From adversity comes strength – repositioning education in agriculture

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Abstract
Much has been written about the decline in agriculture graduate numbers over the past decades and the shortages created in the market place. At the same time, there has been an increased urgency towards professionalising the industry – a focus on education and training, a desire to improve the image of the sector, a move towards social licence and greater engagement with future opportunities, challenges and needs. This paper takes a fresh approach to these issues; drawing together the less commonly reported data on student enrolments in agriculture, the distortions created by misunderstanding course classification data, and the emerging focus on learning and teaching academic standards.

Decline in enrolments resulted in massive loss of income to university departments with commensurate contraction of academic staff numbers and expertise. Misuse of course data and graduate career data contributed significantly to the enrolment downturn. These have now been addressed although it remains work in progress. The development of national Learning and Teaching Academic Standards Statement (LTAS) for university Agriculture represents a significant positive step that engaged academic, student and industry stakeholders in its development. We expect that the AgLTAS statement will facilitate the implementation of academic standards by the agriculture discipline community, inform curriculum design and assist in identifying marketing opportunities for degrees and will contribute to an increasingly professional agriculture

Key Words
Higher education, learning and teaching academic standards, enrolment, field of education

Subheading
The McColl Report (1991) into agricultural and related education *inter alia* considered that there were insufficient graduates to meet the needs of the agricultural industries. Despite this finding, the numbers of students graduating from the higher education institutions in Australia have declined since that time. Very little was done to redress this decline and the graduate numbers continued downwards at least to 2012.

In 2007, the then Australian Institute of Agricultural Science and Technology held a colloquium in Adelaide to consider the paucity of agricultural graduates entering the workforce. Universities received considerable blame from industry for the lack of graduate output but it was unclear what steps industry itself had taken to promote careers in the sector. One outcome of that meeting was the formation of the Australian Council of Deans of Agriculture (ACDA). This action allowed the universities involved with agriculture to speak with one voice on matters regarding agricultural higher education and research. The ACDA accepted the challenge to do what it could to analyse the issue and look for opportunities to change the direction as far as it was capable of doing so.

A first step was to approach the then Federal Minister for Primary Industries to inform him about the parlous state of professional agriculture. He responded that the official position of government was ‘plenty of agriculture graduates and insufficient jobs’, diametrically opposed to the view being expressed by ACDA. The Deans resolved to collect their own statistics which have since been published at various times (Pratley 2008; Pratley *et al.* 2008; Pratley 2012). These statistics were a collation of the individual university’s graduate data. At the same time, in conjunction with agricultural graduate employment company, Rimfire Resources Ltd, analysis of the job advertisements in newspapers and on the internet was undertaken in order to gain a better understanding of the employment market.

These actions by ACDA brought to the fore the substantial decline over time in graduate numbers in agriculture and related areas (Figure 1) and the buoyant employment market for such graduates. The data showed that there were up to six jobs for every graduate over an extended period being seven years to date.

Although this has softened in 2014 (Figure 2) the market suggests that there are still about four jobs for every graduate although these data do not account for informal and direct employee targeting that seems to be significant. These revelations created a substantial response politically, industrially and from educators. There was also great media interest.

Numerous political enquiries and reviews were undertaken further promoting the issues and generating action. They highlighted the lack of a positive image for agriculture, the perception that agriculture related only to farming, the negativity towards agriculture in the schools and the complacency in the education system and the community about food security. One review (Pratley 2013) noted that students were actively discouraged from choosing agriculture as a career by school career advisors who perceived there were no jobs.

Responses occurred from all sectors:

- Industry realised that the lack of graduates was real, generating concern about its capacity going forward and the impact on future opportunities: issues such as social licence became important;
- Communities began to wonder about its own food security as the global food security issue was highlighted;
- The importance of educating children at all levels about food and agriculture was elevated and the significance of organisations such as the Primary Industries Education Foundation Australia (PIEFA) became apparent;
- The impact on universities of lower enrolments was of national concern.

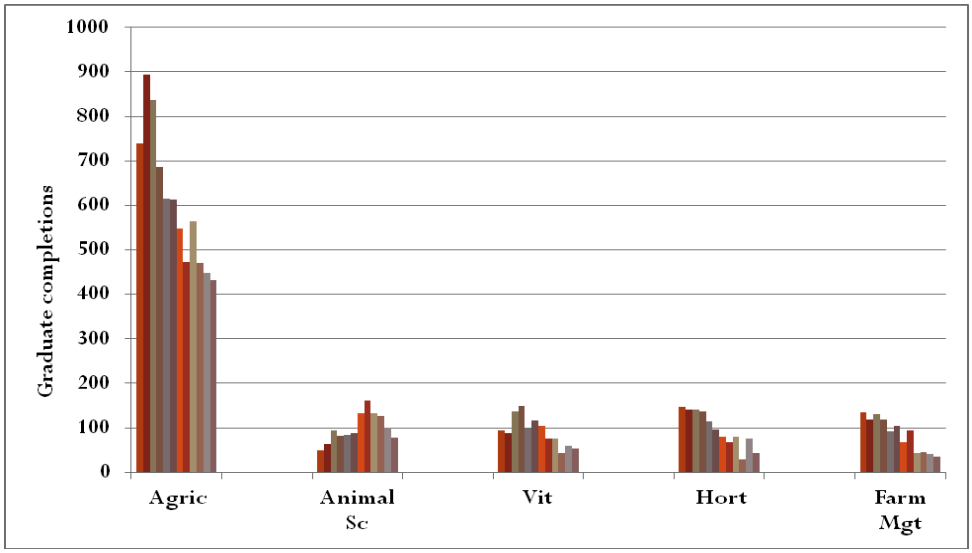

Figure 1. Graduate numbers in agriculture and related areas for the period 2002 – 2012 (Pratley, 2012 updated)

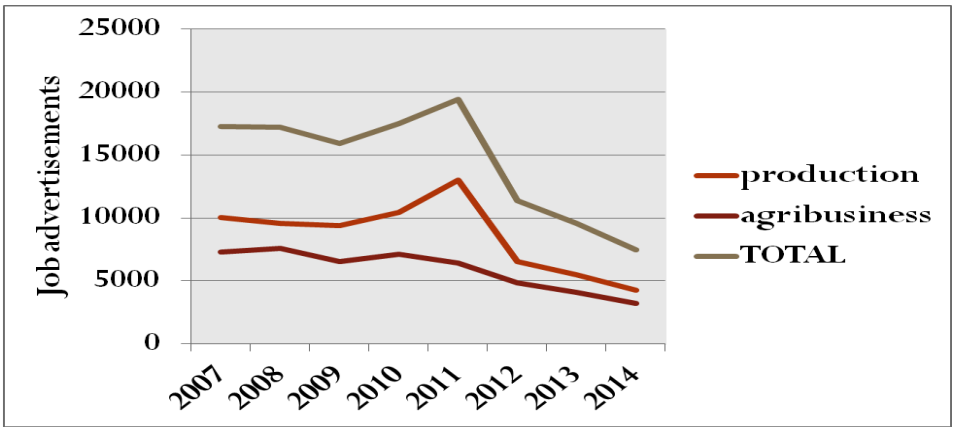

Figure 2. Job market trends for production and agribusiness based on advertisements in newspapers across Australia and on the internet for the period 2007-2014 (Pratley 2012, updated)

Data misinterpretation

During this roll out of information on the demand and supply of agricultural graduates, two questions became important:

1. Why were official data not identifying the shortage of graduates in agriculture?
2. Why were career advisers under the impression that there were no jobs in agriculture and therefore advising students out of such careers?

The ACDA spent much time trying to understand why this happened. Access to official data did provide the explanation. As part of their reporting responsibilities to government, universities provide student data according to categories called Fields of Education (FoE). There are 12 FoEs, agriculture being FoE 05. The range of FoEs is given in Table 1. The codes in Table 1 represent the two digit, or broad, codes. Each FoE is further broken down into components and so fields like agriculture can be separated from horticulture and animal production.

Table 1. Codes for the broad fields of education (FoEs) used in Australia

Broad FoE code	Description
01	Natural and Physical Sciences
02	Information Technology
03	Engineering and Related Technologies
04	Architecture and Building
05	**Agriculture, Environmental and related studies**
06	Health
07	Education
08	Management and Commerce
09	Society and Culture
10	Creative Arts
11	Food, Hospitality and Personal Services
12	Mixed Field programs

Table 2 shows this breakdown to 4 and 6 digit codes and also includes the sub-codes for other areas related to agriculture contained in other FoEs. What is also clear in the tables is that environmental courses are included in FoE 05. So a simple question about the number of graduates in agriculture would generate the 2-digit response unless otherwise requested. This matters since the number created inflates by more than 3x first degree completions in agriculture (Figure 3). In 2010 the number for agriculture and related courses is about 600. Environment numbers around 1500 while FoE 05 is about 2100. Thus the commonly used 2100 significantly misrepresents agriculture at 600. In Table 3, a comparison of the two sets of data in respect of the change between 2001 and 2010 shows again that the 2-digit code is not representative of the situation in agriculture. ACDA now uses the official data for its work as it now understands the basis of the discrepancy. More detailed analysis is given in Pratley (2015a).

This scenario repeats itself in relation to salary and employment status. New graduates are surveyed several months after graduation by Graduate Careers Australia, an agency of government. Responses received are classified according to FoE at the 2-digit code. Hence agriculture is represented by both agriculture graduates and environmental graduates. The latter vastly outnumber agriculture graduates in response and so the combined data are more representative of environmental graduates than of agricultural graduates. This would not matter if the outcomes were similar for both cohorts but that is not the case. Figure 4 shows the differences, agriculture being around full employment (>90%) whereas environment hovers between 60 and 70% full employment in the more recent years. When combined the data show around 70% employment. Representation of the ranges of values for fulltime employment of these cohorts (Figure 5) shows that there

is no overlap between agriculture and environmental graduates over the 10 year period of study and that FoE 05 is largely representative of environmental graduates and unrepresentative of agriculture graduates.

Table 2. 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

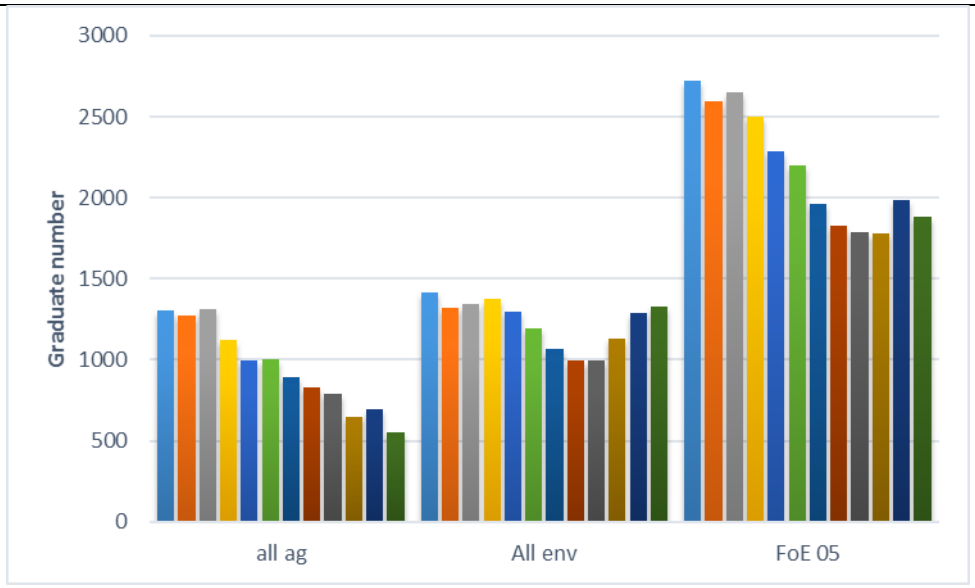

Figure 3. Graduate completions for agriculture and related courses, environmental courses and Field of Education 05 for the period 2001 to 2010 (Pratley, 2015a)

Table 3. 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

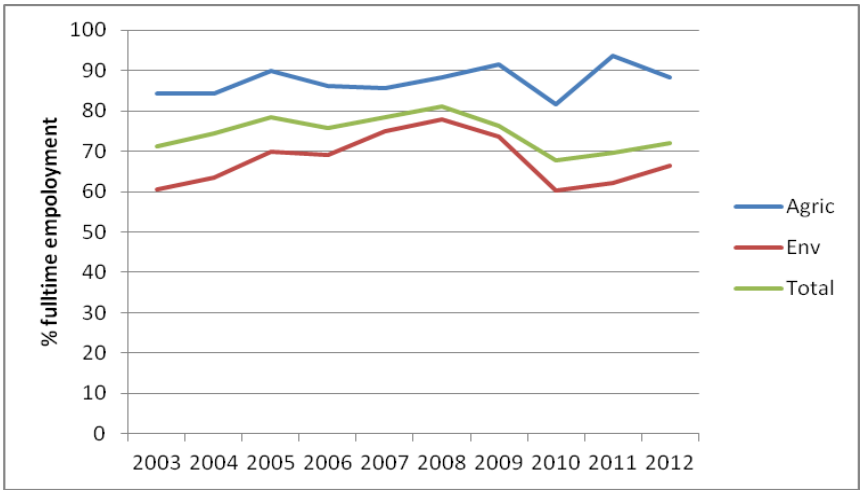

Figure 4. Comparison of full time employment of agriculture and environmental graduates, separately and together, in the Graduate Careers Australian surveys 2003 to 2012 (Pratley, 2015b)

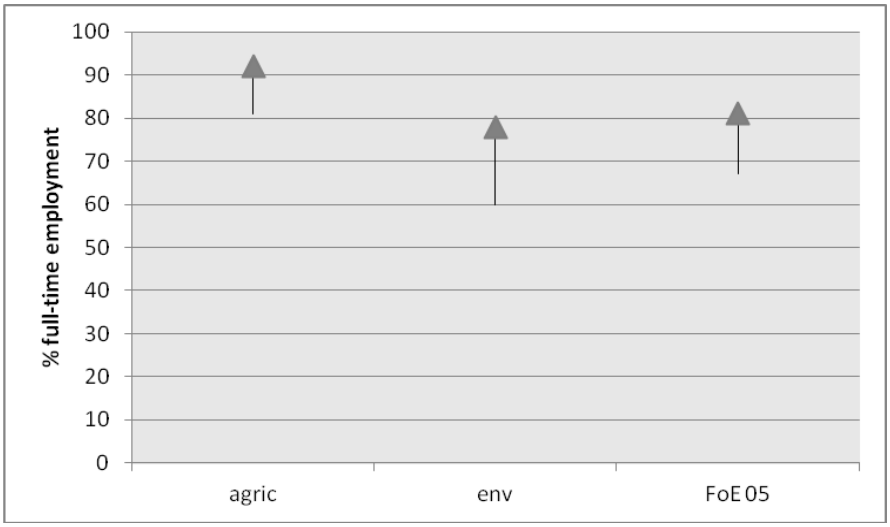

Figure 5. The range, over the period 2003 to 2012, of full employment for agriculture new graduates, environmental new graduates and Field of Education 05 overall (Pratley, 2015b)

These analyses help explain why, on the basis of this 'official' information, careers advisers have formed opinions that there are limited employment opportunities in agriculture. Further analyses of these data are given in Pratley (2015b).

Downturn impact on universities

While much has been written about the decline in numbers of agriculture *graduates* over the past decades and the shortages created in the market place, little has been reported about the *enrolment* numbers in agriculture in the university system during that period. Enrolments are important because they determine the

level of funds received from the government. The funds in turn determine the viability of the university departments that offer the courses. Analysis of official enrolment data shows that in the period 2001-2012, undergraduate enrolments in agriculture courses declined from around 4000 in 2001 to around 1500 in 2012, or a 60% decline (Figure 6).

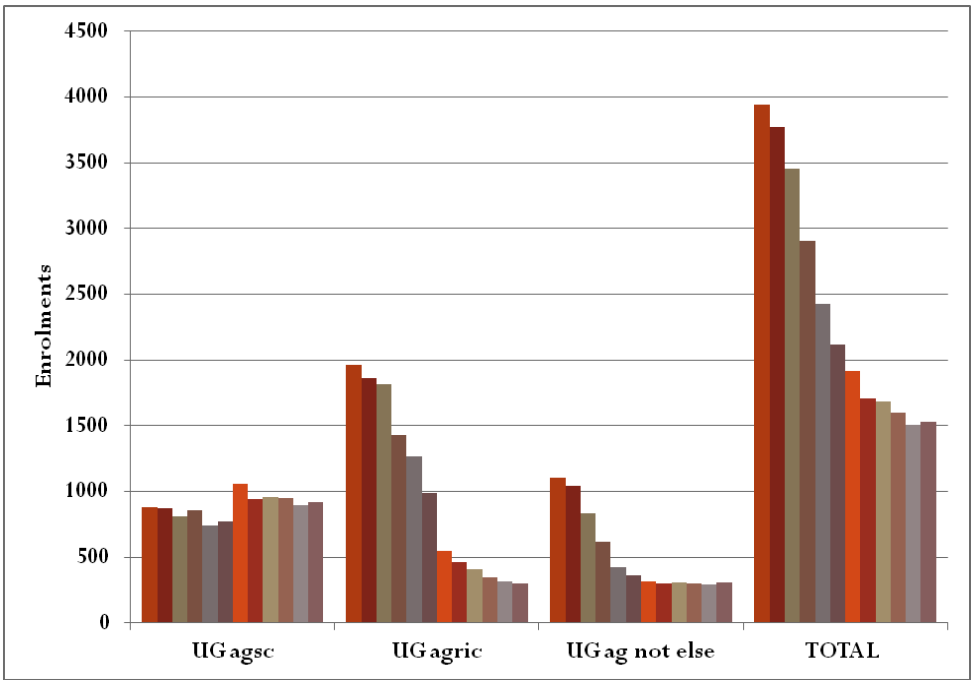

Figure 6. The decline in enrolments in agriculture courses in Australian universities over the period 2001 to 2012 (ACDA unpublished)

Such decline results in massive loss of income to those departments, with commensurate contraction of academic staff numbers and expertise. In general terms, in 2012, a university received around $30,000 a year for a full time agriculture student. If in 2012 there were the 2001 enrolments of 4,000 students, the universities would have received around $120 million for agricultural education. In reality they received only $45 million for agricultural education for 1500 students enrolled, a decline of an estimated $75 million. Most of the funds received go into general university administration with about one third going to the teaching departments. This scenario shows that the decline in departmental funding reduces from around $40 million to $15 million. As a rule of thumb, there is a ratio of about 20 students per staff member and the enrolment downturn therefore is the equivalent of the loss of about 125 academic staff.

The consequences of staff contraction are many. University departments no longer have the range of specialist staff, and the capacity to supervise practical skills development has also diminished. As such training is constrained and there is less call for the associated facilities which then are not maintained to compliance requirement levels.

It is noted that there have been increases in intakes nationally over the years 2013 to 2015, although these are still on top of a low 2012 base. There is a lag in response to this as institutions take a cautious approach to re-building teaching capability as there is a need for departments to become financially stable. It remains to be seen whether there is sustained growth but there are signs of new optimism in the higher education sector.

Towards professionalism

This episode in the evolution of the agriculture sector has been a wake-up call. There has been an increased urgency towards professionalising the industry – a focus on education and training, a desire to improve the image of the sector, a move towards social licence and greater engagement with future opportunities, challenges and needs. Universities have been an integral part of this increasingly professional approach and so the issue of quality in higher education is considered. Learning and Teaching Academic Standard (LTAS) Statements across several disciplines have been published, and are listed as reference points in the national standards framework developed by the Higher Education Standards Panel (Australian Government 2014).

Agriculture Learning and Teaching Academic Standards

Agriculture and related disciplines are offered in 14 Australian universities (as a three- or four year specialist degree or as a major in a science degree). Graduates of agriculture and related sub-disciplines are employed in diverse roles, including but not limited to research, development and extension (R, D and E); primary production in the value chain; policy; finance and marketing; and media. As outlined above, recent inquiries by the ACDA and the state and federal Governments into higher education and skills training for agriculture and agribusiness has highlighted the importance of ongoing tertiary education in agriculture for Australia's economic prosperity. Universities must address the design, content and delivery of their agricultural curriculum to meet the needs of industry now and into the future.

The Agriculture Learning and Teaching Academic Standards (AgLTAS) were developed through a nationwide consultation with industry, graduates and academics and have been endorsed by the ACDA (Botwright Acuña *et al.* 2014a). The standards define the nature and extent of agriculture and also outline the key threshold learning outcomes (TLOs) for graduates. The standards include TLOs that closely reference those for the Science discipline (Jones *et al.* 2011): Knowledge, Understanding, Inquiry and Problem Solving, Communication and Personal and Professional Responsibility (Plate 1). Together these represent what a pass-level graduate in agriculture should know, understand and be able to do upon graduation.

Although agriculture fits within Science, it also has business and social aspects not captured in the Science TLOs. Agriculture is a multi-disciplinary area by its very nature and this is described in the standards. Industry input was vital in developing the national standards to ensure that agriculture graduates left university with the skills and knowledge needed by industry. The industry stakeholders who were consulted agreed that students needed to demonstrate highly developed problem solving and communication skills. Industry specific (vocational) knowledge was generally regarded as attainable during on-the-job training both during and after graduation. The issue of vocational training in agriculture at university is explored in more detail in Botwright Acuña *et al.* (2014b). The importance of undergraduates obtaining valuable on the job training through work-integrated learning or work experience is highlighted in the explanatory notes section of the standards statement. Furthermore, given the dynamic nature and wide range of agricultural industries, the standards highlight that graduates need to be life-long learners, capable of undertaking continued professional development to practice agriculture as professionals.

The new standards will inform the development and design of agriculture curricula delivered at Australian universities and will further promote agriculture as a career to encourage more young people into the growing industry. Greater engagement between universities and industry in curriculum design and cooperation between providers is necessary for curriculum rejuvenation (Dunne 2010; Bellotti 2012). For example, at the University of Tasmania, the standards have informed the proposed redevelopment of the three year Bachelor of Agriculture degree. The standards were mapped against the curricula, which highlighted strengths in inquiry and problem solving that in some activities exceeded graduate level. Opportunities were identified to further strengthen some agribusiness-related topics to reinforce the commercial relevance of student learning outcomes. Higher education providers may choose to use these to demonstrate compliance with the proposed Higher Education Standards Framework in relation to learning outcomes and assessment.

Importantly, the standards will allow Universities to continue their delivery of unique content but enable students to have confidence that their degree is of a high standard. Higher education providers are encouraged to build on the standards as they design and deliver programs that reflect their particular strengths and priorities. They may do this by adding additional TLOs or by requiring the five TLOs to be met at a higher standard in their own organisation. If implemented as a reference point, the standards will support each higher education provider's autonomy, diversity and reputation.

Threshold Learning Outcomes for agriculture

Upon completion of a bachelor-level degree in agriculture or a related sub-discipline, graduates will, as a minimum, be able to demonstrate their knowledge and skills in the following areas:

Understanding agriculture

1. Demonstrate an integrative understanding of agriculture by:
   - 1.1. Explaining the role and relevance of agriculture and its related sciences, and agribusiness in society.
   - 1.2. Understanding the major biophysical, economic, social and policy drivers that underpin agricultural practice and how they contribute to practice change.
   - 1.3. Understanding how information is adopted and the context within which producers, processors and consumers, make decisions.

Knowledge of agriculture

2. Exhibit depth and breadth of knowledge of agriculture by:
   - 2.1. Demonstrating knowledge of the core sciences in the context of agriculture.
   - 2.2. Demonstrating broad generalist knowledge of relevant agricultural production systems and their value chains, with specialist knowledge in at least one area.
   - 2.3. Understanding how knowledge from different sub-disciplines within agriculture is integrated and applied into practice.
   - 2.4. Demonstrating a basic knowledge of economics, business and social science as they apply to agriculture.

Inquiry and problem solving

3. Critically analyse and address dynamic complex problems in agriculture by:
   - 3.1. Identifying contemporary issues and opportunities in agriculture.
   - 3.2. Gathering, critically evaluating and synthesising information from a range of relevant sources and disciplines.
   - 3.3. Selecting and applying appropriate and/or theoretical techniques or tools in order to conduct an investigation.
   - 3.4. Collecting, accurately recording, analysing, interpreting and reporting data.

Communication

4. Be effective communicators by:
   - 4.1. Understanding methods of effective two-way written and verbal communication with different audiences.
   - 4.2. Communicating with a range of audiences in an agricultural context using a variety of modes.

Personal and professional responsibility

5. Be accountable for their own learning and professional work by:
   - 5.1. Being independent and self-directed learners.
   - 5.2. Working effectively, responsibly and safely in an individual and team context.
   - 5.3. Demonstrating knowledge of the regulatory frameworks relevant to their specialist area in agriculture.
   - 5.4. Personally practising ethical conduct.

Plate 1. Threshold learning outcomes for agriculture. Extracted from the Agriculture Learning and Teaching Academic Standards (Botwright Acuña *et al.* 2014a)

Conclusion

In 2007, higher education in agriculture was in a parlous state. Institutions were struggling to maintain agriculture programs. The industry sector faced a shortfall of graduates to take the sector forward into an era of opportunity. Through adversity comes strength and, with the combined efforts of many, the foundations of a firm future have been laid.

One particular outcome of these adverse circumstances was the formation of the ACDA. This brought the university sector together formally and enabled the study of graduate supply and demand through the compilation of data which hitherto had not been considered. The evidence clearly showed lack of supply of, and high demand for, agricultural graduates and helped provide the impetus for others to become involved in building interest in agriculture with schools and the community.

Data anomalies are now well understood but such anomalies will continue to interfere with the understanding unless there are constant reminders. Permanent categorisation of agriculture and environment into separate FoEs is a highly desirable outcome if government can be persuaded.

The decline in enrolments and associated contraction of funding for agricultural higher education has had a big impact to the extent that education delivery has been affected, perhaps permanently. However the recovery phase, albeit slow and steady, is enabling newer smarter approaches to courses.
Agricultural industries have started to appreciate the need for more professionalism and universities are endeavouring to get their houses in order by addressing course standards nationally. With industry input, such standards will inform curriculum development and provide confidence that agricultural degrees are relevant and of high standard.

So, as painful as the last decade has been, the uncertainty has driven a new dimension into agricultural education. There is greater ownership by all involved; there has been an image transition; awareness of career opportunities have been developed; and greater understanding has occurred of data and their interpretation. Taking advantage of the opportunities that lie ahead is in the hands of the agricultural sector which we hope will be well supplied with new age graduates. It is unclear where we would be had there not been the thrust provided by the formation of the ACDA and its data focus.

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