Submission to the Productivity Commission Inquiry

on

Rural Research and Development Corporations

Department of Primary Industries Victoria

Contents

Abbreviations and acronyms

AANRO	Australian Agriculture and Natural Resources On-line
ABS	Australian Bureau of Statistics
CRRDCC	Council of Rural Research and Development Corporations' Chairs
CCRSPI	Climate Change Research Strategy for Primary Industries
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CEO	Chief Executive Officer
DAFF	Department of Agriculture, Fisheries and Forestry
DPIV	Department of Primary Industries Victoria.
GRDC	Grains Research and Development Corporation
NHMRC	National Health and Medical Research Council
PI	Primary industries
PIMC	Primary Industries Ministerial Council
PISC	Primary Industries Standing Committee
R&D	Research and development
RD&E	Research, development and extension
RDC	Research and Development Corporation
VicSPA	Victorian Certified Seed Potato Authority

Key Messages

Market rationale

1. **There is a case for government funding where market failure exists, and action is warranted where the benefits of addressing the market failure outweigh the costs.**

2. **The market for rural RD&E differs from other types of markets in the economy due to the structure of the industry sectors and the length of time it takes for benefits to be realised.**

3. **With comparatively small markets, Australia is disadvantaged in its capacity to access new technologies from off-shore multinational agricultural companies. Where access to new international technologies is achievable, further development and adaptation is commonly required to meet uniquely Australian conditions.**

4. **There are substantial research and evaluation studies which demonstrate the significant benefits that derive to industry and the community from investment in rural RD&E, however, apportioning these benefits accurately is not possible.**

5. **Although Industry funding as a share of total RD&E funding may be relatively low, several factors can contribute to underinvestment by industry.**

6. **Government investment in the RD&E supply chain is needed where the technical risks are higher, industry is reluctant to invest and where spillovers across sectors or under investment in public goods occur.**

7. **Government funding for RD&E can catalyse private sector development and should be reduced as the supply chain matures and there are incentives (such as intellectual property rights and patents) for the private sector to assume more or full responsibility.**

Enhancing the RDC model

8. **The National Primary Industries RD&E Framework builds on the RDC Model and provides a sound basis for driving nationally agreed strategies. Consideration should be given to how the existing model for managing the framework could be enhanced, with particular reference to the institutional and governance arrangements.**

9. **Consideration should be given to the establishment of a funding mechanism for cross-sectoral issues and benefits.**

10. **Ensuring core national capability is a fundamental requirement and essential across multiple sectors and fields of RD&E.**

Rural Research and Development Corporations

Introduction

This submission to the Productivity Commission's inquiry into rural research and development corporation arrangements in Australia has been prepared by the Department of Primary Industries Victoria on behalf of the State Government of Victoria.

The submission has focussed on responding to those issues in the terms of reference which relate to the benefits to industry and the wider community from investment in rural research and development (R&D), the rationale for government investment, the effectiveness of the RDC model in enhancing the competitiveness and productivity of Australia's rural industries, and the scope for improvements to the current model.

The Productivity Commission's Issues Paper focuses upon R&D, reflecting the Government's terms of reference. In this submission, we make reference to extension and practice change as well as R&D. We believe that the extension of R&D is implicit in the RDC model, with the aim of increasing the adoption of new and improved practices and technologies, and therefore increasing the return on investment of government and industry funds.

The fundamental tenets upon which the submission is built are that: there is a case for government funding where market failure exists, and action is warranted where the benefits of addressing the market failure outweigh the costs; and the market for rural research, development and extension (RD&E) differs from other types of markets in the economy due to the structure of the industry sectors and the length of time it takes for benefits to be realised. A summary of the economic rationale can be found in the attachment to this submission.

Section one articulates the market failure rationale whereby government intervention in the form of investment in RD&E is warranted where market failures occur such that producers are unable, or unlikely to, assume full responsibility for the investment. An important corollary to the market failure rationale is that, publicly funded RD&E also contributes to innovation by government, and "has a broad role in shaping an innovative, educated and competitive nation" (Productivity Commission 2005).

Section two covers the benefits of investment in rural RD&E, and the quantified benefits that are realised through increased productivity and competitiveness. While the benefits to industry are quantifiable, the difficulties in accurately estimating the benefits to the broader community are acknowledged.

It is argued in section three that there is a clear rationale for government support based on the difference of market structure of primary industries (to other industries such as manufacturing), the existence of market failure, providing access to global markets, and the public good benefits that are derived in areas such as the environment, biosecurity, animal welfare, food safety, food standards, nutrition and public health.

Some of the factors which may contribute to underinvestment by industry are outlined in section four. These include factors which lead to market failure such as information asymmetry, free riding and inter-industry spillovers. Other factors arise out of the long time periods it may take for benefits to accrue, and lack of support for high risk research. Many of these factors are directly related to the structure of the industry sectors, and provide the basis, subject to the benefits outweighing the costs, for government to provide some funding support.

The case for providing government support may hinge on the point of market failure in the innovation supply chain and this point for intervention can shift over time as the market matures. Government intervention may decline or cease as the research approaches the point where there are incentives for the private sector to assume more or full responsibility.

In section five, the current Research and Development Corporation (RDC) model is examined in the light of its progress in developing and implementing the National Primary Industries RD&E Framework. It is noted that, even at this relatively early stage of the Framework's implementation, a number of significant benefits are apparent (often for the first time).

While considerable headway has been made in progressing implementation of the Framework, section six suggests some of the steps that could be taken to improve the RDC model further, including the institutional arrangements needed to fulfil government expectations and the clarity that is needed on some practical governance issues.

Another suggestion for enhancing the RDC model is to consider the establishment of a funding mechanism specifically focussed upon key cross-sectoral issues, particularly those addressing broad sector and community benefits such as climate change and water.

Ensuring core national RD&E Resource Capability (human and infrastructure) is also suggested as an enhancement which is necessary if the industry and cross-sector strategies' objectives and outcomes, defined under the Framework, are to be fully realised. Providing resources and management for these key resources has been historically problematic. Adequate resources are necessary, along with a new, more centralised approach to managing core capability effectively.

The final sections of the submission suggest that consideration be given to how the national leadership and coordination effort will be managed to ensure that the entity charged with oversight of the Framework has the requisite mandate and authority to fulfil its role and responsibilities. Some prospective fields of advice to stakeholders are indicated.

While noting the sound base that the existing RDC model provides for further improvement, the submission concludes that further changes will be needed, and the model will likely require a continuing evolutionary approach, to avoid system shock and unintended consequences.

Finally, throughout this submission, government has been referred to generically in order to reflect the national effort that goes into the planning, funding, conduct and implementation of RD&E. It should be stressed, however, that in order that gains in agricultural productivity, competitiveness and sustainability continue, particularly given the opportunities and challenges facing the rural sector, it is paramount that the level of Australian Government funding is, *at the very least*, maintained in real terms.

1. Objectives of Research, Development and Extension

The objective of public investment in rural research, development and extension (RD&E) is to maximise net benefits to the community by building knowledge and developing technologies that increase productivity and competitiveness, and reduce impacts on environmental resources. In the context of rural RD&E, the key elements of the system are:

- Strategy driven to deliver outcomes
- Research that produces new knowledge of both a basic and applied nature
- Development and dissemination (extension) of research findings to users
- Acquisition of funds for investing in RD&E
- Aligning funding contributions with the distribution of benefits to —
    - primary industries and downstream industries;
    - consumers; and
    - the community at large.
- Positive externalities, for example, through improvements to public health and social capital, and the natural environment.

Government intervention in the form of investment in RD&E is warranted where market failures occur whereby producers are unable, or unlikely to, assume full responsibility for the investment. Nevertheless, while the market failure rationale is the most appropriate for supporting the case for government funding contribution where the benefits of addressing the market failure outweigh the costs, it is not the only rationale. We agree that publicly funded RD&E also contributes to innovation in the functions performed by government and has a broad role in shaping an innovative, educated and competitive nation (Productivity Commission 2005).

As a general rule, public funding should be directed at public good aspects of research, which in agricultural markets will often relate to the interaction between production technology and the environment. The public good principle for intervention in markets applies to situations where no individual within a collective of interested parties has enough incentive to provide a good or service, such as RD&E, but when they act together, they can overcome problems associated with, for example, free riding and information asymmetries.

2. Benefits of Rural Research, Development and Extension

Benefit-cost analyses and other economic studies show high rates of return to investment in projects in the agricultural sector. For example, Mullen (2010) estimates that investments in Australian Rural RD&E have earned around 15 to 40 per cent real per annum, a contribution of half the increase in gross value of Australian agriculture in recent times. Alston attributes similar benefits to investments in rural RD&E in the United States (Alston *et al* 2010).

Examples of the various empirical works on the returns to investment in rural RD&E are shown in the Productivity Commission's Issues Paper (2010). These indicate some variance in estimated returns (due in part, at least, to methodological differences), however, there appears to be a consensus that investments in rural RD&E results in significant benefits.

Also noted in the Issues Paper is recent work that links declines in productivity growth in the agricultural sector in Australia and other developed countries to falling investment in RD&E.

The level of investment of the parties (industries and governments) is significant at over $1 billion recurrent funds per year. The question as to whether this is sufficient given the opportunities and challenges facing the rural sector can be addressed as follows:

- Productivity growth is generally declining
- Returns from RD&E projects are generally high and therefore further investment will likely generate significant returns (we have not yet reached the point of equi-marginal returns)
- Sector challenges are broadening and intensifying, for example in areas such as climate change, water and energy.

Whereas benefits to the agriculture sector are readily quantifiable, delineation of the private/industry benefits from wider community benefits are more difficult to quantify. There are very few studies that attempt to quantify this benefit split. The distribution of benefits do not readily lend themselves to assessment on a program or aggregate funding level, although they can be practically assessed at a lower level or project basis. Nevertheless, benefit-cost assessments which identify the distribution of benefits to the wider community based on qualitative methods can be used and may be cost effective in some situations.

As a consequence it is difficult to provide an accurate estimate of the relative benefit to industries or the wider community from the whole investment but it is reasonable to assume much of the benefits flow to industry.

3. Rationale for government support

The market for rural RD&E differs from other types of markets in the economy. The rationale for industry-specific arrangements in the rural sector:

> is based on the characteristics of many primary industries with a large number of producers, each accounting for a small share of broadly undifferentiated industry output. This makes it difficult for producers to capture sufficient benefit from R&D they might conduct individually in order for them to proceed. Accordingly, even though the collective benefits may justify the investment, there may be under-provision of rural research (Productivity Commission 2007).

3.1 Market failure

Agricultural RD&E is considered to be generally more susceptible to market failures than RD&E in other sectors such as manufacturing. Capital markets for agricultural assets are not well developed. Agriculture consists predominantly of small firms (producers) that are not able to organise and fund RD&E. The benefits from rural R&D accrue over long periods and are less appropriable to individual producers as others can obtain cost free benefits.[1] Furthermore, agriculture production and environmental conservation are deeply entwined. Conversely, the benefits of R&D in the manufacturing sector are largely appropriable through patents, and non-disclosurable intellectual property; and can be hidden from competitors through industrial processes.

The funding of RD&E is informed by the distribution of the benefits from benefit cost analysis and the nature of the market failure as shown in Figure 1. Research, development and extension can be funded by the public, the private sector, or from a mix of public and private sources.

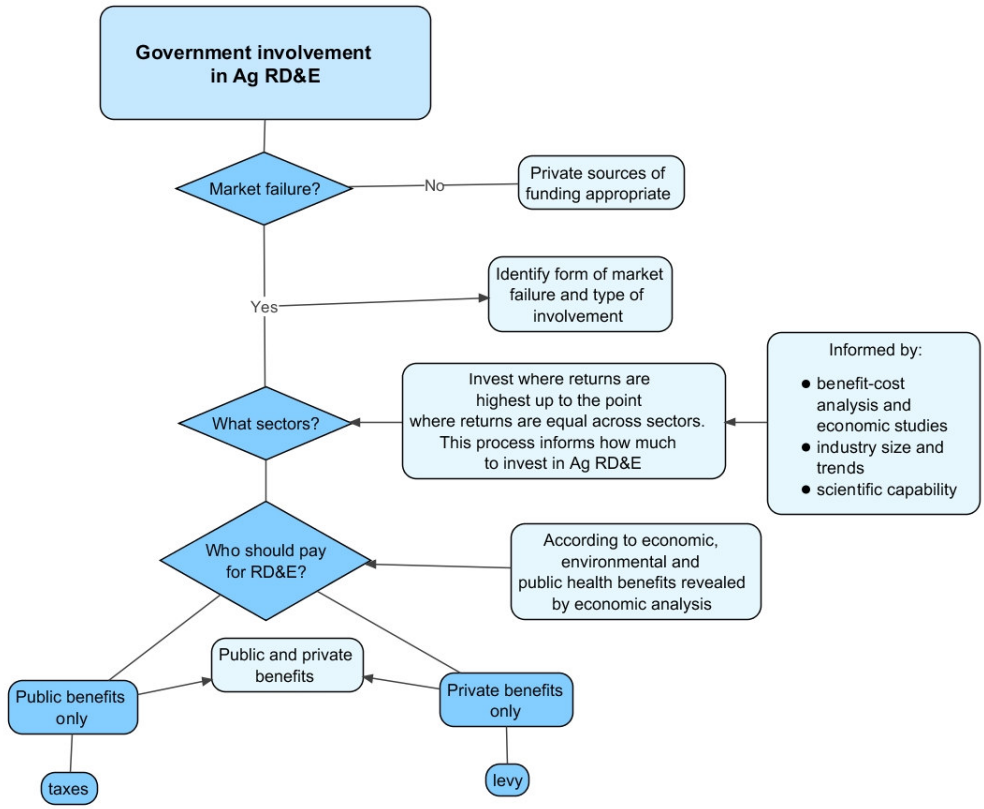
Key messages

1. **There is a case for government funding where market failure exists, and action is warranted where the benefits of addressing the market failure outweigh the costs.**
2. **The market for rural RD&E differs from other types of markets in the economy due to the structure of the industry sectors and the length of time it takes for benefits to be realised.**

Several types of market failure are apparent along the food supply chain. Government intervention is justified where net benefits are generated, for example, in the areas of practice change and extension, R&D, biosecurity, animal welfare, food safety, food standards, quality assurance, nutrition and public health, international market access, and trade practices (Rama and Harvey 2009).

[1] This can occur through observation of neighbours' farming practices, inventions and so on. Small scale innovation and adaptation will occur where the investment is (privately) profitable.

Fig 1. Decision tree guide to government involvement in rural RD&E



Source: DPIV attachment

Where externalities associated with RD&E are specific to a particular group, collective industry-research models can provide an effective means of addressing those externalities without the need for public support.[2] This can (and does) occur on a voluntary basis where there are a small number of producers. In industries with many firms that are also geographically dispersed, compulsory levies are often necessary to avoid the problem of 'free riders' (Productivity Commission 2007).

The use of production R&D levies helps to address problems associated with free riding, as the industry shares the costs of funding research it directly benefits from. This submission endorses the Productivity Commission's conclusion that the governance design is inherently sound:

> Levies that are decided by, and apply to, all beneficiaries of the R&D overcome free riding and the resultant under-provision of rural research. There are strong

[2] Externalities can occur in the food supply chain in a number of areas, such as market access, quality assurance, and environmental and health consequences of food production and consumption (Rama and Harvey 2009).

> grounds for significant public co-funding of those RDCs where there are spillover benefits beyond industry members and where that research would not proceed in the absence of support (for example, research into improving salinity-damaged areas) (Productivity Commission 2007).

Extension is a crucial component in the completion of the value chain. Where there are poor links between research and extension, the results of research are not turned into productivity gains as quickly as they would if the links were strong.

It is in the interests of levy payers for RDCs to fund extension programs which encourage the adoption of levy funded research. Some RDCs already do so, while others regard the extension function as a responsibility of government. Where the benefits of extension are *largely appropriable* by industry, industry should contribute to its funding.

Government frequently takes the lead in researching issues that will ultimately be of relevance and benefit to the entire industry sector and wider community, such as climate change, salinity and water. Such research provides new knowledge that supports planning and practice change in activities such as productivity, environmental management and structural adjustment options.

3.2 The global context

Without government support, Australian farmers can face delayed or reduced access to new technologies and products generated by private sector R&D in comparison with their major global competitors. Box 1 illustrates these difficulties and the importance of government R&D support.

Box 1: The global market

Major multinational agricultural companies, such as those involved in breeding new plant varieties, focus their product development on the major global markets, such as Europe and the United States. Consequently, farmers in these markets are in a position to access the latest technologies and products quickly without the need for any direct contribution to product R&D (other than through the price of products). However, comparatively small markets, such as Australia, do not represent priority targets and consequently farmers in these markets face delayed or reduced access to the new products (for example, crop varieties with improved traits) developed by off-shore multinational agricultural companies.

Even where the new products developed off-shore require no further development in order to work effectively in Australian conditions, such as can be the case for new veterinary drugs or new farm equipment, Australian farmers will often receive a delayed access. This delayed access is exacerbated in the case of technologies and products that require further development and adaptation to meet uniquely Australian conditions. For example, crop varieties with improved disease resistance bred for the US are not suitable for use in Australia without further investment in breeding and selection. This further investment for the Australian market, given its comparatively small size, is not highly attractive to off-shore multinationals on a cost/return basis. Consequently, without some form of assistance Australian farmers can experience a significant delay or even no access to new technologies which puts them at a significant competitive disadvantage.

There is, in addition, significant new knowledge generated internationally that is placed in the public domain. Whilst this knowledge is readily accessible (i.e. access is not constrained by

private intellectual property rights), it commonly requires interpretation and adaptation for Australian conditions.

Assistance to farmers in small markets such as Australia, could include subsidies (such as the human Pharmaceutical Benefits Scheme) or government support for R&D. Australian government support for rural RD&E, is a relatively benign and less distortionary intervention compared with subsidies, particularly where it attracts industry contribution through levies (RDCs). The resulting Australian RD&E capacity enables the further development and adaptation of offshore developed technologies, the ability to form strategic alliances and partnerships, the capacity to develop new technologies in Australia that can be traded for access to offshore technologies, and the ability to address unique Australian issues.

Source: DPIV

Key message

3. **With comparatively small markets, Australia is disadvantaged in its capacity to access new technologies from off-shore multinational agricultural companies. Where access to new international technologies is achievable, further development and adaptation is commonly required to meet uniquely Australian conditions.**

3.3 Public goods

There are also instances where socially valuable investment in RD&E will not occur, or will not occur to the extent that is socially optimal, unless government makes a contribution. Industry investment is dealt with in greater depth in section 4.

Rama and Harvey (2009) argue that

> government intervention in practice change and extension can be justified on economic grounds where it helps produce public goods, such as natural resource management or environmental outcomes. If, for example, extension modifies a farm's production process in a way that also enhances biodiversity on private land, members of the wider community also enjoy these non-excludable and non-rival benefits from biodiversity.

An evaluation of rural Research and Development Corporations (RDCs) undertaken by the Council of Rural Research and Development Corporations' Chairs (CRRDCC 2008), showed that in the first year of analysis, significant benefits from investment were identified (box 2).

Box 2: Benefits from investment by Rural Development Corporations

- A sample of 36 highly successful projects will return $10.5 billion in quantified benefits.
- Of the $10.5 billion in quantified benefits, $5.5 billion will be private benefits (that is, benefits accruing to rural industries). The remaining $5.0 billion will be benefits captured by consumers, other participants in the supply chain and the wider public.
- A sample of 32 random projects from the RDC portfolio will deliver an average return of $11 for each dollar invested (in 2007 dollars).
- A range of significant social and environmental benefits were identified which are distributed broadly to the Australian community.

Source: CRRDCC 2008

The CRRDCC concedes that isolating social and environmental benefits is a major challenge, and quantification is even more difficult. The example is cited of RDCs investing in improvements in water quality by reducing run-off from farms. While the reduced run-off per farm can be measured, the downstream (spillover effects) cannot be easily measured as there may be other factors contributing to water quality beyond the influence of the RDC investment (CRRDCC 2008).

For the purposes of this submission, three examples are provided which demonstrate that there are important community benefits which derive from government investment in rural RD&E. The caveats which apply to these are that other forms of government invention may also be appropriate in the face of market failure such as regulation, standards, market access programs, product labelling, and the provision of information and guidelines.

3.3.1 Food safety

Food safety status may be unknown to both producers and consumers. Accurate tests for the presence of particular contaminants may not be available, or the link between a contaminant and food safety status may be unclear. Government interventions such as regulations and standards would not address this; research is needed to improve understanding of contaminants and their relationship to disease (Rama and Harvey 2009).

A case study on predictive microbiology is provided in box 3.

Box 3: Food safety: predictive microbiology

Meat and Livestock Australia research has provided a scientific basis for assessing pathogen growth at each point in the processing chain. It has been adopted by every sector of the meat-processing industry with the reported result that adoption of the practice has improved the quality of red meat four-fold since 1993.

The spillover effect of this is increased health benefits for consumers. It is estimated that the food safety program is expected to generate $503 million in social and related industry benefits over the next 30 years by reducing food-borne infectious diseases such as listeriosis.

Source: CRRDCC 2008

3.3.2 Food and public health

Nutritious food and healthy eating contribute to good health, and can reduce the risk and cost of various diseases. The estimated economic cost to Australia of the principal diet related conditions, such as coronary heart disease and stroke, and diabetes, is about $6 billion a year (NHMRC 2003).

Private markets may fail to invest adequately in good nutrition and healthy eating, given the public goods and externalities associated with information and illness. Public goods are generated, for example, through basic research into micro-nutrients in food products to better understand their possible interaction and subsequent human health impacts. Furthermore, negative externalities can also be generated where unhealthy eating and

lifestyle produce health costs that the wider community must bear (Rama and Harvey 2009).

3.3.3 Animal welfare

The Department of Primary Industries Victoria (DPIV) along with industry, supports research which generates collective goods (to producers) and generates benefits to the wider community.

Externalities in relation to animal welfare can arise where individual producers have lower standards for animal welfare than desired by the wider community. An individual producer, for example, may have relatively lower welfare standards when controlling flystrike in sheep. This has a negative (non-monetary) impact on members of the community who would prefer greater animal welfare in wool production. This negative externality reduces overall wellbeing in the community (Rama and Harvey 2009).

Such cases are not amenable to quantifiable measurement of the public benefits but they are nonetheless real.

Key Message

4. **There are substantial research and evaluation studies which demonstrate the significant benefits that derive to industry and the community from investment in rural RD&E, however, apportioning these benefits accurately is not possible.**

4. Industry investment

Acting on the premise that investment in RD&E is both desirable and necessary, it would appear to be manifestly the case that industry as a principal beneficiary, should assume a significant responsibility for funding investment. It is not possible to derive how much is spent by states, primary producers and private (non farm) businesses as this information is not collected by the Australian Bureau of Statistics (ABS).

Based on data sourced from the ABS, expenditure on research and development (but not extension) by research service providers for 2006-07 is estimated as follows:

Commonwealth[a]	States	Business	Universities	Total
17%	37%	21%	24%	100%
$204,529,820	$438,792,650	$253,340,000	$286,863,770	$1,183,526,240

a = including Commonwealth, DAFF, CSIRO etc, but not matching funding to RDCs.

Contributions through industry levies to RDCs for the same period were $232,650,000; the Australian Government's matching funding to RDCs was $209,850,000 (DAFF 2010). Thus industry levy funding as a share of estimated total research and development funding for 2006-07 was approximately 20 per cent. This may be relatively low given the

level of industry benefits likely to flow from these investments (see attachment for analysis of industry investment and benefits, and areas for further study,).

4.1 Why doesn't industry invest more?

Some of the factors which may contribute to underinvestment by industry in RD&E are set out below.

- Historically, the public sector has always been the dominant provider of research services to the agricultural sector in Australia as in many other countries. This may have created an over reliance in some sectors of the industry, although it must be noted that some industries have always invested in R&D.
- Producers who fund research may not receive the benefits which can occur over long time periods. Alston *et al* (2010) suggests that this can be up to 50 years, not the shorter time period that is often assumed. On this accounting, some producers may discount the benefits because they will be uncertain or retired or deceased when they flow. Others may consider the opportunity cost over a long period to be greater than the foreshadowed benefits.
- Poor understanding of the sources of technological gain. Producers may not understand the origin of contemporary practices or how key R&D developments were funded, thus taking for granted or discounting the value of levy-funded research.
- Economic benefits from levy funded RD&E may be poorly understood or remembered. Benefit-cost analyses and other economic studies showing high rates of return may not be widely known and understood by producers. Add to this the propensity for technological advances to be absorbed into normal practice and the source of the advances can be forgotten.
- Non-adopting farmers will not favour a levy. Non-adopting farmers will be worse off with a levy. As Alston (2002) explains:

  > Every dairy farmer bears a cost (of a levy) in proportion to their individual production regardless of whether they adopt new dairy farming technology that is generated by the research funded levy. If prices were lowered as a result of productivity gains and supply increases deriving from the adoption of the new technology deriving from the research, non adopting farmers would be made worse off by both the new technology and the levy used to fund it.

- High risk research will not be supported. This is particularly the case where fundamental (rather than applied) research is involved. R&D is subject to two key forms of risk. The first is technical risk, caused by the complexity of the research. The second is market risk, which flows from uncertainty about whether there will be sufficient demand for an innovation that results from R&D. Both technical and market risks tend to be higher at early stages of the R&D spectrum.
- When benefits accrue at a point in the supply/value chain (for example post farm gate) that is different to the point in the supply/value chain at which the levy is collected (for example pre-farm gate).

- Public goods tend to be underprovided by private markets because they are subject to 'free riding' – that is, those who receive the benefit from consuming a good can do so without paying for it.
- Inter-industry spillovers where research funded by one industry can indirectly benefit other industries that have not paid for the research. This can be particularly true for emerging industries that do not have their own RDC and can essentially 'free-ride' from the efforts of established RDCs, and in RD&E on cross-sectoral issues. The current RDC model addresses free-riding within an industry sector, but is less well equipped structurally to address cross-sectoral issues.

Key message

5. **Although Industry funding as a share of total RD&E funding may be relatively low, several factors can contribute to underinvestment by industry.**

4.2 Private sector investment and attraction

The private sector (non-farm businesses) is predominantly represented by commercial entities, such as seed companies, who will invest in the RDE/innovation supply chain where they are able to capture a benefit and where the benefits exceed the costs. Government funding for RD&E should not crowd out private funding. Conversely, government funding for RD&E can (ultimately) be an important means of attracting private funding and completing the supply chain.

There is often a case for government funding where market failure exists. Along any innovation supply chain (broadly defined as the progressive stages from Concept to Fundamental research to Applied research to Development & demonstration to Commercialisation to Market adoption), the point of market failure can be expected to shift over time. Commonly, as the market matures, the point of market failure will shift to earlier stages. In essence, this means that market failure declines as the private sector becomes able and prepared to invest earlier in the RD&E/innovation supply chain. Consequently, the point (focus) of government funding in the innovation supply chain will move to earlier stages or cease.

Research into canola breeding and development provides a useful case study of progression to exit over the supply-chain points (box 4).

Box 4: Canola case study

In 1972, DPIV initiated a canola breeding program, in partnership with the Federal Government's Oilseeds Research Council (subsequently replaced by the Grains Research and Development Corporation [GRDC]). At that time, canola production in Australia was small, being less than 50,000ha. Then, DPIV's canola breeding program extended along the innovation supply chain to the stage of producing market ready varieties which were subsequently commercialised through private sector seed companies for seed bulking, marketing and distribution. In 1980, DPIV's first canola variety was commercially released and by 2002/03 DPIV varieties represented 65-70 per

cent of the total Australian canola area sown.

By 1990, Australia had emerged on the global stage as an exporter of canola seed. Rapid growth led to exports exceeding two million tonnes in 1999-2000. Annual exports of canola have now stabilised at around 1.0 to 1.7 million tonnes, with our main export markets being Japan, China, Pakistan, Europe and Bangladesh. In 2009, Australian canola production was 1.6m tonnes.

The growth and maturation of the canola industry resulted in the progressive entry of local and international private seed companies seeking to invest in earlier stages of canola breeding, in order to achieve market advantage. This was a clear signal that the private market was ready to take over part of the innovation and commercialisation chain and consequently, DPIV established an exit strategy in 2004 whereby DPIV investment of government funding retreated to pre-competitive germplasm development where the market-failure and role-of-government remained. Thus, DPIV divestment has left later (downstream) stages of the innovation supply chain to the private sector where private benefit and investment has grown. The investment of DPIV, and the GRDC, in early canola breeding was catalytic and critical to the establishment of the elite canola cultivars – conventional, herbicide-tolerant, high stability oil and low-rainfall environment types – that are now being successfully bred, produced and delivered to growers by the private sector.

This case study also illustrates the temporal and dynamic nature of appropriate government interventions and exits.

Source: DPIV

A further case study is provided in box 5 on the development of a new tissue-culture technology approach to the production of pathogen tested seed potato production.

Box 5: Potato Mini Tuber Production

Efficient commercial potato production relies upon a source of pathogen tested seed.

In the early 1980s DPIV accessed a new tissue-culture technology approach. This new approach was based upon the production of pathogen tested plantlets in tissue culture to produce mini-tubers (mini potatoes) in polyhouse pots. The mini-tubers are subsequently planted in the field by private certified seed potato producers to bulk up seed potatoes which are used by commercial potato growers to sow their crops.

DPIV further developed the tissue culture technology to increase the efficiency of pathogen tested mini-tuber production and also held the tissue culture variety germplasm collections on behalf of the industry. Over many years DPIV provided a commercial (fee-for) service of providing mini-tubers for the seed potato industry.

In the early 1990s DPIV sought to commence an exit strategy from essentially a production role and explored the potential for commercial companies to take over DPIV's large scale mini-tuber production. However, it was not until January 2010 that VicSPA (Victorian Certified Seed Potato Authority, an industry organisation) took over DPIV's role in maintaining the tissue culture collection and the production of mini-tubers for the potato industry, thereby enabling DPIV to exit from that role. DPIV's expertise is still called on to provide specific pathogen testing services.

This case study illustrates the timeframes often required to ensure an orderly exit and a sustainable private sector capacity.

Source: DPIV

Shifts in the focus of government investment can also apply to extension, as illustrated in Box 6.

Box 6.: DPIV – private sector collaboration in extension.

Historically, most DPIV industry extension activities were conduced by providing information and services directly to farmers, particularly through group discussion forums.

Over time, industry needs have evolved and become more diverse, which has supported the development of a range of private and community service providers. This has been particularly evident in those areas where services generate private benefits (such as on-farm productivity and business development), and therefore a preparedness by farmers to pay for or contribute to these services.

DPIV's response to this maturing operating environment has been a new service delivery strategy. It emphasises a collaborative service delivery approach, whereby DPIV supports and packages R&D information to effective private and community service providers who then provide services to farming clients. DPIV continues to provide services directly to farmers in areas of predominantly public benefit, such as natural resource management, and where effective private or community service providers are yet to establish.

An example of this collaborative approach to extension is the BestWool/BestLamb network program, designed to accelerate changes in practice on Victoria sheep properties. While DPIV administers the program with some RDC support, many of the network activities are delivered by private service providers, and participating producers pay an annual network membership fee. This example is reflective of the public and private benefits derived from most productivity-related extension activities.

Key messages

6. **Government investment in the RD&E supply chain is needed where the technical risks are higher, industry is reluctant to invest and where spillovers across sectors or under investment in public goods occur.**

7. **Government funding for RD&E can catalyse private sector development and should be reduced as the supply chain matures and there are incentives (such as intellectual property rights and patents) for the private sector to assume more or full responsibility.**

5. Current RDC Model

5.1 Backgound

The RDC model established in 1989 under the *Primary Industries and Energy Research and Development Act 1989* has some important features which are the envy of many other nations, and has an impressive track record of returns. Two key features of this model include:

- a mechanism to attract industry investment into rural RD&E; and

- the ability to direct RD&E efforts to industry priorities through industry-led boards and their organisations, and thereby improve the uptake of new knowledge and technologies

This model has in essence been a competitive one with providers competing for funds from the investors and this has not led to a high degree of national coordination or collaboration.

Mounting cost pressures, budget constraints and the broadening of the RD&E agenda to an increasing number of cross-sector issues (for example, climate change, water, animal welfare) and the consequent emergence of larger gaps in capability, forced a rethink of the model.

In 2005 the Primary Industries Ministerial Council (PIMC) proposed a new more collaborative model of a *national* research capability supported by *regional* development and *local* extension, where research could be provided at a distance if it was tested regionally and extended to users locally. **Inherent in this concept was the interdependence of the parties *nationally* and the need for strategic oversight of it.**

In 2007, PIMC agreed on principles for cooperation and in 2008 agreed to the development of the National Primary Industries (PI) RD&E Framework (the Framework) comprising an initial tranche of 14 sector and an initial seven cross-sector RD&E strategies.

Industry organisations and RDCs have been actively involved in the establishment and development of the Framework under a Statement of Intent (DAFF website) which characterises the process and arrangements of its development and review.

5.2 The Framework

The National Primary Industries RD&E framework (the Framework) brings together RDCs, governments, the CSIRO, universities and private providers. The outcomes which PIMC expects to achieve through implementation of the Framework are set out in box 7.

Box 7: National Primary Industries RD&E Framework outcomes

The National RD&E Framework is expected:

(a) to provide shared strategic directions and priorities for national and sector level primary industries RD&E in Australia that enhance the productivity and sustainability of Australia's primary industries;

(b) research capability will more comprehensively and holistically cover the present and future strategic needs of stakeholders nationally;

(c) public research capability will become more integrated, interdependent and specialised, and have larger critical mass with less fragmentation across the nation;

(d) efficiency and effectiveness of RD&E will be improved and as a consequence returns

	on investment will improve;
(e)	RD&E investment will improve the capability of the national system in priority areas and ensure effective and efficient use of resources, including infrastructure;
(f)	the Parties will collaborate to retain and build capability in fields strategically important to their jurisdictions and industries;
(g)	the national research capability will be an integral component of a wider innovation agenda, supporting development and extension; and
(h)	research undertaken in one location will developed and extended nationally for primary industries.

Source: DAFF website

Under the framework, the national primary industries RD&E system is progressing well and developing into a more strategic, more responsive, more cooperative and interdependent capability with resources utilised more efficiently and effectively. This is vital given the rate of change and the challenges and opportunities faced by the industries it serves.

To date, eight RD&E strategies have been approved by industries and government(s) (PIMC) and a further nine will be considered later this year. As the half way point of the development of the Framework approaches, work is continuing on the Framework's on-going management. Particular areas of focus are: how national research will be provided to the regions, management of intellectual property, national approaches to extension, evaluation, harmonising administrative processes and data sets.

Even at this relatively early stage of the Framework's implementation, a number of significant benefits are apparent (often for the first time):

- There is high level collective oversight of the National Primary Industries RD&E effort by governments and industries. This is provided by PIMC, Primary Industries Standing Committee (PISC) and its R&D subcommittee, the Chairs and Chief Executive Officers (CEOs) of RDCs, who are regularly considering progress of the Framework and approving strategies.
- An agreement to cooperate strategically between industries, governments and universities exists in the form of a Statement of Intent which has been signed by all PISC agencies, all RDCs and the Deans of Agricultural Universities.
- A series of nationally agreed strategies are being approved by the parties which will or do provide 'whole of chain' coverage and a more detailed level of strategic priorities to connect to the National Research Priorities.
- Strategy development and governance is more inclusive and involves a broader range of stakeholders, and includes a much higher portion of the total funding. The development of each strategy has involved a wider group of stakeholders including industry, RDCs, PISC agencies and universities, thereby capturing the vast bulk of the funding devoted to their implementation.

- The focus on future capability needs (human and infrastructure) is stronger and more strategic. In the process of comparing the current capability with the future capability needs of each strategy, significant gaps in capability and the urgent need to address them have been revealed. Some plans to address these needs have been implemented (for example, pork, dairy, grains).
- Dialogue between the parties is more cooperative and strategic. There is a greater collaboration through teamwork and sharing of information. The process of building the Framework has brought the parties closer together to address a common purpose. This has led to better understanding of the various perspectives and growing trust.
- New funding models are appearing for:
  a) service provisions which are longer term and provide more security for providers and investors alike – the pork and dairy strategies for, example, have established more stable rolling-budget arrangements with key providers.
  b) the conversion of under-utilised assets to new, higher priority assets. Departments in Queensland and Victoria have converted older assets to new without the funds being returned to consolidated revenue which has been the tradition.
  c) important cross-sector strategies such as for climate change. All PISC agencies and RDCs co-funded the establishment and implementation of the Climate Change Research Strategy for Primary Industries (CCRSPI). This is the first national strategy of its kind.
- Agencies are now defining their strategic priorities more clearly and with an eye to the national Framework (as "major', "support" or "link) (DAFF website) which is allowing them to narrow and deepen capability, and at the same time rely on others to deliver research to their jurisdictions in areas of lower priority.
- Larger coalitions of specialists are now collaborating on crucial scientific areas. Under the guidance of CCRSPI, for example, large groups of scientists have come together to bid for climate change funding in a cooperative and coordinated way.
- Consolidation and collaboration under the Framework has facilitated a freeing-up of the rate of evolution of the system generally, which previously had been changing relatively slowly. A number of under-utilised assets or lower priority programs had been retained unnecessarily with consequent impact on efficiency and the ability to invest in new higher priority areas.

These areas of progress give significant confidence that the nationally coordinated, strategic PI RD&E Framework will add significantly to the previous RDC model.

6. Enhancing the model

6.1 Institutional arrangements

The Framework, with the strong support of PIMC and the RDC Chairs and CEOs, has been developed with the PISC R&D subcommittee as the coordinating working group.

As noted in section 5.2, considerable headway has been made in progressing implementation of the Framework. There is still, however, much that needs to be done if the outcomes which PIMC has set, are to be realised. Work is underway on implementation and operational issues such as access to research and intellectual property protection, filling capability gaps, overcoming free riding and reviewing approaches to the provision and funding of extension services. It is questionable, however, whether the PISC R&D Subcommittee can provide the necessary oversight for the on-going implementation of the Framework. Dedicated resources are expected to be required, together with authorisation in key development areas (such as described below in section 6.2).

6.2 Government expectations

While the existing arrangements have served to provide a sound base for moving forward, the extent and range of responsibilities that now rest with PISC and its subcommittee are significant. Providing the necessary oversight of the Framework's implementation on an on-going basis, that will meet stakeholders' expectations, will require dedicated resources, together with authorisation in key development areas. It is possible that some of those expectations may be beyond the wherewithal of the PISC and its R&D subcommittee. While the roles and responsibilities of the stakeholders are set out in Part 4 of the Statement of Intent, greater specificity is needed on some practical governance issues, including:

- Clarity from governments in defining and communicating their priorities with RDCs and industries, particularly in relation to the application of governments co-contributions.
- Ensure that considerations for investing government funds have been subjected to rigorous analysis of the benefits and costs of addressing the identified market failure(s); and the level of co-investment in projects is cognisant of the beneficiaries.
- An appropriate level of government involvement in governance of strategies where government funds are used.
- Specify government funding being constrained to RD&E responsibilities (where E includes education) and excluded from broader marketing, promotion and policy representation roles (which are solely or primarily an industry benefit).

- Ensuring government and RDC investments are guided by the national strategies (developed under the Framework) and defining the evaluation, performance reporting and monitoring requirements for investments in RD&E.
- Establish a cross sectoral funding mechanism to ensure the cross-sector strategies and core capabilities can be efficiently and effectively funded. Appropriate interaction with RDCs would be required.

Key message

8. **The National Primary Industries RD&E Framework builds on the RDC Model and provides a sound basis for driving nationally agreed strategies. Consideration should be given to how the existing model for managing the framework could be enhanced, with particular reference to the institutional and governance arrangements.**

6.3 Enhancing cross sector RD&E

The enhanced focus, emphasis and management of cross sectoral RD&E are imperatives. The expanding involvement of RDCs in identifying and collaborating on cross-sectoral issues through the strategies being developed under the National PI RD&E framework should be continued and encouraged.

Additional focus and emphasis could be achieved through the establishment of a funding mechanism specifically focussed upon key cross-sectoral issues, particularly those addressing broad sector and community benefits such as climate change and water, where the range of beneficiaries and the long term nature of the issues go well beyond the role and mandate of sectoral focussed RDCs.

Resourcing a cross-sector funding mechanism requires further discussion and analysis.

Key message

9. **Consideration should be given to the establishment of a funding mechanism for cross-sectoral issues and benefits.**

6.4 Ensuring core National RD&E Resource Capability

Under the Framework, each industry sector and cross-sector strategy is identifying its available and future RD&E capability needs (human and infrastructure). This will include the core underpinning (human and infrastructure) capability required by each strategy in order to achieve its identified objectives and outcomes. The Framework recognises the role of all stakeholders (governments and industries) in contributing to the identification and maintenance of this capability.

There are, however, a number of core National RD&E Resource Capabilities that are important across multiple sector and cross-sector strategies and which underpin the effectiveness of the Framework. These include, for example, banks of national plant genetic resources, and reference collections of insects and plant and animal

diseases/pathogens required for national biosecurity functions, as well as important resource databases such as AANRO. Providing resources and management for these key resources has been problematic and significant free-riding occurs which threatens their functionality and some international commitments. A new, more centralised approach to managing this core capability effectively is required.

Key message

10. Ensuring core national capability is a fundamental requirement and essential across multiple sectors and fields of RD&E.

6.5 National Leadership and Coordination

In order that the intended outcomes of the National PI RDE Framework are to be fully realised, serious consideration must be given to the mandate, roles and authority of the entity charged with its oversight. The entity[3] should have the capacity and authority to provide advice to the stakeholders (government and industries) on:

- The establishment of National Rural Research Priorities.
- Oversight and future development of the National Primary Industries RD&E Framework.
- The allocation of funds to cross-sector strategies
- The identification, management and resourcing of core National Resource Capabilities
- The establishment of consistent national monitoring, evaluation and reporting protocols across the Framework, including the analysis of performance outcomes and facilitating continuous improvements.
- The establishment and maintenance of key national data bases that will inform investments, focus and performance across the Framework.
- Undertake strategic reviews of the comprehensiveness of National Primary Industries RD&E capability emanating from capability plans contained in each of the sector and cross-sector strategies of the Framework.
- The strategic analysis of portfolio balance across the Framework to inform future directions, opportunities and threats. This would include developing a balanced approach to the distribution of funds for short, medium and long term RD&E, including the nexus between pure research, strategic research, applied research and extension.

6.6 Implementing a new model

As noted earlier, the existing national PI RD&E model provides a sound base for further improvements to its effectiveness and efficiency in achieving government, industry and

[3] A key question here is whether any existing entity has the capacity or the authority.

community benefits. Further changes to the model should be done with the engagement and authorisation of all the parties to the Framework. Similarly, the rate of change to the model will likely require a continuing evolutionary approach to avoid system shocks and unintended consequences.

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Attachment

MAXIMISING THE BENEFITS FROM GOVERNMENT INVOLVEMENT IN AGRICULTURAL R, D and E

Economics and Policy Research Branch[4]

Introduction

The focus in this paper is on ways of thinking about how to maximise the benefits from agricultural research, development and extension (R, D and E). The questions asked and discussed are:

- What is the objective of investing in R, D and E?
  - What is the market failure?
- What sectors to invest in?
  - How much should we invest?
- Who should pay?
- Who funds R, D & E?
- What should change?

What is the objective?

The objective of public investment in agricultural R, D and E is to maximise net benefits to the community by technologies which increase productivity and reduce impacts on environmental resources. In the context of agricultural R, D and E, benefits flow to:

- Primary producers
- Consumers
- External benefits, for example through improvements to public health and the environment.

[4] This paper was prepared to promote discussion at a workshop convened by the R&D sub-committee of the Primary Industries Standing Committee, 8-9 June 2010. Helpful comments on an early draft were provided by John Mullen.

A decision tree can be used to help decide when and where to invest in agricultural R, D and E (see Figure 1). The steps are as follows:

Market failure

The presence of market failure or other rationale[5] needs to be established if the benefits from government involvement in R, D and E are to be maximised. Often this is not clear and discussions between project proponents and economists will identify the form of market failure and the type of involvement that is necessary. The conditions that cause markets in agricultural R, D and E to fail are categorised as:

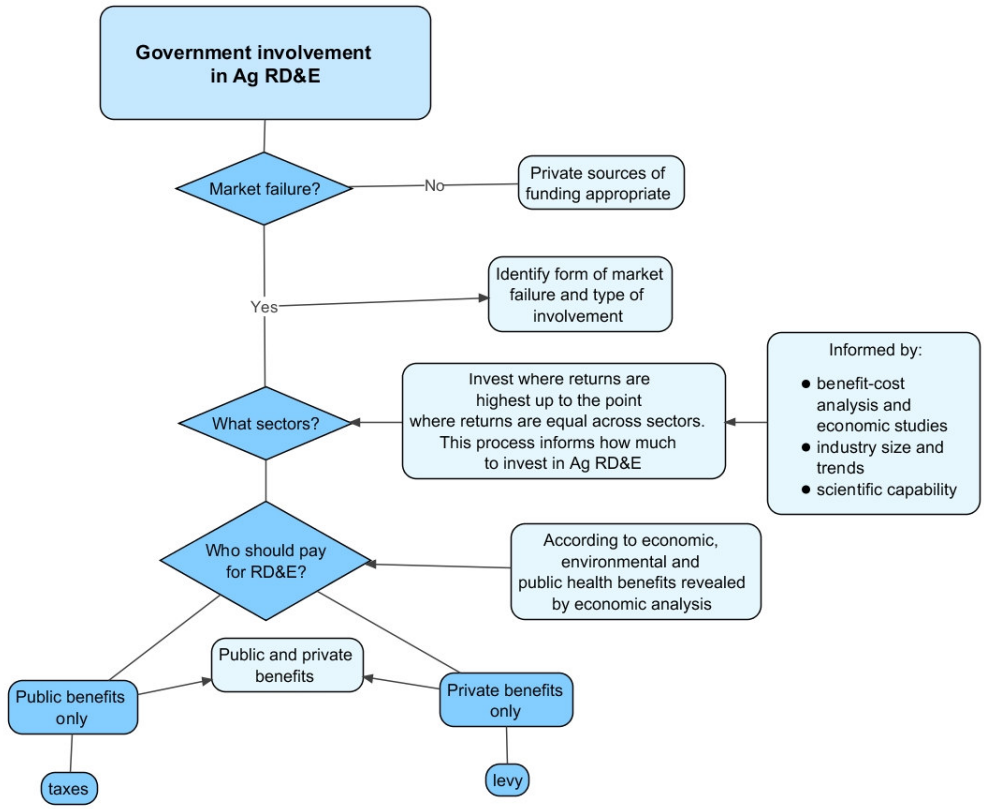
- Public goods
- External benefits and costs

Agricultural R, D and E often delivers disembodied[6] information-based technologies which are likely to have the features of public goods in that that one person's use does not diminish the amount available to others and the benefits can be available to others.

[5] Market failure is an important rationale, but not the only rationale for investment in R&D as explained by the PC (2007). In the case of rural R&D, investment in R&D is needed to support the functions of government such as the development of food safety policy and standards.

[6] As distinct from embodied technologies which refer to technologies incorporated in products such as chemicals or crop varieties.

Fig 1. Decision tree guide to government involvement in rural RD&E



What sectors and how much?

Choices have to be made between investments in sectors (industries) and areas of work, such as adaptation to climate change.

This question is informed by:

(a) *Benefit-cost analyses and other economic studies* — these show high rates of return to projects and to the agricultural sector. For example Mullen (2010) estimates that investments in Australian agricultural R, D and E have earned around 15 to 40 per cent real per annum, contributing half the increase in gross value of Australian agriculture in recent times. Similar benefits are attributed to investments in agricultural R, D and E in the US (Alston et al 2010).

(b) *Size of sector, trends and prospects* — small improvements in efficiency across large sectors may equate to a large return on investment. Conversely, small and declining sectors may mean small returns relative to other opportunities. Emerging forms of production may provide large returns on investment.
(c) *Available scientific capability* — will determine the types of R, D and E that can be undertaken.
(d) *Maintain essential scientific capacity to respond to emergencies and to protect environmental assets*, such as biosecurity.

Investment should occur in sectors (and projects) which show high rates of return. This should be estimated using benefit-cost analysis. Quantitative or qualitative[7] approaches to benefit-cost analysis can be used.

Investment in projects should occur up to the point where the returns from an additional dollar of investment would earn the same expected benefit across all areas of R, D and E (often referred to as the point of equi-marginal returns). Investing up to the point of equi-marginal returns will determine *how much* should be invested in R, D and E for each sector.

What is the relative size of public and private benefits from R, D and E?

Quantitative evidence showing returns to agricultural R, D and E come from the University of New England (UNE). Qualitative evidence comes from the Productivity Commission. They are briefly explained below.

University of New England

[7] DPI Victoria is trialing a qualitative approach to estimate net benefits from proposed R, D and E. This project has the prospect of a fast yet rigorous estimation of net benefits. The process involves economists working with scientists to systematically describe and estimate benefits, costs and net benefits. Proposed projects can then be ranked according to estimated net benefits.

A submission made by UNE to the Productivity Commission's 2007 report on public support for science and innovation cited two studies that quantified the private/public benefit split from Cooperative Research Centre (CRC) projects (UNE 2006). The two studies found:

- Cattle producers and beef processors, marketers and consumers in New South Wales accrued $251 million in economic benefits, around 64 per cent of the total benefits from the investment, and
- Australian sheep producers were estimated to receive 75 per cent of the benefits derived from Australian Sheep Industry CRC projects.

These results were derived using computerised generalised equilibrium models.

Productivity Commission

A 2007 report by the Productivity Commission and 1995 review by its predecessor the Industry Commission discussed private and public benefits from rural R and D. Both reports indicate there are social and environmental benefits from rural R and D, but there is little quantitative evidence of the magnitude of these benefits (PC 2007; IC 1995).

In summary, no comprehensive analysis is available to inform us as to relative shares of private and public benefits from all R, D and E. The limited evaluation work available suggests that the benefits are predominantly economic, with most benefits accruing to producers.

Who should pay for R, D and E?

The funding of R, D and E is informed by the distribution of the benefits from benefit cost analysis and the nature of the market failure as shown Figure 1. R, D and E can be funded by the public, the private sector, or from a mix of public and private sources. Each is explained below:

Public funding

This is appropriate where the benefits accrue to society as a whole, or to large groups of producers and there are poor incentives for individuals or groups to fund the proposed work. That is, the investments have the features of a public good. Examples include:

- Basic research, knowledge and training
- Industry-specific basic research, such as the pre breeding phase in the development of new crops
- Cross industry research, such as some types of climate change research
- Food science research to inform development of regulatory standards
- Science infrastructure such as research institutes and equipment
- The development of scientific capability
- Disembodied information-based technologies applying to farming systems

Private funding

Private firms will invest in R, D and E where the benefits are appropriable through patents, or by embodied technology in new products such as new chemicals and crop varieties.

Prior to the introduction the current R and D levy, producers under-invested in research where the benefits flow to all members, often known as *collective goods*.

Private funding — R, D and E Levy

Given the large number of small farms and the public good nature of information based R&D, there is no incentive for farmers as individuals to solve the problem of under investment.

The introduction of the industry R, D and E levy improved incentives for producers to invest in collective goods. Some observers may believe the system is working perfectly. High rates of return to R, D and E should induce producers to vote to increase levy funding yet this is not the case. This would be expected so long as rates of return from R, D and E exceeded the opportunity cost of funds. With several exceptions, RDCs have not increased levy rates. Alston (2002) explores possible reasons for why producers have incentives to not set levies at the optimal level. They include:

1. *Producers who fund research may not receive the benefits.* This is because the benefits of agricultural R, D and E can occur over long time periods. Research by Alston et al (2010) suggests that this can be up to 50 years, not the shorter 20-30 year time period that is often assumed. Given this, producers may discount these benefits because they will be retired/deceased. A similar type of inequity arises when levy-funded research and extension is only applicable to a small group within an industry.

2. *Poor understanding of the sources of technological gain:* Producers may not understand how key R, D and E developments were funded, thus discounting the value of levy-funded research.

3. *Non-adopting farmers will not favour a levy:* Non-adopting farmers will be worse off with a levy as explained by Alston (2002) in the case of dairying:

> 'Every dairy farmer bears a cost (of a levy) in proportion to their individual production regardless of whether they adopt new dairy farming technology that is generated by the research funded levy. If prices were lowered as a result of productivity gains and supply increases deriving from the adoption of the new technology deriving from the research, non adopting farmers would be made worse off by both the new technology and the levy used to fund it.'

4. *The economic benefits from levy-funded R, D and E may be poorly understood:* Benefit-cost analyses and other economic studies showing high rates of return may not be widely known and understood by producers.

5. *High risk research will not be supported.* Some research may be too risky and uncertain for producers, thus being discounted in voting for a levy. For example, projects towards the 'basic' end of the research spectrum.

The above reasons may explain why producers, generally, do not seek to increase levies for R and D.

Mix of private and public benefits

Most R, D and E investments will have a mix of benefits in which case shared funding is appropriate. Examples include:

- Plant breeding: germplasm trait identification for economic and environmental purposes
- Food science: aspects of food safety which provide benefits to firms and to the development of regulatory standards

Who funds R, D and E?

In an ideal world, optimal funding for sectors and projects would be determined from the process shown in Figure 1. Investment would occur in sectors and projects up to the point of equi-marginal returns. The sum of all project and sector investments determines how much to invest.

In the real world, agencies can attempt to maximise the benefits from their agencies funding by introducing the steps discussed in earlier sections of this paper. That is, by investing in areas of market failure, investing where returns are highest, and funding R, D and E according to whether the benefits accrue to the public, private firms and industry alone, or a mix of both.

Current funding of R, D and E indicates that producers fund around 20 per cent of total spending of around $1.18 billion.

What should change?

The previous sections suggest that industry may be under investing in R, D and E and the importance of investing in projects and sectors up to the point of equi-marginal returns. Two issues require further study:

1. *Under-investment in R, D and E by producers:* RDCs will invest where the benefits are more readily appropriable to members. By definition they will be reluctant to invest in areas research where the benefits are long term, uncertain, or where the benefits spillover to other sectors. This is understandable. Thus some socially beneficial research will not be undertaken.

   Rational, profit-maximising behaviour suggests producers would vote to increase levies where rates of return exceed their opportunity cost of funds. Generally, producers have not done this. It is important to understand the reasons for this behaviour as this will provide information to assist the design of levies and other institutions that may be needed to encourage socially beneficial research.

2. *Levy design and the matching grant*: This is related to point (1) above. Levy design and whether a matching grant is required is a very complex issue. Alston, Freebairn and James (2004, p 58) conclude

> '…current general policy of a blanket dollar for dollar matching grant is clearly sub-optimal….The socially optimal policy is strictly an empirical question that will vary from industry to industry and case to case, and within industries, among different types of levy-funded research. Theoretical analysis such as that in the present paper, alone, cannot answer this question but has demonstrated the importance of further work to pursue a specific answer.'

The Productivity Commission is expected to examine levy arrangements as part of its current Inquiry into Rural RDCs.

If changes are made as result of research on points 1 and 2 (above) then government and industry shares of total funding for R, D and E may change. Total investment by industry may increase, as industry identifies new areas for high return investment. For example, if industry shares of total funding of $1 billion increased to 25, 50 and 75 per cent of total funding, then the contributions from the Commonwealth and states would be less.

Findings for discussion

1. Rates of return of around 15-40 per cent are evident from the work by Mullen (2010). Mullen's work and other economic studies are measuring economic benefits and these largely accrue to producers.

2. Yet producers only contribute around 20 per cent of total spending.

3. There is a mismatch between producer benefits and producer contributions. Why is this? Producer behaviour is understandable, as:

(i) *The RDCs will largely invest in short to medium term research where there are clear benefits to members.*

(ii) *There will be a reluctance to invest in cross sectoral projects, as the benefits are not sufficiently appropriable by any one RDC*.

(iii) *Producers may be reluctant to vote to increase R and D levies as*

a. producers who fund research may not benefit from it;
b. producers, generally, have a poor understanding of the sources of technological gain involving RDC-sponsored research;
c. non- adopting producers will not favour the levy; and
d. the rates of return from R, D and E may be poorly known and understood.

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