

Development, implementation and evaluation of a hub and spoke multi-institutional national model to tertiary education in sheep and wool science

E. K. Doyle ^{A,C}, S. W. Walkden-Brown^A and P. J. Sommerville^B

^ASchool of Environmental and Rural Science, University of New England, Armidale, NSW 2351, Australia.

^BAustralian Wool Education Trust, PO Box 240, North Melbourne, Vic., Australia.

^CCorresponding author. Email: edoyle3@une.edu.au

Abstract

Context. The sheep and wool industry is an important and established primary production entity for Australia. Specialised tertiary education in the field of sheep and wool is pivotal to the advancement of the industry. Sheep and wool education has evolved over time synchronously with changes in the presentation of tertiary teaching. The face-to-face teaching and 4-year specialised degree in animal and wool science has now developed into an online learning system, with individual units made available to students across the country. This is delivered using a hub institute, University of New England and spoke universities across Australia.

Aims. The study evaluated the development and delivery of the hub and spoke method of tertiary education in sheep and wool science.

Methods. The data for this study comprised routine information gathered during university enrolment and specific student survey data from two questionnaires. The first questionnaire was an annual (2010–2017) survey of enrolled students ($n = 289$) and the second questionnaire was a survey of graduates from 2012 to 2015 ($n = 128$) from sheep and wool science.

Key results. Student numbers studying sheep and wool science in the hub and spoke program have increased three and a half fold in 10 years. The employment success of students studying the sheep and wool units is over 50%.

Conclusions. Utilising a hub and spoke model for online education delivery allows one university to specialise in a specific curriculum that can be offered across multi-institutions.

Implications. The tertiary training package, developed by the sheep and wool industry, has provided an estimated 400 graduates into the industry in 10 years.

Keywords: sheep and wool, agriculture education, agricultural employment.

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Introduction

Sheep and wool education at the tertiary level in Australia began in 1951 when the NSW University of Technology, now The University of New South Wales (UNSW), established the Wool Technology course (subsequently renamed Wool and Pastoral Science then Wool and Animal Science). The traditional agricultural courses offered in Australian universities before this, focussed the curriculum on soils and crop production and education in animal husbandry, was limited to diploma courses (Kennedy 2010). Aspects of sheep and wool production were also integrated into the ecosystems on the basis of Rural Science degree at the University of New England from its inception in 1955 (McClymont 1996). The UNSW course had similarities to the agricultural courses in other Australian universities, but had a strong focus on sheep and wool production, emphasising

research findings, commercial aspects and wool processing, to link with the sheep industry. The Bachelor of Wool and Animal Science at UNSW ceased enrolling students in 1997, but the specialist program produced 359 undergraduates and 239 postgraduate students, over the 46-year period, many of whom contribute or have contributed greatly to the sheep and wool industries (Kennedy 2010). The most significant contribution made by graduates, in the view of Kennedy (2010), was the commercialisation of objective wool measurements.

To ensure the continuation of education and training of tertiary students in the field of wool science, the Cooperative Research Centre for Premium Quality Wool 1993–2000 (Wool CRC) invested in an education program, with a significant tertiary training component. The program funded the development of specialised units in wool biology,

metrology, technology, production and marketing, as well as an electronic database of high-quality teaching material and graphics on PowerPoint slides. It supported the simultaneous delivery of these units to students at four Universities (Universities of New England, New South Wales, Adelaide and Western Australia) by using videoconferencing. The video lecturing linked selected experts from industry with undergraduate students at all of these institutions. The project identified the need for industry involvement to ensure relevance of content and to provide a contribution of funds for ongoing education and training in the area (Hynd *et al.* 2000). The evolution of sheep and wool education overtime is summarised in Fig. 1.

In line with this view, the Australian Wool Testing Authority (AWTA Ltd) Wool Education Trust was established in 1997, with a donation of A\$3 million from unappropriated AWTA Ltd profits. Its objective was to promote the future development of the wool and wool textile industries and support relevant tertiary education. In 2004, the Australian Wool Innovation (AWI) company agreed to donate A\$4 million to the Trust, at which time the organisation was renamed the Australian Wool Education Trust (AWET). The Trust owns and manages the education resources produced from the Wool CRC and the material remains available on www.woolwise.com. AWET trustees have a long-term strategy to use its funds in ways that will produce national benefit in vocational education and training (VET) and tertiary education in the area of wool science (AWET 2006). The Australian Wool Education Trust is a perpetual trust administered by five Trustees, including two appointed by the AWTA Ltd, two by AWI Ltd and one by the Wool Industries Australia (woolwise.com).

In 2001, the Australian Sheep Industry Cooperative Research Centre (Sheep CRC 2001–2007) continued the practice of the Wool CRC, supporting a tertiary education program (undergraduate and postgraduate), and VET and school level education and training in sheep, meat and wool science, so as to support both the sheep meat and wool industries. A project evaluation of tertiary education showed

that none of the 13 Australian Universities offering agricultural and animal science-based degrees had sufficient student numbers and staff resources to deliver specialist sheep and wool science training individually (Welsman 2006). It was clear that an education program on this scale needed a senior appointment to coordinate the development of resources and oversee its delivery. AWET and the CRC co-funded the position of a professor of sheep and wool to be based at UNE. David Cottle was recruited and took up this position in early 2002.

A ‘hub and spoke’ model was proposed, whereby a ‘hub’ University would provide specialist sheep and wool science units by distance education (supplemented with intensive residential schools), into which students from other participating universities (‘spokes’) could enrol as part of their existing degree. The hub university would develop online educational resources, utilising industry experts and deliver theoretical material using an online learning system, while supplementing this with practical components using 3 day intensive schools attended by the students (Cottle 2003). Funding for the development of the course materials was provided by the Australian Sheep Industry CRC 2001–2007, Meat and Livestock Australia, AWI and AWET.

Towards the end of the Sheep CRC 2001–2007, a formal survey of job opportunities for University degree graduates specialising in livestock was conducted, arriving at an estimate of 756 jobs per year (Cottle and Williams 2006). In 2006, only 600 students graduated with a tertiary degree in agriculture and fewer than 100 in animal science (Pratley and Acuña 2015). Consequently, the Sheep CRC commissioned a market review of the demand for the sheep and wool science units and the most effective delivery methods (Welsman 2006). The report found that the specialised sheep and wool units required a critical mass of students to be self-financing and this was likely only if delivered from one University. It found that the hub and spoke model could be effective only with the ongoing support of ‘spoke’ Universities and long-term industry financial support to fund staff and assist with the updating of learning materials.

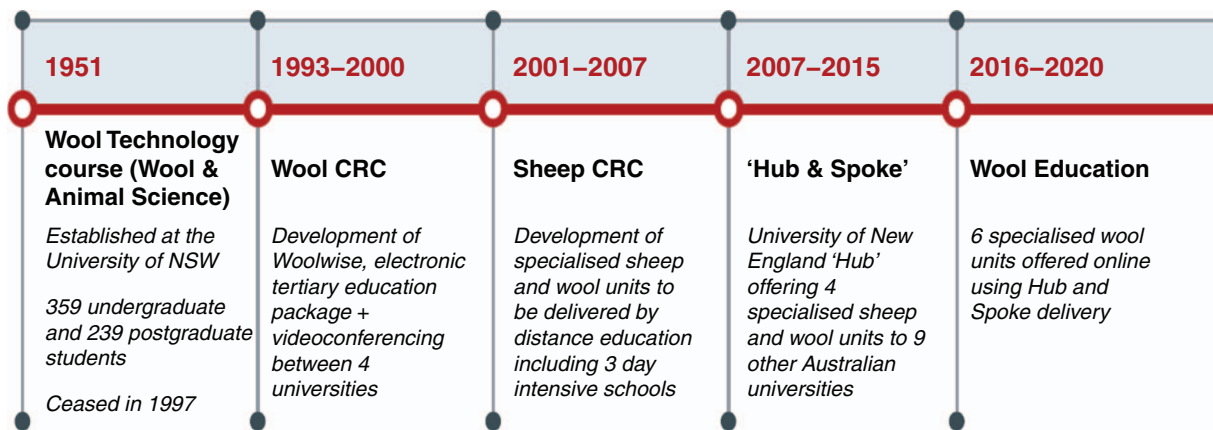


Fig. 1. The evolution and change in the delivery of sheep and wool education in Australia from 1951 to 2020.

The University of New England (UNE) provided the hub, with the following nine other Australian Universities providing the spokes: University of Sydney (USYD), University of Western Sydney, Charles Sturt University (CSU), University of Western Australian (UWA), Murdoch University, Curtin University, Adelaide University, University of Queensland and University of Tasmania (UTas.).

Following recommendations from the Welsman (2006) report, AWET decided to fund a lecturer position at the University of New England (a Sheep CRC core participant). The position would support the delivery of four specialised wool units, namely, wool biology and metrology, wool processing, wool marketing and clip preparation and sheep production, to undergraduate and postgraduate students by using the hub and spoke model. Dr Emma Doyle was appointed to this position in 2007.

At the time that the opportunity for a hub and spoke model was being considered, agricultural faculties around Australia were experiencing a decline in enrolments and only 1.5% of university students were studying agriculture (Norton 2016). Universities were competing for enrolments and the attendant funding associated with them. A significant barrier to the hub and spoke model was the transfer of student load and associated income from the spoke universities to the hub. To counter this, a subsidy of A\$1000 per student per sheep and wool unit was provided to spoke universities by AWET. The cost of students attending intensive schools at the hub university, often from states such as WA and SA, was also a disincentive for students, and travel expenses for students to travel to intensive schools in NSW and Vic. were also reimbursed. Undergraduate scholarships to support students interested in pursuing a career in the sheep and wool industry were also provided, with funding being shared between AWET and industry bodies. The scholarships provided stipends of A\$6000/year and work experience with the industry partner. AWET also supports up to 15 scholarships for Honours and Masters research related to sheep and wool science, with a value of A\$6000 each (A\$7000 as of 2017).

In 2006, the Sheep CRC 2001–2007 began a process of distribution of the intellectual property developed during its term to organisations that could ensure its continual use and development. In 2007, the intellectual property for the educational material the CRC had developed was assigned to AWET. This included the additional modules of applied animal nutrition, sustainable land management, meat technology, genetic evaluation and breeding, sheep meat production and marketing and managing the sheep enterprise. AWET then licenced UNE to continue delivering all these modules as the hub in the hub and spoke model.

The University of New England has been delivering the sheep and wool units under the hub and spoke model from 2007 to 2020, with the financial support of AWET. In 2015, another wool unit was developed, namely, fundamentals of sheep and wool science, which included sheep meat and wool production, wool marketing, biology and precision sheep management. This unit was designed to be a core unit in an integrated VET and higher education degree, offered by UNE as an online unit. In 2016, a further unit was introduced to the

AWET-supported suite of sheep and wool units. Sheep management is a unit designed to be complementary to the sheep production unit and includes both physical and financial sheep management. During this period, AWET has supported undergraduate wool education by an amount in the order of A\$3.6 million (AWET 2018).

The sheep and wool units offered at UNE have been delivered on an online learning management system since their inception. Moodle is the current learning platform employed, which allows students to view unit lecture material, recorded lectures, participate in real-time lectures and practical sessions, self-evaluate using multiple-choice quizzes, submit assessments electronically and receive feedback and grading online, as well as online examination. Three of the sheep and wool units currently offered have a 3-day intensive school mid-point through the unit. This allows students to obtain hands-on practical experience and industry interaction to support the theory delivered online. However, three of the units, namely, wool biology and measurement, sheep management and fundamentals of sheep and wool, are delivered entirely online. Filming of the AWTA laboratory, sheep properties and shearing sheds and interviews with key industry representatives has allowed the students to view material that would otherwise have been delivered in the intensive school. These units were developed as online teaching only, due to demand from full-time working students that could not attend intensive schools.

Our broad aim in the present paper is to detail the development and delivery of the hub and spoke method and to assess its efficacy in terms of the following:

- (i) enrolments and cross-institute participation;
- (ii) the drivers for students to enrol in these units and their demographic;
- (iii) the assessment of the level of student satisfaction with the units and factors influencing this;
- (iv) the extent to which completion of the sheep and wool units leads to employment within industry;
- (v) the identification of the employment destinations of students completing the sheep and wool units and factors influencing employment success and destination type; and
- (vi) the success of the hub and spoke in delivering benefit directly to the industry by providing compatible graduates into sheep and wool industry positions.

Materials and methods

The data for this study comprised routine information gathered during university enrolment and specific student survey data from two questionnaires. The first questionnaire was an annual survey of currently enrolled students between 2010 and 2017 (student survey). The second questionnaire was a survey of graduates and was implemented during 2012–2015 (graduate survey). The work was approved by the UNE Human Research Ethics Committee (Approval no. HE10/198) and both surveys were implemented using the web-based surveying tool, Survey Monkey[®]. The student survey comprised 42 questions on student demographics, motivation for enrolment, background and experience, career aspirations

and recommendations on unit content. There were 289 respondents studying at least one of the sheep and wool units, namely, sheep production, wool marketing, wool processing and wool biology and measurement. Past students were invited to undertake the graduate survey via social media. It comprised 33 questions on employment destinations, taxable income, factors influencing employment success and demographics.

Statistical analyses

Descriptive data are presented without formal analysis. To assess statistical association between survey response variables, Survey Monkey[®] numbered response data for each question were entered into database format and codified such that each respondent formed a row and their responses to each question formed columns. Using the statistical software JMP13 (SAS Institute, Cary, NJ, USA) two-way contingency-table analysis was performed to test association between different responses and significance determined by the chi-square value in a likelihood-ratio test.

Results and discussion

Effectiveness of the hub and spoke model

Students studying sheep and wool science have continued to grow since the hub and spoke program began in 2007 and have increased three and a half-fold in 10 years (Fig. 2). The continued growth in tertiary enrolments into specialised sheep and wool units is despite a significant decline of 60% of students graduating from agricultural and related courses during a similar period (2001–2012; Pratley and Acuna 2015). The growth is evident in UNE enrolments, as students are drawn to the University due to the sheep and wool offerings.

Cross-institute enrolments have remained steady over the period as the units are offered online, which allows access to learning material from across Australia. This has provided the opportunity to have more students studying specialised sheep and wool science than in previous education programs.

Responses

There were 128 respondents who graduated from at least one of the four wool units from 2007 to 2014. Key demographics of all the students enrolled in the hub and spoke sheep and wool units from 2007 to 2017 are shown in Figure 3. The majority (90%) of students were under the age of 29 years old and 69% came from NSW/ACT. The gender ratio was 63% female.

The demographic of the students that participated in the two surveys (student and graduate) was similar to that of the cohort. Thus, the responders were considered unbiased and reflected the sample group. The responders from the student survey were 65% from NSW/ACT, 65% female and 88.5% between 18–30 years of age. The demographic of the responders from the graduate survey; 68% from NSW/ACT, 62% female and 75% between 24–30 years, which would reflect the age group of the students that previously had studied the sheep and wool units, graduated and working. The response rate to the student survey was between 50–77%, depending on the year cohort. This is considered a high response rate for a voluntary online research survey, compared to other tertiary distance-education online surveys, averaging 33% response rate (Nulty 2008).

Student motivation and demographic

The motivation of students to enrol in the sheep and wool units was predominately (56%) the 'desire to work in the sheep

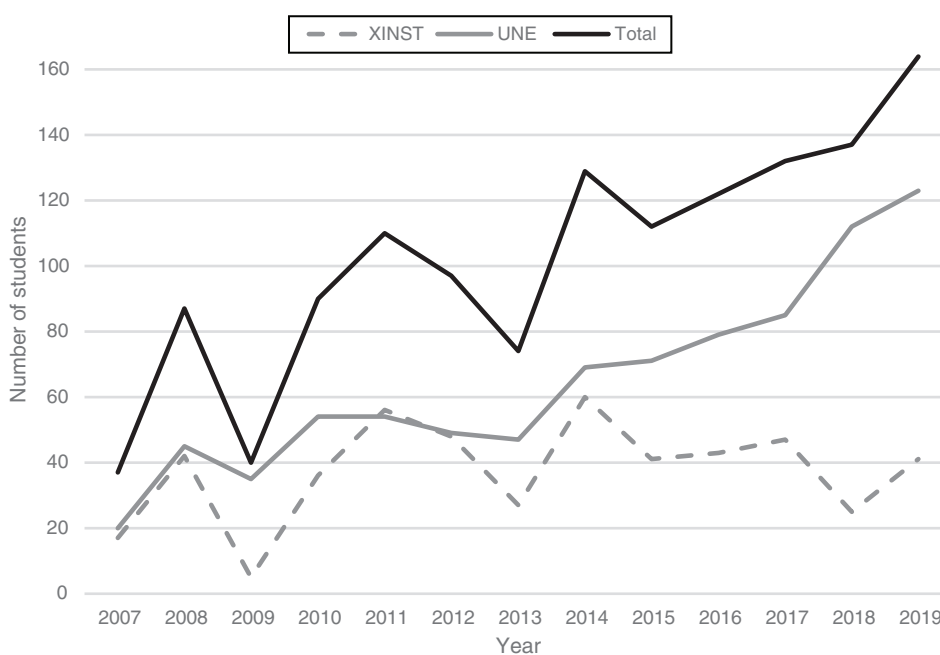


Fig. 2. Total number of student enrolments in sheep and wool units at UNE from 2007 to 2019. The cohort is made of UNE ('hub') students and cross-institute (XINST) students from nine 'spoke' universities. Student numbers from enrolments in four sheep and wool units from 2007 to 2015 and six units from 2016.

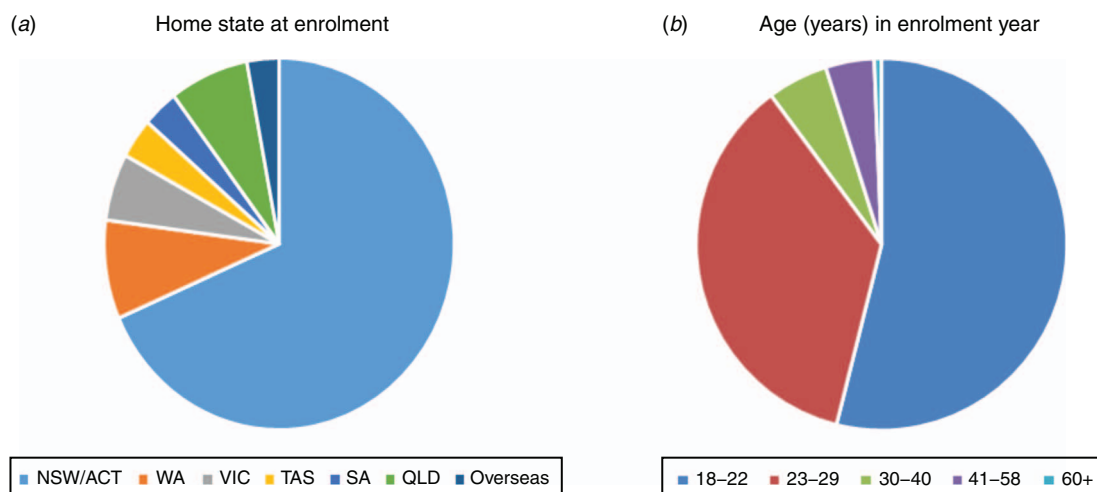


Fig. 3. Home state (a) and age (b) demographics of students enrolled in sheep and wool units under the hub and spoke model from 2007 to 2017.

industry on completion of study' (Table 1). The students were asked whether they were raised on a rural property and about the nature of the production enterprise. The students raised on a wool property (30%) were more likely to choose their motivation to work in the sheep industry on completion of the study (66%, $P = 0.001$) than were those with other production enterprises (<11%). Interestingly, 25% of students studying sheep and wool were not raised on a rural property, but chose the units due to a desire to work in the sheep industry (44%), recommendation from friends (16%) or to see whether they were interested in the sheep industry (19%). Students from other production enterprises, namely sheep meat (20%), cropping (13%) and beef (11%), were varied across all motivations for choosing this field of study.

The offering of specialised sheep and wool units at UNE has also attracted students from other states, that would have otherwise studied at a local university. A large number of students (34%) enrolled in these units and studying at UNE originated from outside of NSW (Fig. 4). In contrast, the cross-institute students studying the units at the spoke universities tended to originate from the same state/territory as the university. A student from Victoria personally commented the following: 'I was not attracted to any of the agricultural degrees in Victoria. I wanted to come to UNE because of the double degree in Agriculture and Business and the sheep and wool units'. This same student was employed by Elders Wool division before graduation and was recently employed as a wool buyer. Another student stated, 'I could have chosen to study at CSU, where my parents studied agriculture. However, I came to UNE for the sheep and wool units and specialist genetics'. This student has also been employed in the wool industry in a genetics position.

Career aspirations of students studying sheep and wool units

The main career aspirations of students studying sheep and wool units was working on the family property, managing a

Table 1. Why did you choose to study sheep and wool science?

Motivation to study sheep and wool	Percentage ($n = 262$)
Desire to work in the sheep industry on completion of study	56
To manage family owned property	7
Currently working in the sheep industry	6
Recommendation from course advisor/lecturer at your University	6
Recommendation from friend	8
Scholarship holder	2
Raised on a sheep property	3
To see if I am interested in the sheep industry	12

sheep property, extension and research (Fig. 5). Notably, 53% of the students raised on a wool production enterprise aspired to work on the family property in the future, which was significantly ($P = 0.05$) more than students from sheep meat enterprises (6%) and other backgrounds (2%). Students raised on a sheep meat enterprise were more likely to aspire to a career managing a sheep property (37%), than were students from other production enterprises (4–14%; $P = 0.05$). Students that were not raised on a property had a significantly greater desire to be involved in research as a career option (29%) than were students raised on a rural property (beef 4% to 18% sheep meat; $P = 0.05$). There was no significant ($P = 0.35$) difference in career aspirations between male and female students, except for those students wanting a future in research. More than three times as many females than males wanted a career in research, proportion to total number of male and female students ($P = 0.05$). Befittingly, the top four career aspirations of undergraduate students (Fig. 5) were the same top four career destinations identified as employment sectors in the graduate survey (Fig. 6), these being working on family property, managing a sheep property, research and extension.

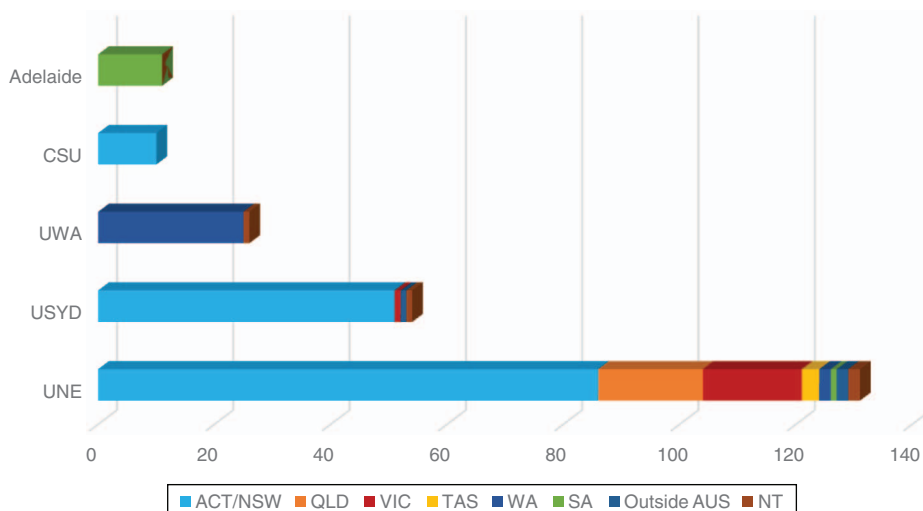


Fig. 4. Numbers of students studying sheep and wool units at UNE by home university enrolment and home state (universities with fewer than 10 enrolments are not presented).

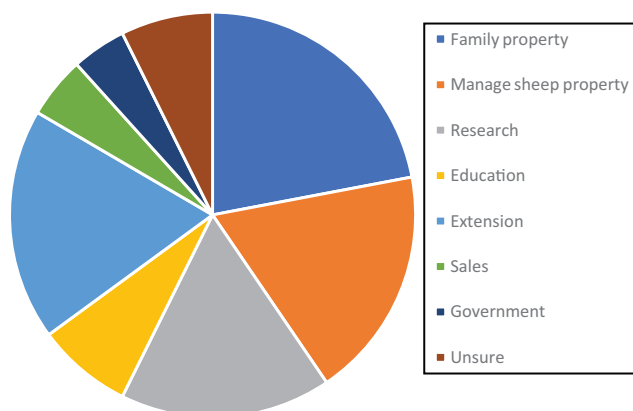


Fig. 5. Future career aspirations of undergraduate students studying sheep and wool units.

Sheep and wool unit student satisfaction

The respondents that answered the questions on the level of satisfaction with the units ($n = 201$) were questioned about each sheep and wool unit they studied and if they would recommend the unit to fellow students. The majority of students (91%) studied the sheep production unit and 90% of students would recommend this unit. The wool biology and measurement, wool marketing and wool processing units were studied by 26%, 23% and 24% of students respectively. The responding students were highly complementary of the units at 88%, 96% and 94% respectively, for each of the above-mentioned units. These results are particularly high compared with average student satisfaction (65%) of tertiary teaching reported across all higher education in Australia in 2013 (Norton 2016). This is likely to be due to the close interaction of the curriculum with industry activity and engagement. Of the students that completed only one sheep and wool unit during their degree, 90% of students stated that their reason for not studying further units was due to finishing

their degree and not having spare electives to study further. The students were asked which of the aspects of the units they thought were helpful and which were not useful to learning. The intensive schools were the highlight for the majority of students (>90%) in each of the four units. A student comment about the best aspect of the sheep production unit was ‘The intensive school had a whole bunch of industry people which allowed for me to communicate with people from industry’. The students did not want any changes made to the content of the units. The students were asked how the sheep and wool units compared with other units within UNE or at their home university. Over half (55%) of students thought that the units had a workload similar to that of other units and 44% of students agreed that the content of the sheep and wool units was more interesting than that of other units. The responses were no different regardless of the student studying at UNE or the spoke universities.

Graduate students – demographic and attitude towards studying sheep and wool

Respondents to the graduate survey had completed their degrees evenly across 2007–2014. The students had studied the four core sheep and wool units proportionally to those that responded to the student survey. To determine the geographical distribution of the graduates, they were asked in what location they are currently employed and, more specifically, whether they were located in rural, regional or city areas (Fig. 7). The majority (63%) of graduates were located in New South Wales, mainly in rural and regional areas. Many of the remaining graduates resided in regional Queensland and Western Australia. Furthermore, graduates were asked what distance from your family home is your current job? More graduates ($P = 0.001$) moved further than 300 km away from the family home (50%) than did graduates who were currently employed in the same town they grew up in (28%). Curiously, there was no significant difference in the

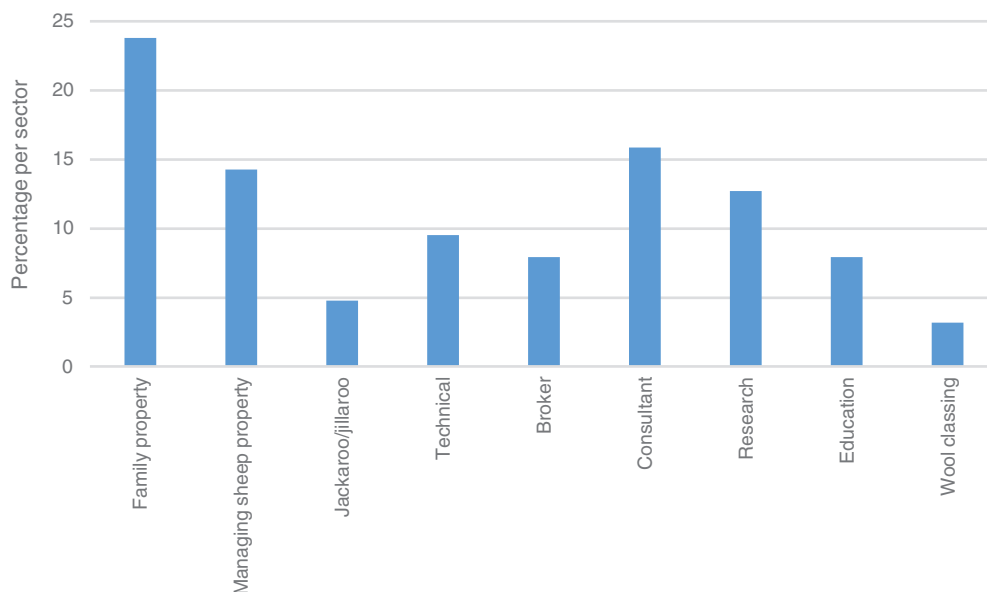


Fig. 6. The percentage of graduates in each sector, who studied sheep and wool units under the hub and spoke model and are now employed within the sheep and wool industry (graduation between 2007 and 2014).

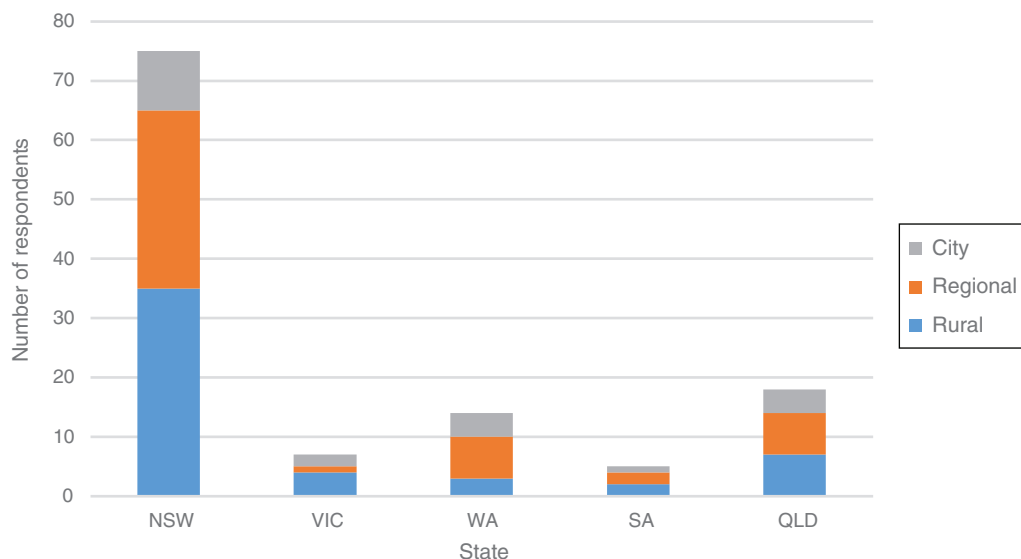


Fig. 7. Location of graduates' current employment, specifically rural (farm), regional town or city (capital city). Respondents from Tas., NT, ACT and overseas were not included, due to small numbers ($n = 9$).

relationship between graduates that were currently employed in the sheep and wool industry and those in another sector in relation to distance from family home and current job.

The graduates were asked directly of their attitude towards having studied the wool units. The responses were positive, with 83% answering 'glad that I did', while no student answered 'prefer not to have done them'. Of the graduates currently employed in the sheep and wool industry, 84% answered 'studying the sheep and wool units assisted in obtaining current position'. The graduates were provided with an 'open-ended' question 'how did the sheep and wool

units assist you in obtaining this position'? Some of the comments made by graduates were 'greater knowledge and insight', 'looked good on transcript' and 'strong fibre knowledge has gained a company-wide profile as a knowledgeable source of information across the wool pipeline'. More specifically graduates were asked 'what content of the sheep and wool units was most useful for you to perform your work?'. Many of the respondents commented that the contacts within industry they made during their study was the greatest asset for them to perform their work within industry. The perception of

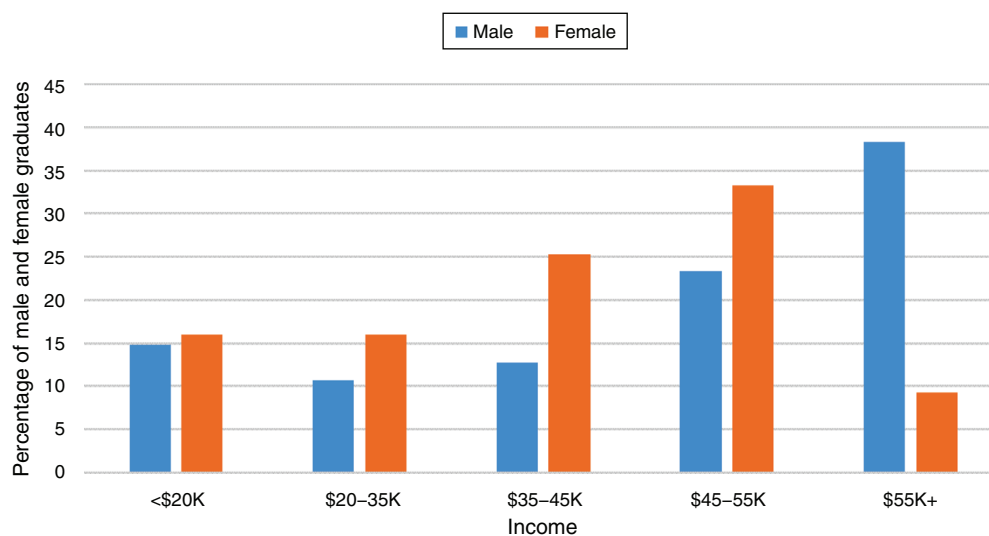


Fig. 8. Starting taxable income of male and female first positions following graduation.

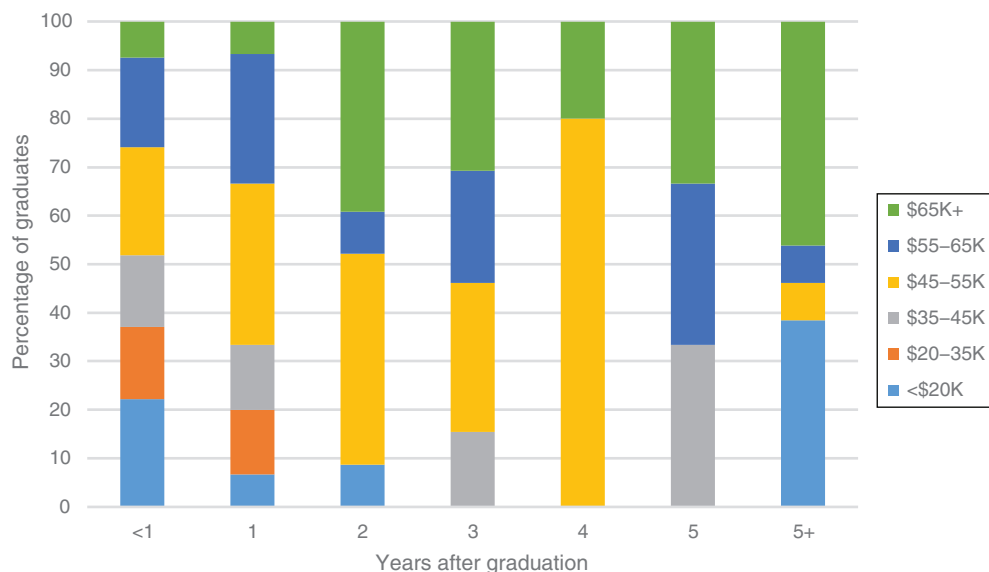


Fig. 9. Taxable income of graduates less than a year to over 5 years following graduation and completion of at least one sheep and wool unit at UNE.

career opportunities within the sheep and wool industry was varied, with a third of graduates choosing ‘limited jobs available’ and 38% stating ‘jobs are available, but not readily advertised’, while the remaining chose ‘positions are readily available for graduates wanting a career in the industry’ and no comment. The results suggest the importance of training tertiary graduates with industry involvement to support recruitment into the sheep and wool workforce.

Income

The starting taxable income of the first position following graduation showed that 70% of graduates began on A\$35 000 and over; <A\$20 000 (16%), A\$20 000–35 000 (14%),

A\$35 000–45 000 (20%), A\$45 000–55 000 (30%) and more than A\$55 000 (20%). The lower income (<A\$20 000) is consistent with over 20% of graduates returning to the family property, with living expenses removed from income. There was no significant difference in starting income of those graduates employed in the sheep and wool industry and those in another sector. The starting taxable income was not significantly different between male and female graduates, except for those graduates starting on more than A\$55 000+ after graduation than were female graduates (Fig. 8). This outcome corresponds with the latest mapping of Australian higher education graduates, showing higher net earnings

Table 2. Career satisfaction responses (presented as percentage) of graduates from sheep and wool units ($n = 74$)

Response	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
In general my career has lived up to expectations	22	45	20	11	2
My daily work is always varied and interesting	26	55	13	3	3
Considering all factors associated with my work, my remuneration is sufficient	15	41	31	9	4
My future career holds good prospects	24	51	18	4	3
If I had to do it over again, I would definitely choose this career path	24	45	15	11	5

of male graduates with a bachelor-level degree than those of equivalent female graduates, and was also identified specifically in the agriculture sector (Norton 2016). This may be explained by the destination of recent agricultural graduates, shown by Pratley and Crawley (2018). The study used information from the Gradlink program from 2004–2014 and represented eight institutes. The male graduates were more likely to be employed in finance and trading or farming, than were females. Female graduates were more likely to be employed in animal industries than were males (Pratley and Crawley 2018).

The taxable income of graduates employed for periods of up to 5 years and over are displayed in Fig. 9. The taxable income of graduates increases with years of employment, up to 5+ years following graduation, where 38% of this cohort have a taxable income of <A\$20 000. This is explained by the choice of many graduates to return to the family property after working within industry for 5 years and their living expenses supported by the farm business.

The perspective of graduates on their career choice and job satisfaction is highly positive (Table 2).

Does studying sheep and wool science lead to employment in industry?

Of the surveyed graduates that responded ($n = 126$) to the question 'are you currently employed in the sheep and wool industry?', 53% answered yes. The jobs in which these students are employed in the sheep and wool industry is varied, with working on family properties, managing sheep properties, consulting and research being the top four positions (Fig. 6).

Wool scholarship holders

In the student survey, scholarship holders ($n = 33$) who were financially supported during undergraduate study by AWET and other sheep and wool industry bodies were identified. The scholarship holders have been mainly UNE students (75%), followed by those from UWA, CSU, Curtin, Murdoch, USYD and UTas. The students were predominantly raised on farms (70%), with 23% coming from wool, 21% from sheep meat, 11% from cropping and 15% from beef enterprises (2% unidentified). Despite 28% of students not being raised on an agricultural production enterprise, only 9% identified as having no experience on farms before beginning tertiary study. The main career aspiration of scholarship holders were in

extension (27%), research (19%) and managing a sheep property (12%).

Twenty graduate scholarship holders were directly contacted to participate in the graduate survey. Only one of these students was not in the agricultural sector and nine graduates were specifically employed in the sheep and wool industry. The positions ranged from managing the family sheep property, agribusiness manager, research officer, sheep genetics project officer and wool broker.

From 2007 to 2017, 1030 students have enrolled in modules provided by the hub and spoke model. Of these, 75% have enrolled in at least one wool module. On the basis of this survey, it is estimated that the model has resulted in ~400 graduates taking up a career in the industry. Many others now work in companies and/or organisations that interact with the industry. The investment by AWET in tertiary education equates to approximately A\$9000 per 'career' graduate. The survey has shown that the investment has facilitated the entry of new wool specialists into the industry, which otherwise would not have occurred. Adoption of the model for other primary industries, such as cotton, with low enrolments in tertiary study, is worthy of consideration by other universities and funding bodies, to support delivery.

Conclusions

The student evaluation of the sheep and wool units offered under the hub and spoke model of delivery was extremely positive. Student interaction with industry and study of units designed by industry has provided students with tertiary education that is transferable. The employment success of students studying the sheep and wool units is over 50%.

This evaluation of the hub and spoke model of teaching a specialised agricultural curriculum demonstrated that it can be effective. However, financial support of the hub university is required to offer units attracting low enrolments to all involved.

Data availability

The data that support this study cannot be publicly shared due to ethical or privacy reasons and may be shared on reasonable request to the corresponding author if appropriate.

Conflicts of interest

Peter Sommerville is the secretariat of the Australian Wool Education Trust, funder of the research. However, this author

had no contribution on the design of the experiment, collection of data or analysis. Stephen Walkden-Brown is an Associate Editor of Animal Production Science but was blinded from the peer-review process for this paper.

Declaration of funding

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References

- AWET (2006) Australian Wool Education Trust Progress Report. Available at www.woolwise.com
- AWET (2018) Australian Wool Education Trust Annual Report–2018/2019. Available at www.woolwise.com
- Cottle D (2003) Sheep and wool science education at Australian universities. *Wool Technology and Sheep Breeding* **51**(4),
- Cottle D, Williams M (2006) Future human capability building in the sheep and wool industry. *International Journal of Sheep and Wool Science* **54**(2), 62–69.
- Hynd P, Auer P, Crook B, Hocking Edwards J, Daily H, Osborne L (2000) The development of a wool education resource database. *Asian-Australian Journal of Animal Science* **13**(Suppl), 30–38.
- Kennedy J (2010) The role of The University of New South Wales in the Advances in Wool Technology and Sheep Breeding since 1951. *International Journal of Sheep and Wool Science* **58**(1), 6
- McClymont GL (1996) All flesh is grass. Inaugural lecture, 11 July 1955. In 'Rural science: philosophy and application'. (Ed. JS Ryan) pp. 1–12. (University of New England: Armidale, NSW, Australia)
- Norton A (2016) Mapping Australian higher education 2016. Grattan Institute, 81.
- Nulty DD (2008) The adequacy of response rates to online and paper surveys: what can be done? *Assessment & Evaluation in Higher Education* **33**(3), 301–314. doi:10.1080/02602930701293231
- Pratley JE, Acuna TB (2015) From adversity comes strength – repositioning education in agriculture. In 'Proceedings of the 17th ASA conference', 20–24 September 2015, Hobart, Tas., Australia. Available at www.agronomy2015.com.au
- Pratley JE, Crawley N (2018) Graduate destinations in Agriculture. *Agricultural Science* **29/30**, 6–15.
- Welsman SJ (2006) 'Demand for CRC-UNE educational resources and industry short courses.' (Report delivered to The Sheep Industry CRC and the University of New England: Armidale, NSW, Australia)

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