Recent trends in Australian tertiary agricultural science education

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Introduction

Although in the last decade the Australian economy has been dominated by a buoyant mining sector the agricultural sector still makes a significant contribution. In 2013-14 farm production was valued at AU$51 b with AU$41 b exported and 270,000 people were employed in the sector (Australian Government 2015).

More recently, the Australian mining sector has matured, particularly as it moves from the development of new mining projects to production. Public and policy discussion has considered the reinvigoration of agricultural exports with phrases such as "moving from the mining to the dining boom".[1] Importantly, the Australian Government has considered issues in and around the agricultural sector with Green and White Papers on Agricultural Competitiveness (Australian Government 2014, 2015), although this process tended to overlook the contribution of universities to agricultural education (ACDA, 2014).

The White Paper describes several trends that may affect the sector, including global population growth, growth of affluence, changes in consumer sentiments, transformative technologies and globalization and climate change.

These broad trends are likely to affect the contribution of agriculture to the Australian economy, and importantly for the university sector, interest in pursuing agricultural science as a career. To place this discussion in context this brief paper will describe several aspects of the Australian agricultural education sector including:

- Trends in agricultural science enrolments and graduations,
- The innovation environment, and
- The integration of technological innovation into agricultural education.

[1] See for example: www.brw.com.au/p/business/mid-market/from_mining_boom_fighting_dining_LTpM9TnyR7ptpIlwMqMxxN

Trends in agricultural science enrolments and graduation

Australia has 43 universities and of these 15 are members of the Australian Council of Agricultural Deans offering agriculture and related disciplines as 3-4 year undergraduate and various types of postgraduate degrees.

Despite some earlier confusion about the number of agricultural graduates and employment prospects in the sector, recent analysis by the Australian Council of Agricultural Deans (ACDA) (Pratley 2008; Pratley et al. 2008; Pratley 2012) has demonstrated both a decrease in the number of graduates (Fig. 1) but also a surplus in the number of positions available for new graduates (Fig. 2). Pratley and Acuña (2015) suggest that there are currently four positions available for each graduate. Despite the imbalance between the numbers graduating and employment demand, Government data have not been identifying the shortage of graduates (Pratley and Acuña 2015).

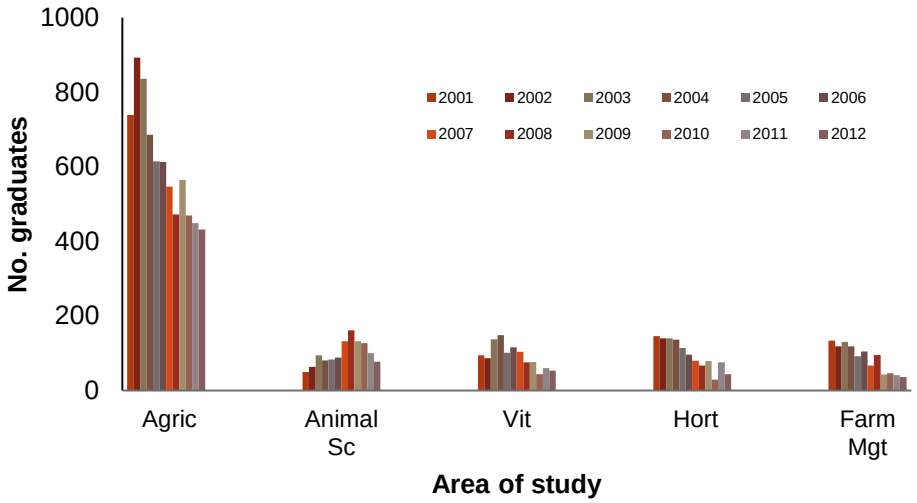

Figure 1. Graduate numbers in agriculture and related areas for the period 2002 – 2012 (Pratley, 2012 updated)

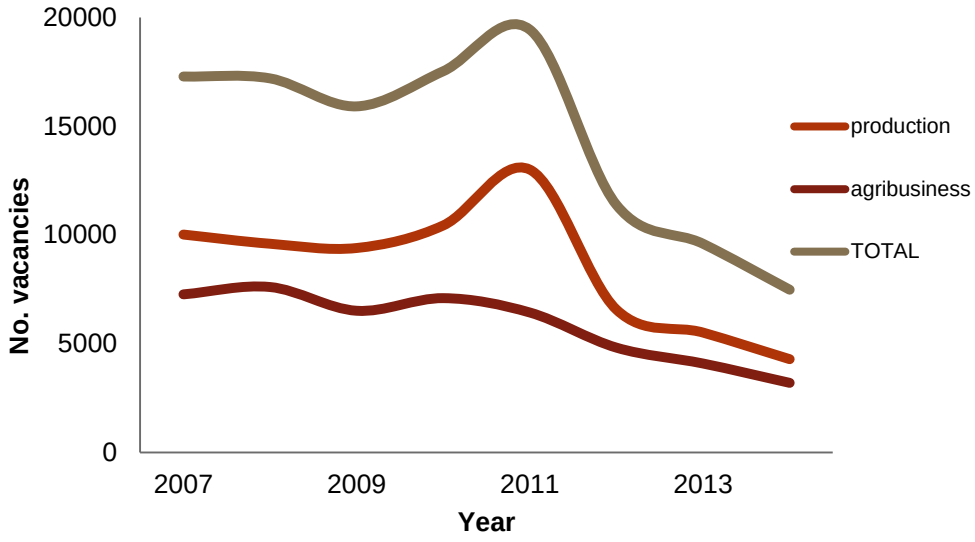

Figure 2. Job market trends for production and agribusiness based on advertisements in newspapers across Australia and on the internet for the period 2007-2014 (Pratley 2012, updated)

Similarly, careers advisers were using Government data to advise against careers in agriculture (Pratley and Acuña 2015). Student data are collated by the Government in terms of categories termed Fields of Education (FoE), and these can be summarized as very broad areas of study, or two digit codes, or broken down into four or six digit codes for different fields such as horticulture or animal production (Table 1).

A key feature of this approach is that both Agricultural Science and Environmental Studies are included in FoE 05, such that it considerably inflates the overall number of graduates. For example, in 2010 the number of agricultural graduates was around 600, whereas the number of environmental graduates was around 1500, to give a total for FoE 05 of 2100 (Pratley and Acuña 2015, Pratley 2015). This analysis also shows that the number of undergraduate completions for agriculture (based on the 6 digit code) declined by 53% from 886 in 2001 to 413 in 2010.

This trending decline in enrolments, however, appears to have stabilized with a 15% increase in enrolments reported in early 2014.[2]

The same coding applies to graduate salary and employment status. Whereas agricultural graduates have almost full employment (>90%), those for environmental science do not (*c*. 60-70%) (Fig. 3) and considering the sector in terms of the two digit code presents a somewhat pessimistic, and misleading, view of agricultural graduates' employment prospects.

[2] www.theland.com.au/news/agriculture/general/news/boom-times-in-agribusiness/2687065.aspx?storypage=0

Table 1. Agriculture and related sub-codes in the Field of Education (FoE) categorisation used in Australia

Broad Code (2-digit)	*Narrow* (4-digit) and *Detailed* (6-digit) Code
01 Natural and Physical Sciences	0107 Earth Sciences 010709 Soil Science 0199 Other Natural and Physical Sciences 019905 Food Science and Biotechnology
03 Engineering and Related Technologies	0303 Process and Resources Engineering 030307 Food Processing Technology
05 Agriculture, Environmental and related studies	**0501 Agriculture** **050101 Agricultural Science** **050103 Wool Science** **050105 Animal Husbandry** **050199 Agriculture, n.e.c.** **0503 Horticulture and Viticulture** **050301 Horticulture** **050303 Viticulture** **0505 Forestry Studies** **050501 Forestry Studies** **0507 Fisheries Studies** **050701 Aquaculture** **050799 Fisheries Studies, n.e.c.** **0509 Environmental Studies** **050901 Land, Parks and Wildlife Management** **050999 Environmental Studies, n.e.c.** **0599 Other Agriculture, Environmental and related studies** **059901 Pest and Weed Control** **059999 Agriculture, Environmental and related studies, n.e.c.**
06 Health	0611 Veterinary Studies 061101 Veterinary Science 061103 Veterinary Assisting 061199 Veterinary Studies, n.e.c.
08 Management and Commerce	0803 Business and Management 080321 Farm Management and Agribusiness

Table 2. The percentage decline in graduate completions for Field of Education 05 and for agriculture from 2001 to 2010 (Pratley, 2015b)

Source	2001	2010	Decline (%)
Undergraduate (UG) completions (FoE 05) (2 digit code)	2991	2207	26
Undergraduate (UG) agriculture completions (6 digit code)	886	413	53

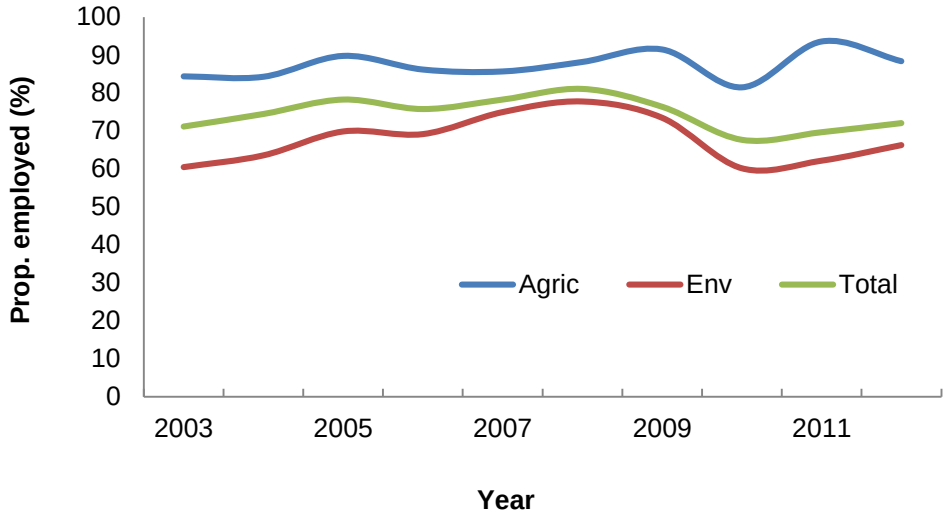

Figure 3. Comparison of full time employment of agriculture and environmental graduates, separately and together, in the Graduate Careers Australian surveys 2003 to 2012 (Pratley, 2015b)

A large portion of the funding for Australian universities comes from the Australian Government and is distributed on the basis of undergraduate student enrolments. Over the period 2001 to 2012 undergraduate enrolments (as opposed to graduates as described in Table 2) declined from 3942 to 1526, or 61%. This is likely to have impacted on staffing levels and loss of capability within agricultural faculties, with Pratley and Acuña (2015) assuming a ratio of 20 undergraduates to each academic staff member.

The innovation environment

In Australia, agricultural research is mainly undertaken by universities, CSIRO (the national science agency), private companies and State Governments. In the Australian federation, agriculture sits as a state responsibility, rather than at the federal level as with the USDA.

Funding for Australian agricultural research comes from a variety of sources, including from research bodies that combine producer levies and Government co-contributions under the *Primary Industries Research and Development Act 1989*, the Australian Research Council, Cooperative Research Centres and arrangements with private companies.

The contribution of universities to overall research appears to be increasing over time. Research productivity, as measured by refereed publications, is shown in Fig. 4, with the total number of publications in the period 1996-2013, across all types of research organization, increasing from 640 to 803 papers/yr. Whereas the output of both CSIRO and State Governments exhibits a small decline over this period, the proportion of papers produced by universities increased markedly, from 41% of the total to 66%. Assuming that the funding base remains stable, it is likely that this trend will accelerate with a reduction in

research activity by several state governments and decreased funding for the CSIRO.

This trend is important as in many Australian universities academic staff are on contracts that involve a mixture of research, teaching and service. Thus, it is likely that students will engage with staff that are active researchers, and this research will inform their teaching. Income from research, however, does not cover academic salaries, with these often substantially supported by income from teaching.

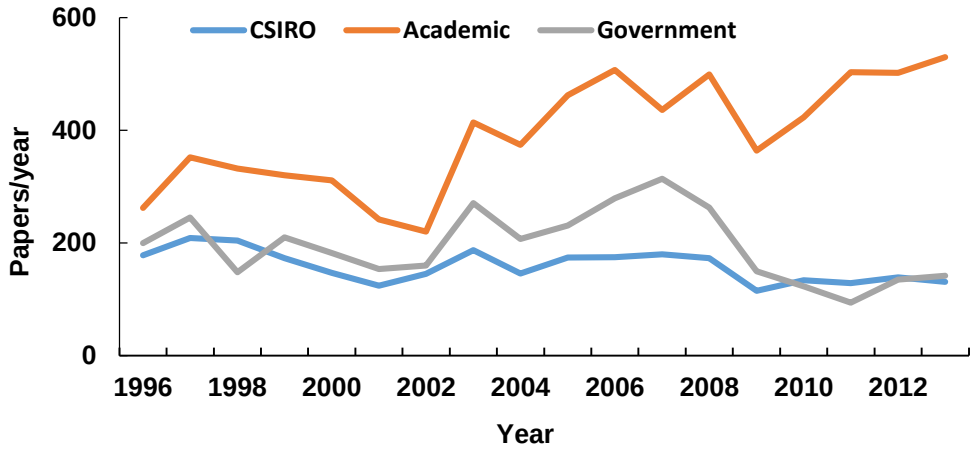

Figure 5. Numbers of publications from CSIRO, universities and government in Australia over the period 1996-2013 (ACDA, 2015 unpublished)

How have recent advances in technology been incorporated into agricultural science courses?

The incorporation of technology in Australian agricultural science degrees can be considered in terms of two components (a) the use of technology to deliver lecture material and (b) new approaches to allow the development of insights into different farming systems.

(a) *Technology and learning*: most Australian universities use on-line technology to deliver lectures and manage course content, such that students can access course material from off-campus locations. This is particularly important where rural students are living in locations distant from campuses and also for those undertaking part-time study. The amount of application varies across and within universities, as it is not always possible to deliver content in this manner. This is particularly the case for units with a practical component, and here universities may require an intensive face-to-face period of activity.

(b) *New technological approaches*: There has been some innovation in this area. Examples include:

1. The development of on-line "4D" farms by Dr Stuart Barber of the University of Melbourne, with colleagues from Sydney University, the

University of Queensland, Massey University and Murdoch University[3,4]. Eleven virtual farms were selected from across Australia and New Zealand, with these allowing students to compare divergent farming systems, and develop an understanding of the systems spatial and temporal.

2. Active research on various aspects of precision farming by the Precision Agriculture Research Group at the University of New England,[5] with output from this work being used within undergraduate and graduate certificate units in precision agriculture.[6] This is currently Australia's only postgraduate course in precision agriculture.

Conclusions and implications

There has been a steady decline in agricultural enrolments, however this may have now stabilized possibly due to the imbalance between jobs available and number of graduates. The contribution of universities to agricultural research appears to be increasing both in terms of actual outputs, and also as a proportion of total output. This trend may increase as the CSIRO and State Governments reorientate their research portfolios. Much of the research funding available is applied in nature and an interesting tension in coming years will be between producing outputs which result in practical outcomes compared to producing high impact papers in international journals. The latter is the consequence of national and international university ranking schemes.

A range of factors may affect Australian agriculture into the future, such as changes in both the amount and quality of food, and challenges such as from climate change and globalization. A strong university sector will play a role in meeting these challenges, as it has in the past, both through maintaining the skills base to allow innovation and also producing graduates with the necessary skills to lead future change. Some universities are actively engaging with new technological approaches in agricultural education.

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[3] https://www.youtube.com/watch?v=kw1SK4qTiR0

[4] http://research.vet.unimelb.edu.au/cattleandsheep/4dfarm.html

[5] http://www.une.edu.au/current-students/resources/academic-schools/school-of-science-and-technology/research/precision-agriculture/about

[6] http://www.une.edu.au/current-students/resources/academic-schools/school-of-science-and-technology/research/precision-agriculture/education-and-extension

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