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# Re-inforcing Rural Innovation

**Australia's agricultural sector has long considered itself at the forefront when it comes to innovations, and there is a long history of Australian-developed farming technologies being adopted worldwide. To a significant degree, the technical base for much of this innovation has been publicly funded agricultural research agencies such as the CSIRO and State Departments of Agriculture.**

**The development of intellectual property rights has negated some of the spillover effects that justified public funding of agricultural research and development in the past. Given this, it is legitimate to re-evaluate the appropriateness of previous levels of public investment in agricultural R&D.**

While debate on appropriate Government research and development policy is normally left to academics and bureaucrats, two events that recently coincided succeeded in elevating this debate to the front pages.

The first was the release of figures by the Australian Bureau of Statistics, revealing that Australia's gross expenditure (Government and private) on research and development (R&D) as a proportion of GDP had slipped to 1.49% - in the mid-range of OECD countries - but falling over recent years against a rising OECD trend. Within that figure, business R&D investment was 0.6% of GDP, ranking Australia seventh lowest of all 24 OECD countries.

The second was the release of the final report of a working group established following a National Innovation Summit held in February 2000. The report focussed on Australia's apparent poor performance in R&D, and made a series of recommendations considered necessary for Government and industry in order to overcome the so-called R&D crisis, and lift the rate of innovation in Australia generally.

Co-incidental to discussion about the general level of investment in R&D in the Australian economy, the question of the appropriate level of investment in agricultural R&D in Australia is also looming as an issue requiring public debate.

There are two reasons for this. The first is the tendency for Governments of all hues to continue the downward trend in the real level of budget allocations to agricultural research and extension agencies. In the absence of significant industry resistance, this trend will continue in the future. The second is the development of intellectual property rights which mean that private corporations are now able to capture the benefit of some types of agricultural R&D that they were previously unable to. As a result, the spillover argument that justified Government investment in these areas of R&D in the past may have been diminished.

Before considering these issues, it is useful to examine the current level of investment in agricultural R&D within the Australian economy. For a number of reasons, Australian agriculture has had a relatively high level of investment in R&D compared to other industry sectors in the economy. In part this is a result of Commonwealth Government policy which provides funding for Commonwealth rural research through agencies such as the CSIRO, and also contributes matching public funds for industry R&D contributions, up to 0.5% of the gross value of production. In addition, State Governments have also traditionally funded significant agricultural R&D portfolios.

Unfortunately, there do not appear to be readily available statistics detailing total public investment in agricultural R&D in Australia. The Industry Commission report of 1995 cited a 1985 study which concluded that public-sector agricultural research amounted to 5.04% of agricultural GDP, the second highest in the OECD.[1]

Available figures for 1992/3 indicate a public-sector investment of 4.6% for that year, in comparison with an OECD average of 2.48%. These figures do not include private R&D investment, which is estimated to have grown from 8% of total Australian agricultural R&D in 1981, to 30% in 1993.[2] As a result, total Australian agricultural R&D investment in 1992/3 may have been in excess of 6% of agricultural GDP, although the level of investment has probably reduced since that time.

## How Relevant are the Statistics?

Irrespective of the figures, aggregate national or industry statistics in relation to R&D expenditure are of limited value for a number of reasons. The first is that definitions of what constitutes R&D differ across national boundaries. The

second and related reason is that different countries provide varying levels of incentives for private investment in R&D, and this, combined with the definitional differences already noted, can result in significant distortions when comparing data between countries. As a result, there is no guarantee that the country with the highest R&D investment level has an optimum level of investment, in terms of the return that investment generates in increased productivity.

Further complicating comparisons is the state of a nation's or industry's economic cycle. All other things being equal, a rapid increase in national or industry GDP will create the impression that R&D investment has declined as a percentage of GDP, and the reverse will apply when an economy or industry sector contracts. Both these situations will distort apparent R&D investment levels.

Of even greater significance, however, are the relative importance of various industries within a national economy, and the significance of R&D investment in each.[3] Economies and industries that do not involve elaborate product transformation are less likely to obtain productivity benefits (more outputs from the same inputs) from high R&D investment than industries or economies relying more heavily on elaborate transformation, such as electronics.

This is reflected at an industry-sector level in Australia. For example, in its Research and Development report of 1995 the Industry Commission highlighted that irrespective of the aggregate national R&D investment figure, in some industry sectors (such as electronics and computing) Australian R&D investment was equal to 8.7% of the value of production.[4] In other sectors such as non-ferrous metals, R&D investment was only 0.36% of the value of production. Both or neither of these levels of R&D investment may be optimum for the relevant industry, despite the apparent large differences in R&D investment levels.

A further complication arises in relation to public R&D funding, because often the objectives are not simply to increase productivity, which is the main motivation for private R&D investment. Often, the objective of publicly funded R&D is to achieve public-good outcomes that are desired by Governments, which typically include environmental and social objectives. If there is a strong bias towards these objectives in public R&D funding policies, an industry with apparently high R&D investment levels may in fact be underinvesting in R&D that could increase industry productivity.

## How much R&D is enough?

Ultimately, questions about the optimum level of investment in R&D for an industry such as agriculture or a nation boil down to some fairly simple economic fundamentals.

The simple, basic rule is that increased investment in R&D is justified while ever each extra dollar invested generates a higher return than could be achieved by investing that dollar elsewhere. At an industry or national level, this crudely means that further R&D investment is appropriate if the returns are higher than the average return on capital for firms in an industry sector, or higher than a measure such as the long-term bond rate.

### Spillovers and externalities

Spillovers and externalities are terms that are used interchangably in discussion about R&D. The terms refer to any unpaid benefit (or unrecompensed cost) from R&D that flows to individuals or organisations other than those undertaking the R&D. The value of the spillover benefits (or costs) of R&D that flow to the broader community are often termed the social returns from R&D.

As a simple example, farmer X may invest resources in trials to find a cheaper and stronger method of constructing farm fences. Even though the farmer's neighbours have not invested in similar research, they could quickly copy any successful outcome from these trials, and hence benefit from the R&D investment, at no cost. In this example the spillover benefit to neighbours – effectively increased productivity - may negate any return on the R&D investment for farmer X. As a result, the R&D is less likely to be carried out privately, even though the end result would be more efficient utilisation of capital by all the farmers, which benefits the nation.

While sounding simple, this "rule" papers over some major problems associated with R&D investment decisions. Perhaps the most obvious is actually quantifying the returns, especially in an industry such as agriculture, which has significant externalities which impact over an extended timeframe. Adding to the complications are problems associated with the inability of an individual farmer to capture the benefits of a successful R&D investment. As the Industry Commission report acknowledged, "the spillovers from rural research are large, and possibly larger than those from industrial research. This could lead to relatively greater underinvestment in rural research, in the absence of government intervention."[5]

In considering this problem, it is also important to remember that spillovers are not restricted to one farmer looking over the fence (intra-industry) and copying a more productive neighbour. Spillovers can also be inter-industry, (improvements in satellite technology improving weather forecasts for farmers), and are often international, with communication innovations perhaps being the greatest contribution to increased spillovers relative to any other technological advance. For example, a major Canadian discovery that enhances livestock reproduction can be understood and copied within weeks in Australia, rather than the years that may have been required for this to occur before modern communication technologies were developed.

## The Role of Government

The research work of Michael Porter is commonly referred to in discussions about national productivity and competitiveness. He considers the role of Government in a most general sense is to "deploy a nations resources (labour and capital) with high and rising levels of productivity.[6] He further explains that "To achieve productivity growth, an economy must be continually upgrading. This requires relentless improvement and innovation in existing industries

and the capacity to compete successfully in new industries." He further comments that "Nations gain advantage not as much from the factors available today… (human resources, knowledge, infrastructure etc.) …as from the presence of unique institutional mechanisms to upgrade them continually".

For a sector such as Australian agriculture that depends so heavily on sales into competitive export markets, the need to relentlessly pursue productivity improvements is doubly critical. The role of Government, based on Porter's conclusions, is to ensure that any barriers preventing innovative upgrading of productive factors in industries are overcome. In the case of agriculture where spillovers are substantial, a key barrier is obviously potential underinvestment in R&D, which is the basic starting point of productive innovations. The nature of spillovers (whether they benefit other industries, or the entire community) should to some extent dictate how Governments overcome them. R&D that has large potential community-wide returns (eg environmental research) should be fully-funded by Government, while shared funding is more appropriate if industry and the wider community are likely to benefit (eg. higher grain yields)

Apart from providing public funds, Governments also have a broad policy role that impacts on firms or industries propensity to invest in R&D. As noted, R&D investment decisions will be influenced by the degree to which the firm or individual is able to capture some or all of the benefits potentially arising.

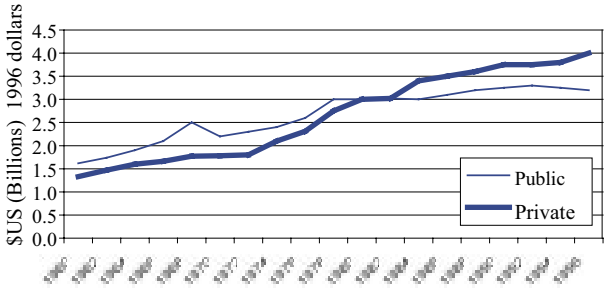
If a firm or individual is not confident of being able to secure the benefits arising from the research, or if property-rights to capital items (such as land) are relatively less secure, then it makes more sense to seek short-term, exploitative gains, rather than to invest in activities that may only provide a return over a much longer timeframe.

## The Impact of Intellectual Property Rights

One example of a Government policy decision reducing spillovers, and thereby encouraging greater private-sector investment in agricultural R&D is the case of Intellectual Property Rights (IPR) legislation in the USA.

IPRs for biological inventions first developed as a result of Plant Variety Rights legislation introduced in the US in 1970. They have been augmented and extended by decisions of the US Supreme Court in 1985 and 1987 enabling patents to be granted for microorganisms, plants and animals. Evidence suggests that these decisions have promoted private sector agricultural R&D investment in the US.[7] Private sector R&D efforts in plant breeding, measured in scientist years, are now more than twice the plant breeding efforts in the public sector. The private sector also owns the majority of plant variety certificates and patents that have been awarded. In addition, private investment in US agricultural research has exceeded public investment since 1980, and is continuing to grow, as the following figure shows.

**Public and private agricultural R&D investment in the USA.** (Source: USDA)




At first glance, these results suggest that the development of IPRs has reduced spillovers to such an extent that the previous level of public agricultural R&D investment is no longer justified. This has been the subject of a substantial investigation by the USDA (admittedly a publicly funded organisation with a substantial agricultural R&D role) and the conclusions of that investigation are relevant to Australian agricultural R&D policy.

The US study concluded that despite the development of IPRs, publicly funded investment in agricultural research aimed at improving productivity has earned an average annual rate of return of 35%, and therefore continues to be a solid public investment.[8] This rate of return was calculated over a large number of R&D projects, and it was also concluded that despite the increasing private-sector investment in agricultural R&D, there was no evidence that returns to public investment were declining. Similar, more recent US analysis of almost 300 studies estimated that average annual rates of return on the R&D investment were 80%, which reduced to 47% when the cost of communicating the results to farmers via rural extension agencies was included.[9] A 1995 Australian study using different methodology found average annual rates of return of between 15 and 40% for Australian agricultural R&D investment, somewhat lower than the US figure.[10]

A second conclusion of the major US research project was that agricultural research continues to require Government involvement for two main reasons. The first is that despite IPR protection, in the plant industry private sector investors have managed to capture as little as 10-12% of the economic benefit of improved varieties, and therefore continue to underinvest. The second is that the public sector has reallocated its efforts into more basic research areas such as the development of technologies that enable advanced genetic manipulation to occur. In effect, the public sector has moved into more fundamental, high-risk research areas that the private sector relies on in much of its research activity.

A third conclusion was that there are many agricultural R&D areas where private investment incentives remain very weak, especially those areas that have significant public-good spillover components. These include basic research into plant and animal genetics and physiology, soil physics and chemistry, water and soil quality, land degradation, climate change issues, ecosystem impacts, human nutrition and diet, and food safety and quality issues. It was also

concluded that the private sector does not fund research to inform public decision-making, such as economic and social studies or the collation of industry statistics.

A further observation arising out of the study related to the changed focus of private research in comparison with that which is publicly funded. For example, it was found that with private investment, the focus for barley industry R&D had shifted to improving the processing characteristics of varieties, rather than improving plant yield. There is also increasing concern being expressed about the propensity of private organisations to develop patented plant varieties that lock farmers into the use of a propriety herbicide or pesticide, and the lack of incentive for chemical companies to develop technologies that reduce the need for pesticides to be used. These issues are of increasing concern as US Universities and State experiment stations have increased their reliance on private-sector funding from 14% in 1978 to 20% in 1994.

One further issue considered was whether continued public-sector agricultural R&D investment "crowds out" increased private sector investment. The USDA report concluded that there is little evidence that public agricultural research crowds out private research and that in fact the opposite may well be the case. There are indications that private R&D investment appears to be occurring more frequently where publicly funded basic research has uncovered new technologies. The report found that in 1992, more than 40% of private agricultural R&D is product development research, whereas less than 7% of public research funds are directed at this type of research.

## The Implications for Australia

There are some significant "spillovers" from these findings about US agricultural R&D investments for Australian policymakers.

The first is the need for a more rigorous analysis of agricultural R&D investment returns by Research and Development corporations, and publicly funded research organisations. There has been a reluctant and somewhat selective approach to this analysis by research organisations in the past, and often what analysis is carried out suffers from the perspective that the organisation is simply "marking its own homework". The level of returns the industry and the community generates from their respective R&D investments is a critical issue in arguing for funding levels in the future.

The second conclusion is that establishing a secure intellectual property-rights regime is obviously a significant stimulus to greater private-sector R&D investment, but it does not automatically follow that public-sector funding of agricultural R&D should be reduced. This is particularly so given the ever-increasing demands by the community for lower-priced food and fibre that is chemical-free, and produced via environmentally friendly production technologies. These are not priorities where benefits will easily be captured by private-sector R&D investment.
August, 2000

***(Footnotes)***

1 Industry Commission (1995). Research and Development. AGPS.

2 Alston et.al. (1998) Financing agricultural R&D in rich countries. AJARE 42(1)

3 Mitchell (1996). Do Australian firms undertake too little R&D? Agenda 3(2).

4 Industry Commission. (1995) op.cit.

5 Industry Commission (1995) op.cit.

6 Porter (1990) The Competitive Advantage of Nations. Macmillan Press.

7 Klotz-Ingram et.al.(1999) The changing Agricultural Research Environment. AgBioForum. 2(1)

8 Fuglie et.al (1996) Agricultural Research and Development: Public and Private investment under alternative markets and institutions. USDA ERS Report 735.

9 Alston et.al (2000)Research returns redux: A meta-analysis of the returns to Agricultural R&D. AJARE 44(2)

10 Mullen & Cox (1995). Returns from research in Australian broadacre agriculture. AJAE. 39(2)

**COMMENTS CONTAINED IN THIS DOCUMENT ARE BASED ON INFORMATION AVAILABLE AT TIME OF PUBLICATION.**

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