OPINION: Delivering science for maximum industry benefit: An academic's perspective

D.W. Pethick

Murdoch University, Murdoch, WA 6150.

Abstract

This paper discusses some of the factors that contribute to the ability of scientists in the discipline of Animal Science (including Agricultural and Veterinary Sciences) to make significant industry impact. Factors discussed include the need for sound undergraduate training in fundamental sciences taught in an agricultural context and better recognition of industry impact as a metric for scientific achievement and promotion. Funding of program over project-based research is a suggested means for ensuring better impact. Finally, the term 'scientific engineer' is used to describe the 'ideal' scientist that our industries are striving for.

Background

This paper discusses some of the factors that contribute to the ability of scientists in the discipline Animal Science (including Agricultural and Veterinary Sciences) to make significant industry impact.

Training

A strong theoretical base in the sciences is essential: Training of undergraduates in the applied disciplines of Agricultural, Animal or Veterinary Sciences is a crucial starting point for the development of scientists into the future. I began my Bachelor of Agricultural Science in 1971 and undertook essentially two years of biological sciences followed by two years of 'true' agricultural science where subjects such as biochemistry were taught in years three and four within a strong agricultural context (these subjects were called Agricultural Biochemistry I and II). The subjects were still strongly theoretical and included long and detailed practical sessions aimed at honing laboratory and written skills. At least for the author this was a most enjoyable learning period, because I was from a mixed farming background and had little interest in acquiring further practical skills like handling sheep/cattle or learning the history of machinery development for broad acre cropping. After the 4-year undergraduate degree, a 1-year full time research Honours program was undertaken studying the aetiology of pregnancy toxemia in ewes. This again involved a combination of theoretical biochemistry of ketosis combined with on-farm studies of clinical cases. Looking back, I was privileged to receive a strongly theoretical course in Agricultural Science that gave me a very strong scientific base that still benefits me to this day. In this context, professionals within agricultural supply chains are highly skilled and they want to deal with people who know and understand science.

Are today's degrees doing the job? Today's degrees are a little different than the one I completed. First, degrees are no longer 'free' and back in the 1970s new graduates didn't 'worry' as much about obtaining jobs, as this seemed almost automatic. Second, modern-day degrees are shorter (a number of universities have moved/are moving to 3-year science degrees having a Major in Agricultural Science or Animal Science, for example) and tend to be focused on a vocational stream compared to the more broad-based degrees in the 1970s, 1980s and 1990s. Rather than all students undertaking a range of subjects, which equipped them with a broad base, today's degrees tend to assemble subjects from specific disciplines often outside of Agriculture and Animal Science. For example, the subject 'biochemistry' might in fact be taught within a medical context. Such offerings are driven by the need for larger class sizes and the economies of scale given the ever-decreasing investment in the university sector by Government (which for undergraduate students is now essentially a subsidy, given that more than 50% - and sometimes up to 75% - of university revenue is obtained from non-government sources). Indeed the agricultural and animal sciences have gone through a difficult period with declining student enrolments further exacerbating the decline of many degrees in these areas. Moreover, the (generally) low student numbers in universities that have been omnipresent for many years means that specialist staff in the majority of animal science disciplines have become depleted, since undergraduate student teaching loads largely support tenured staff.

One approach to improve the specialist teaching in animal science is to align such a degree with Veterinary Science in some way, because there are obvious curriculum synergies to improve economies of scale. This now happens in a number of universities in Australia, and indeed has been commonplace in other countries (e.g., the USA, where Animal Science is generally regarded as "pre-vet") for many years, and facilitates a stronger flow of students, and hence staff, into the basic animal science disciplines.

An area of weakness at least for me, was poor training in the art of writing and obtaining grants. This was partly because I studied my PhD internationally and so I was initially naïve of the Australian research and development systems upon my return. Certainly my PhD students, and those of the majority of my colleagues, are closely imbedded within research grants where they are given some of the research (e.g., preparing animal ethics applications), reporting and financial management responsibilities. Such skills will place them in good stead if they decide to continue in research (or an allied field) as a career.

Universities and Animal Science

Universities, perhaps like all employees, are a combination of good and bad. A significant weakness is that they cover just so many disciplines, which makes decision making difficult as there is usually just one set of rules for all, from the arts and humanities to the sciences. Another weakness is the excessive emphasis placed on the Australian Research Council (ARC) grants system by university administrators when, in the area of the 'animal sciences', more and stronger focus should clearly be directed towards the relevant Rural Research and Development Corporations (RDCs). Ironically, and in terms of the money returned from Canberra to universities through the research block grant funds that universities receive to assist in research and research training, a Meat and Livestock Australia (MLA) "Strategic and Applied Research Funding" grant, or an Australian Pork Limited (APL) "Research and Innovation Open Tenders" grant, has exactly the same return as an ARC grant (see Category 1 research grants; http://www.innovation.gov.au/RESEARCH/RESEARCHBLOCKGRANTS/Pages/AustralianCompetitiveGrantsRegister.aspx).

Another weakness is the excessive focus on inputs such as the monetary values of grants obtained and an almost singular focus on publications as the major output for determining promotion, prestige and even university rankings within the discipline of 'Animal Science'. Indices like the *h* index and citation frequency are increasingly seen as defining metrics with some faculties/schools/departments even suggesting particular thresholds that should be achieved for probation of (new) early-career staff and promotion of existing staff. Clearly these metrics are important but they are just one of many factors that should be considered. An overwhelming weakness, however, is the lack of credence given to industry reports, industry engagement and industry "impact". The recent Excellence in Research Australia (ERA) exercises placed no emphasis on industry impact. Moreover, all universities now strongly promote themselves in the press as 'world class', 'global', 'international' and so on, but rarely do they promote themselves as delivering outcomes for societal change.

A further weakness in the university sector, at least in Australia, is the excessive competition between universities meaning that rationalisation of course offerings and concentration of expertise within States is spoken about but seldom achieved. In the latter stages of undergraduate degrees sharing of course material and even students between universities would be a better use of (increasingly) scarce resources. There are clearly too many Animal Science- and Veterinary Science-related degrees in Australia; in contrast, California (population about 38 million) has one Veterinary Science faculty and The Netherlands (population about 17 million) has one University teaching Agriculture. Rationalisation of course offerings will almost certainly require a political solution given State and university rivalries.

Of course the strengths of universities includes their diversity which when managed appropriately can bring new ideas and groups together to solve research agendas. Another great strength of universities is flexibility that academics have with respect to their field(s) of research. For instance, I have published works on eight species (sheep, cattle, pigs, horses, rats, chickens, dogs and humans), which is entirely related to being imbedded within a diverse faculty of Veterinary Science.

Project versus program research

Program research the way of the future: Australia has developed mechanisms for promoting research in 'animal science' that are generally seen as the 'envy of the world'. In particular these systems include the RDCs and more recently the Cooperative Research Centre (CRC) program. The RDC system is where producer and processor levies are collected and matched by Government, for the purpose of undertaking research across the relevant animal industry supply chains. Producer-owned companies such as MLA and APL then manage these funds. Traditionally projects were (and still are) called for and then funding of individual researchers has been undertaken to solve single-issue research agendas, with research projects generally spanning 12-24 months. However, research questions have increasingly become more complex and require the following: (1) a national focus; (2) teams with broader skills; (3) clear industry engagements to maximise the impact of the research; and (4) in most cases, funding for a greater length of time than 'one-off' projects. The CRC system encapsulates program research at its best. In the red meat sector, major CRC programs were initiated by collaborative planning involving scientific and industry

stakeholders. These are then managed and massaged into shape with the help of MLA. This early involvement of the entire supply chain assures all players have 'skin in the game', which is in the form of private, levy and government dollars plus significant in-kind contributions from research and collaborating industry organisations. The success of the Beef, Sheep, Pork and Poultry CRCs are well recognised and documented. Indeed they have been so well recognised for their industry outcomes that many industry players are worried about the future research 'landscape' when the current wave of animal science and production-based CRCs finish. However, a cut-down CRC-type approach can easily be managed by an individual RDC given industry support and the will to succeed. The development of MLA's Meat Standards Australia (MSA) program, for both beef and lamb and sheep meats, are very prominent examples.

Unfortunately program research can be challenging for many of the Federal and State government research agencies and even some universities. Such institutions are often unwilling to contribute research staff in-kind and instead are increasingly insisting that staff time be paid for from the research funds. This is a naïve approach and could be aligned to a commercial company asking for research and development without contributing to the costs. It is puzzling logic to suggest that scientists who are paid for by the taxpayer should then be paid again!

Publishing and industry outcomes

Research should be published to achieve industry credibility: Most levy-funded research can be classified as public good, especially in the sheep and cattle sectors. Only a small proportion of the outcomes have a significant intellectual property (IP) component meaning that focusing on patents and the like as outcomes is short-sighted, unhelpful, and in the vast majority of cases will never meet the transaction costs associated with the exercise. Nevertheless many research institutions and universities place a great emphasis on IP, which is usually misguided and only serves to delay the contracting and research processes. It is relatively simple to understand when IP is important, e.g., when dealing with a company product, and this should happen quickly and easily.

Given that IP is not typically a crucial issue it is important that research outcomes are published so as to underpin credibility and industry uptake. This is especially the case when the research is contributing to new industry structures. Classical examples are the development of the MSA program for beef and lamb and sheep meats. These programs have created new systems that did not exist 10 years ago, and many components of these systems have placed new requirements on livestock producers, sale yards, transporters, abattoirs, wholesalers and retailers. Industry-changing programs quite naturally are often challenged by stakeholders, e.g., why the need to do this and that? There is typically just one simple answer, namely "because of the science", and it's not science until it is published. Meat and Livestock Australia in combination with the Beef and Sheep CRCs should be congratulated on their instance to publish all outcomes relating to MSA (and in many other areas) typically as 'special editions' in national and international journals.

The role of RDC's

Close engagement with the RDC's is important: The RDCs are complex organisations with high-level expertise and connections across the supply chain. For example, MLA has subsections that cover on-farm research, off-farm research, industry systems, livestock producer engagement, economic analysis and marketing. Moreover they have a close relationship with the Australian Meat Processors' Corporation and the relevant peak councils. Given this wealth of expertise and systems it is important that researchers engage fully and professionally with 'their' appropriate RDC. This is not often the case and instead many researchers simply see the RDCs as a funding agency, which is a clear recipe for failure and final disgruntlement.

There are numerous ways to increase the engagement of researchers with the RDCs and industry. One example is program-based research, as discussed above, where a significant industry issue is addressed over a sustained period of time and is given sufficient funding and resources to do so. In my own area of research this would represent MLA's programs in genetic and eating quality improvement, which has seen sustained research programs for more than 20 years. A related example is the Lamb Supply Chain Group that has been a successful initiative undertaken by MLA and the Sheep CRC. This group meets quarterly to plan strategies for increasing lean meat yield and eating quality in prime lambs. The group has all subsections of MLA represented, i.e., the key peak council, plus scientists and extension people from universities and the State Departments of Agriculture/Primary Industries. The outcomes have seen the growth of MSA lamb, initiation of new research into carcase grading for lamb, new genetic systems for carcase yield and eating quality. Perhaps most importantly the group has managed the now close collaboration that exists with major stakeholders in the form of processors and retailers. In summary, a

sustained research program with transparent scientific and engagement strategies is the most powerful mechanism for ensuring high quality research and Industry outcomes.

Each RDC, therefore, should ask themselves how they have performed in program research? As an example, perhaps the Australian pork industry might self examine the adequacy or otherwise of sustained commitment to meat science?

End user engagement

Changing the practice of end users is a very powerful tool for adoption: Adoption of research within the sheep and cattle sectors can be difficult and indeed there are scientists who are experts in extension. There are all sorts of jargon in this field, e.g., 'early adopters', 'innovators', the 'middle majority', the 'laggards' and so on, to describe the propensity of livestock producers to adopt new research outcomes. A far more effective root to adoption is to change the practice of end users. The MSA systems are a case in point, namely that once lamb and beef processors/retailers provided financial incentives for beef and lamb carcasses that complied with grading requirements, adoption became rapid and extensive.

Conclusions

Research in the animal sciences is a demanding and sometimes risky business. One essential ingredient not mentioned so far is the need for a sustained approach from individuals, scientific organisations and the RDCs. Successful researchers don't see 'funding opportunities' but rather an opportunity to contribute to industry change, growth and success. The MSA schemes have taken some 15 years since their inception to finally become truly industry re-defining programs and research and adoption is still on-going. Indeed, I believe the French term 'Engineer' should be used in Australia. In the French scientific system, there are scientists, scientific engineers, technicians and extension experts. Scientific Engineer positions are highly sought after and high-quality scientists, who are also experts in translating outputs for industry, fill them. A case in point is the conversion of research in molecular biology and genetics into industry outcomes for the sheep and cattle industries. The molecular biologists made early inroads into a limited number of genes that might have relevant production effects, but essentially the area has under delivered given the investment. In fact it has been the quantitative geneticists (scientific engineers) who have converted molecular technologies into industry outcomes in the form of genomic selection. Training and systems, as discussed above, should encourage and reward scientific engineers, who to some extent can be trained. However engineers are also born, meaning they have the desire, passion, and background industry knowledge to reach this status. It is important that research administration within all organisations embraces the term 'scientific engineer' and has appropriate rewards.

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