Recruiting and Managing Research Scientists in the Australian Rural Sector

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Abstract

The Rural Industry Research Corporation (RIRC) sector, is a significant and unique part of the Australian investment in research, development and innovation. It directly funds or influences, through leverage, 8 to 10 percent of Australian investment in R & D. Rural Industries and, more recently, the RIRCs have taken a proactive approach to recruiting, developing and managing the intellectual capacity of their particular industries for the past 25 years. This has most commonly taken the form of postgraduate scholarships for research training. A longitudinal study of the destination and effectiveness of postgraduate scholars in one RIRC, Meat and Livestock Australia (and its predecessors) has revealed a very high completion rate (98%) of postgraduate study and a subsequent retention rate within the meat and associated industries of 80%.

The quality of the science research output from the rural industries using these programs to recruit and train researchers is examined on a sector and discipline basis. The principal research disciplines of Agricultural Science and Plant and Animal Sciences were ranked in the top 5 for both relative output and impact, producing at about twice the average rate for Australian disciplines. At the same time Australian agricultural scientists servicing the rural industries have long had a strong presence and consequent diaspora in international agriculture. This disapora has been informally managed in an effective manner through the strong national and international networks within the clearly defined field of Agricultural Science. As the boundaries of Agricultural Science become more blurred with the emergence of new disciplines such as Molecular Biology and Information Technology a more proactive approach to managing this diaspora will be required.

Therefore, in this increasingly globalised science world and, in spite of the apparent success of this sector in managing its intellectual capacity, there is a strong case for the rural industry sector to participate in any initiatives to manage the intellectual capacity of Australian science and particularly its diaspora.

Introduction

The Rural Industry Research Corporation (RIRC) sector is a significant and unique part of the Australian investment in research, development and innovation. It directly funds or influences, through leverage, 8 to 10 percent of Australian investment in Research and Development (R&D). The RIRC model is unique in that it is supported by industry (farmer and processor) funding levies matched by government subsidy. This funding partnership has led to several unique characteristics of the sector, particularly in the approaches it has taken to the recruitment, training and management of researchers within the sector.

The Agricultural Science sector of the Australian Science and Technology (S & T) community traditionally has had a very active and diverse diaspora for a number of historic, scientific and economic reasons. Historically, the development of agricultural industries

capable of delivering largely perishable products to very distant markets in a challenging and unfamiliar environment, has necessitated the development of unique scientific and technological techniques and products. These have included the discovery of the micro-nutrient requirement of soils for plant growth, the domestication of a number of plant species such as lupins and subterranean clover, and technological developments such as refrigeration and the combine harvester. The success of Australian agriculture in utilising S & T to become a major exporter of both goods and services from these unique and challenging circumstances has gained the Australian agriculturalist an enviable reputation internationally. Consequently, this has produced a strong and vibrant flow of agricultural scientists both into and out of Australia for a considerable time, due to the very international nature of the industry, and ending in a considerable diaspora. Australian agriculturalists have and do operate in all areas of research, education, policy and consulting outside of Australia and have frequently taken leadership positions. As a result of the international nature of the agricultural community the rural industries have always seen the need to recruit high quality researchers into their industries.

Evolution of the RIRC Model

Australia's Commonwealth and State Governments have had a long involvement in helping primary industries undertake activities for the common good of their members. These activities include the development of markets, promotion of sales, R&D, information collection and distribution, and various other programs including environmental protection and sustainable development (CIE 2003).

The first such arrangement for rural R&D was established in 1936 for the wool industry under which the government introduced a compulsory industry levy that helped fund both wool promotion and wool research. It was also for the wool industry that the Commonwealth first matched industry levy moneys on a one-for-one basis — in 1945 for wool promotion and in 1953 for research. Between 1955 and 1982 separate statutory rural R&D schemes, with matched industry and Commonwealth contributions, were established for many other industries. For constitutional reasons, levies had to operate under Commonwealth legislation, though in many cases, funds were disbursed to state-based R&D committees that established their own R&D agendas.

In 1985, the various funding arrangements were amalgamated into a single piece of Commonwealth legislation under the Rural Industry Research Act. The first of the newer style RIRCs, the Meat Research Corporation, was formed at that time. The statutory RIRC model was established across the board in 1989 through the passing of the *Primary Industries and Energy Research and Development (PIERD) Act*, with a view to the various bodies that allocated R&D funds becoming commercial investors in and brokers of R&D on behalf of industry, with transparent accountability to both industry and government.

The 4 broad objectives for the statutory RIRCs established under the PIERD Act, are to:

- Increase the economic, environmental and social benefits to members of primary industries and to the community in general by improving the production, processing, storage, transport or marketing of the products of primary industries;
- Achieve the sustainable use and sustainable management of primary industries;
- Make more effective use of the resources and skills of the community in general and scientific community in particular; and
- Improve accountability for expenditure upon R&D activities in relation to primary industries.

Nine RIRCs are currently constituted under the PIERD Act.

- Cotton Research and Development Corporation (CRDC);
- Fisheries Research and Development Corporation (FRDC);
- Forest and Wood Products Research and Development Corporation (FWPRDC);

- Grains Research and Development Corporation (GRDC);
- Grape and Wine Research and Development Corporation (GWRDC);
- Land & Water Australia (LWA);
- Rural Industries Research and Development Corporation (RIRDC);
- Sugar Research and Development Corporation (SRDC); and
- Tobacco Research and Development Corporation (TRDC), which is expected to join Horticulture Australia Limited (an industry-owned RRDC, see below) in the near future.

Since 1997 six of the RIRCs established under the PIERD Act have been transformed into industry-owned corporations (IOCs) under which R&D is more closely integrated with market development. Industry-owned RIRCs have been established progressively since the formation of Meat and Livestock Australia (MLA) in 1997, with the two most recent – the Australian Egg Corporation (AEC) and Dairy Australia (DA) - coming into existence in 2003. The IOCs emerged largely from those industries where there had previously been a statutory marketing authority with a parallel statutory RIRC. Their strategic and operational planning for R&D therefore becomes more closely integrated with their planning for marketing. However, the constitution for Australian Wool Innovation (AWI) does not provide for any marketing role, while the constitutions for Australian Pork Limited (APL) and the Australian Egg Corporation (AEC) provide for overall strategic planning for the industry. The six RIRCs are:

- Australian Egg Corporation (AEC) whose R&D activities had previously been handled by RIRDC;
- Australian Pork Limited (APL);
- Australian Wool Innovation (AWI) Pty Ltd;
- Dairy Australia (DA);
- Horticulture Australia Limited (HAL); and
- Meat and Livestock Australia (MLA).

The RIRC model, its evolution, development and current operation has been described recently in some detail in a report by the Centre for International Economics (CIE 2003) for the Department of Education, Science and Training (DEST).

RIRC Investment in Research and Development

- Since its inception in 1985, RIRC investment in R & D has grown steadily to reach $454 million in the 2002-3 financial year. A full breakdown of the investment in 2001-2 is shown in Table 1.
- The RIRCs - through research partnership arrangements with State Government Departments, Universities, CSIRO and Cooperative Research Centres (CRCs) - leverage further R & D investments equivalent to their own, resulting in a total annual investment controlled by the RIRCs equivalent to $900 to $1000 million. This constitutes about 8 to 10 percent of the total annual Australian investment in R&D.
- A feature of the RIRC model has been its planning processes leading to the development of detailed strategic R & D plans with time horizons of 5 years and in some cases longer (CIE 2003).

The relatively specialised nature of this research and more frequently its non-urban location have led the rural industries to pay particular attention to the recruitment, training and management of its human capacity in research.

Table 1. Size of industry and Commonwealth contributions to total RIRC expenditures in 2001-02

RIRC	Industry contribution	Commonwealth contribution	Total expenditure [a]
	$ million		
Cotton RDC	6.1	7.2	14.6
Australian Dairy Corporation [b]	36.5	15.4	51.9
Fisheries RDC	6.7	15.8	20.4
Forest and Wood Products RDC	3.4	3.3	7.0
Grains RDC	63.2	40.8	113.8
Grape and Wine RDC	6.6	5.8	12.4
Land & Water Australia		11.6	23.9 [c]
Rural Industries RDC [d]	4.7	15.3	22.5
Sugar RDC	4.1	7.0	10.5
Tobacco RDC	0.475	0.235	0.937
Meat and Livestock Australia	18.7	22.9	45.7
Horticulture Australia Limited	22.8	26.2	45.2
Australian Wool Innovation Pty Ltd	53.7	14.4	31.8
Australian Pork Limited	3.5	3.7	7.4
Total	208.9	195.5	391.5

a Includes some other sources, and not all contributions in the year may be expended
b Precursor of the current Dairy Australia
c Mostly from the Commonwealth
d Includes eggs, now covered by the Australian Egg Corporation

Source: Agriculture, Fisheries and Forestry Australia (AFFA) (2002)

Intellectual Capital Audits are an Essential Part of the RIRCs R & D Planning Processes

With the development of each new Strategic R & D plan some RIRCs have undertaken audits of the intellectual capital available to the particular corporation to implement the planned research. These audits have varied in form from quantitative analysis of current intellectual capacity in the light of future needs to more qualitative analysis of strengths in particular disciplines with the Australian higher education sector and CSIRO.

Dairy Australia is currently undertaking a Dairy Industry R&D Capability Planning project that incorporates an audit. The former Meat Research Corporation, now an industry-owned corporation Meat and Livestock Australia has undertaken 2 quantitative audits in the past decade, the first in 1992, and another more recently in 2001. Both audits have identified deficiencies in intellectual capacity in particular areas of research interest for MLA. In particular the 2002 audit identified the following areas of concern:

- Deficiencies in Intellectual Capacity (IC) by the year 2020 have been predicted in the following discipline areas as a result of an analysis of supply and future demand.
- Animal Health, Animal Production and Plant Sciences.
- Intellectual Capacity (IC) is considered to be a likely constraint to industry activity and development in the next 2 decades in the absence of proactive measures to address deficiencies.
- It is estimated that approximately 600 additional postgraduates will be needed over the next 20 years to meet IC needs to 2020.

The largest RIRC, the Grains Research and Development Corporation (GRDC) has qualitatively identified current areas of deficiency in particular disciplines and sub-disciplines within Australian universities and subsequently funded 5 Chairs in these disciplines within the universities (GRDC 2003).

The RIRCs Commitment to the Development of Intellectual Capacity and Leadership within their Industry Sectors

Postgraduate Research Training

The RIRCs and their predecessors have traditionally been strongly committed to the development of intellectual capacity within their industries, largely through the support of postgraduate research training. These programs, their objectives and an evaluation of their effectiveness are discussed in later sections. Ironically these programs began before Australian universities were offering comprehensive postgraduate research training. The early postgraduate awards in the wool and meat industries enabled Australian students to complete postgraduate research degrees overseas, leading in some cases to the beginning of the 'Australian Diaspora'. With the development of postgraduate research programs in science and economics within Australian universities in the 1950s and 1960s, the RIRC postgraduate scholarships became more strongly focused on Australian universities.

The RIRCs have maintained this long-term commitment to research training and most now have ongoing postgraduate scholarship programs. As the Commonwealth has developed its own generic postgraduate scholarship programs the RIRCs have, if anything, intensified their interest in postgraduate research training. An important strategy behind these moves has been the perceived need by the rural industries to ensure that they recruit and maintain the best students as researchers within the rural industry sector. As the Australian university sector has become larger and more diversified, the need for this recruitment strategy has become correspondingly greater.

Although postgraduate scholarship programs do vary within individual RIRCs, the general features of these programs are:

- scholarships awarded on both merit and targeted basis;
- merit scholarships are used as an important strategy to recruit high quality students into the industry;
- targeted scholarships are used to ensure researchers are available in priority discipline areas where deficiencies exist;
- scholarships can be tenable both inside Australia and outside where special skills are required;
- scholarship stipends are paid at the Australian Postgraduate Research Award (APRA) industry rate or considerably above; and
- in general scholarships are not bonded.

In some cases, top-up scholarships to the APRA awards are offered to outstanding students in priority areas of need. This allows the Corporations to maximise the funds available for postgraduate scholarships.

RIRCs also seek to develop leaders within Industries

More recently this investment in the development of Intellectual Capacity and leadership within rural industries has become broader following a number of initiatives to promote more general education and specifically leadership. There are a wide range of individual programs within the RIRCs in these areas. The following are examples of comprehensive programs across a number of RIRCs that the Rural Industries Research and Development Corporation has initiated, developed and managed.

Cooperative Venture on Capacity Building for Innovation in Rural Industries- led by RIRDC

The Cooperative Venture on Capacity Building for Innovation in Rural Industries was established in 2001 by R&D corporations to enhance capacity building in rural industries in Australia. It invests in R&D that focuses on: enhancing the understanding of learning; improving organisational arrangements to support rural human capacity building; and inspiring innovative farming practices.

The Rural Industries Research and Development Corporation manages the Cooperative Venture on behalf of Agriculture, Fisheries and Forestry Australia; Meat & Livestock Australia; Dairy Research and Development Corporation; Land & Water Australia; Murray-Darling Basin Commission; Grains Research and Development Corporation; Sugar Research and Development Corporation; and the Grape and Wine Research and Development Corporation. The Cooperative Venture offers its participants a unique opportunity to become part of a powerful network involving rural R&D industry corporations and Commonwealth agencies. Each participant can learn from the experience of the others, as well as contribute the benefit of their experience.

Australian Rural Leadership Foundation

In order to meet the national need for strong and enlightened leadership of and within rural industries, the Rural Industries Research and Development Corporation initiated and developed a sophisticated national leadership program for rural Australians in the early 1990s. The 2-year program for rural community and industry leaders selects 32 participants each year for a comprehensive leadership program that begins in the Kimberly and culminates in an extended study of markets in one of Australia's major trading partner countries.

The sponsorship for individual competitive scholarships that support the participants is funded by the RIRCs as well as by government and industry. Graduates from this program have formed an extensive and effective network leading the future directions of rural Australia.

Effectiveness of RIRC Recruitment and Management Strategies

The effectiveness of the investment in intellectual capacity has received less evaluation. However, the extended history of these postgraduate programs in well-defined industries does provide an excellent opportunity to evaluate the effectiveness of these research scientist recruitment strategies. Two excellent studies have been commissioned in the meat research sector. The first by the Meat Research Corporation in 1992 (Russell et al) was comprehensive and covered the effectiveness of education investment from 1965 to 1990. The second, commissioned by Meat and Livestock Australia in 2001 (Entwistle 2001), covered the overlapping period from 1975 to 2000 and was confined to a review of MLA postgraduate programs 1975-2000. Broadly the outcomes of the studies were very similar, and therefore the discussion will focus on the more recent Entwistle study that sought to determine:

- postgraduate scholars remaining in the industry;
- relative impact of these scholars;
- effectiveness of stipend as a recruitment mechanism;
- Merit vs Targeted areas; and
- overall effectiveness of the program.

The findings of this study provide an interesting insight into the outcomes of a postgraduate recruitment and training program over a quarter of a century. Although these studies are restricted to the Meat and Livestock industries it is likely that similar long-term programs in the wool and wheat industries have achieved comparable outcomes.

This MLA study found that approximately 200 postgraduate students had been supported in the 25-year period from 1975-2000, of which 167 were traceable. The principle findings of the study were:

- 80% of the students studied in Australia;
- 70% enrolled in a PhD;
- 75% of scholarships were awarded on a merit rather than targeted basis;
- 98% of students successfully completed their studies;
- a high retention rate of 80% of awardees are currently employed in meat industries or Australian agriculture; and
- 75 % of awardees were adjudged to have made high-level contributions to the industry during their career.

This MLA evaluation concluded that the postgraduate scholarship program was a very important and effective method of recruitment and retention of researchers into the meat and livestock industries. The study also revealed the importance of offering merit scholarship stipends above the general Australian Postgraduate Research Award (APRA) to attract high quality students from related disciplines outside agriculture. More than 50% of postgraduate students undertaking PhDs in agriculture faculties were supported by RIRC scholarships. Both this study and the earlier study (Russell et al 1992) concluded that there would be an under supply of researchers for rural industries if the RIRC scholarship schemes were not in existence.

Research Performance of the Sector

The above studies have demonstrated the effectiveness of the postgraduate training schemes in recruiting and retaining researchers within rural industries. As more than 80% of the postgraduates were training at Australian universities, it is important to ask what is the performance of this research sector that is relying on domestic graduates? What is the quality of the research output of the rural industry sector that is largely supported by the RIRCs?

In an industry sector there are a number of indices that may be used to evaluate the effectiveness of the research undertaken. At the macro level this can be evaluated by:

- portfolio economic analysis of returns to investment;

- comparisons of industry performance in relation to our OECD competitors; and
- international comparisons of quantity and quality of scientific research.

Economic Analysis or Returns on Investment

The accountability of the RIRCs to government, because of the matching R &D funds provided by government, has resulted in the constant evaluation of the effectiveness of this research investment. There have been numerous studies of returns on this R &D investment at the project, program and portfolio carried out by individual RIRCs that have been reported elsewhere. For instance an economic analysis of the Grains Research and Development Corporation's investment indicated that grains R&D is delivering an overall benefit to cost ratio of 6.6, based on conservative assumptions. When account is taken of benefits flowing to off-farm, the benefit to cost ratio increases to 7.8. This equates to a net present value of about $3 billion flowing to the wider community through grains R&D (GRDC Annual Report 2002-3).

The Rural Industries Research and Development Corporation's analysis of returns from research and development for established agricultural industries found that most projects provided a rate of return in excess of the strategic plan performance target of 25 per cent. The equivalent range for the benefit–cost ratios was 0.8 to 120 (discount rate of 5 per cent) and most being greater than the performance target of 10. By comparison, most projects in the Emerging Industries evaluation in 1997/98 were found to have provided a rate of return in excess of the 20 per cent target. The equivalent range for the benefit–cost ratios was 0 to 11.8 (discount rate of 8 per cent) and the majority were greater than the performance target of 5 (RIRDC Annual Report 1998-9). In a specific analysis of returns from research and development for the rice industry, the average net benefit to investment ratio (NBIR) for the projects evaluated was about 40 with a range from 9 to 99. The average internal rate of return (IRR) was about 100% with a range from 45 per cent to 180 per cent (RIRDC 2003 Annual Report).

While it is not easy to develop satisfactory techniques for measuring these returns and any such technique involves a range of assumptions which influences the final conclusions, these results compare well with the cost-benefit studies of agricultural research productivity that have been made in Australia and overseas. These have concluded that the annual internal rate of return generally varies between 20 and 80 per cent (Tribe and Peel 2001). In general, these evaluations have found returns on R & D investment are excellent when compared with the 10% returns required by the investment of public funds.

Numerous studies of individual programs within the RIRCs have been undertaken using cost/benefit analysis to generally indicate that the returns to investment are excellent. However, it is not the intention of this paper either to analyse these in detail or to undertake detailed comparisons of industry performance because these measures include factors other than innovation.

Quality and Impact of the Science

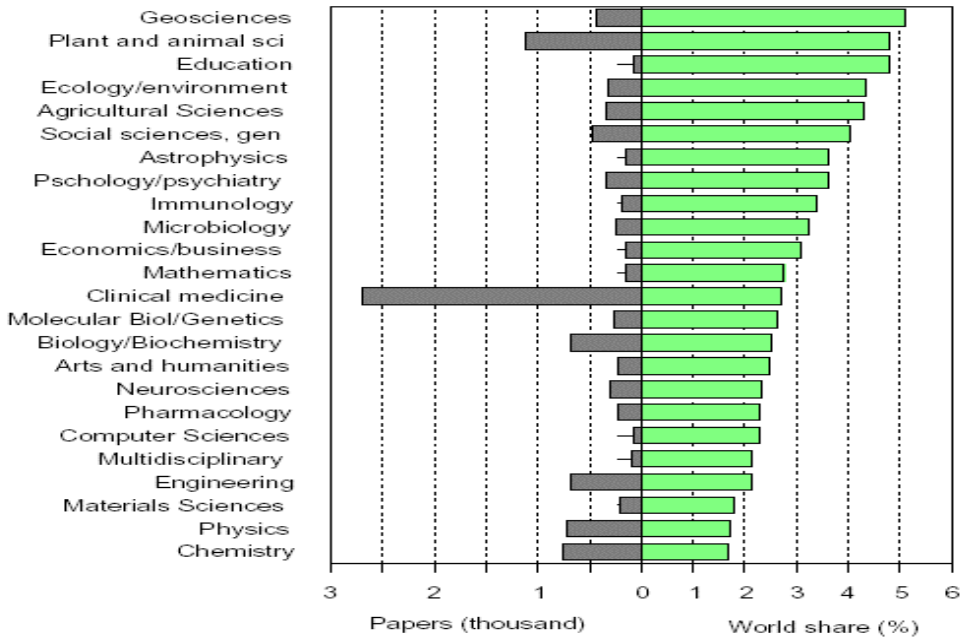
An examination of the science quality is a more appropriate measure of the research output in this case. In terms of science output, impact and innovation (measured by patents) the Australian agricultural research sector performs well compared with other science disciplines (Figure 1). The 2 particular disciplines of Plant and Animal Sciences and Agricultural Sciences rank in the top 5 Australian disciplines in terms of output, producing 4 % of the world's publications in these disciplines, which is twice the national rate (2 %). The sector also makes some contribution to the ecology and environment discipline that is also ranked in the top 5, producing 4% of world output.

The impact of these disciplines relative to the rest of world output is equally impressive with all 3 disciplines of plant and animal sciences and agricultural sciences ranking in the top 5 disciplines in Australia and having an impact greater than the world average.

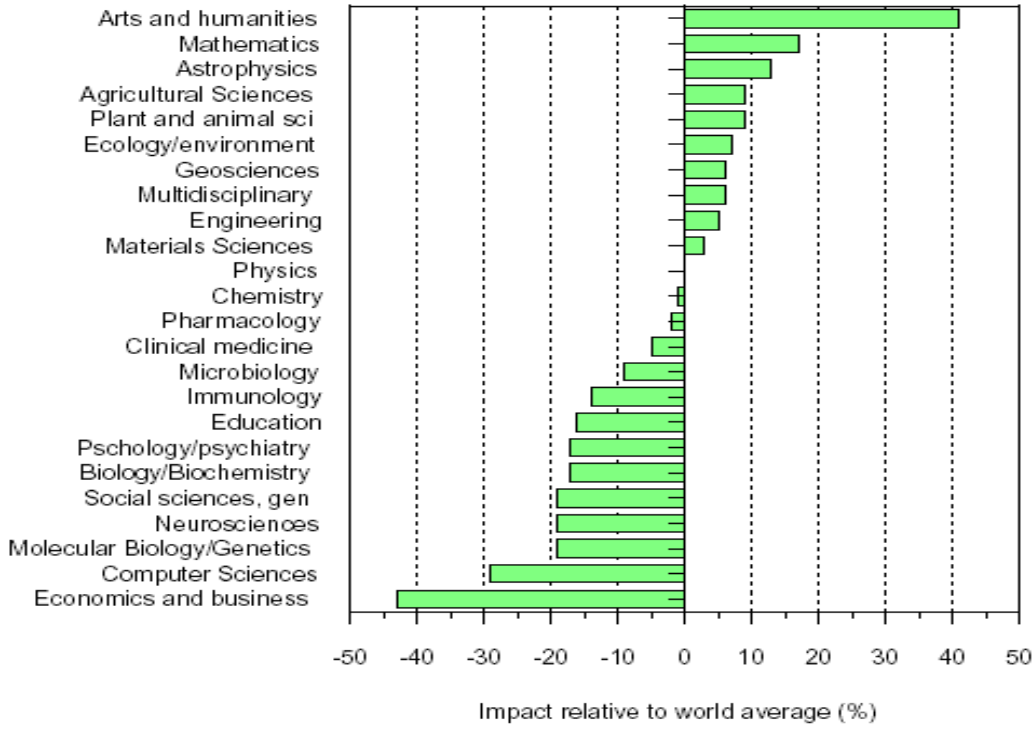
The success of the rural industry sector by definition and practice is strongly related to research applications because these industries have had to be globally competitive

Figure 1: Australian Research Performance by discipline in the period 1992-97 relative to world output (a) and research impact (b)

World Output (a)



Research Impact (b)



Source: DEST - S &T 2002 Statistics- -derived from ISI data (DEST 2002)

as domestic protection has been systematically removed. Concurrently, subsidies are provided to agricultural industries in our major OECD trading partners and competitors – the United States of America and the European Union. Consequently, the sector has had to make productivity gains to remain globally competitive, as well as develop exporting opportunities for services, agricultural commodities and their derivative manufactured products.

Therefore the commercialisation of agricultural science products and innovations is another measure of the quality of the research output from the sector. In the period 1980 to 2002 agriculture produced about 50% more US patents than any other industry sector (Figure 2).

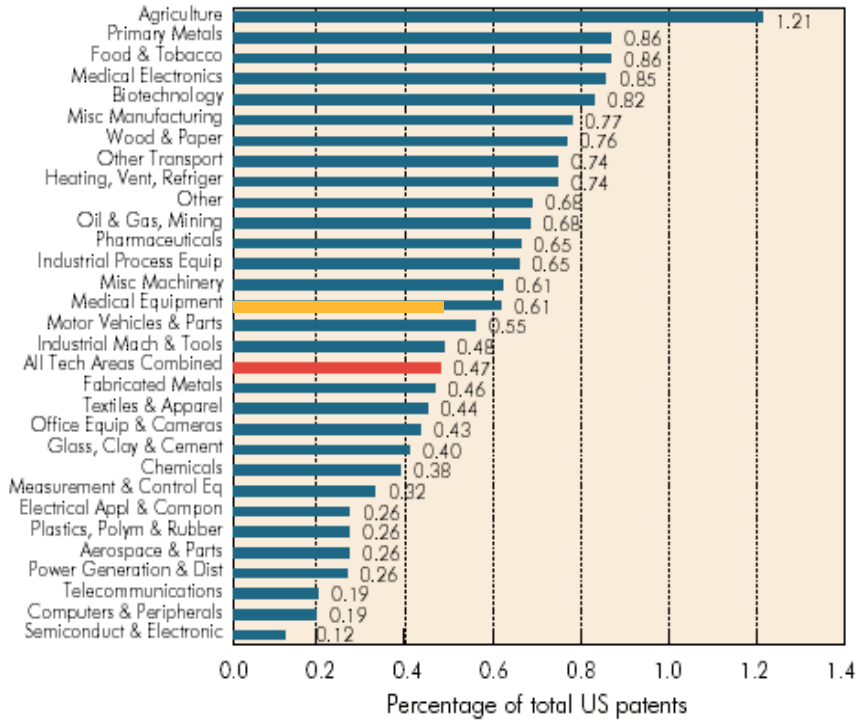
In this 20-year period that parallels the period of postgraduate support, agriculture produced 1.2 % of all US patents whereas the average for all technological areas in Australia combined was 0.47 %. This performance has implications for both the quality of the research scientists involved and the context in which they received their education. The close relationship with industry mandated in the governance and planning processes of the RIRCs (CIE 2003) results in an industry context for postgraduate education that may favour later commercialisation of research through patents.

Future Implications for RIRC performance

Agriculture together with mining has been a pioneer of the applications of science and technology to Australian industry. Before the general introduction of PhD programs in Australian universities in the middle of last century, the recruitment and training of intellectual capacity often involved support for overseas postgraduate training. In the 21st century this is no longer the case except for some particularly specialised areas of science.

The evidence is strong that these postgraduate and postdoctoral recruitment and training programs have been very effective at both recruiting and retaining researchers within the particular industry, and

Figure 2 *-Australia's Share of US Patent and Trademark Office (USPTO) Patents 1980-2002 by industry group*



Source: DEST – S & T Statistics – CHI, International Technology Indicators Database, 1980- 2002 (DEST 2003)

agriculture in general. As a result the RIRCs are strongly committed to these intellectual capacity building-programs. However, the high retention rates of researchers may have a downside if not managed appropriately in an increasingly globalised science community. If there is little postdoctoral cross fertilisation in the intellectual research capacity of particular industries there is a chance that that industry may not appropriately harvest the other 95 plus percent of new knowledge in that particular field. Research managers may well have to address this possibility.

This opportunity may arise sooner rather than later because there is a large cohort of postgraduate students currently in training or finishing, as a result of a large number of rural industry CRCs. Although there does not appear to an oversupply of researchers at the current time, this could happen in the near future leading to the distinct possibility of some movement of postdoctoral scientists overseas.

Rural industries have been managing their Agricultural Science diaspora for a considerable period. This diaspora is predominately involved in international agricultural science through international aid agencies such as the United Nations and its Food and Agricultural Organisation (FAO), international agricultural research institutes, consulting firms, agribusiness and academia. A feature of this informal management has been the strong national and international networks within rural industries and the willingness of host organisations to be generous in their leave provisions. However despite the very worthwhile goals of these international development programs, the Australians working for long periods in this sector tend to remain there rather than returning to make large contributions to Australian science, technology and innovation within our rural industries. When this has occurred the losses have been balanced by successful recruitment overseas of experienced and eminent scientists to fill identified deficiencies within the rural industry-related disciplines and sub disciplines. The best recent examples of this are the overseas recruitment to 5 GRDC university Chairs in identified areas of deficiency (GRDC 2003).

In an ever changing and increasingly globalised world there are good reasons to believe that the Australian Agricultural Science diaspora may benefit from more proactive management in the future. Agricultural science is increasingly dependent on the emerging disciplines such as Molecular Biology and Information Technology that are not embedded within the traditional agricultural networks. The trend to absorb and incorporate Agricultural Faculties within Science Faculties in Australian universities will further dilute and weaken the agricultural networks and therefore the informal management of the diaspora.

In summary, the RIRCs have evolved very effective recruitment, development and management of intellectual capacity within their particular industries. However, in an increasingly globalised world where cross and multidisciplinary science is becoming increasingly important, the agiculutural sector through the RIRCs should be a participant in any national endeavours to manage Australia's SET personnel and particularly its considerable diaspora.

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Footnote

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PART 4

EARLY CAREER RESEARCHER, EXPATRIATE AND HUMAN RESOURCE PERSPECTIVES