakeholders is questionable. The move to more commissioned research by some RIRCs, covering larger areas of work, partly negates this point. However, the pay-off to economists' efforts is likely to be greater if the focus is on large areas of work.

Ex post BCAs. These are important for reporting and accountability purposes. Project benefits can be estimated in a more reliable way, compared to *ex ante* studies, so that this type of study is a valuable adjunct to *ex ante* studies of broad work areas.

Within Agriculture Victoria most emphasis is placed on *ex ante* studies. *Ex post* studies are being undertaken as part of a broad evaluation of departmental activities. To date scientific projects have been assessed, but in future will include evaluating policy projects. Careful thought is needed as to how much time should be devoted to this type of assessment in comparison to *ex ante* studies.

Staff skill issues. Regular workshops on benefit estimation issues can help ensure that economists maintain and develop their skills.

Where a large number of *ex ante* analyses is needed for the RIRCs, the approach taken in Agriculture Victoria has been to form small teams of economists to discuss and develop the BCA with scientific staff. This approach promotes a good understanding of the project, allows cross-fertilisation of skills within the team and collective problem-solving, and helps lighten what could otherwise be a large and daunting task. Exchanges of staff between research organisations would have similar benefits.

Data issues. The availability of relevant data is a major means to promote improved quality and consistency. In turn, the value and usefulness of the BCA for decision-making is enhanced if useful, relevant data are widely available. Most RIRCs publish statistical bulletins but in some cases these require review to be relevant for the conduct of BCAs.

Research. Little published work exists on such variables as the probability of research success and the adoption of technology. In the case of adoption, historical studies may not be a reliable guide to adoption levels today if there has been significant structural change. At present assumptions have to be made, and these may not be very good. It is important to assess the claims of scientists with other experts. Given the significance of these variables, research on these topics by industry and practitioners of BCA should be encouraged.

Data bases showing titles, authors and abstracts. While difficult, efforts should be made, as this will save time and improve the quality of subsequent studies.

Spreadsheets. Apart from the major spreadsheets which incorporate discounted cash flow analysis, a number of agricultural benefit–cost spreadsheets are in use and readily available. Wilson (these Proceedings) provides a summary.

Consistency and the quality of benefit–cost studies can be improved by developing and refining spreadsheets, but there are limitations. The focus should be mainly on the other issues discussed in this section, namely, the skills of economists, the availability of *ex ante* economic studies of broad work areas, the availability of good data, additional research on key variables, and enhanced data bases on economic studies.

Further Work and Priorities

To improve the quality (including consistency) and value of BCA for decision-making, emphasis should be placed on the following.

The development and availability of relevant statistical data. Steps have been taken by some RIRCs. In some cases additional efforts are needed to improve the quality of the information and fill gaps.

Ex ante BCAs on 'broad areas of work'. Requires emphasis by research organisations, including RIRCs.

Ex post BCAs on broad areas of work.

Research on important variables, such as the probability of research success and adoption. Discussions among research organisations are needed to arrange work on these topics. The availability of good studies will assist efforts to improve consistency across projects, industries and research organisations.

Regular meetings with individual RIRCs. This would enable work priorities to be developed to promote improved BCA. The most important issues are: the availability of relevant statistical data; the need to commission and encourage research on key variables; and the commissioning and encouragement of economic studies on broad areas of work.

Staff skills and training. This is important, but largely an issue for individuals and research organisations.

Data bases on titles and authors. This issue might be pursued by RIRCs and individual research organisations. Ideally, an abstract of each study should be available.

The Next Steps

If there is agreement on the issues identified in this paper, then the Research Evaluation Group for Agricultural Economists (REGAE) might be the forum to progress the agenda. REGAE might arrange meetings individually and collectively with RIRCs to discuss broad issues and to promote cooperative efforts.

Acknowledgments

The comments and ideas of Loris Strappazzon, Paul Cashin and John Brennan on earlier drafts of this paper are gratefully acknowledged.

Appendix

Sources of Inconsistency in Benefit–cost Analysis

Inconsistent data

Adequate, consistent and accurate data are not available for many, particularly smaller industries (prices, quantities, areas, farm or stock numbers).

On-farm cost and farm management data can be unavailable or difficult to find.

Localised or regional data can be unavailable or hard to find.

Data on smaller industries can be hard to find.

Large workloads over short periods limit the ability to search for data not readily available.

Methodological inconsistencies in doing benefit–cost analysis

Benefit estimation:

Has to be thought about in terms of supply or demand shifts;

Approximations such as cost reduction or profit methods need to be understood in terms of a partial equilibrium model;

Distributional consequences may not be considered;

Price effects and elasticities are often ignored;

Some projects comprise several discrete subprojects, the benefits of which must be estimated separately;

Many projects require on-farm capital expenditure for the results to be adopted;

Changes to the technology may have complex effects in multi-enterprise or rotational farming systems;

Using the same annual benefit figure every year may not accurately reflect the economic effect of some new technologies or practices;

Some innovations, such as genetic improvement, may lead to an exponential increase in benefits over time;

It can be difficult to estimate what would have happened in the absence of the project — would things have become worse, stayed the same, or improved?

Probability of success

Unless the probabilities of success of different types of research projects are based on documented past experience the estimates may be quite inaccurate.

Using just an expected value may not reflect reality — there may be a distribution of possible outcomes.

Adoption rates

Attributes of the innovation will affect how many people adopt it, and how fast.

Without surveys or previous studies, adoption can be difficult to predict.

Adoption with and without

Adoption of the technology may occur without the project's help, particularly in extension projects.

Estimating adoption without the project can be just as difficult as estimating it with the project.

Target area or population

Needs to be defined tightly in terms of incomes, soil types, farm size, etc.

Data needed to define the target population can be hard to find.

Disadoption and research lead time

Some innovations will be replaced by others in the future.

Other innovations will remain in use for many years, although they may be refined.

Costs

Project leaders are often not used to thinking of the full costs of their projects.

Simple multiplier formulas may not give an accurate idea of the full costs of a project.

Discount rates

Most RIRCs follow the Commonwealth Department of Finance recommendation of 8% real.

A few, like the Dairy Research and Development Corporation, use a different discount rate.

Implications of New Directions in Research Policy for Research Evaluation Activities

Financing Agricultural Research in Australia: 1953–1994

J.D. Mullen*, K. Lee† and S. Wrigley**

Abstract

The role of the public sector in financing rural research in Australia is the subject of continuing debate. A major constraint to this debate is the availability of data detailing trends in the financing of rural research by the public sector, by primary producers through the Research and Development Corporations (RDCs) and by the private sector. In this paper a data base for the period 1953 to 1994 assembled from the State Departments of Agriculture, CSIRO and the major universities, and a more limited ABS (Australian Bureau of Statistics) data set are used to identify trends in public and private support for rural research. A trend towards applied research funded by RDCs and greater interest in the public sector in measuring the environmental consequences of agricultural technologies and other 'spillovers' to the wider community are likely to have implications for the demand for the economic evaluation of agricultural research.

THE development and adoption of new technology is an important source of economic growth and development. New technologies for Australian agriculture result from public and private investments in research conducted in State, federal and private institutions and from the research of other countries and international research agencies. In Australia the public sector has directly provided a large proportion of the research and advisory services available to agriculture. The rationale for public sector involvement has been based traditionally on the expectation that the private sector, consisting of a large number of small farmers, would underinvest in such services because of their 'public good' characteristics. This public-good nature derives from two sources. First, the knowledge generated by research is non-rival in consumption, that is, it can be used by many at a low marginal cost and so should be priced below average cost of production. Second, it is difficult for those who finance the research to appropriate its benefits and deny them to 'free-riders' who do not contribute to the cost of the research.

Both the public sector role in agricultural research and the level of research investment have come under scrutiny. A widely held view, reviewed by Harris and Lloyd (1991), has been that the level of public investment in R&D has been too low. The public sector role was examined by the Industries Assistance Commission in 1976 and Industry Commission in 1995, and there have been a number of inquiries into the appropriate role of State Departments of Agriculture. While there has been a lack of consistency with respect to the underlying philosophies and the findings of these reviews, they have in general identified a need for greater industry financing of rural research. The institutional evolution of the rural industry research and development corporations (RDCs) since the 1950s reflects a growing belief that rural industries should take greater responsibility for the direction and funding of rural research.

There has been little empirical analysis of these issues. An important stumbling block has been the lack of an extended series of data on agricultural research expenditure in both the private and public sectors. Even descriptive statistics concerning the growth and sources of rural research funding have been unavailable except in recent years.

The objective of this paper is to report trends in rural research in Australia from 1953 to 1994 with respect to total expenditure on production (as opposed to processing) research, sources of funding and the nature of research, using the data set

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assembled by the authors extending from 1953 to 1994 and the ABS Research and Development data set. Several measures, including research intensity, have been used to assess changes in real support for production research in the public sector. (The data set compiled by the authors has been submitted for publication in the Agricultural Economics Bulletin Series, NSW Agriculture.)

The authors collected expenditure data from State Departments of Agriculture, CSIRO and major universities.[1] The main attraction of this data set is its length of coverage and its identification of the contribution of the RDCs and their forebears.

Surveys to collect R&D expenditure data were initially undertaken by the Department of Science (Project Score) in 1968–69, 1973–74 and 1976–77 and then by the ABS in 1978–79, 1981–82, 1984–85, 1985–86, 1988–89, 1990–91 and 1992–93. Hence the ABS data set consists of only 10 observations since 1968–69. In studies of R&D in US agriculture, Chavas and Cox (1992), Pardey and Craig (1989) and Huffman and Evenson (1993) have found that research expenditure may have an impact on productivity for 35 years. Hence the ABS data series is inadequate for most empirical analyses of the relationship between research and productivity growth, and gives an incomplete picture of the growth in rural research and the contributions of the RDCs in the 1950s and 1960s. However, it does provide information about expenditure by the private sector and changes in the nature of rural research over time.[2]

Nominal Expenditure by All Research Institutions

The trends in nominal research expenditure across public research institutions from the authors' data set are summarised in Figure 1 and Table 1. Total expenditure on agricultural research rose from $9.0 million in 1953 to $530.5 million in 1994. Expenditure on research has increased in all institutions with strong growth from the mid-1960s until the late 1980s. The State Departments as a group invested more in rural research than did CSIRO, with the universities playing a relatively small role.[3]

A similar trend is evident from the shorter ABS series (Table 2). In general the two data series seem to be highly consistent. In recent years the biggest divergence occurred in 1988–89 when the authors' estimate of R&D spending fell to 76% of the ABS estimate. The ABS expenditure estimate for 1988–89 appears to be abnormally large; it exceeds the 1990–91 estimate and is almost as large as that for 1992–93.

The Committee of Economic Enquiry (1965, known as the Vernon Report) estimated that as a percentage of total public R&D in Australia, expenditure by the public sector on rural research was about 35% at that time. Since then this percentage, by ABS estimates, has declined from over 20% to about 15%.

The ABS data on rural research by the private sector are collected by product field rather than by socioeconomic objective, as for research in the public sector,[4] and hence the series are not strictly comparable. Nevertheless, private sector research has risen from about A$1.5 million in 1976–77 (one per cent of total agricultural research) to about A$58 million in 1992–93, or 10% of total agricultural research.[5] Note that this estimate of research by the private sector does not include levy payments by producers or research carried out by producers

[1] This data set has already been used in a study of the relationship between productivity in Australian broadacre agriculture and investment in public research (Mullen and Cox, 1995) and in a study of the contribution of RDCs to Australia's rural research industry (Alston et al. 1995). This data base was assembled as part of a project funded by the Australian Wool Research and Development Corporation (now part of the International Wool Secretariat) and the US Congress Office of Technology (now defunct).

[2] Expenditure on research in the forestry and fishing industries has been deducted from total agricultural research by the public sector as estimated by ABS to allow greater comparability with the authors' data set. This has not been done for the estimates of R&D by the private sector.

[3] The abnormally high expenditure by CSIRO in 1977 (Fig. 1) was due to the Australian Government's substantial capital investment in the CSIRO National Animal Health Laboratories in Geelong. Incomplete records suggest that this was an appropriation in 1977 that was expended over 1977 and 1978.

[4] ABS has only collected private-sector research by socioeconomic objective in the last two surveys. In 1990–91, the product field estimate of private-sector research was lower than the socioeconomic estimate but in 1992–93, the reverse was true. The socioeconomic objective of relevance here is economic development in plant and animal production. This classification system asks why the research is done. The product field classification apportions total R&D expenditure toward the products/processes to which it was directed. Research into new veterinary chemicals would be classified as pharmaceutical and veterinary rather than agricultural.

[5] The IC estimated that expenditure on rural research by business enterprises in 1992–93 was A$71 million (10% of total rural R&D). This estimate is based on ABS data collected on a socioeconomic basis and includes expenditure on forestry and fishing.

Table 1. Nominal and real expenditure on rural research in Australia.

	Nominal expenditure				Real Total
	Depts of agriculture ($'000)	Universities ($'000)	CSIRO ($'000)	Total ($'000)	($'000)
1953	5 295	326	3 407	9 028	9 028
1954	6 093	452	3 554	10 099	9 755
1955	7 536	1 289	3 971	12 796	11 940
1956	7 814	583	4 473	12 869	11 218
1957	8 164	738	4 609	13 512	11 365
1958	9 323	812	5 400	15 536	12 829
1959	9 501	1 126	6 189	16 817	13 754
1960	9 666	1 562	7 125	18 354	14 096
1961	10 773	1 779	7 849	20 400	15 151
1962	11 249	2 113	9 374	22 736	16 425
1963	12 410	2 334	10 143	24 888	17 748
1964	14 224	3 693	11 746	29 663	20 389
1965	14 806	3 672	14 244	32 722	21 497
1966	17 073	4 162	14 413	35 648	22 780
1967	21 433	4 484	17 013	42 929	26 144
1968	23 998	5 001	18 565	47 564	27 772
1969	26 347	5 295	18 608	50 251	28 076
1970	29 297	5 588	22 471	57 356	30 268
1971	32 826	7 063	26 427	66 316	32 206
1972	37 175	7 749	28 581	73 504	32 675
1973	42 411	6 920	30 230	79 561	32 519
1974	48 960	8 181	38 713	95 855	34 138
1975	64 749	9 617	47 609	121 976	34 583
1976	73 481	11 216	51 740	136 437	33 608
1977	79 669	11 024	56 240	146 932	32 571
1978	92 845	14 829	89 823	197 497	40 517
1979	97 418	14 840	63 352	175 610	33 870
1980	110 602	17 037	76 389	204 028	35 510
1981	124 463	19 261	92 187	235 912	36 562
1982	141 447	21 111	111 708	274 266	37 616
1983	163 624	24 538	126 907	315 069	38 974
1984	173 253	26 415	105 076	304 744	35 573
1985	188 039	32 074	115 725	335 838	36 948
1986	205 284	38 613	132 962	376 859	38 724
1987	208 971	39 035	129 365	377 370	36 585
1988	226 555	39 058	131 561	397 174	36 969
1989	241 799	43 091	115 789	400 680	35 458
1990	270 298	47 640	126 446	444 384	37 438
1991	264 934	55 535	161 846	482 315	38 896
1992	266 205	55 203	172 893	496 709	38 805
1993	266 963	58 523	173 885	505 141	38 560
1994	280 486	61 844	173 727	530 461	40 126

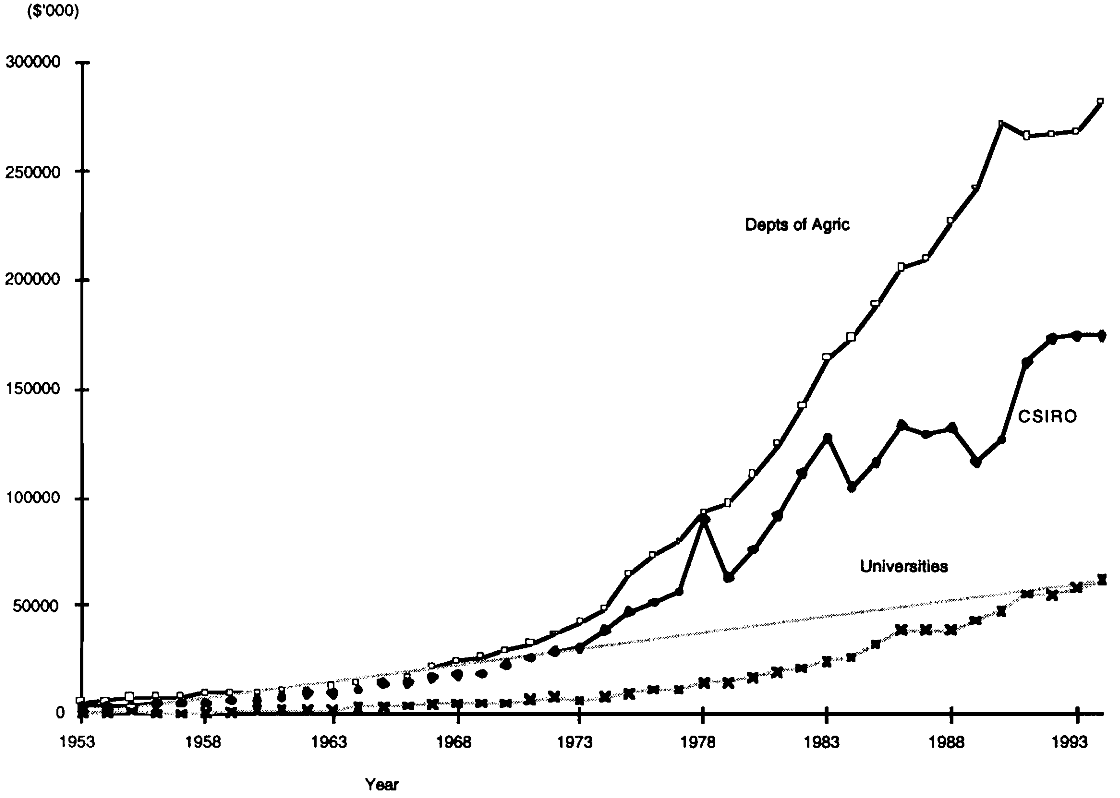

Figure 1. Research expenditure by institution (nominal dollars).

Table 2. ABS agricultural research expenditure estimates.

Year	Public sector R&D ($'000)	Private sector R&D ($'000)	Public ag. R&D as percentage of total public R&D (%)	Basic ag. R&D as percentage of total ag.R&D (%)	Mullen et al.'s R&D as percentage of ABS estimate of R&D (%)
1968–69	50 999	0	20.4	11.85	98.53
1973–74	76 238	7 244	18.0	0.00	125.73
1976–77	133 220	1 475	20.6	22.03	110.29
1978–79	179 106	2 378	22.2	na	98.05
1981–82	271 382	1 317	23.0	26.84	101.06
1984–85	382 005	4 654	22.9	18.76	87.91
1986–87	461 129	11 503	22.3	22.71	81.84
1988–89	525 895	23 590	21.5	19.65	76.19
1990–91	470 323	32 279	15.3	17.77	102.25
1992–93	539 444	58 002	15.3	15.11	93.64

themselves.[6] Nor does it include research into many purchased inputs such as pesticides and pharmaceuticals used for veterinary purposes. The fact that the product field and socioeconomic estimates of R&D by the private sector have been reasonably similar in the two years for which they are both available suggests research into purchased inputs by the private sector may not be that large and that technology in this form is largely imported embodied in the inputs.

Some growth in expenditure by the private sector has been financed by the RDCs. No doubt the introduction of a 150% tax concession for R&D in 1985 also contributed to the increase in rural R&D by business enterprises. Nevertheless, the share of agricultural research undertaken by the private sector in Australia is still much smaller than in the USA and UK. The growth in agricultural research by the private sector has not been large enough to offset the relative decline in public-sector research. Hence the share of agricultural R&D in total R&D in the Australian economy has declined from about 18% in 1981–82 to about 10% in 1992–93.

Support for Rural Research in Real Terms

So far expenditure on research has been discussed in terms of nominal dollars. Two measures have been used to gain some appreciation of whether there has been a real increase in the resources devoted to agricultural research: deflation to a constant dollar, and research intensity.

An obvious measure of the real increase in rural research resources is obtained by deflating nominal expenditure by a price index. This measure is an implicit index of the quantity of rural research resources through time. The most appropriate deflator would have been one based on movements in the prices and quantities of inputs used in the public research sector. Such an index has been available from the ABS only since 1977–78. As an alternative, a price index of total expenditure on goods and services by public authorities has been used (detailed in Table 3). The authors estimated that real expenditure (constant 1953 dollars) increased fourfold from $9 million in 1953 to $40 million in 1994. It grew linearly until about 1970 but since then the rate of growth of expenditure has been slow (Fig. 2 and Table 1).

[6] Alston et al. (1995) estimated that the contribution of the private sector through levies and research undertaken by private business firms was probably about 21.5% in 1993–94.

Agricultural research intensity (ARI) is defined as the ratio of expenditure on research to the value of the industry. The value of the industry can be expressed in terms of either gross value of production (GVP), or the value added by production as measured by gross domestic product (GDP). The main difference between these two is that the value of purchased inputs is deducted from the former to give the latter, which is a measure of the value added by land, family labour and management. The authors did not have agricultural GDP at State level. It is not clear whether research intensity should be expressed in terms of GVP or GDP, as a significant proportion of public research expenditure is related to technologies based on purchased inputs. It seems likely that the use of purchased inputs has grown faster than the use of other inputs. Hence the growth in GDP has been less than in GVP and consequently research intensity measured in terms of GDP has grown more than research intensity measured in terms of GVP.

Another dimension to the calculation of ARIs is whether values are expressed in real or nominal dollars. ARIs can be expressed as a ratio of nominal R&D expenditures to the nominal value of production or as the ratio of real expenditures to the real value of production (i.e. a ratio of the index of the quantity of research to an index of the quantity of production). These two ratios are the same only if the price index for research is the same as that for agricultural production. Thus four ARIs are possible from combining the GVP or GDP measures of the value of production with the real or nominal values for research and production.

In nominal terms, research intensity for Australia based on GVP grew from 0.39% t to a maximum of 3.07% in 1978 before declining to 2.39% in 1994 (Table 4), growing sixfold over the whole period. This national average conceals important differences between major research institutions (Table 4 and Fig. 3). The Victorian Department of Agriculture has always had a lower ARI than the other institutions. The SA Department has switched from a low ARI to having a high ARI along with the WA Department. ARI in the NSW Department has been declining since the mid-1970s and is now similar to that of the Department in Queensland. It is interesting to note that in a recent study of productivity growth in broadacre agriculture (Knopke et al. 1995), the ranking of States by productivity growth was the same as their ranking by ARI (in 1994) except that the productivity of Queensland was lower than that of Victoria — this may have resulted from a more severe drought condition in Queensland.

Table 3. Price deflators and the RDC contribution.

	Research deflator index	Index of farm prices received	Total government expenditure (% of GDP)	RDCs contribution to public research (%)
1953	100	100	29.2	15.6
1954	104	100	26.3	11.3
1955	107	93	26.8	10.3
1956	115	90	27.2	12.6
1957	119	100	26.2	12.8
1958	121	93	27.2	14.2
1959	122	86	27.5	14.3
1960	130	90	27.1	15.0
1961	135	93	27.6	15.3
1962	138	86	29.5	15.8
1963	140	90	28.8	16.9
1964	145	97	28.4	17.0
1965	152	93	29.3	17.2
1966	156	97	30.6	19.7
1967	164	97	31.2	19.3
1968	171	93	31.1	18.5
1969	179	93	31.1	17.8
1970	189	90	30.3	16.9
1971	206	86	29.6	17.6
1972	225	93	30.5	14.3
1973	245	128	30.2	13.4
1974	281	152	31.6	13.2
1975	353	97	35.9	11.2
1976	406	138	36.4	13.1
1977	451	152	36.5	11.2
1978	487	159	38.2	7.6
1979	518	193	36.6	8.0
1980	575	228	36.0	7.4
1981	645	241	36.5	7.7
1982	729	241	38.4	7.3
1983	808	252	41.3	7.6
1984	857	266	42.2	8.2
1985	909	272	42.3	10.1
1986	973	272	42.7	10.6
1987	1 032	293	42.1	12.0
1988	1 074	345	39.1	13.3
1989	1 130	386	36.6	15.6
1990	1 187	376	38.2	17.0
1991	1 240	328	39.8	19.0
1992	1 280	338	41.3	18.9
1993	1 310	331	40.5	20.1
1994	1 322	345	38.5	21.1

*Excluding QDPI

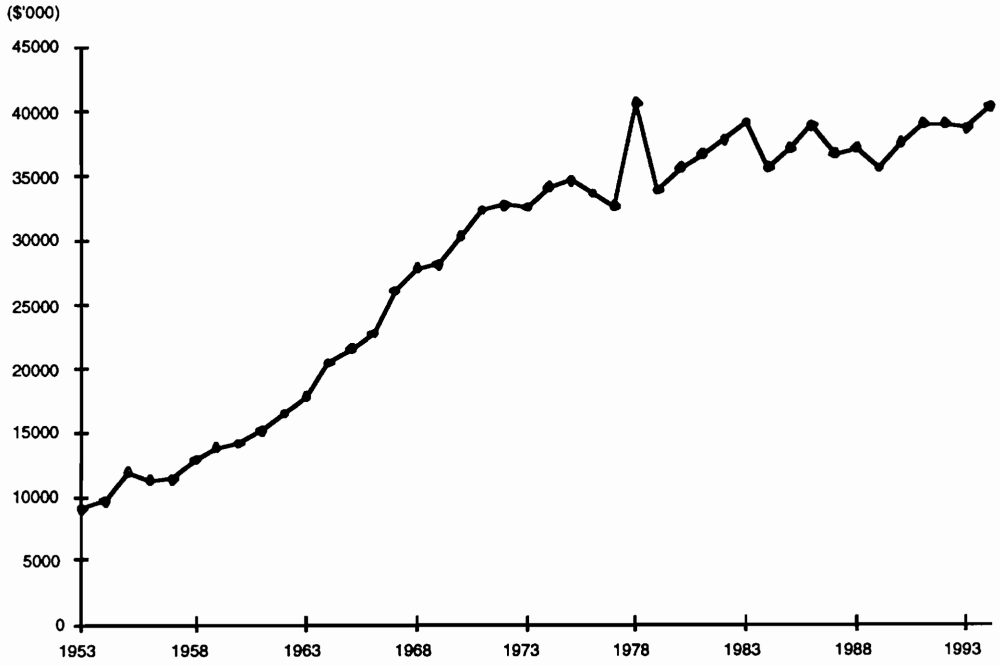

Figure 2. Real expenditure on agricultural research (1953 dollars).

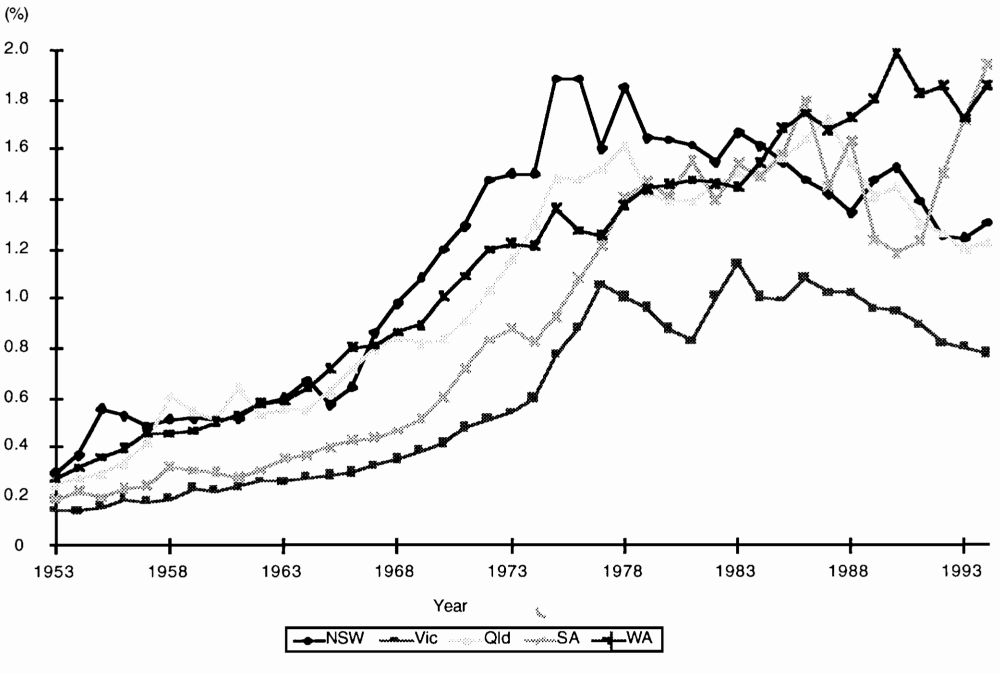

Figure 3. Nominal research intensity by department.

For Australia as a whole, research intensity based on agricultural GDP rose from 0.6% in 1953 to 4.4% in 1994, after peaking at 4.9% in 1986, growing by a factor of more than seven for the entire period. This growth in public expenditure on rural research is much larger than the growth of general government expenditure. Expenditure by Commonwealth and State governments in Australia grew from 29% of GDP in 1953 to 42.7% in 1986 and was 38.5% in 1994 (Table 3). Neither did public research in total increase to the same extent as public agricultural R&D. The ABS data suggest that total public research expenditure as a percentage of GDP grew from around 0.75% in the mid-1970s to 0.87% in 1992–93 (Table 2). Alston et al. (1993, p. 14) note that, of OECD countries in 1985, Australia was second only to Canada in the level of its research intensity defined in this way. The growth in private sector research has tempered but not offset the trend for public support of rural research to decline in recent years. This decline in research intensity since 1986 is of a similar order of magnitude to the decline in total government expenditure as a percentage of GDP since 1986.

The nominal RI series may be misleading (as noted by Pardey and Roseboom 1989 p. 23), since the price of farm products received by Australian farmers has been falling in real terms (owing to research-induced technological change, among other things) while the price of R&D has more likely risen in real terms. A 'real' ARI is obtained when both series are deflated — research expenditure by the price index for public expenditure on goods and services, the value of agricultural gross domestic product by Australian Bureau of Agricultural and Resource Economics (ABARE)'s index of prices received by farmers. Real research intensity (GDP-based) rose from 0.6% in 1953 to 1.1% in 1994 after peaking at 1.9% in 1974, growing by a factor of about 2 over the whole period (Table 4). As Figure 4 shows, real ARI has been declining since the late 1970s. Nevertheless, even in real terms, public support for rural research grew significantly after 1953.

The Contribution of the RDCs

Producers have for a long time supported rural research in public institutions through levies. This history is reviewed in Donaldson (1964), Williams and Evans (1988) and Alston et al. (1995). The last paper reviewed the role of RDCs in the Australian rural research sector and drew inferences for US rural research were RDCs to be more widely used there. The objectives of the RDC system include:

- an increase in resources available for rural research;
- an increase in industry support for agricultural research; and
- greater opportunities for industry to influence the direction of research.

It is not possible to isolate the effects of the RDCs on the public rural research sector from the effects of changes in the significance of the agricultural sector to the Australian economy and from changes in perceptions about the appropriate role of government in the economy. In particular there is growing acceptance of the view that government should confine its activities to areas of market failure. With respect to rural research, this implies that public funding is most appropriate for 'public goods', where a significant proportion of the benefits from new technology spill over to the general community. Where benefits are largely captured by producers and consumers of the commodity in question, the RDC system can be an appropriate way of funding research.

Data on expenditure by RDCs were provided by the Commonwealth Department of Primary Industries and Energy (DPIE). According to this data set, total expenditure by the RDCs rose strongly from $63 million in 1984–85 to $252 million in 1994–95, reflecting in part the commencement of a number of new corporations such as the Land and Water R&D Corporation. The activities of the set of RDCs under the administration of DPIE are much broader than research into production agriculture. This is clearly the case for the Energy and Fisheries RDCs but most of the other RDCs undertake research activities into the processing of rural products and into environmental issues. Some research activities funded by RDCs are also undertaken by the private rather than the public sector. Expenditure in these latter two areas cannot be identified in the DPIE data base.

The authors estimated the funds received from the RDCs by public research institutions to undertake production research activities.[7] This type of funding was not always clearly identifiable in published financial statements. In particular it was unavailable for the Queensland Department of Primary Industry (QDPI) and had to be extrapolated for four years in the mid-1980s for CSIRO. Note also that the authors' estimate includes both the producer levy and the Commonwealth contribution. The contributions from

[7] These funds were contributed not only by what are now known as the RDCs, but also by private sector firms and individuals and by organisations such as the Rural Credits Development Fund of the Reserve Bank. These latter sources of funds were relatively unimportant.

Table 4. Research intensity in Australian agriculture.

	Nominal Research Intensity				Real RI	
	Gross value of production based measures				GDP-based	
	CSIRO (%)	Ag. depts (%)	Univ. (%)	Average (%)	Average (%)	Average (%)
1953	0.15	0.23	0.01	0.39	0.59	0.59
1954	0.15	0.26	0.02	0.43	0.66	0.64
1955	0.17	0.33	0.06	0.56	0.85	0.74
1956	0.20	0.34	0.03	0.56	0.86	0.68
1957	0.20	0.35	0.03	0.58	0.88	0.74
1958	0.23	0.40	0.04	0.67	1.05	0.80
1959	0.26	0.40	0.04	0.71	1.13	0.79
1960	0.29	0.39	0.06	0.75	1.20	0.83
1961	0.31	0.42	0.06	0.80	1.30	0.90
1962	0.36	0.44	0.08	0.88	1.46	0.91
1963	0.37	0.45	0.08	0.91	1.51	0.97
1964	0.40	0.49	0.11	1.02	1.67	1.11
1965	0.46	0.48	0.11	1.07	1.74	1.06
1966	0.45	0.54	0.12	1.12	1.85	1.14
1967	0.50	0.63	0.12	1.26	2.07	1.22
1968	0.53	0.69	0.15	1.37	2.30	1.25
1969	0.52	0.74	0.13	1.40	2.39	1.24
1970	0.62	0.80	0.15	1.57	2.73	1.30
1971	0.71	0.89	0.19	1.79	3.15	1.32
1972	0.76	0.99	0.19	1.97	3.53	1.46
1973	0.74	1.04	0.14	1.96	3.42	1.79
1974	0.85	1.08	0.13	2.11	3.59	1.94
1975	0.96	1.30	0.16	2.46	4.12	1.13
1976	0.95	1.34	0.18	2.49	4.13	1.40
1977	0.93	1.32	0.16	2.44	4.00	1.35
1978	1.40	1.44	0.21	3.07	5.15	1.68
1979	0.88	1.35	0.15	2.44	4.11	1.53
1980	0.91	1.32	0.14	2.43	4.09	1.62
1981	0.97	1.31	0.17	2.49	4.20	1.57
1982	1.05	1.33	0.17	2.57	4.41	1.46
1983	1.09	1.41	0.21	2.71	4.83	1.51
1984	0.83	1.37	0.17	2.41	4.35	1.35
1985	0.86	1.40	0.20	2.51	4.60	1.38
1986	0.94	1.45	0.25	2.66	4.92	1.38
1987	0.86	1.39	0.23	2.50	4.66	1.32
1988	0.79	1.35	0.19	2.37	4.27	1.37
1989	0.63	1.32	0.19	2.19	3.90	1.33
1990	0.64	1.36	0.20	2.23	3.94	1.25
1991	0.77	1.26	0.26	2.29	4.09	1.08
1992	0.79	1.22	0.26	2.27	4.12	1.09
1993	0.78	1.20	0.27	2.27	4.18	1.06
1994	0.78	1.26	0.26	2.38	4.37	1.14

producers is roughly half the total, although this rule of thumb becomes less reliable from the mid-1980s with the advent of the Rural Industries and the Land and Water RDCs which have a much higher Commonwealth contribution.

With these qualifications in mind, the authors estimated that the contribution of the RDCs has increased in nominal terms from $1.2 million in 1953 to $100 million in 1994 (excluding QDPI) (Table 3), implying greater support from rural industries for rural research. However, relative to total public rural research, the RDC contribution has been small and has varied widely since 1953 (Fig. 5). RDC funding as a percentage of expenditure on research by all institutions (except QDPI) rose from about 16% in 1953 to almost 20% in 1966 before declining to just over 7% in 1982. This decline largely reflected the inability of levies to keep pace with the rising cost of research, although there were also small declines in funds received from the RDCs in the late 1970s. Since then new RDCs have begun and in 1985, the RDCs were constituted in their present form. Their contribution to funding public institutions has risen strongly to just over 20% of total research expenditure in 1994 (Fig. 5). The increase in RDC funding has not been large enough to support a real increase in expenditure on research.

A final issue in this section concerns changes in the nature of research being undertaken. This issue is relevant to the debates about the extent of spillovers between agriculture and other sectors of the economy and consequently to the level of public support for rural research. The expectation of greater spillovers from basic research activities provides a stronger rationale for public funding these activities compared with more applied research. One objective of the RDC model was to give producers greater influence on the nature of research undertaken.

The ABS provides a breakdown of agricultural R&D spending into four categories: pure basic, strategic basic, applied, and experimental development. Confining attention to general government rural research (excluding universities), the share of total rural research activities undertaken by government that was categorised as pure basic or strategic basic rural research has fallen from about 25% in 1981–82 to 15% in 1992–93. In their submission to the IC (p. 762 of the IC Final Report, 1995), the RDCs suggested that 11% and 27% of their expenditure supported basic and strategic research, with the remaining 62% going to applied research. This is a much larger share to basic and strategic research than the ABS estimate. Perhaps strategic research is not being defined in the same way. The concern with a trend of this nature is that, because RDCs in general only partly fund research undertaken in the public sector, they may be attracting public funds to activities more appropriately funded by themselves.

Rationale for Increased Public Support in the 1950s and 1960s

There appears no clear statement explaining why public support for agricultural research increased so strongly in the 1950s and 1960s relative to both the size of the agricultural sector and the growth in government spending in general. It is perhaps tempting to see growth in the Departments and CSIRO as an example of successful rent-seeking by the agricultural sector. However, few research and extension programs administered by State Departments had the political profiles of rural adjustment and finance schemes, statutory marketing issues, and inputs subsidy schemes, presumably because their impact of farm profitability was less direct.

Alternatively the authors have tried to infer why support grew from general policies toward the rural sector, from science policy and from views about the role of government at that time. Some appreciation of the issues can be gained from the Report of the Committee of Economic Enquiry (1965) (the Vernon Report). While declining, the rural sector was still a much larger part of the economy than it is now. The value of rural production as a proportion of GNP had declined from 21.3% in 1948–49 to 12.6% in 1961–62, while the share of rural exports in merchandise exports declined only from 86% to 77% in the same years. Rural exports made an important contribution to financing the high level of imports required for economic growth. The Vernon Report (p. 157), quoting a speech by the Federal Minister of Commerce and Agriculture in 1952, noted that an expansionist farm policy still in place when the Vernon Report was written was also based on concerns about defence requirements, food security and the dollar problem. The Report noted that an expansion of research programs was one of several measures used to achieve these policy ends.

With respect to research policy, the Vernon Report noted that 'the relationship between research and development and the growth of productivity was self-evident (p. 418), and that Australia imported much new technology embodied in inputs. It argued for an increase in Australian R&D. With respect to rural research, the Report noted that 'Australia spends about three times as high a proportion of its GNP on research in primary industry as does the United States. Since the primary industry contribution to GNP in Australia is about three times as great as in the United States, it appears that Australian research in primary industry is roughly comparable in scale with that in the

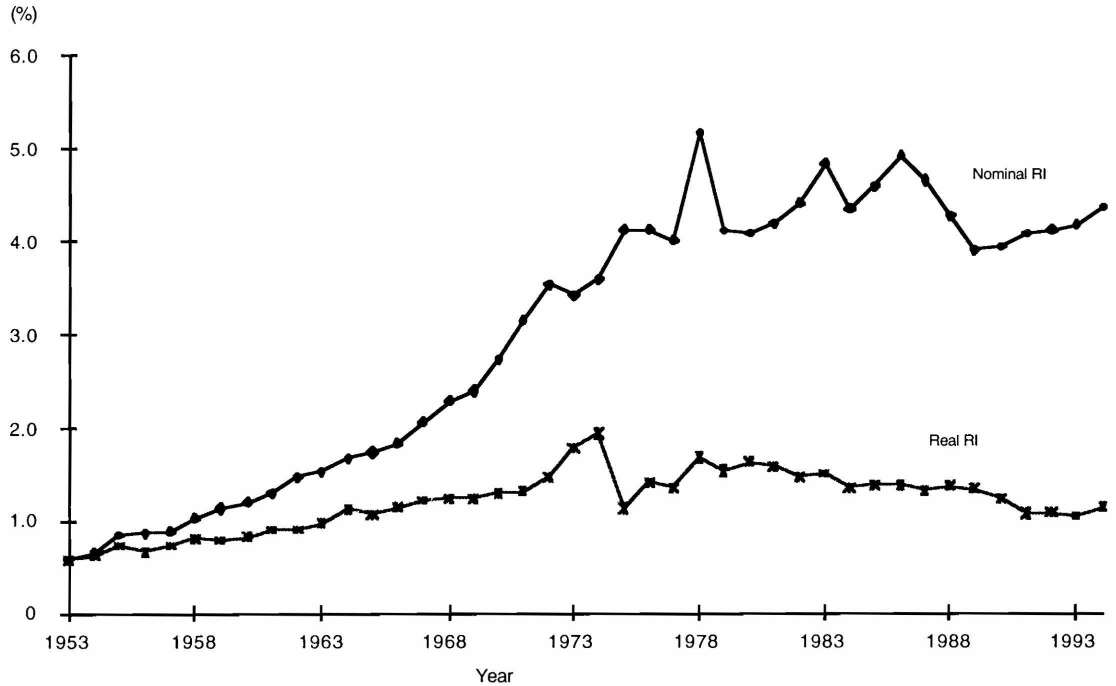

Figure 4. Nominal and real research intensities for Australia.

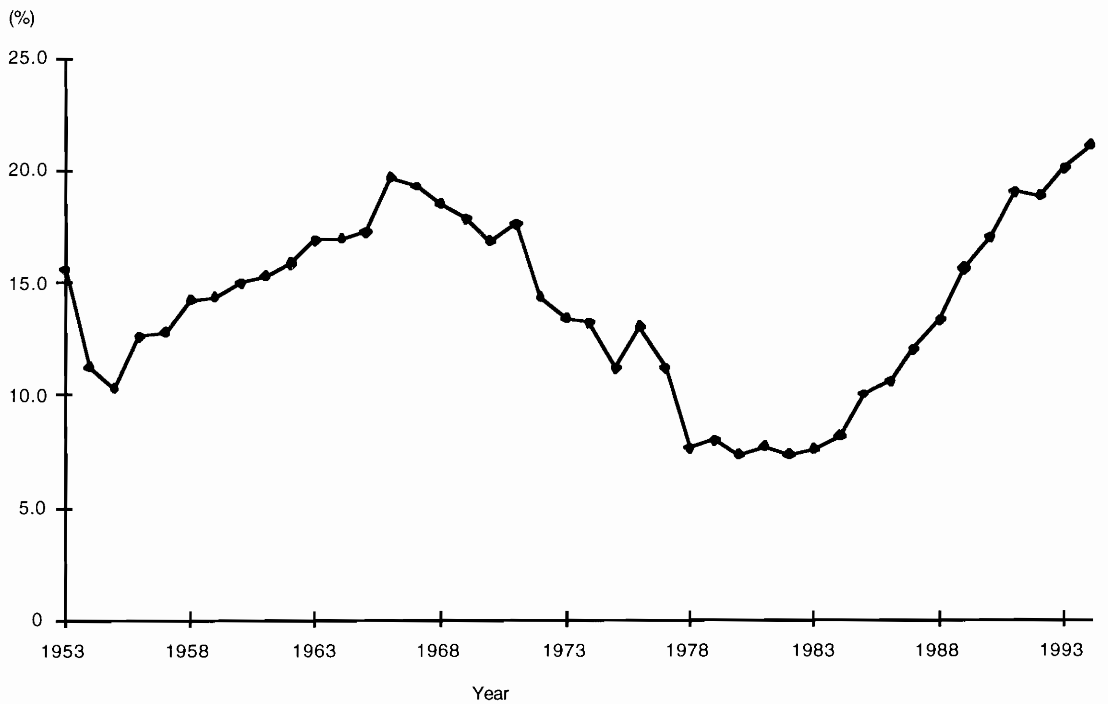

Figure 5. RDC contribution to all institutions (excluding QDPI).

United States' (p. 424). At that time about 35% of public research funds went to primary industries, and this probably amounted to about 25% of all research expenditure.

There was no direct discussion of the roles of the public and private sectors in financing rural research. The tenor of the Vernon Report suggested acceptance of the view that rural research should be funded largely by the public sector, perhaps reflecting a view that it was appropriate for governments to make science and technology investments that would increase productivity and add to wealth.[8]

This central role of government also seemed to be accepted by Donaldson (1964), who reviewed the use of levies on producers to fund research. He argued for continuing public funding on the grounds that consumers benefited from rural research in the form of lower prices. This rationale for public funding is broader than that enunciated in more recent reviews of the role of government in agricultural research, such as that by the Industry Commission. In particular Donaldson has overlooked the fact that producers and consumers share not only the benefits from research but also the incidence of levies imposed to fund research, and hence levies ameliorate the 'free-rider' problem.

Conclusion

This paper reports trends in financing rural research in Australia from 1953 to 1994 using a data set assembled by the authors and the more limited ABS data set. In nominal terms, the authors estimated that expenditure on rural research in public institutions rose from about $9 million in 1953 to about $530 million in 1994. ABS data suggested that expenditure by the private sector had increased to 10% of total expenditure on agricultural research by the end of the period. CSIRO is the largest single agricultural research body in Australia. As a group the State Departments of Agriculture account for the largest share of expenditure on agricultural research. Universities make a relatively small contribution to agricultural research and rely heavily on external grants for funding. The RDCs were contributing about 20% of research expenditure for those institutions for which data were available, and at least half of this contribution was publicly funded.

Several measures of the real increase in resources used in agricultural research were presented. In constant dollar terms, public expenditure rose from $9 million in 1953 to $40 million in 1994, displaying little growth since the late 1970s. Real agricultural research intensity (GDP-based) increased from 0.6% in 1953 to 1.1% in 1994 after a peak of 1.9% in 1974. This suggests that public sector support for rural research, after increasing significantly during the 1950s and 1960s, has been drifting down since the early 1970s. Despite this gradual decline in support, real research intensity has increased by a factor of nearly two since 1953. This increase cannot be explained either by the increased support from RDCs or by a general increase in the size of government in the economy. Perhaps it reflects a widespread perception that agricultural research was a good investment at a time when a broader role for the public sector in the economy was accepted and agriculture was a much larger sector within the national economy.

Relative to other 'rich' countries, public sector support for agricultural research in Australia is large and the private sector rural research industry is small. This raises the question of whether the public sector has 'crowded out' the private sector. It is not an easy question to resolve. Much production research is focused on 'industry' rather than 'public' goods, the implication here being that special institutional arrangements such as RDCs are required to overcome the 'free-rider' problem. In Australia this research has been undertaken in public research institutions with RDC support, but other arrangements more closely aligned with the private sector are conceivable. On the other hand, the Australian agricultural sector is smaller than that of other rich countries and hence the private sector is unlikely to invest in research here that could be more efficiently done in larger agricultural sectors and imported embodied in purchased inputs such as chemicals.

One theme for this workshop centres on trends in the demand for the economic evaluation of research. The data base reported here was assembled in response to the need for evaluation of investment in R&D at a highly aggregate level. The results of this work and discussion of future directions for evaluation at this aggregate level can be found in Mullen and Cox (1995), who estimated that the returns from investment in research in broadacre agriculture over 1953 to 1988 may have been in the order of 15–40%. In the context of this workshop, it is interesting to note that estimates of returns from research at an aggregate level are often lower than the rates of return estimated in many analyses of individual research projects. This divergence can be partly

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[8] Perhaps reflecting what Nelson (1991) has termed the 'progressive gospel of efficiency', a philosophy for the advancement of society that had wide currency in democracies such as America earlier this century.

explained by the selection of successful projects for evaluation, but another factor is likely to be the difficulty of identifying the unique contribution of a particular project from the contribution of other related research.

With respect to the evaluation of research investments at project or program level, the data sets presented above can be used to make a few subjective assessments. On the demand side, increasing funding by the RDCs means that an increasing proportion of the research portfolio is likely to be subject to some form of economic evaluation. This is because an increasing number of RDCs are asking for benefit–cost analyses of projects submitted for funding as a means of satisfying their statutory requirement to use funds in an accountable fashion. It is also likely that central financial agencies such as Treasury Departments will require great accountability by Departments of Agriculture for the ways in which they use public funds. Hence there is renewed interest in measuring productivity growth both within agencies and in the industries they service, and incorporating this growth in a benefit–cost framework. As economists, we would hope that the value of these tools to efficient resource allocation will become a more important rationale for their use than accountability requirements

On the supply side, evidence that the research portfolio is becoming more applied in nature, partly in response to the influence of the RDCs, seems to suggest that the 'cost' of evaluating projects is falling. This observation is based on the presumption that applied research is more easily evaluated than basic research. The focus of applied research is often a particular technology in a particular industry. Hence it is relatively straightforward to estimate the reduction in per-unit costs and 'spillovers' to other sectors of the economy are not usually significant. Offsetting this is an increasing interest in public research institutions in measuring and changing the environmental consequences of agricultural technologies. Empirical evidence of this trend is still limited by the way in which research expenditure data are reported.[9] There is also interest in identifying and measuring the benefits of rural research that spillover to the wider community. Both environmental and spillover goods involve valuing changes in goods unlikely to be priced in a market, hence benefit–cost analyses of research involving such goods are likely to be quite complex.

[9] One of the SEO (socioeconomic objective) categories in ABS data is Environment but it is not cross-classified with the agricultural sector. CSIRO now reports a category called 'Environmental aspects of economic development' by plant and animal production.

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The Industry Commission's Inquiry into R&D in Australia: Outcomes and Implications for Research Evaluation Activities

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Abstract

This paper uses the guidelines for research policy design developed by the Industry Commission to categorise its policy recommendations. The foci of these changes are highlighted and the recommendations that have implications for research evaluation activities determined. Government responses to the IC recommendations are also reviewed from a research evaluation perspective. The trends evident from this review are then used to suggest areas where a group such as REGAE may be able to make a broader contribution to research policy in the longer term.

THE report by the Industry Commission (IC) on Research and Development (R&D) policy in Australia is a comprehensive set of documents. This paper does not aim to review all aspects of R&D considered by the IC. Rather, its primary focus is to address the issue of whether the potential research policy changes which may stem from the IC inquiry are likely to result in changed demands for quantitative research evaluation efforts. And is the current set of methodology used for research impact evaluation sufficient to meet these demands, or are further refinements and developments required?

The paper attempts to provide a condensed summary of the policy changes recommended by the IC and the response by government to these recommendations. It uses this summary to highlight areas of the IC assessment and government response likely to result in increased or decreased interest in formal research evaluation activities, and therefore what role such a group as REGAE might play in this process.

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An Overview of the Industry Commission's Draft and Final Reports

Background to the Industry Commission Inquiry

In May 1994 the Government referred to the Industry Commission the issue of 'research and development undertaken by industry, government agencies and higher education institutions'. The IC was asked to 'examine and report on:

- the effect of research and development activities on innovation in Australia and its impact on economic growth and industry competitiveness; and
- the efficiency and effectiveness of policies and programs which influence research and development and innovation in Australia' (Industry Commission 1995, p. xiii).

The IC had 18 months to consider these issues. It received a large number of public submissions, held meetings with a large range of groups, held a set of public hearings and seminars and prepared a Draft Report by December 1994 (Industry Commission 1994). After further public consultations the Final Report was released in May 1995 (Industry Commission 1995).

The Inquiry covered all aspects of R&D in Australia and all sectors, not just rural industries. As the IC indicated, it did '... not attempt to provide answers to questions about the "correct" magnitude and composition of R&D. Rather, it ... focused on the importance of getting the processes and incentives for R&D right, in the belief that this should allow appropriate outcomes to emerge from the system'. The IC provided a detailed background of R&D in Australia and summarised much of the expenditure patterns and relativities and the structure of the current research system. Although many important issues are raised by these comparisons, they are not discussed here. Two aspects are briefly summarised: the set of guidelines for policy design developed, and IC recommendations for policy change.

An overview of IC suggested R&D policy design guidelines

One important issue to which the IC gave considerable attention was development of a list of broad guidelines for R&D policy design. These are worth repeating as they are used later to summarise IC policy recommendations, and bear relevance to the focus of this workshop. After detailed consideration of theoretical developments and implications and the experience of governments both in Australia and overseas, the IC suggested the following guidelines for policy design:

(i) *Diversity should be encouraged.* Given the uncertainties and information problems, a combination of interventions is desirable, as well as a choice of funders and research performing institutions.

(ii) *Private incentives should be built on where possible.* Much R&D would be done by firms in the absence of any government assistance or involvement. R&D that users initiate themselves is likely to best meet their needs. Government action which promotes user-driven research can therefore be an effective form of intervention.

(iii) *Assistance schemes should be simple and transparent, with well-defined criteria.* Lack of information and uncertainty about the likely social benefits from alternative projects greatly limit any potential pay-off to administrative discretion in supporting private R&D. Selective assistance schemes with vague rules also encourage firms to 'position' themselves for support and can be costly to administer.

(iv) *Assistance levels should be broadly consistent.* Where assistance is provided with similar expectations of social benefits, it should be provided at comparable rates, and 'double-dipping' should be avoided.

(v) *Research should be monitored and evaluated.* To justify support, research needs to produce benefits. Some benefits are hard to measure, but where practicable, evaluation can help ensure that funding goes to the right projects for the right reasons. Objectives need to be specified beforehand, and evaluation should not be limited to successful projects.

(vi) *'Contestability' should have a major role in research funding.* In many areas of research there is scope and potential for a range of providers to do the work. Funding mechanisms which can target the researchers and organisations that produce the best, most cost-effective research have obvious attractions.

(vii) *Government's roles in sponsoring R&D should be clear and its requirements clearly articulated.* Governments are responsible for three different tasks when sponsoring R&D: one is to determine priorities, a second is to choose particular research projects and the third is to perform and disseminate the research. Each task can require different skills and perspectives, but these roles are often intermingled. There can be benefits in government clarifying and in some cases separating their roles in the range of activities for which they are responsible'. (Industry Commission 1995, p. 11)

These guidelines were developed during the preparation of the Draft Report and were not changed as a result of the subsequent public consultation process in the Final Report. This suggests that very few in the R&D community saw reason to suggest or argued strongly for significant changes in these principles.

Of these seven principles, three include suggestions which have potential implications for those involved in formal research evaluation activities. That with the clearest implications is guideline (v), 'R&D should be monitored and evaluated'. The IC concluded that consistent and regular evaluation of the impact of research is the only effective way for governments to be sure that R&D policies are achieving efficient resource allocation. In particular the IC suggested that it is the only way to ensure that funding is going to the correct projects or research areas. For this evaluation to be fully effective the Commission emphasised the importance of having the objectives of research clearly defined, and of these objectives being relatively simple. The IC especially emphasised the importance of evaluating the impact of not just successful projects. It did not clearly recommend that all projects should be evaluated; however, the discussion in places suggests that it believes at least a major share is necessary.

During discussions of guideline (iii), that 'assistance schemes should be simple and transparent', the IC suggested that a lack of consistent and clear information on the social benefits of research limits the scope for governments to provide discretionary support to private R&D. Evaluation activities can provide this information. The first challenge is to be able to estimate the full social welfare gains from the research. As has been highlighted in the recent literature, a reasonably extensive set of methodology has been developed to measure these total welfare impacts. Alston and colleagues (1995) provide a good summary and more recently there have been attempts to measure empirically such effects of research as health and environmental impacts (see for example, Lubulwa et al. 1995; Lubulwa 1996).

Despite these developments, one issue not given much empirical attention in the theoretical literature and applications is the ability to identify the share of research benefits that is appropriable versus that which is non-appropriable by those who undertake the initial research. This is the second challenge. The IC used the term 'spillovers' to describe this area. It defined spillovers as '... any unpaid benefit (or uncompensated cost) from R&D that flows to individuals or organisations other than those undertaking the R&D. It is the difference between the private and social returns to R&D' (Industry Commission 1995, p. 5). The term 'spillovers from research' has been used in the research evaluation literature for some time. However, it has not been used in quite the narrower IC sense. Alston and colleagues (1995, 343–349) provide a recent general discussion. Davis (1991) provided a more detailed review of this area and suggested a modelling process for empirically estimating spillovers in the agricultural sector based on the notion of production environments. These discussions and the empirical work summarised uses spillovers to refer to the general concept of applicability of research results over a range of conditions. It has not focused specifically on the issue of whether this applicability has or has not appropriateness dimensions. This is the real empirical challenge. During its inquiry the IC undertook a major econometric study which attempted to establish the relationship between R&D expenditure and changes in productivity. This included an econometric assessment of the spillover effects of research between countries and within Australia. As has been the case with most of these types of econometric studies, aggregation problems and general inadequacy of the available data leave the results in a reasonable state of uncertainty. There is still a considerable way to go in this area.

Finally, guideline (vii), 'the government's role ... should be clear and clearly articulated' highlights, among other things, the need for governments, when supporting public R&D, clearly to identify priorities. Priority-setting is a very broad area and covers many issues at a range of levels of decision-making. There is probably a need to develop a much clearer perspective regarding its scope and nature. However, an important issue for those involved in research evaluation is what the potential role for using research impact assessment methods and results to support this priority-setting process is. As discussed later, the IC gave this point some consideration (Industry Commission 1995, 871–893). Several books produced recently consider this issue in more detail, including Alston et al. (1995) and Davis and Ryan (forthcoming). The IC had access to earlier papers upon which these were based but probably not the final versions. In the Report, however, it seems not to have given all aspects of this area full consideration.

Although the IC spent considerable effort developing the policy guidelines in the remainder of the report, and especially in the recommendations, the links back to these guidelines seem unclear. The remainder of this section uses the guidelines to summarise the IC recommendations, and based on these groupings, highlights the sets of recommendations likely to have implications for research evaluation activities.

IC recommendations for policy change

The sheer volume of the IC Report makes it difficult to summarise effectively. The briefest overview has been provided by the IC itself, when it stated that its

'Key policy proposals include:

- CSIRO — a need for wider community influence on its priorities and a greater role for government in monitoring its performance;
- the universities — an enhanced role for the ARC in funding according to performance;
- business — more widespread R&D support for smaller companies unable to use tax concessions;
- the rural sector — changes to enhance the role of the RDCs in rural research.' (Industry Commission 1995, p. 1)

While this brief summary highlights the broad areas of focus of the recommendations it hides the fact that the Final Report contains a substantial number of recommendations. They are not always clearly identified, and in fact are often mixed in a range of statements or conclusions. The IC detailed summary identifies 39 recommendations/statements. However, in the body of the Report there are more. The Government in its response to the Report identified 51 recommendations to which it responded.

Here, the authors try to condense these into a more manageable format to facilitate discussion, using the six 'research sectors' adopted in the IC's summary section, namely: government research agencies, university and related research, business R&D, rural research, linkage mechanisms (Cooperative Research Centres) (CRCs) and national priorities. Within these the 'government research agencies' sector has been limited by the IC primarily to Commonwealth Government areas of responsibility. In fact, most IC attention focused on the largest Commonwealth-funded research institution, CSIRO. The authors separate CSIRO recommendations from others. The IC did make some recommendations regarding State research institutions, limited to the State Departments of Agriculture and considered under 'rural research'. In addition to adopting the six mentioned research sectors the authors refer to the 51 recommendations identified by the Government (a very brief summary of these is provided in the Appendix). In doing so the hope is not to have omitted some recommendations which the Government found difficult to respond to and therefore chose to ignore.

The use of the policy guideline and research sector classification of the 51 recommendations enables a very broad overview of the IC Inquiry. Table 1 provides this summary, and the Appendix provides a breakdown of this information using the recommendation numbers allocated by the Government in its response. A reasonable degree of care is required in drawing conclusions from this simple count of recommendations, since it does not reflect the relative importance of any one recommendation. However, the count does to some degree reflect the relative IC attention to particular areas and therefore reflects to this degree the need it saw for possible policy change.

At research sector level universities, rural research and CSIRO received the major change focus. Interestingly, although the IC placed considerable attention during the Inquiry and in the Final Report on the importance and need for national priorities, it made no recommendations for change in this area, although in the body of the report there are suggestions for changes.

Assistance consistency (13) and research monitoring and evaluation (11) received most attention in terms of the research policy guidelines. Relatively few suggestions for change were made in the diversity encouragement, transparency and contestability areas. These are probably policy areas which, if emphasised, would suggest that the IC believed more major policy changes were required. Assistance consistency is more likely to be an area reflecting fine tuning than major changes. Monitoring and evaluation recommendations are most likely to reflect concern about a lack of information regarding effectiveness and impact rather than areas indicating the need for major policy change. For a reasonable share (7) of the recommendations, the authors had difficulty determining which policy guideline was relevant.

If the breakdown of recommendations within research sectors is considered, differences in policy guideline area emphasis are evident. For government agencies, especially CSIRO, emphasis was clearly on the need to clarify the role of government and increase its input as well as increase evaluation, reflecting concern that insufficient information is available. This lack of consistent and detailed information could be at least one reason why more significant policy changes were not recommended. It is difficult to expect that, without this information, the IC would in a position to conclude that current arrangements are the most effective policies available.

Table 1. Summary of the number of IC recommendations by policy guidelines and research sector focus.

Policy guidelines	Government agencies		University and related	Business R&D	Rural research	Linkages	National priorities	Total
	CSIRO	Other						
Diversity encouraged		1	1					2
Build on private incentives	1	1	1	2	1*			6
Assistance simple and transparent			1	1	1			3
Assistance consistent			3	6	4			13
Research monitored and evaluated	4		1		3*	3		11
Contestability			2			1		3
Government role and requirements clear	3		2		1	1		7
Other/not clear	2		2		2	1		7
Total	10	2	13	9	12*	6	0	52*

*Recommendation 36 has been included under two different policy guidelines — the total is therefore 52, rather than 51 as stated in the text.

Table 2. IC recommendations likely to have implications for research evaluation activities.

Monitoring and evaluation	
CSIRO	
5	Evaluations include unsuccessful and prematurely terminated projects.
9	Resource agreements and performance indicators with Government departments.
10	Create an independent agency to monitor and evaluate research impacts.
University and related	
22	All funding programs should be reviewed periodically.
Rural research	
29	Rigorous and comprehensive *ex post* evaluations to guide future research.
30	Regular reviews of ways RDCs report to levy payers.
36	States to separate research as corporations, and undertake explicit priority-setting and impact evaluation.
Linkage mechanisms	
50	Evaluate public-good component, especially for public funds share.
51	Evaluate in terms of opportunity costs of other types of funding.
Clearer Government role (priority-setting)	
CSIRO	
1	CSIRO to fund public-good research and widely disseminate it.
6	Government needs to exert more influence over CSIRO's allocations.
7	Annual forum for government to provide priorities for public-good research.
University and related	
16	Criterion for allocating basic research funds to be international excellence.
19	ARC identify transparent priorities and allocate on basis of excellence.
Rural research	
35	State departments should fully cost, unless additional social benefits identified.

Recommendations for the university and related sector were much more evenly spread between the policy guideline areas. The IC concluded that scientific excellence was an appropriate allocation criterion for university research because of its link to teaching and education. Perhaps this explains why its recommendations focused less on clarifying the role of government and the need for improved evaluation and more on suggesting a wider range of changes in all policy guideline areas.

The focus for suggested changes in the business sector was much narrower. All recommendations were for building on private incentives and associated simplicity, transparency and consistency areas. This suggests that the IC is indicating that the role of government is clear — to build on private incentives — and it is then necessary only to refine some aspects of existing policies.

The RDC structure for the rural research sector was accepted as an important intervention policy for rural research. The majority of recommendations represented fine tuning of this system. The always controversial issue of the level of matching government funding was the focus of one recommendation. The need for more rigorous and extensive impact evaluation was raised. Interestingly, under rural research the IC raised the issue of State government funding and included two recommendations for policy changes in this area. It did not include recommendations at this State level for the other sectors.

The majority of IC recommendations for the 'linkage sector' related to suggestions for refinement to the review processes for the CRC initiative which is a relatively recent development. It is only during the last year or so that the first of these CRCs has been operating long enough to produce observable results. Only a few reviews have been conducted and the process is still evolving.

During discussion of IC policy guidelines, it was concluded that those most likely to require support from systematic research evaluation efforts are monitoring and evaluation, and transparency and clarification of the government's role (priority-setting). As highlighted in Table 1, 21 recommendations related to these three policy guidelines. Not all are likely to have implications for quantitative evaluation; however, based on our assessment, 15 could be relevant. Table 2 provides a summary of these under the policy guideline headings.

Based on this assessment there were no 'assistance simplicity and transparency' recommendations that seem to have direct implications for evaluation activities. Several themes can be identified, including:

(i) the IC found a need for increased project/program-level quantification of research benefits as current information is far from complete, especially for unsuccessful and less successful projects;

(ii) there is a need for an independent group to provide much of this evaluation information;
(iii) it is very important to be able to identify separately social and private benefits from research;
(iv) there is an important need for more integrated priority-setting activities that are transparent and public.

As discussed in the first part of this section, the methods and efforts of groups such as those represented at this workshop have potential to contribute significantly in these areas.

The next section considers the Government's response to the IC recommendations.

The Government's Response to the Industry Commission's R&D Report

In December 1995 the Government launched its 'Innovate Australia' policy statement (Australian Government 1995). Attached to the statement was a comprehensive set of press releases, among them a set of responses by the Government to the IC's R&D Report recommendations. A condensed list is presented in the Appendix, and is used to develop Table 3, which provides a very aggregated summary of the percentages of recommendations agreed to by the Government.

Overall, the Government agreed with about 70% of the IC recommendations. Within research sectors, there was considerable variability in this agreement. For example, for the university and business sectors agreement was about 50%, while in the linkages area the government agreed with all recommendations. Clearly, as stated above, these trends based just on numbers have to be treated with caution — it could be that the most important recommendations were among the 30% the Government disagreed with or deferred decisions on.

Again, in policy guideline areas there was considerable variability. Only 33% of the 'assistance simple and transparent' area was accepted, while all the 'contestability' recommendations were. The two most important areas for research evaluation received over 70% agreement to changes.

If the 15 recommendations identified in the previous section as most likely to have implications for research evaluation activities are considered, nine of the 15, or 60%, were agreed to by the government. Of the other six, two were recommendations relating to State Government agricultural research, and the Government deferred these decisions to the States. Since it agreed to similar recommendations in other areas, it would be likely to agree with these. Of the remaining four recommendations, the Government disagreed with two, for the rest it deferred its decisions. These two were the suggestion that an independent agency for monitoring and evaluation of public-sector funded (CSIRO) research be established (recommendation 10). The Government did not agree that this was necessary as it felt that CSIRO already had extensive reporting and evaluation activities. In addition it suggested that the need for increased demand for benefit–cost studies of all types of research would be covered by its response to recommendation 5. There it indicated that CSIRO and the Bureau of Industry Economics (BIE) would consult to address this lack of full coverage on the evaluation front.

Table 3. Summary of Government's response to IC recommendations by policy guidelines and research sector focus (percentage agreed to as opposed to disagreed or decision deferred).

Policy guidelines	Government agencies		University and related	Business R&D	Rural research	Linkages	National priorities	Total
	CSIRO	Other						
Diversity encouraged		100 (1)	0 (1)					50 (2)
Build on private incentives	100 (1)	100 (1)	100 (1)	100 (2)	0 (1)			83 (6)
Assistance simple and transparent			0 (1)	0 (1)	100 (1)			33 (3)
Assistance consistent			67 (3)	50 (6)	75 (4)			62 (13)
Research monitored and evaluated	75 (4)		0 (1)		67 (3)	100 (3)		73 (11)
Contestability			100 (2)			100 (1)		100 (3)
Government role and requirements clear	100 (3)		50 (2)		0 (1)	100 (1)		72 (7)
Other/not clear	50 (2)		50 (2)		50 (2)	100 (1)		58 (7)
Total	80 (10)	100 (2)	54 (13)	56 (9)	64 (12)	100 (6)	0	69 (52)

Note: Numbers in brackets represent the number of recommendations in this group. This is the same as in Table 1.

The other recommendation (16) with which the Government disagreed was that international excellence be the allocation objective for basic university research. The Government felt that the inclusion of tangible benefits to the community should be an important allocation factor. For those involved in evaluation activity, this difference of opinion perhaps suggests that better methods for evaluation of fundamental research are important.

In summary, based on Government response, four of the five themes identified in the previous section are still likely to be applicable. Creation of an independent agency for research evaluation and monitoring (theme (ii)) was rejected. On the other hand, the disagreement between the IC and Government on the appropriate criteria for allocation of funds to university basic research suggests that more attention to methodology development for, and empirical attempts at, evaluation of the impact of basic research could be an important area for evaluation attention.

Conclusions: Implications for Research Evaluation Activity

Brief overview

One of the important conclusions of the IC Final Report was 'The uncertainty and lack of information about the outcomes of government intervention means that a robust policy for R&D must involve a combination of approaches. Measures that are introduced need to be recognised as experimental in the first instance and designed and reviewed accordingly' (Industry Commission 1995, p. 10). Many might feel that this is a weak conclusion and thus sets the scene for very vague policy change recommendations. This paper does not attempt to debate this type of issue. However, from a practical research evaluation group point of view, this clearly suggests that still considerable effort is required before a minimal (necessary) level of systematic, consistent and reliable information about the impact of (public sector) research is available. To be effective, these impact evaluations also need to cover a wide range of research areas and types of research interventions.

In its response to the IC Report the Government accepted in principle many IC recommendations for increased research evaluation activities. However, in most cases this acceptance has been with very few concrete initiatives to set a strong path for filling the gaps in information the IC found. Interestingly, these gaps were also identified in the earlier IAC Agricultural R&D Inquiry (Industries Assistance Commission 1976). In that Inquiry, the IAC undertook one of the first major comprehensive project-level evaluations of a research group in the agricultural area. It did not attempt this in the recent Inquiry, but instead opted to undertake an aggregative econometric analysis of research expenditure impacts on productivity analysis. One is, therefore, left wondering whether this gap will be filled by the time of the next major review. The Government rejected the recommendation for an independent monitoring and review institution for CSIRO and instead decided to leave the issue of more comprehensive evaluation of both successful and unsuccessful projects to negotiation between CSIRO and the BIE.

In an appendix the IC summarised the available empirical research evaluation information. However, its coverage was far from complete, especially in the project-level evaluation area. There are significantly more evaluations than were identified. In addition it is important to develop a basis for their classification and to provide an assessment of comparability.

Priority-setting was the other area that received important consideration. However, the IC made no firm recommendations in this area.

Some possible implications for REGAE

This brief review of the IC Inquiry into R&D policy in Australia and the Government's response suggest a few possible roles for a group such as REGAE. These possibilities can be summarised.

Co-ordination of empirical evaluation efforts

- Encourage and support the establishment of data bases of research evaluation studies and results which are regularly updated. Given IC difficulty in assembling a complete set of research evaluation study results this could be an important function. Regular updating and publication of this type of information could encourage further studies and especially identify where gaps might exist. In the longer term, this type of information would provide a base for analyses that could begin to identify so-called research production functions.
- Develop guidelines for ensuring that evaluations are consistent and therefore the results reasonably comparable. Activities such as the second workshop session are a good step in this direction.
- Support an activity which looks more closely at the issue of priority-setting in research, especially the desirability and feasibility of incorporating

formal research evaluation methods and analytical results in priority-setting activities. An important first step could be to expand the review of the current status of this type of activity in Australia and New Zealand, and to look at experiences overseas.
- Develop interaction between the agricultural and other sectors on methods and approaches, especially since the Government has suggested that BIE be responsible for this evaluation advice to, for example, CSIRO.

Possible areas for methodology development

- Further development of methods for evaluation of spillover effects (as defined by the IC and more broadly) from research have been highlighted. Especially important seems to be development of methods for identifying the difference between private or appropriable benefits and non-appropriable benefits.
- A related issue is evaluation of the benefits to what is often called 'basic research' (or knowledge generation). Based on the difference of option between the IC and Government in this area, it requires further consideration and possible methodology attention. Some theoretical aspects of knowledge generation and impact on the research production function have received limited attention. For example, Alston et al. (1995, 22–27) summarise briefly some of this work, and Bantilan and Davis (1991) link these developments to the probability of success of research. However, there is an important need to expand that work to an applied level. Further investigation of the possible impact via shifting the research production function and/or influencing the probability of success of future research seems required. All past empirical efforts, including IC analysis, has focused on the aggregated link between knowledge increments and total research expenditure. However, econometric estimation of these relationships has captured the aggregate impact of all types of research effort. These types of analyses are unable to separate the successful from the unsuccessful and whether the latter could have been avoided, nor what the relative impacts of basic research versus strategic and applied have been, and especially whether changes in focus of expenditure have had an effect. The implications of the IC Inquiry in this area reflect an important lack of concrete information on this type of impact. In discussing the university sector the IC recommended that the allocation criteria should be limited to 'excellence by international standards'. The Government, however, disagreed and said that it is appropriate that judgments be made based on potential to deliver tangible benefits to the community. More concrete empirical evaluation evidence seems the only long-term way to resolve this difference in judgment.

In conclusion, there are implications for research evaluation arising from the IC Report and the Government's response to it. REGAE members must be aware of these implications and prepare themselves to contribute the required solutions.

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Appendix

Summary of the Industry Commission's R&D Policy Recommendations

Government number	Brief recommendation features	Government decision
Government Agencies		
	CSIRO	
1	CSIRO to fund public-good research and widely disseminated	Agreed
2	Commercial exposure minimised — avoid joint equity projects	Agreed
3	Not contracts promising shared revenues from IPR	Disagreed
4	Full costing of externally initiated research	Agreed
5	Evaluations include unsuccessful and prematurely terminated projects	Agreed
6	Government needs to exert more influence over CSIRO's allocations	Agreed
7	Annual forum for government to provide priorities for public-good research	Agreed
8	CSIRO Advisory Committee — appointed by Board, advise public	Agreed
9	Resource agreements and performance indicators with government departments	Agreed
10	Create independent agency to monitor and evaluate impact	Disagreed
	Other agencies	
11	Greater contestability for DSTO-funded research	Agreed
12	External earnings requirement not appropriate for DSTO	Agreed
University and related		
13	Same funding arrangements for research as teaching	Agreed
14	Funding be competitive for all sectors if not tied to student numbers	Agreed
15	ARC to determine basis for allocation of research quantum funds	Disagreed
16	Criterion for allocating basic research funds be international excellence	Disagreed
17	ARC be given statutory independence and report direct to government	Disagreed
18	ARC receive increased autonomy distributing funds among programs	Agreed
19	ARC identify transparent priorities and allocate on basis of excellence	Agreed
20	Increased funds for ARC with expanded role	Disagreed
21	Full cost pricing of contracted research if funder has commercial interest	Agreed
22	All funding programs should be reviewed periodically	Deferred
23	Postgraduate scholarships should remain non-taxed	Agreed
24	Competitive funding for medical research via NHMRC to continue	Agreed
25	Transfer funds for John Curtin School of Medical Research to NHMRC	Deferred
Rural research		
26	Downstream processor in RDC levies if majority wish	Agreed
27	Flexibility retained of value or volume base for RDC levy	Agreed
28	RDCs free to determine what reserves	Agreed
29	Rigorous and comprehensive *ex post* evaluations to guide future research	Agreed
30	Regular reviews of ways RDCs report to levy payers	Agreed
31	$1 for $1 via RDCs up to 0.25 GVP then $1 for $2, no ceiling	Disagreed
32	Task Force to review appropriateness of government support for adoption, etc	Agreed
33	Expand RDC levies to include regional basis and focus	Agreed
34	Extension carried out with research. RDCs will be appropriate for this	Disagreed
35	State Departments should fully cost unless additional social benefits identified	Deferred
36	States to separate research as corporations, explicit priorities and evaluation	Deferred
Business R&D		
37	150% tax concession maintained not matched with other countries	Agreed
38	The 'contamination' provision of the tax concession should be revised	Disagreed
39	Syndication limited to losses from R&D expenditure	Disagreed
40	Syndication not by public or private tax exempt entities unless full risk	Agreed
41	Non-taxable grant for tax loss companies	Disagreed
42	Non-taxable competitive grants retained for projects with collaboration	Agreed
43	Continue competitive grants through criterion 9	Agreed
44	NPDP be terminated	Disagreed
45	Review Concessional Loans Scheme early as possible	Agreed
Linkage mechanisms		
46	CRC review process; compare without, how effective have these used private firms	Agreed
47	CRC review process: check degree of cross-subsidisation	Agreed
48	CRC review process: check extent of research integration	Agreed
49	Assess overlap and duplication in CRC system	Agreed
50	Evaluate public-good component especially for public funds share	Agreed
51	Evaluate in terms of opportunity costs of other types of funding	Agreed

Table A1. Summary of IC recommendations by policy guidelines and research sector focus (numbers represent recommendation number for the Government's response).

Policy guidelines	Government agencies		University and related	Business R&D	Rural research	Linkages	National priorities	Total
	CSIRO	Other						
Diversity encouraged		11	17					2
Build on private incentives	2	12	21	43, 45	36			6
Assistance simple and transparent			25	44	28			3
Assistance consistent			13, 15, 23	37, 38, 39, 40, 41, 42	26, 31, 32, 33			13
Research monitored and evaluated	5, 8, 9, 10		22		29, 30, 36	46, 50, 51		11
Contestability			14, 24			49		3
Government role and requirements clear	1, 6, 7		16, 19		35	47		7
Other/not clear	3, 4		18, 20		27, 34	48		7
Total	10	2	13	9	12	6	0	52

Public Funding of Agricultural R&D — Policy Trends and Implications for Research Evaluation

Denis Hussey*

Abstract

Changes to institutional arrangements and pressures on government expenditure have resulted in greater contestability and accountability in the processes for determining R&D funding. A major consequence has been the need for all participants to improve the information and analytical capabilities needed to demonstrate the merits of proposed R&D, particularly where it involves taxpayer funding to deliver asserted public benefits. The R&D policy environment will continue evolving in the same direction with greater focus on the justification — the market failure principle — for public funding. This has a number of implications for professionals in the 'evaluation industry'. Developing improved methodologies and answers is only one of the implications, and possibly not the most important.

EVALUATING the merits of R&D investments, especially the involuntary investments of taxpayers,[1] is a growth industry. A major influence on this growth has been the changing environment in which funding and investment decisions are made. Funds are tighter, contestability is increasing and those providing the funds are exercising more influence over how the money is spent.

The response has been much as would be expected — everyone with an interest in R&D has found it necessary to improve their information and analytical capabilities in order to gain funding, and demonstrate the relative merits of the R&D they either want done or want to do. Over the last decade in Australia there has been significant progress in the extent and sophistication of R&D evaluation methods and their application.

The causal link here would appear to be one where the evaluators — who more often than not have some fairly direct vested interest in funding levels and allocations — have found it necessary to respond to changes in the policy environment. The changing role of government, mainly a reflection of the continuing search for efficiency gains and solutions to 'fiscal shortages', has delivered policies which demand more clinical approaches for deciding how much public money to spend and where to spend it. Uncritical acceptance of the judgments of the scientific community is a thing of the past. However, it should be added that this type of expertise is still critically important to the new way of doing things.

There is every reason to expect policy on public R&D funding and delivery to continue evolving in the same direction and quite rapidly. This means the 'evaluation industry' will also be required to change and adapt. The interesting questions concern exactly how and with what purpose?

As already suggested, evaluation methodologies and activities appear largely to have evolved in response to the requirements of changing policies and institutional arrangements. Such a response possibly carries the risk that evaluators become too preoccupied with justification, and contribute less than they might to ensuring sound 'big picture' policy development in the future.

[1] Here the term 'taxpayers' includes those who pay so-called 'industry levies', since such levies are as involuntary as any other tax.

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Professionals in groups such as the Research Evaluation Group for Agricultural Economists (REGAE) have an important contribution to make towards the continuing development, from the national interest perspective, of better R&D policy. This may require some self-discipline, because becoming buried in methodological complexity and an ever-increasing volume of data can be an attractive comfort zone, particularly for those working in organisations that may consider further policy reform disadvantageous.

It is important and useful regularly to revisit some of the fundamental trends and principles underlying good R&D policy, particularly those that should guide public R&D funding and delivery. The purpose of this paper is briefly to recapitulate the trends and principles, set out some views on how they are likely to influence future policy and practice, and draw some implications for the R&D evaluation industry. The first two areas draw heavily on a paper ACIL prepared as a background document for an R&D strategy forum convened by the National Farmers' Federation in August 1995 (ACIL 1995).

The Changing Role of Government

The paper by Davis and Brennan (these Proceedings) examines the report of the Industry Commission's (IC) most recent R&D review, with particular emphasis on implications for R&D evaluation. As they note, it is a lengthy and detailed set of documents. This is probably as much an indicator of the political character of this area of policy as it is an indicator of the complexities involved.

As Davis and Brennan note, the IC gave considerable attention to developing guidelines for R&D policy design. While much of the report's content changed between the draft and final versions, the guidelines appeared fairly invariant.

Most of the guidelines are consistent with the premise that government involvement be the minimum and most cost-effective necessary to get the job done. In this respect they are consistent with the changing role seen for government in successful economies and in Australia.

The role of government in the economy is being re-engineered around the world. In Australia, the Hilmer review and the Commonwealth–State COAG agreements are key driving forces. R&D will be included because it is too important to leave out.

A reducing and redirecting of government involvement is occurring for fundamental reasons.

- First, a cyclical reversal is occurring in the extent of direct government involvement in the market, and in accepting responsibility for individual and group decisions.
- Second, people are growing weary of high taxes. They would like to keep more of the money, and they want governments to borrow less.
- Consequently, governments have to manage with less money.
- Finally, competition and markets are experiencing a renaissance. The emphasis is shifting to how governments can make markets work better, rather than supplanting them.

The trend toward 'smaller and redirected' government will not continue forever. However, for the purposes of R&D policy and evaluation, the current trend represents the 'foreseeable future'.

Integral to the reform process is renewed focus on appropriate policy principles. And their application is improving and extending. It is therefore important regularly to revisit the principles and their relevance to R&D policy and practice. It is easy to overlook or forget them when the focus is on methodological development and detailed evaluation of the particular.

Market Failure is the Key Premise

The principles underlying economic reform and the re-engineering of the role of government rest on the premise of market failure. Markets fail when benefits spill beyond the research originators and result in less than optimum R&D. Spillovers beyond individual businesses, but within an industry, are the justification for industry taxes. Spillovers to the wider community are justification for more extensive government involvement, including public funding.

The mere existence of spillovers is not enough. Government involvement and taxpayer funding are needed only when the spillovers mean R&D will not proceed because the originator cannot capture sufficient of the benefits. Often private R&D will occur even though others get some free benefits. Public benefits free-ride private investment throughout the economy.

Spillovers may justify government involvement, but there is still the issue of the best form of involvement. Justification for taxpayer funding does not necessarily mean the public sector has to be involved in delivery. It is important the two issues be treated separately.

The following is a simplified checklist for good policy design.

- Start by taking the competitive market as the default option — it works satisfactorily in most parts of the economy.
- Then ask if there is a *prima facie* case that the market is failing. Much market failure is more imagined than real.

- If there is failure, then examine its nature and cause.
- Next, and before anything else, see whether the cause can be treated directly. It is always better to fix causes than treat symptoms.
- Finally, if government involvement is the only way, make sure the most cost-effective option is chosen. And be careful not to replace market failure with even worse government failure.

Doing this is not easy, but decisions are going to be made. If nothing else, trying to do it correctly adds discipline and transparency to the judgmental process.

This approach to policy design, and particularly the use of the market failure premise, will be more correctly and more vigorously applied to R&D policy in the future. This will have significant implications for the levels of taxpayer funding, and for the structure and *modus operandi* of the research delivery system. The public sector's role is going to diminish as it is increasingly established and demonstrated that more competition and private investment can deliver public benefits at lower cost, and sometimes at no cost, to the general taxpayer.

Some Major Future Developments

The types of changes in Australia's R&D system suggested by the evolving policy environment and the principles are already well underway. They are the foundations for further change.

R&D expenditure as a proportion of gross domestic product (GDP) has grown faster in Australia in the early 1990s than in most other countries. The IC attributes this mainly to business R&D expenditure, which has been growing at 13% a year. An important influence has been the increased exposure of industry to international competition. Innovation is crucial to competitiveness, and firms innovate using their own money only when they have to.

The introduction of R&D corporations (RDCs) and cooperative research centres (CRCs) is also changing incentives and outcomes in agricultural R&D. It has taken only a few years for the RDCs to change culture and attitudes extensively.

Notwithstanding altruism, patriotism and professed commitment to principles, practically-oriented arguments about money usually head the list. Much of the policy debate, and much of the evaluation activity, is targeted at determining who benefits and who should pay. In particular, if a justification for taxpayer funding is being sought, then emphasis will inevitably be on demonstrating the public benefits. Why would someone seeking public funds go to the trouble of trying to establish the extent to which these could free-ride, or how the market failure could be corrected at source?

These aspects of R&D policy can be expanded by considering farmers and the role they play in the debate over, and analysis of, funding. Why would farmers, regardless of the market failure premise and policy principles, not want as much public funding as possible? It seems the expected thing for them to do — and they do.

Currently, the ratio of taxpayer funds to farmer levy (specific-purpose industry taxes) contributions suggests that farmers do 'pretty well'. It may be that the current ratio is about right. However, the correctness of the ratio is the not the issue to focus on. What is required is to look at the industry levy justification separately from the justification for public funds. There is a ratio, but its value is somewhat incidental.

Separating the two issues could bring advantages.

- First, it would break the nexus between levies and government funding, insofar as this link puts too much focus on how much taxpayer money levies can leverage.
- Second, having broken the nexus:
  - farmers would be more inclined correctly to assess what industry levy investment is justified, and to take even closer interest in how it is spent; and
  - processes for determining public funding would focus on the public benefits, particularly whether they can free-ride, or whether market failure can be corrected directly.

This would be an approach driven by the correct application of market failure principles, rather than debate over ratios where market failure tends to be used to rationalise a desired ratio. The justification for levies is spillovers within the industry. This justification has no relevance to what the public funding should be.

Public funding is justified where those wider spillovers dissuade the R&D from going ahead. However, before governments rush in with taxpayer funds based on estimates of public benefits used to justify such funding, more direct options which may cost the taxpayer less must be considered.

Treating the two components separately need not alter the way RDCs operate — they could still spend both components in an integrated fashion. However, it might help focus separately on the funding of institutions such as CSIRO, universities and State Departments of Agriculture, which are particularly big users of public funding.

Farmers may be better off in the longer term if they were less concerned about the quantum of public funds under the matching arrangements and kept the focus of industry RDCs on handling within-industry spillovers. They could then focus separately on ensuring appropriate public funding was directed to relevant basic research of value to all agriculture.

Whether or not levy-paying farmers come to this view remains to be seen. However, it is very likely that the policy influences and principles referred to earlier will result in farmer levy-payers having to contribute an increasing proportion of total funding.

As this happens, the incentives they face to ensure their collective investments are worthwhile and performing will sharpen. So too will their interest in opportunities for correcting market failure. The farming community, along with others, inevitably will want to look more intensely at ways of improving the market-based incentives for private investors to undertake R&D, and to embody the output in what they manufacture and sell.

Regardless of these types of developments, governments will continue to fund R&D where the market failure justification is strong and correcting market failure at source is difficult. However, there will be changes in this area, too, both in the direction of more rigorous application of the market failure principles to decide what research, and in the direction of more contestability to decide who does it.

As approaches for deciding what R&D is publicly funded change, this will, in turn, lead to changes in the structure and ownership of the research delivery system. As contestability increases, private providers will be more encouraged. Increased private provision, under contract, will increase the competitive pressures on public institutions. If public provision shrinks, private providers will be further encouraged by reduced crowding out.

With experience, governments will become more adventurous. Before long, extensive private provision, including by overseas providers, of publicly and levy funded R&D will become another 'ho-hum' issue. Public research facilities will not disappear because some will compete successfully, and it is strategically smart to have some.

Suggesting that such developments will occur often stirs concerns about the supply of R&D infrastructure and of skilled human resources. The underlying implication is that reduced public funding will result in both being in short supply. This is very unlikely.

Infrastructure is a means to an end. Getting the supply right should be driven by the demands from an increasingly contestable funding system. The worst approach is to have it supply-driven. The potential consequences are that supply does not match demand, some cost-effective opportunities are suppressed, and the existence of supply-driven infrastructure can overly influence research — a case of 'since it exists, it must be used'.

The widespread view seems to be that infrastructure — currently mainly public — is being run down. There has been some criticism of the RDCs for leveraging the infrastructure and not contributing enough to its renewal.

Their approach seems appropriate, given their role. Why would any 'business' pay more than it has to? If the RDCs cannot maintain the strategy because government funding is reduced, they will have to change tack. The skills they have shown to date will be used to spend just enough to maintain their supply base. This sort of demand-driven influence will spread as there is more contestability in other areas of funding. Funders will shop around for the best deals.

Private interest will come not just from firms that undertake R&D using their own infrastructure, but also from property investors seeing opportunities. If they can fund and own large retail and office complexes, then they can do the same with research facilities. Public providers could sell and lease back their facilities, releasing funds for more R&D or even expenditure savings.

Human capital is probably more important than infrastructure. Physical assets can be created faster than skilled human beings. However, the difference should not be overstated — there is an international pool of skills.

If too few are being trained, the cause will be found in the market for these skills. It is hard to avoid the conclusion that if Australia is short of people interested in science then it is because alternative careers look better. If this is the case, then the solution is fairly self-evident.

In agricultural R&D the RDCs have delivered considerable change to incentives and funding decision-making. The likely evolution of the RDC model and its implications is the final topic in this selective review of major future developments.

The RDC model has been a success when viewed as a stepping stone on the evolutionary path of R&D policy. It has established that the sky does not fall in when there is some competition, or when users and funders exert more influence. It has created confidence to press on with wider and more disciplined application of the principles.

What is now needed, and will emerge, is Mark II of the RDC model. What might constitute a new and progressive set of challenges to keep this organisational form at the leading edge of funding policy and practice?

The next logical step is to improve their understanding of, and focus on, the application of the market failure premise. The Kerin–Cook policy statement in 1989, which effectively launched the current crop of RDCs, was quite explicit in saying that market failure was the main rationale for corporations, industry levies and public funding.

If the RDCs can be criticised then it would be on the grounds that their adherence to the market failure premise has been, at best, patchy. Two main reasons for this can be identified.

First, the market failure justification given in the 1989 policy statement fails to appear explicitly from then on. The legislation is silent on this rationale, and reads more like a charter to plug gaps, pick winners, and generally do good works considered of benefit to levy payers and taxpayers. Naturally, the RDCs' mission statements and objectives reflect the legislation. There has been a tendency not to have priority-setting and funding primarily driven by the market failure premise, although it usually lurks as a justification when needed.

The second reason is that the model's incentives require regular demonstration of results. This usually means evidence of adoption. Research evaluators have been active in demonstrating the very good returns RDC funding delivers.

The demands of funders for 'demonstrable benefits' must place pressure on corporations to encourage adoption with, perhaps, reduced regard for the market failure premise. It is probably more than coincidence that as the corporations have matured, they have become increasingly involved in facilitating, kick-starting, launching, commercially joint-venturing and otherwise using their funds to increase the adoption of R&D.

The perceived need to do this is often the consequence of misdiagnosed market failure when deciding to fund the research. If a corporation sees an area where it thinks underinvestment is occurring — a gap or missed opportunity — and jumps in without adequately establishing that the market is really failing, then it increases the likelihood that adoption will be poor when the research is delivered.

If private investors have moved on because it was commercially unattractive — rather than because market failure prevented them capturing sufficient of the benefits — then 'unattractiveness' may also mean no commercial interest in adoption. Not interested, that is, unless someone helps them with a launch, kick-start or similar inducement — a subsidy, in the old language.

The likelihood of this happening would be reduced if legislation made the market failure premise more explicit as the main basis for funding decisions. This change would then flow through to RDC objectives, mission and funding criteria, and to the expertise necessary to diagnose failure. This is the main change required in developing the Mark II RDC model.

Implications for R&D Evaluation

It is fairly certain that the R&D policy environment will evolve in the directions and manners described. While those arguing professionally for these types of changes might be able to claim some responsibility, the main drivers will be the trend to smaller government, which will be around for some time yet, together with the squeeze on public funds relative to demands.

From an evaluation perspective this would seem to imply more of the same, and to an extent it probably does. It would seem probable that the demand for better and more defensible assessments increases as the competition for scarce public funds increases. But it also means other changes for at least some of those professionally involved in this area of work. The changes can be characterised as those that will occur and those one would like to see occur.

The development of evaluation methodologies and the steady growth in data and accumulating assessment results are the building blocks for continuous improvement in the bases for public funding decisions. Such a progression is a fairly natural path for professional analysts to take, and conveniently coincides with what is currently required by those determining the allocation of public funds.

However, a reasonable question to ask is how relatively important very sophisticated analysis might be in the future if public funding and public involvement become relatively less important. Given the extent of current public involvement, this possibility might seem rather remote and even fanciful. Unquestionably, there will always be public funding and the associated need to assess spillover benefits, set priorities for public funding, and evaluate outcomes. But, as private investment and delivery increases, the need to have detailed evaluations of public benefits to justify public funding should diminish. At least the resources devoted to it should diminish. And analysts will need to be more vigilant about over-engineering methodologies and spurious accuracy which may not be cost-effective.

Take the extreme example where all market failures have been removed. In these circumstances there is no need to worry a jot about evaluating public benefits. The nationally optimum R&D investment would be occurring under a structure of market incentives, and all the remaining spillovers would be free-ridden. The focus of R&D evaluation would then be very much from the commercial perspective. Will an R&D investment be judged to have sufficient prospects of being profitable to the private investor?

An agricultural chemical company, considering the development of an improved anthelmintic or herbicide to increase market share and profits, never stops to analyse the likely public benefits as part of its decision-making. That is, unless such analysis is going to be required to ensure it qualifies for some public funds on offer. As long as prospective profitability and risk are acceptable, the investment will proceed. In these circumstances a rational investor would not abandon the prospect just because there was going to be some free-riding.

While the notion of no market failure is extreme it does raise issues of some policy relevance. If the relative role of the public sector and public delivery decreases, then there would seem to be a *prima facie* case for reducing the resources devoted to public funding evaluation. It is important that resources devoted to this area of activity are commensurate with the size of what is at stake. The resources put into assessing an investment should bear some relationship to its relative importance. Is enough assessment being done on this front?

Perhaps a more practical and realistic question to draw from the above observations is what role professional evaluation should play in helping to deliver better R&D policies along the lines described. This is the area where one would like to see changes occur. It may, however, be a little difficult for some to embrace, because what is being suggested is that public analysts devote more attention to changes in policies, which will result in a diminished need for public analysis.

Some of the evaluations of public funding have produced quite large estimates of benefits and rates of return. Such estimates appear to provide compelling justification for public funding. In many instances they enticingly suggest that considerably more taxpayer money should be invested.

The point to make is that as well as using these estimates for justifying public funding, evaluation professionals should also use them as signposts for locating supposed market failure, and critically analysing its character and the prospects of doing something about it directly. In other words, the contribution of professional analysts should not be confined to analysis and measurement for justifying public funding. Their analysis should also contribute to examining critically the validity of market failure diagnoses, and developing policies which will reduce genuine market failures currently making taxpayer funding necessary.

When estimates of very large returns from public investment in R&D are seen, one cannot help but ask two separate but related questions. One is whether, in all instances, it really is market failure that has caused such an attractive investment not to occur — are we always sufficiently careful in our analysis to make sure we have not given an optimistic spin to an opportunity which was rejected by private investors because it was not profitable, rather than because of genuine market failure? I believe that is done more often than we care to admit.

The other question begged by high numbers relates to the diagnosis and correction of market failure. High returns in situations of genuine market failure would seem to indicate they are the areas where efforts to fix market failure at source should be concentrated. How frequently do evaluation professionals use them for this purpose, and get involved in the necessary analysis and policy design? Not frequently enough, I suggest.

Methodological improvement and continuing empirical enlightenment are important and worthy professional challenges. However, in making these contributions there is need to be conscious of our abilities and responsibilities for improving the policy environment through the use of this type of work. Too much focus on the 'justification' side of the business — particularly if it leads to producing spurious detail — will mean a policy contribution from our part of the profession that is below its potential.

One cannot help but be reminded of what the 'Modest Member' — Bert Kelly — once said in response to calls for even more measurement of the effects of tariffs, even though the case for their reduction had been well established. He said something along the following lines:

When one's foot is being crushed by a wagon wheel, there is little comfort in being told that someone is about to measure its weight more accurately.

Reference

ACIL 1995. Future directions in agricultural R&D policy and practice. Paper presented to a forum convened by the National Farmers' Federation to discuss a national strategy for agricultural research in Australia, Canberra, August 1995.

Workshop Summary and Implications

John P. Brennan* and Jeff Davis**

THE papers presented at the workshop provide a review of three main aspects of the application of research evaluation methods, namely: (a) use of research evaluation in Australia and New Zealand; (b) improving consistency in benefit–cost analyses across organisations; and (c) implications for research evaluation activities of new directions in research policy.

In the first session, the current status of the use of research evaluation in Australia and New Zealand was examined. It is apparent that the various research organisations in both countries have a range of levels of use for research evaluation. It remains unclear from the information presented whether formal research evaluation methods are used more by institutions undertaking the research than those providing funding for the research. It is also not clear what share of research funding is supported by these formal evaluations. The papers identified the need for further data before a clear picture of the use of research evaluation is defined.

There is clearly a broad range of research institutions in Australia. In addition to the rural research and development corporations, Commonwealth funding institutions such as the Australian Research Council, Department of Primary Industries and Energy, Department of Finance and Australian Centre for International Agricultural Research are also important. State funding institutions include Departments of Agriculture and State Treasuries, while the central administrations of the universities are also research funders. The research provider institutions include Commonwealth institutions such as CSIRO and the CRCs, State Departments of Agriculture, Conservation and Land Management, Forestry and Fisheries, universities and the private sector.

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In New Zealand, the institutional structure is distinct from that in Australia. The Foundation for Research, Science and Technology allocates funding for 'public good science', and the research providers are the (government-owned) Crown Research Institutes, universities and the private sector.

Several themes for further work emerged from the papers presented and the related discussions. The question was posed as to whether the economic evaluation of research and development has a benefit–cost ratio greater than unity. This is clearly an issue of which all involved must be conscious at all times.

To enable the use of research evaluation to be monitored, there is need to document the research evaluation activities carried out in each research organisation. It was proposed that a complete set of data on the current use of research evaluation in each organisation be compiled. In addition, it was evident that there were opportunities for increased coordination and cooperation between research organisations on the issue. A number of possible efficiency gains from increased coordination and communication were identified, both within groups of research funders and research providers, and between the funding and providing organisations. Funding organisations are driven by the increasing demands by government for accountability, but the issue is whether 'wall-to-wall' benefit–cost analyses provide appropriate measures of accountability. There is also a need for research managers and researchers themselves to be trained to recognise the value and the limitations of the results of benefit–cost analysis. There has been a trend to increasing quantity rather than quality in research evaluation in many research organisations, a trend which needs to be reassessed.

In the second session, consideration was given to the extent to which it is possible to develop consistent benefit–cost analysis across organisations, and to assessing progress made. The features of a range of software developed for research evaluation were compared. The simplified nature of many of the software packages, to enable them to handle the project-level evaluations required by many organisations, were highlighted. There was discussion of the value of the simplified models, and the need for a broader whole-farm and across-industry perspective in the approaches used for estimation of benefits. However, there was a trade-off between the detail of these software models and their ease of use. The development of software more closely related to the current theoretical framework was one area identified for further work. Overall, there was limited support for a single standard benefit–cost analysis package, but scope exists for some level of standardisation of features between current software.

In discussions on the development of guidelines for estimation of benefits, a number of issues were raised, in particular whether it was feasible or desirable to develop guidelines for estimating benefits. The key issue of agreement was that sharing and developing common data and having consistent methods of estimating on-costs, for example, were essential. Another key issue was the need to consider the technologies being evaluated in the context of the system in which they are produced (i.e., whole-farm effects), and their impacts on other parts of the system (across industries). Because different institutions use research evaluation analysis to support different types and levels of decision-making, general guidelines were generally not considered feasible. Regular workshops to develop staff skills and training for research evaluation can improve consistency within organisations, and cooperation in training workshops was suggested as a means of facilitating consistency between organisations.

There was some discussion regarding whether it was cost-effective for project-level benefit–cost analyses to be carried out by the research provider as part of the research proposal process. It was suggested that the most useful evaluations are of 'broad areas of work', rather than individual projects, and that increased work at that level would be the most cost-effective use of evaluation resources. The key benefit from the process was the improvement in quality of the research proposal that comes from encouraging scientists to consider issues relating to the economic impact of their research. However, the lack of consistency across organisations meant that the results were often not comparable, and therefore not usable in decision-making.

Concern was expressed that many scientists and research administrators have little faith in benefit–cost analysis, especially when carried out as part of research funding proposals. This issue of credibility is an important one in relation to the development of more consistent and more repeatable evaluations.

Other areas that emerged from the discussions were the need for further information, and possibly research, on the adoption levels and profiles of different technologies, and the probabilities of success of different types of research. Both areas were highlighted as requiring coordinated activities that could be shared by participants throughout the research evaluation process. Research areas in which concern was expressed on the difficulty of arriving at a consistent estimate of the likely benefits included improved quality, basic research, environmental research and economic information and policy research.

Another issue that emerged as needing further work was the use of new growth theory to enhance research evaluation. There is a need to examine this theory to determine issues relevant to research evaluation and the usefulness of that approach to research evaluation in practice.

In the third session, the changing environment for research evaluation and the implications of those changes for the research evaluation process were examined in detail. The issues considered were whether the possible changes will create a change in demand for research evaluation applications, and whether the changes require developments to existing methods, the way they are used, or to the groups that are likely to undertake them.

In the historical review of research funding in Australia, changes in the mix of funding for research were identified. For this workshop, the key issue was whether the trends have implications for research evaluation activities. One trend identified was an increase in the proportion of the research portfolio likely to be subject to evaluation. There is also a trend toward increased demand for measuring past productivity growth. The trend toward more applied research means that the cost of evaluations may fall, although this is offset by the trend to evaluate the benefits of environmental research and intersectoral spillovers, likely to be more difficult and costly to evaluate.

The recent Industry Commission Inquiry into Research and Development proposed a substantial number of changes in the research policy arena. A summary of the main changes proposed, and progress with their implementation, was presented. It is apparent that a number of these changes will lead to changes in the role and level of research evaluation in the near future. Particular implications for REGAE in the coordination of empirical evaluation activities include the need for data bases of research evaluation studies and for increased consistency between evaluations. An examination of the desirability and feasibility of incorporating formal research evaluation in research priority-setting was also identified as one implication of the Inquiry, as was the need for interaction between agricultural and other sectors on methods and approaches. There were also some areas of methodology development, particularly methods for evaluating spillover effects and methods for handling basic research activities, that emerged as significant.

In addition, the changing research policy environment is also important. The issue of future developments in the funding and provision of R&D in the public sector, particularly the role of market failure in determining the role of government, was seen as critically important. There are likely implications for research evaluation activities from the policy changes and the policy environment. It is also likely that such changes will require significant changes or developments in the research evaluation methodologies and practices, and possibly in the groups likely to undertake them. One issue that emerged was the implication of policy developments, particularly in relation to market failure, the role of government, and crowding-out of the private sector in research provision. With the preponderance of public sector in current research provision, these are critically important issues to be considered in more detail. One possibility raised was the reduction in the significance of public-sector research evaluation as the relative importance of public-sector research declines. It was suggested that research evaluation efforts should concentrate more on the policy issues of diagnosis and correction of market failure than on identifying areas of high economic return. Related to this was the suggestion that it was possible that high estimated rates of return to research also indicate relatively high private returns to research. Therefore even if these private returns are not the full benefits one role of public funders might be to develop funding strategies which optimise public free-riding on these private providers.

In conclusion, the workshop has brought together a large number of people to address key issues relating to research evaluation. The information provided in the papers and the stimulation provided by the speakers led to valuable discussions of a number of issues. More significantly for those involved in research evaluation, the workshop identified a number of issues that need to be explored and developed further. Action groups were identified to follow-up on these issues which will provide a basis for future activities of the Research Evaluation Group for Agricultural Economists.

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