R&D: A Good Investment for Australian Agriculture

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This paper was drawn from a paper Mullen gave as President of the *Australian Agricultural and Resource Economics Society* to to the 51st Annual Conference of AARES, February 13 – 16, 2007, Queenstown, NZ but updated using more recent ABS data.

Introduction

In a companion paper, trends in productivity growth in Australian broadacre agriculture were reviewed. It has been growing at a rate of 2.5 percent over several decades with little evidence of a marked slowdown, despite some weakness in recent years associated with drought conditions.

Within the Australian economy, productivity growth in agriculture has been around 3 times that in the economy as a whole and has markedly outpaced the decline in the terms of trade facing farmers over the past 15 years. International comparisons are difficult to make but the evidence available suggests that Australian agriculture has performed well against the agricultural sectors of most other counties.

Taken together, these trends suggest that productivity growth in broadacre agriculture has been at a rate likely to have made the sector more competitive relative to agricultural sectors in other countries, noting that the final outcome is also influenced by trade and farm support policies in these countries and by exchange rate conditions.

An important source of productivity growth has been domestic investment in R&D. The objectives of this paper are to review trends in public investment in R&D, since the public sector remains the largest investor, and to review evidence that the returns from investment in agricultural research remains high.

Trends in Public Investment in R&D

The way in which the data on R&D investment has been assembled from ABS sources and a previous dataset developed by Mullen, Lee and Wrigley (1996) is described in Mullen (2007). R&D expenditure data below relate to financial years, but the convention of referring to the 2002–03 year, for example, as 2003 has been adopted. Expenditure is attributed to research providers, rather than funders. As a result, expenditure by state departments of agriculture or universities, for example, includes funds obtained from rural RDCs. Attention is focussed on farm production research and investment in R&D in fisheries and forestry is not included.

Total public expenditure on agricultural R&D in Australia has grown from A$115 million in 1953 to almost A$690 million in 2005 (in 2004 dollars). Figure 1 shows that expenditure growth was strong to the mid-1970s. The trend in expenditure has essentially been static since that time. As a percentage of total expenditure on R&D, expenditure on agricultural R&D in 2005 was 6.5%. It has declined steadily from 20% in 1982. Expenditure on environmental research throughout the economy has never exceeded 10% of total expenditure and was 5% in 2005.

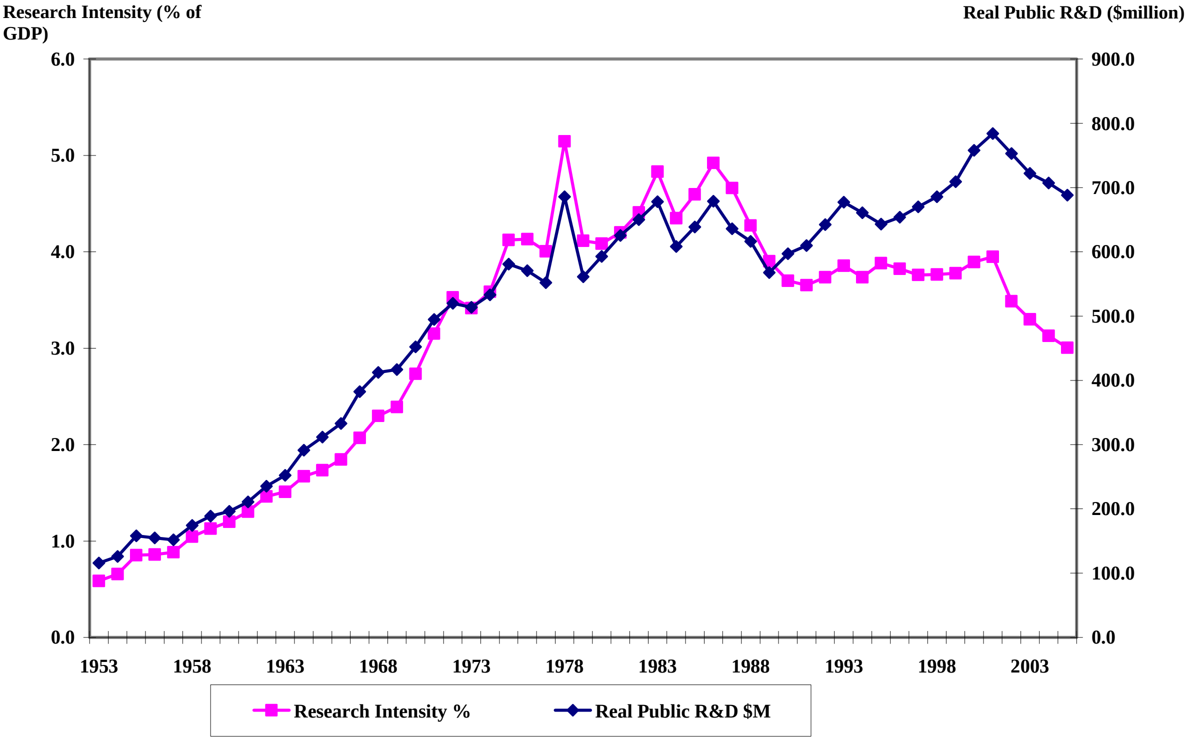

Figure 1: Real public investment and research intensity in Australian agriculture: 1953–2005.
Source: Derived from public financial statements of public research institutions and the ABS

Research intensity is a measure of investment in R&D relative to the size of the agricultural sector, GDP in this case (figure 1). Agricultural R&D intensity grew strongly in the 1950s and 1960s. However, it has been drifting down from about 5% of GDP pa in the period 1978–86 to 3% pa in 2005. Research intensity in Australian agriculture has typically exceeded that in other developed countries (2.6% pa) and is much higher than research intensity in most developing countries.

In Australia, the public sector has always been the dominant provider of research services to the agricultural sector (Figure 2). The private sector has generally been responsible for less than 10% of total agricultural R&D, although its share in 2005 was 16%. This contrasts sharply with other developed countries where agricultural R&D is roughly shared between public and private sectors (Pardey et al. 2006). From ABS data, state organisations, presumably dominated by the state departments of agriculture or their equivalents, have been responsible for about half of all agricultural

R&D in Australia, with the Commonwealth responsible for a quarter and universities, about 15%. From the 2005 ABS survey there was evidence that more research is being undertaken by universities and the private sector, and less by state and Australian government organisations. The share of agricultural R&D undertaken by states has declined to 38%. This structural change was noted by the Federation of Australian Scientific and Technological Societies (June 2007). FASTS was particularly concerned about a decline in support for science R&D relative to other broad areas of research such as medical and health research, engineering and technology R&D and R&D in humanities and social science.

The focus of this paper is on publicly funded agricultural research.

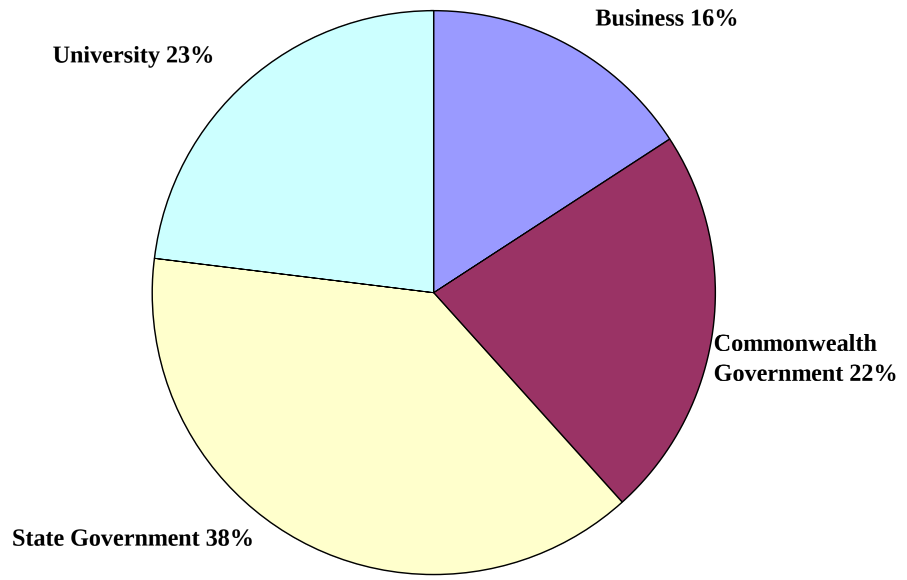

Figure 2: Expenditure shares of agricultural R&D in Australia by providers of research services: 2004–05.
Source: Adapted from ABS sources (8112.0), various years

For most of the 1990s, expenditure on plant and animal R&D was similar, but by 2005 it was a third as much again as that on animal R&D. Perhaps this partly reflects the growing importance of the Grains Research and Development Corporation (GRDC) as a source of funds. During the 1980s, the share of total RDC funding from the GRDC was under 20%, but by 2001 it had risen to 30% before declining to 23% in 2005.[1] The leading state for the location of public agricultural R&D in 2005 was Victoria, followed by NSW and Queensland (similar amounts).

A recent international review of agricultural R&D by Pardey et al. (2006) found that public investment in agricultural R&D in real dollars (2000 international dollars) had only risen from A$15.2 billion in 1981 to about A$23 billion in 2000. Expenditure on agricultural R&D in 2000 in developing countries (55.7% share of total) exceeded

[1] Research levies are generally related to output value.

that in developed countries – with China, India and Brazil emerging as major investors. Public research intensity in developed countries was 2.4% pa and total agricultural research intensity was about 5.2% pa. Research intensity in less developed countries was often very low, such that average public research intensity in developing countries was 0.53% pa. By 2000, about a third of all agricultural R&D was undertaken in the private sector, but little of this was in developing countries. The world's poorest countries are still dependent on technology spillovers from rich countries both individually and collectively, through the CGIAR system and through organisations such as Australia's ACIAR.

A feature of the agricultural research sector in Australia has been the prominent role played by what are now known as the RDCs. In approximate terms, RDCs commission agricultural research on a competitive basis amongst public and private research providers using funds from levies on production and matching Commonwealth grants (up to 0.5% of the value of production). The attraction of the RDC system is that it ameliorates the non-excludability characteristic of information generated by research, while preserving the benefits from its non-rival nature.

In 2005, total expenditure by the RDCs was A$511 million (nominal), which is over half the total public expenditure on agricultural R&D, although, it probably overstates RDC funding for agricultural research because some of these funds were used to fund research of a non-production nature, such as research into processing or environmental areas. Recall also that less than half of total RDC funds are raised from farmers (because of the predominant Federal funding of the LWA for example). In the 1980s, RDC funding only amounted to about 15% of total public expenditure on agricultural R&D.

Returns from Investment in Research

In the companion paper on trends in productivity in Australian agriculture (and reported in detail in Mullen (2007)), the real value of agricultural output since 1953 was decomposed into components associated with traditional inputs, growth from investments in public infrastructure such as transport and communications and technical change from R&D both domestic and international. The long-term trend in productivity for broadacre agriculture in Australia is in the vicinity of 2.5 percent per annum. Acknowledging its speculative nature, perhaps up to 0.5 percent per annum can be attributed to factors such as public infrastructure and the education levels of farms. Perhaps the remaining 2 percent can be attributed to technical change, arising from public and private investments in research and extension where a significant component of both activities is related to the adaptation of foreign knowledge spillins. Mullen speculated that domestic R&D activities may be directly responsible for productivity growth in the order of 1.2 percent per annum and foreign spillins for 0.8 percent per annum – a 60:40 split.

For this scenario the contribution of domestic research is particularly significant. Almost half the value of output in 2003 can be attributed to new technology generated by domestic research since 1953. Were it not for domestic research the real value of output would have contracted from about $35b to less than $20b in 2003 which serves to highlight the importance of domestic R&D in maintaining output levels. At a real rate of interest of 4 percent, the compound value of the stream of benefits from domestic research (1.2 percent) from 1953–2003 is A$878 billion (in 2004 dollars).

The compound value of public investment in research between 1953 and 2003 was A$64.5 billion and the estimated total back to 1918 was A$77.4 billion (in 2004 dollars). Mullen (2002) estimated that private R&D in Australia and public extension expenditure might add a further 40 percent to domestic R&D investment, giving a total of A$90.3 billion since 1953 and A$108 billion since 1918 (in 2004 dollars).

Two scenarios for investment analysis relate Australian R&D investment first, to productivity growth at the rate of 2.0 percent per annum and second, to productivity growth at the rate of 1.2 percent per annum. These scenarios 'bracket' the potential benefits from domestic research. Under the first scenario, domestic research generates productivity gains of only 1.2 percent and some productivity gains, 0.8 percent, are picked up from foreign sources without any domestic mediation. It is more likely the case that some domestic research is required to capture the benefits from foreign spillovers. Hence under the second scenario, domestic research is required to capture any of these foreign benefits, and domestic R&D can lay claim to the whole 2.0 percent gain.

Note that for these benefit-cost scenarios, only benefits between 1953 and 2003 were recognised, a conservative approach particularly with respect to the flow of future benefits. Costs between 1918 and 2003 were recognised to allow the estimation of IRRs. Results are sensitive to this assumption.

Under the most optimistic scenario where all productivity gains at the rate of 2.0 percent are attributed to domestic research investments made since 1918, the internal rate of return (IRR) is 17 percent and the benefit-cost ratio (discount rate of 4 percent) is 17:1 (Table 1). If it is assumed that productivity gains from domestic public and private research and extension result in productivity gains of 1.2 percent then the IRR is 15 percent and the benefit-cost ratio is 8:1.

All estimated IRRs are within the range suggested by Mullen and Cox (1995), although at the lower end of this range.

Table 1: Rates of return to research in Australian agriculture.

Scenario:	Benefit-Cost Ratio	IRR
Productivity growth @ 2.0%:		
(a) Public research only		
R&D from 1918-2003	17.0	17%
R&D from 1953-2003	20.5	
(b) Public + private research + extension		
R&D from 1918-2003	12.2	16%
R&D from 1953-2003	14.6	
Productivity growth @ 1.2%:		
(a) Public research only		
R&D from 1918-2003	11.3	16%
R&D from 1953-2003	13.6	
(b) Public + private research + extension		
R&D from 1918-2003	8.1	15%
R&D from 1953-2003	9.7	

Supporting Evidence

Although based on empirical estimates of productivity growth, the benefit cost scenarios are based on a somewhat subjective decomposition of this growth. The conclusion that investment in R&D has earned returns in excess of 15 percent per annum is supported by econometric analysis at an aggregate level and by a multitude of project level benefit cost analyses. There has been no systematic review of these project level studies but Mullen (2004) and Raitzer and Lindner (2005) review a limited sample of Australian studies.

Mullen (2007) reviewed previous econometric analyses and reported recent research of his own. Extending earlier research (Mullen and Cox, 1995), the econometric model used by Mullen (2007) related growth in TFP to a stock of knowledge available to farmers, the level of education of farmers, the terms of trade, seasonal conditions and investment in extension. Research is likely to have an impact on TFP over many years. The two alternatives considered by Mullen were a knowledge stock based on the previous 16 years of research investment and one based on the previous 35 years of investment.

He concluded that the returns on investment are likely to have remained within the 15- 40 percent per annum range estimated by Mullen and Cox (1995). The lower returns are associated with a 35 year lag model and the higher returns with a 16 year lag model estimated for the period since 1969.

More strongly, the results presented here suggest no evidence that the returns from agricultural research are likely to decline markedly either as investment increases or over time because of diminished research opportunities. In view of this, every effort should be made to preserve the current rate of investment, irrespective of how the ongoing debate about the extent of public funding is resolved.

Concluding Comments

While productivity growth has remained high, public investment in agricultural research in Australia has been static ($700m in 2004 dollars) for two decades and research intensity has declined. Meanwhile the research sector has continued to evolve both in terms of where investments are made and how they are managed. ABS statistics reveal a shift in research resources to plant industries from animal industries which may underpin average broadacre productivity growth given the observed higher rates of productivity growth in the cropping industries. The increasing importance of funding through RDCs and CRCs may well mean that a greater proportion of research investment is of an applied nature, boosting productivity growth in the short run but perhaps at the expense of growth in the longer term.

In my view investment in agricultural research, at least over the range in investment levels experienced from 1953 to 2003, has earned moderately high rates of return and there is little evidence the rates of return are likely to decline markedly either as investment increases or over time because of diminished research opportunities. Hence a safe policy option is to maintain current levels of investment in research.

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