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Classifying public benefit in Australian agricultural research

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Abstract

Australia has a unique system of funding agricultural research and development that involves the establishment of Corporations to collect and manage statutory industry levies that are matched by public investment. The reasons for delivering public R&D investment to agriculture through such a model are numerous, and were carefully considered when the model was being established in the late 1980s. Over time, questions have arisen as to the level of public benefits generated by the Rural Research & Development Corporations (RDCs) and whether these levels are appropriate given the level of public investment provided to them. The focus recently has been on the number and size of benefits that are environmental and social in nature. However, as public investment in agricultural R&D can be justified on many grounds, determining the returns to such investment, and the appropriate levels to continue to invest, needs wider consideration. Such considerations include how the portfolio as a whole meets the other justifications for public investment including the strategic mix, supporting research infrastructure, encouraging private investment, and ensuring the socially optimal level of research is being undertaken. This article considers the historical development and reasons for funding agricultural research using the RDC model, and develops some tools that can be used to classify benefits, beneficiaries, source of investment and portfolio characteristics to demonstrate that the goals of public investment are being fulfilled. These tools can also be used as management tools in priority setting and strategic planning at the portfolio and program level – but importantly are best applied as partial inputs under a more comprehensive evaluation or priority setting approach.

Introduction

A series of Corporations was established by the Australian Government and rural industries in 1989 in order to fund rural and agricultural research (including fisheries and forestry). These Rural Research & Development Corporations (RDCs) have a unique funding structure whereby both government and industry members (through compulsory levies) contribute funds to be invested in research and development (R&D). Given the multiple sources of funding, questions have arisen regarding the responsibility of such institutions to fund research that delivers public benefits. Indeed, the issue of public and private benefit is central to the funding mix of agricultural research and development in Australia. Associated with answering such a question are many issues including the justifications for public funding of research, the definition of a public benefit, what proportion of a RDCs budget should be addressing public benefits, and how the contribution to such public benefits can be monitored and measured.

The Australian Primary Industries and Energy Research and Development (PIERD) Act 1989 makes provisions for the funding and administration of research and development relating to primary industries with a view to: (1) increasing the economic, environmental and social benefits to members of primary industries and to the community in general by improving the production, processing,

storage, transport or marketing of the products of primary industries; (2) achieving the sustainable use and sustainable management of natural resources; (3) making more effective use of the resources and skills of the community in general and the scientific community in particular; and (4) improving accountability for expenditure upon research and development activities in relation to primary industries. Since established, a number of the original RDCs no longer come under the PIERD Act. This is because some industries have set up producer-owned companies that collect levies for both marketing and R&D. These companies do still receive matching funds from the Australian government and work in partnership with government and industry.

This article seeks to discuss the question of 'what is a public benefit in agricultural R&D in Australia?' Over the last decade or so, a triple bottom line approach has been used to allocate the benefits of research and development into the categories of economic, environmental and social benefits. It has often been assumed that the environmental and social benefits equate to 'public benefits'. However, the many justifications for public investment in agricultural R&D, using the RDC model, leads to a much wider potential definition of public benefits from such research. A secondary question in defining a public benefit as it relates to publicly funded research, has been the difference between actively funding research aimed at generating a public benefit, versus funding research aimed at achieving industry benefits, with spillovers resulting in public benefits.

Public investment in agricultural research in Australia

Agricultural R&D in Australia has always been supported with the use of public resources. Initially, the support was primarily through the State governments, with the Commonwealth government also taking an interest. Agricultural research has been directly funded and carried out by government through their own research agencies, and institutions such as Universities and the Commonwealth Scientific and Research Agency (CSIRO). The first industry to have its research administered by government, with a combination of government resources and industry levies, was the wool industry in the 1930's. From 1955 to 1982, similar research funds were established for a wide range of industries including the wheat, tobacco, fisheries, wine, dairy, meat, honey, eggs, chicken meat, pigs, dried fruits, oilseeds, barley and cotton industries (AFFA, 2001). In 1985, the Rural Industries Research Act was established to amalgamate rural industry legislation and provide one Act for administration of rural industry R&D funds. The exception was for the meat industry, where the Meat Research Corporation (MRC) was established under its own Act. In 1987, the Horticultural Research & Development Corporation (HRDC) was also established under its own Act. In 1989 the PIERD Act was introduced. Subsequently, a number of industries have created industry-owned companies independent of the PIERD Act under the Corporations law including meat, wool, horticulture, pork, forestry, dairy and eggs. The industries took the decision to make this transition in order to increase industry control over decision making and also increase flexibility and industry representation to assist with identifying market driven R&D that has high potential to be widely adopted by industry.

The statutory RDCs remaining under the PIERD Act are the grains, sugar, cotton, fisheries and grape and wine RDCs. There are also two other statutory RDCs that are not tied to industry levies. These are Land and Water Australia (LWA) and the Rural Industries RDC (RIRDC). RIRDC was established to support R&D for small established industries not large enough to sustain an independent RDC, as well as new and emerging industries. RIRDC also has the brief to fund R&D on cross-industry issues. Some industries within RIRDC's portfolio contribute both statutory and voluntary levies. LWA's brief was to identify and fund research into the natural resource management issues that face multiple industries. LWA also had a role in facilitating partnerships with industry RDCs in order to fund research into NRM issues. In May 2009 it was announced that LWA was to cease operations from June 30 2009.

As well as the RDCs, agricultural R&D is also supported by public funds channelled through Universities, CSIRO, Cooperative Research Centres (CRCs) and state agricultural departments. The Productivity Commission (2007) reported data from the Department of Agriculture, Fisheries and Forestry that showed that AU$1.2 billion was spent on agricultural R&D in 2002-03, and that States and Territories provided 43% of the investment, the Australian government (including higher education institutions and RDCs) had contributed approximately 40%, and private business investment contributed around 17%.

Since the 1970's in Australia there has been much policy and academic discussion regarding the appropriateness of publicly funding agricultural research, for what purposes such public funding should be used, the appropriate level of funding, and the most effective and efficient ways for the resources to be administered. This debate has occurred in the context of declining total expenditure in agricultural research, especially from public sector (Mullen and Crean, 2007). Kerin (1989) noted that under-investment by the private sector is likely to be greatest where industry is characterised by many small firms, where research cannot be appropriated by individual firms (e.g. basic research) and where the benefits have the characteristic of a public good. Rothschild (1998) suggested that there had been four main objectives for public involvement in R&D in Australia including: to ensure rural industries have adequate R&D resources to sustain and improve the rural sector's position in both the domestic and rural economies; to stimulate those in the community who benefit from rural R&D to provide an adequate share of the resources invested; to ensure resources are used effectively; and to support areas of R&D in the national interest. Public goods in the context of research were defined by Kerin (1989) as being those relating to the management of natural resources and environment and the support of public policy. Innovating Rural Australia (AFFA, 2001) defined public good R&D as research that is undertaken to benefit several social groups, and that does not provide direct and exclusive economic returns to private individuals or firms. Examples of public good research in Australian agriculture provided by AFFA (2001) included improved food safety, improvements in occupational health and safety, contributions to regional development and employment, the provision of stable commodity production to support low cost food security, and an innovative culture in rural industries that also serves to support complimentary industries such as transport, processing and retail services.

Most commonly, environmental and social benefits have been identified as appropriate public benefits that should be generated from public investment in agricultural R&D. In a review of the Joint Venture Agroforestry Program, Bauer et al. (2003) presented a triple bottom line based framework for considering direct and indirect impacts of research (Table 1).

Table1: Bauer *et al.* (2003)'s triple bottom line framework for assessing impacts of research undertaken by the Australian Joint Venture Agroforestry Program

Economic Benefits	Social Benefits	Environmental Benefits
Productivity improvements	Viable country towns	Aesthetics and recreation
Price premiums	Occupational health and safety	Biodiversity
Income diversification	Additional employment	Recreation
Maintenance of market access	Value added tourism	Reduced salinity
Product range and quality	Cost savings to government	Reduced soil erosion
Carbon credits		Reduced flood damage

In the 2001 review of the performance of the Australian rural RDCs, AFFA (2001) identified community benefits from the RDCs to include: stronger industries in rural and regional Australia; direct benefits to communities; regional development; improvements in food safety; environmental benefits; medical advances; and new consumer products. In a more recent review of the economic, environmental and social returns from rural R&D investment, CRRDCC (2008) identified a number of environmental and social benefits which are detailed in Table 2.

Table 2: Environmental and Social Benefits from Rural RDCs

Environmental benefits	Social benefits
Increased water use efficiency	Improved food safety and security
Improved water quality and biodiversity outcomes	Increased profits for suppliers
Reduced chemical usage	Increased consumer welfare
Reduced waste	Strengthening rural communities
Reduced emissions of greenhouse gases or carbon sequestration	Improved human health
	Improved occupational health and safety
Improved land use and soils management	Enhanced R&D research capability
Reduced salinity	Improved training
	Animal welfare

The challenges of funding agricultural research in Australia

There are a number of challenges involved with the funding of agricultural research in Australia and these can be categorised as those challenges associated with: the large number of small businesses in Australia; attracting private sector investment in basic and strategic research; attracting private sector investment in agricultural research to socially optimal levels; and the funding of natural research management research in agricultural contexts. Many of these challenges are similar to those experienced by the agricultural sectors of countries such as the USA, United Kingdom, Netherlands and New Zealand (Alston *et al* 1997).

Challenge: the Australian agricultural industry is made up of a large number of small businesses

The public funding of research, and in particular agricultural research, is usually undertaken to address a market failure or for research into issues that will directly benefit the public. In this context, a market failure refers to a situation where government intervention is necessary as the market itself is not efficient at producing or using goods and services. This is usually associated with a situation where there are non-competitive markets, externalities are produced, or when public goods are involved. The major argument forwarded for market failure as a justification for publicly funding agricultural research in Australia relates to the large number of small businesses that make up the industry. The Senate Standing Committee on National Resources (1982; 34) noted that 'Australia's rural industries contain a large number of small production units. It is not feasible for such small businesses to support their own technological development. Therefore, substantial Government intervention is necessary in the research and extension areas if our essential food and fibre industries are to remain economically viable'. Kerin (1989) noted that private investors in the agricultural sector in Australia aren't often large enough to manage the risk of research that does not lead to positive commercial outcomes and the Industry Commission (1995) also identified risk and uncertainty as appropriate reasons for public intervention in R&D funding. But Charles (1994) noted that market failure arguments do not apply in some areas of agriculture where private sector investment in research has been significant - such as in regards to fertilisers, pesticides and agricultural machinery, where the benefits of research have been captured by larger private companies.

Challenge: attracting private sector investment in basic and strategic agricultural research

Strategic research is often funded through public investment, as it usually results in basic knowledge that can be applied to a wide range of applications, and those applications are usually not limited to one industry. Research applicable to a wide range of production systems and regions can be considered 'public good' in nature as public goods are those goods whose consumption by one person does not reduce their availability for others (Charles, 1994). Kerin (1989) noted that basic research often results in published papers that allow knowledge to be freely available, transferable and capturable by others. Therefore private investors are unlikely to allocate resources to research of this nature. In contrast, applied research and development often results in patents and licences, which if held by private firms can restrict the community's access to new knowledge (Kerin, 1989). The 1995 Industry Commission inquiry into rural research found that RDCs were successful in pursuing more basic research than the private sector business enterprises, with 38% of the total R&D effort for RDCs

being basic in nature, and only 6% of the effort of the private sector businesses being basic in nature. Harris and Lloyd (1990) also argue that strategic research suffers from a capturability, and therefore free rider, problem, with inadequate incentives for the private sector to conduct this R&D. Likewise, applied research that can result in patents and capturability of all benefits will be undertaken by the private sector. However, there are also arguments for encouraging some applied research to be carried out by the public sector in order to discourage the patent system being used to ensure benefits can only flow to a limited number of industry members.

In order to address the market failure, the public sector not only contributes resources to invest in research, but this investment also has the purpose of further stimulating private investment in research, to achieve socially optimal outcomes. Where the private investor cannot capture the benefits completely, and they can be utilised by those who did not invest in the research, a free-rider problem develops. The compulsory levy system operating to fund the RDCs (together with the public investment) ensures that the free-rider problem is eliminated, as most members of an agricultural industry are contributing funds to the research (Charles, 1994).

Even though there are arguments for using public investment to encourage greater private investment, the private investment should still contribute funding to government provided services (e.g. research programs) up to the point where the contribution matches the benefits received from the government services (Kerin, 1994). The 2001 report Innovating Rural Australia (AFFA, 2001) demonstrates that the RDC system has been successful in encouraging greater private investment with agricultural R&D and that over all rural R&D income and expenditure had increased steadily since 1985. An example was provided that the dairy industry increased its contribution to R&D from 0.06% of GVP in 1985-96 to 0.45% of GVP in 1998-99.

The levy system utilised by the RDCs allows this private investment to occur efficiently. There are sometimes arguments for not collecting a levy, for example where the potential beneficiaries are widely dispersed or difficult to identify, or if it is impractical or very costly to collect the levy from the potential users. Also, if the national benefits (both public and private) from the research and development are likely to be high, but the costs of levy collection are also high, then it may be more efficient to fund research from governments general revenue (Kerin, 1989). It is because of these considerations that Land & Water Australia, the Rural Industries R&D Corporation and the Fisheries R&D Corporation receive large parcels of funding that are not matched by industry levies. The USDA has instigated public-private R&D partnerships in order to boost public benefits and encourage private research (Lyons-Johnson, 1998). The federal government had been funding basic research, but the outputs of this research were not being pulled through to the private sector. The government was not taking the step of commercialising research themselves, and the private sector was not funding its own basic research due to risk and long time-frames. However, the development of partnerships has addressed this concern. This works through industry or a private firm signing on to be a member of the public research organisation, and having a seat on the board. In return for signing on as partners to a project, industry co-operators are given the first opportunity to obtain a license to market the resulting technology. The government is able to provide the long-term and high-risk research, while the private sector partner contributes experience with commercialising and marketing the technology (Lyons-Johnson, 1998).

Challenge: attracting private sector investment to socially optimal levels

The optimal level of R&D activity for a particular industry is said to occur where the marginal social cost and return of the research portfolio is equal to those available in alternative investment areas (Charles, 1994). However, determining the appropriate level of public investment necessary to achieve the socially optimal level of industry benefits is difficult and there is often an absence of information and data to assist with this understanding. The policy statement establishing the RDCs (Kerin, 1989) also recognised that the optimal level of government investment in R&D relates to the marginal cost and return of the research, and further notes the difficulty in measuring such marginal benefits (Watson, 1996). One method of determining this optimal level is to consider the quality of marginal research projects undertaken by the rural R&D bodies. This method was promoted by Charles (1994), and by the Council of Rural RDC Chairs in 2008. The method would involve assessing the returns to the research investment that was considered a marginal priority when

funding decisions were made. It is those projects that would be unlikely to be funded if the level of resources available for investment were reduced. If those projects are still achieving a high return (for example as measured by a high benefit/cost ratio) then the socially optimal level of return from that area of investment has not yet been reached. However if the benefit/cost ratios for those lower priority projects are achieving low returns, then it is likely that the optimal level of investment has been exceeded, and that those resources could be achieving better returns if invested in research in a different industry or sector of the economy.

While there can be clear arguments established for the contribution of public resources to funding agricultural research, questions remain regarding the appropriate mix of public and private benefits that should result from public and shared funding of research. A DPIE review of rural research in 1993 (DPIE, 1993) followed the establishment of the PIERD Act and recognised that most research comprises both public and private good components, and that such components do not need to be provided for in separate, unrelated projects and programs. The Task Force carrying out the review also endorsed the view that a specific proportion of RDC budgets should not be specified as going towards public good research. Rather, if primary industries R&D is well conceived and executed, the outcomes of industry advancement and sustainable management of resources should not be in conflict. It was argued that the integration of industry, environmental and other public objectives should occur at the earliest possible point in the R&D cycle to ensure these multiple goals are achieved (DPIE, 1993).

Harris and Lloyd (1990) recognise that the goals of agricultural R&D are not always compatible and that the distribution of benefits should determine who should pay. Examples of potentially incompatible goals include increasing consumer welfare, increasing the farm sector's net income, improving conditions for farm workers, or preserving the environment. The Productivity Commission (2007) concluded that there are strong grounds for significant public funding for some rural RDCs, where there are spillovers from research that would not have proceeded in the absence of industry support. However, they also concluded that some industry-focussed RDCs could be less reliant on public funding as they are not demonstrating spillovers in line with the public investment received.

The 1993 review of rural research (DPIE, 1993) noted that the objectives defined in the PIERD Act did make reference to community benefits, but the Act does not make reference to or provide a definition of public good or public interest R&D. It also noted that the RDCs that were established under earlier legislation (MRC, HRDC and Wool) excluded any reference to community or public good benefits at all. However, when the Ecological Sustainable Development policy was introduced in 1990 the relevant Minister wrote to all RDCs to emphasise the priority that should be placed on meeting the goals of the policy. Subsequently, Agriculture Ministers have corresponded with the RDC Boards every two to three years to communicate current government priorities that the RDCs should be aware of and seek to address in their portfolios. From 1994 to 2001 priorities included promoting regional development, cultivating human resource creativity and innovation, addressing consumer food safety concerns and issues associated with OH&S (AFFA, 2001).

Challenge: funding natural resource management research in agricultural contexts

Often, the consequences of managing private land for productive agricultural purposes can have negative impacts on public natural resources, both on- and off-site. There is generally little private incentive for individuals to manage natural resources on private land in order to prevent such negative impacts (spillovers) unless there is also a private benefit from doing so (e.g. a potential productivity improvement). The lack of such private incentives can lead to market failure with respect to the management of land to prevent negative spillovers (Pannell, 2008). Similarly, there is market failure with respect to the private sector having an incentive to carry out research and development with respect to natural resource management (NRM). In a 1996 report published by Land & Water Australia titled 'Sustainable Management of Natural Resources: who benefits and who should pay?' it was noted that it is not necessary however for the public funding of NRM activities to necessarily equal the estimated size of public benefits (thus introducing the concepts of marginality and additionality). Rather, appropriate policies should allow the public benefits to free ride on private investment where possible, and the public funding should only be to the extent sufficient to secure change in the behaviour of those targeted (Hussey, 1996). This concept is also applicable to

research into natural resource management in terms of public funding providing the incentive for industry and other private research investors to invest their own money into such research. There is also a role to be played in funding research into management practices that will be adopted by landowners on the basis of providing both private benefits to the landholders and public benefits to the natural resource base.

Donaldson (1996) notes that there are a wide range of stakeholders who have the potential to gain some benefit (and incur some costs) from managing and utilising natural resources or their raw materials. Such stakeholders include "businesses which profit from servicing agriculture and industry, and the communities that develop around them; tourism and recreation including fisherman, nature lovers and water sports; environmental groups with an interest in nature conservation and biodiversity maintenance; local, State and Federal governments as part of their responsibility for administration, policy and management of resources; the nation and its people, through lifestyle and standard of living, including high quality water for all purposes" (Donaldson, 1996). The presence of such a wide range of stakeholders indicates that there is justification for public contributions to managing and researching such issues.

Kerin (1989; 22) in a key policy statement establishing the RDC model, justified government funding into natural resource management through noting that 'where a government sells access rights to those natural resources or collects a resource rent tax from industries that exploit those resources the community benefits from the income that the government receives, either through lower taxes or through increased services. R&D is a catalyst for the development of resource-based industries. Consequently funding research in these areas can be viewed as an investment that will generate direct income for governments, since over time it will lead to better utilisation of a publicly owned resource'.

A framework for classifying public benefit in agricultural research in Australia

The benefits from the rural RDCs cannot always be easily categorised using the triple bottom line approach of economic (or industry), environmental and social benefits. This approach does also not always capture the complexity of reasons that can be used to justify public investment in RDCs. Table 3 presents a matrix-based framework that can be used to categorise benefits from agricultural research. It identifies benefits that accrue to various beneficiary groups including the industry funding the research, as well as spillover benefits to other industries (other agricultural industries and other sectors), the public (including society and government), and overseas (in this context spillovers refers to the application of research and development overseas). In each of the beneficiary groups, the benefits can be further categorised as economic, environmental or social in nature.

Table 3. Framework to classify public benefit in Australian agricultural research

Benefit type	Beneficiary			
	Producers	Spillovers		
		Other industries	Public	Overseas
Economic				
Environmental				
Social				

There are some benefit types that may be difficult to categorise, particularly in terms of beneficiary type. For example, consumer surplus (in a competitive market, whether a research levy is placed on consumers or producers is irrelevant in terms of who bears the brunt or incidence of that levy – they will share the burden of research funding based on the benefits they receive) is often categorised as a public benefit, as it results in the consumer paying a lower price for goods than the maximum they are willing to pay. However, others argue that it is an industry benefit, as the consumer is considered part of the industry chain. Improved quality of food or fibre is another benefit that some consider to be public, however, once again, it can also be considered an industry benefit, as ultimately it increases the demand for an industries product and it is the industry members who then receive the ultimate

benefit. However an improvement to the actual safety or health standard of that food or fibre product can be considered a public benefit, as can improved nutritional value. Capacity building of industry members with respect to on-farm skills can be considered an industry benefit, as it is ultimately benefiting the industry members in terms of improved productivity or reduced costs of production. However, it can also be considered a public benefit if the capacity building improves the skills of the individual with respect to aiding the community or environment. Note also that in the Australian agricultural context, Australian Governments are likely to have less concern for overseas consumers (the purchasers of Australian exports) than Australian consumers and producers.

Where natural resource benefits occur on farm, they are said to be industry benefits (e.g. soil improvements, reduced erosion, improved biodiversity, vegetation that reduces on-farm salinity and erosion). However, there are also off-farm benefits from these improvements and these should be considered public benefits. It has also been argued that if they are only spin-offs of work that has significant private benefits, then they cannot truly be considered public benefits. If this were the case public benefits would have to be defined very narrowly as those benefits that are only from outcomes that only have a public benefit, and no private benefit component. However, often the presence of the private benefit is the delivery mechanism by which changes are adopted that lead to the public benefit. Also, the size of the private benefit on its own may not be sufficient to encourage adoption of a sustainable practice, but knowing that there will also be public benefits can encourage adoption. Without research to identify practices that are win-win with respect to private and public benefits, then some other government incentive would be required for individuals and businesses to make significant investments to achieve those same public benefits. The benefits of research into natural resource management have been extensively considered in a series of cost-benefit analyses carried out for Land & Water Australia (see Chudleigh, Simpson and Schofield, 2006).

Table 3 is also of use when considering the concept of spillovers from an investment decision made with the primary purpose of achieving economic benefits for industry participants. The framework can be used to demonstrate how multiple benefits can flow to multiple beneficiaries (including the public) from a single investment. Economic evaluations completed in 2007 and 2008 and used as part of Council of Rural Research & Development Corporation Chairs (CRRDCC) impact reporting can be used to demonstrate how the identified benefits from an investment can be represented. As an example, Table 4 presents the identified benefits of the investment by the Fisheries R&D Corporation into assessing proposed Marine Protection Areas using the framework (that was presented in Table 3). As can be seen, this investment has largely resulted in public benefits.

Table 4: Framework of Benefit Types and Beneficiaries for Fisheries Marine Protected Areas Investment (adapted from Agtrans Research, 2008)

Benefit type	Beneficiary			
	Producers (Fisheries)	Spillovers		
		Other industries	Public	Overseas
Economic	Reduced impact of the displaced catch leading to reduced financial impact of sales foregone and reduced impact on industry profits	Reduced impact on those providing inputs to the industry supply chain (e.g. processors, repairs and maintenance suppliers)	Reduced potential unemployment Reduced compliance costs due to greater industry ownership of the revised MPAs More efficient development of MPAs for other Australian fisheries	
Environmental			Marginally improved set of biodiversity and conservation assets	
Social			Lowered impact on localised fishing communities and reduced social costs of disruption and dislocation of families, particularly in Tasmania	

It is often difficult to determine if the optimal level of research investment is being reached. Identifying and measuring the returns to projects at the margin of funding decisions is one method of attempting to determine if this optimal level is being reached. Attempts are currently being made to determine the profile of returns to the RDC portfolio as a whole by having each RDC contribute a series of economic analyses on randomly selected groups of investments. In the past, RDCs have often undertaken economic analyses on their 'best performing' projects or programs and it has been difficult to develop a picture of returns across the whole portfolio, including those that were unsuccessful. Therefore it was difficult to determine what proportion of projects may be having a small return. If it were found that returns were not declining over time, or there were very few or no projects with low returns, then it might be concluded that the marginal returns of investing in research in the industry is still exceeding marginal costs. If this were the conclusion, then a case could be made for continuing or even increasing the public investment as industry alone, with less public involvement, is not capable of funding the socially optimal level of research.

As well as selecting projects or groups of projects for analysis using a random approach, RDCs are also asked to discuss two factors regarding the priority of the research topic being analysed at the time of funding: was the research topic a high priority for the RDC at the time of funding; and was the research topic a high priority for industry at the time of funding? These questions are seeking to address not only the 'marginality' issue in terms of the socially optimal level of funding, but also whether the industry would have funded the research topic itself without the imperative to address 'public issues' provided by the presence of public funding. This is the issue of 'additionality'. Consideration of this issue is seeking to address the question of whether significant environmental and social spillovers could still be achieved in the absence of public funding, if it is found that most of the environmental and social benefits achieved are actually flowing from research projects and programs that were primarily aimed at addressing high priority industry issues.

The framework presented in Table 3 is of use for classifying most benefits, however there are other dimensions that cannot be captured using this matrix that are also of importance for demonstrating public benefits of agricultural research. An important dimension to consider is where a research project fits on the spectrum of basic research through to applied research, development and adoption. Each project within an RDC portfolio can normally be allocated to one of the categories along the dimension, and considering the value of projects falling into each category can lead to an understanding of the distribution of resources into each category. Considering the value of funds obtained from industry co-funders in each category is also of benefit in considering the appropriateness of funding going into each category. An example of a framework that could be used to report such a dimension is presented in Table 5.

Table 5 can also be used to report on the value of private (industry) investment being obtained by the RDCs, as well as the value of investment by other dimensions of the public sector (e.g. universities, state departments of primary industry, CSIRO) that is being obtained by the RDCs. One of the justifications for publicly supporting agricultural R&D is to ensure that research is being funded to support national and rural priorities. Each of the RDCs fund research to address these priorities (described earlier in Table 1). Each of the RDCs already have reporting systems in place as part of the Annual Reporting and Strategic and Operational Planning documents to identify how the portfolio of projects funded is contributing to these priorities.

Table 5. A framework for the classification of research type and value

Research dimension	Number of projects	Total Value Invested ($)		
		RDC	Industry	Other research institutions and funders
Strategic				
Applied				
Product development				
Extension				
Development of research infrastructure and human resources				

Conclusion

In conclusion, public investment in agricultural R&D can be justified on many grounds. Therefore when determining the returns to such investment, and the appropriate levels to continue to invest, a wide range of considerations need to be made. Recently, there has been an increasing trend towards reporting environmental and social benefits as a means of demonstrating the returns to the public investment in rural RDCs. However, there is a need to consider exactly to whom those environmental and social benefits accrue, and to also recognise that there are some economic benefits that accrue to beneficiaries other than the levy paying industry. There is also a need to consider how the portfolio as a whole meets the other justifications for public investment including the strategic mix, supporting research infrastructure, encouraging private investment, and ensuring the socially optimal level of research is being undertaken. This article has developed some tools that can be used to classify benefits and portfolio characteristics to demonstrate that the goals of public investment are being fulfilled. These tools can also be used in priority setting and strategic planning at the portfolio and program level

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