Australian Government

Department of Education

SMARTfarm Learning Hub: Next generation technologies for agricultural education

Final report 2018

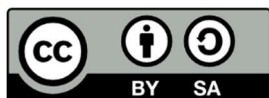|	
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Partner institutions:	University of Tasmania
	Central Queensland University
	The University of Sydney
	University of Southern Queensland
	The University of Melbourne
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https://smartfarmhub.education/
https://www.facebook.com/smartfarmhub/

SmartFarm
LEARNING HUB

Acknowledgements

List of acronyms used

Universities

CQU	Central Queensland University
NMSU	New Mexico State University
QATC	Queensland Agricultural Training Colleges
UMelb	The University of Melbourne
UNE	University of New England
USQ	University of Southern Queensland
USyd	The University of Sydney
UTas	University of Tasmania

Other acronyms

AgLTAS	Learning and Teaching Academic Standards Statement for Agriculture
AMS	automatic milking systems
EBVs	estimated breeding values
FOO	food on offer value
MLA	Meat & Livestock Australia
NDVI	Normalised Difference Vegetation Index
PfS	Pastures from Space
PGR	pasture growth rate
NDVI	Normalised Difference Vegetation Index
PIEFA	Primary Industries Education Foundation Australia
RHET	Royal Highland Education Trust
RITLS	real industry technology learning system
TLOs	threshold learning outcomes
VET	vocational education and training

Executive summary

In 2015–2016 there were 282,000 people employed in agriculture in Australia (Australian Bureau of Agricultural and Resource Economics and Sciences [ABARES], 2017). Despite the recognition that the modern agricultural industry is complex and demanding, it still has one of the lowest proportion of workers with post-secondary qualifications across the economy (Senate Standing Committees on Education, Employment and Workplace Relations, 2012), with approximately 7.8 per cent of the agricultural workforce with tertiary qualifications compared with 25 per cent for the broader population (Pratley, 2012). Pratley and Botwright Acuña (2015) have also reported that there is already a skills shortage in the industry, with an estimated four jobs available for every tertiary agricultural graduate in Australia.

Additionally, those students who are graduating with an Australian agricultural degree are doing so without gaining the fundamental skills and knowledge required in the current technical and rapidly changing environment. Key skills that require development include attaining a theoretical understanding of new technologies and the practical ability to use them in an analytical and problem-solving context (Trotter et al., 2016).

There is a recognised skills shortage in the Australian agriculture industry that is exacerbated by the failure of universities to keep pace in educating students in the latest agri-tech systems. A collaborative project between seven universities in Australia and the United States of America (USA), the SmartFarm Learning Hub developed real industry technology learning systems (RITLS) using real farm data and commercially available systems to be used in tertiary teaching to increase graduate capabilities and readiness for employment within the agricultural industry. There were several RITLS developed for the SmartFarm Learning Hub website.

The Australian agricultural industry faces many workforce challenges, including:

1. a shortage of tertiary graduates to fill available positions, and
2. employees possessing the knowledge and skills of how to use the latest agri-tech tools and systems.

The SmartFarm Learning Hub project aimed to increase the employability of tertiary agricultural students by preparing them with the skills and knowledge for a successful career in an increasingly complex and highly technical industry. The SmartFarm Learning Hub is a collaboration between seven universities, both within Australia and the USA, namely the University of New England, University of Tasmania, Central Queensland University, University of Southern Queensland, The University of Melbourne, The University of Sydney, and New Mexico State University. Each of the partner universities has a SmartFarm with a diverse range of enterprises and environmental conditions represented, from the highly productive dairy systems in Tasmania to tropical beef production in Central Queensland and the arid rangelands of New Mexico (Trotter et al., 2016). Each university produced a learning module focused on inputting authentic farm data into an RITLS, which has been uploaded onto the project's website (https://smartfarmhub.education/), enabling students across the world to access and analyse data and outline the subsequent management decisions they would make to increase on-farm profitability, productivity, and sustainability.

Each of the modules has been evaluated as part of an action research cycle (McTaggart, 1991), with the feedback received utilised to improve them for future student cohorts. Results indicate that the project has achieved its aim, with students perceiving their employability skills to have increased as a result of completing the modules. This action research project has provided both research outcomes and critical feedback to improve the learning materials. Students were invited to complete an online survey, consisting of Likert-scale questions (Likert, 1932), at the conclusion of the practical asking for their perceptions on a range of aspects. The questions ascertained whether students perceived that the learning outcomes (derived from the Learning and Teaching Academic Standards Statement for Agriculture) (Botwright Acuña & Able, 2016) were achieved, the level of enjoyment of the content and learning experience, the applicability of the learning module to future employment, ICT skills, system usability, and their demographic details.

Student responses indicate that they believe the use of industry tools in teaching is important for their future career, with 90 per cent of respondents indicating they would use the knowledge derived from completing the 'Rainfall to Pasture Growth Outlook Tool' practical in their future employment. When asked whether completing the same practical would increase their employability in the agricultural industry, one student said:

> It's important to be able to apply data about environmental factors to on-farm management decisions and future planning

However, there are still tighter links that can be made in the practical to enhance employability skills. One suggestion is that key skills students can include on their curriculum vitae (CV) could be highlighted in each RITLS module.

Education institutions in Australia and across the world are able to use any of the learning modules available on the SmartFarm Learning Hub website without charge and with freedom to amend the material to suit their teaching. This is because each of the RITLS learning modules, consisting of student and educator resources for academics, tertiary students, school teachers and their students (and, in the future, for farmers) were developed as part of the SmartFarm Learning Hub and are available via a Creative Commons Attribution-ShareAlike licence.

Key findings/Take-home messages

- The SmartFarm Learning Hub is an open-access website enabling students, teachers, and farmers access to training packages for the latest livestock and grazing management technologies. These include:
  - *Pastures from Space Plus,* which has several new features including satellite imagery with 30m x 30m resolution and a stocking rate calculator
  - *The NRM Spatial Hub,* providing rangeland resource mapping and for which Stage 1 has been completed with positive feedback from landholders
  - *Ear-deployed accelerometer sensors,* currently used as research tools and capable of identifying sheep behaviour.

Each of the seven institutions undertook the following to create learning modules for the project:

- University of New England – MaiaGrazing, PA Source, ProductionWise

- The University of Melbourne – Dookie Dairy database (Robotic)

- University of Tasmania – Pasture.io, Sense-T Sensor Smart Irrigation

- Central Queensland University – EBV Simulator

- University of Southern Queensland – Scheduling Irrigation Diary

- The University of Sydney – Pastures from Space

- New Mexico State University – NRM Spatial Hub

The learning modules have been updated for consistency, and in 2018 a further selection of modules for high school teachers have been added. These include: Global Navigation Satellite Systems; Accelerometer Monitoring Animal Behaviour; Estimating Green Biomass; Soils: Texture, CEC and pH; Plant Stress Detection Glasses and SFLH Drones Module. These can be found on the home page of the SmartFarm Learning Hub website, under "Educational Resources"/"School Teachers". There will also be resources and tools for farmers uploaded. These are examples of the ongoing commitment of the project team to the sustainability of the SmartFarm Learning Hub, with many licences for access to commercial systems undertaken for a further five years beyond project completion.

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Chapter 1

Overview

The SmartFarmLearning Hub, a website (see: https://smartfarmhub.education/), is a world first; it links real industry technologies with educator resources and student learning packages (see Figure 1). It provides higher education providers, school teachers and their students online access to data and systems from commercial scale smart-farms across Australia. This project introduces a completely new level of interaction between students, educators and industry with the use of real industry tools, systems and data. This model could be developed and applied in other sectors outside agriculture revolutionising the linkage of industry and learning institutes across the Australian education sector.
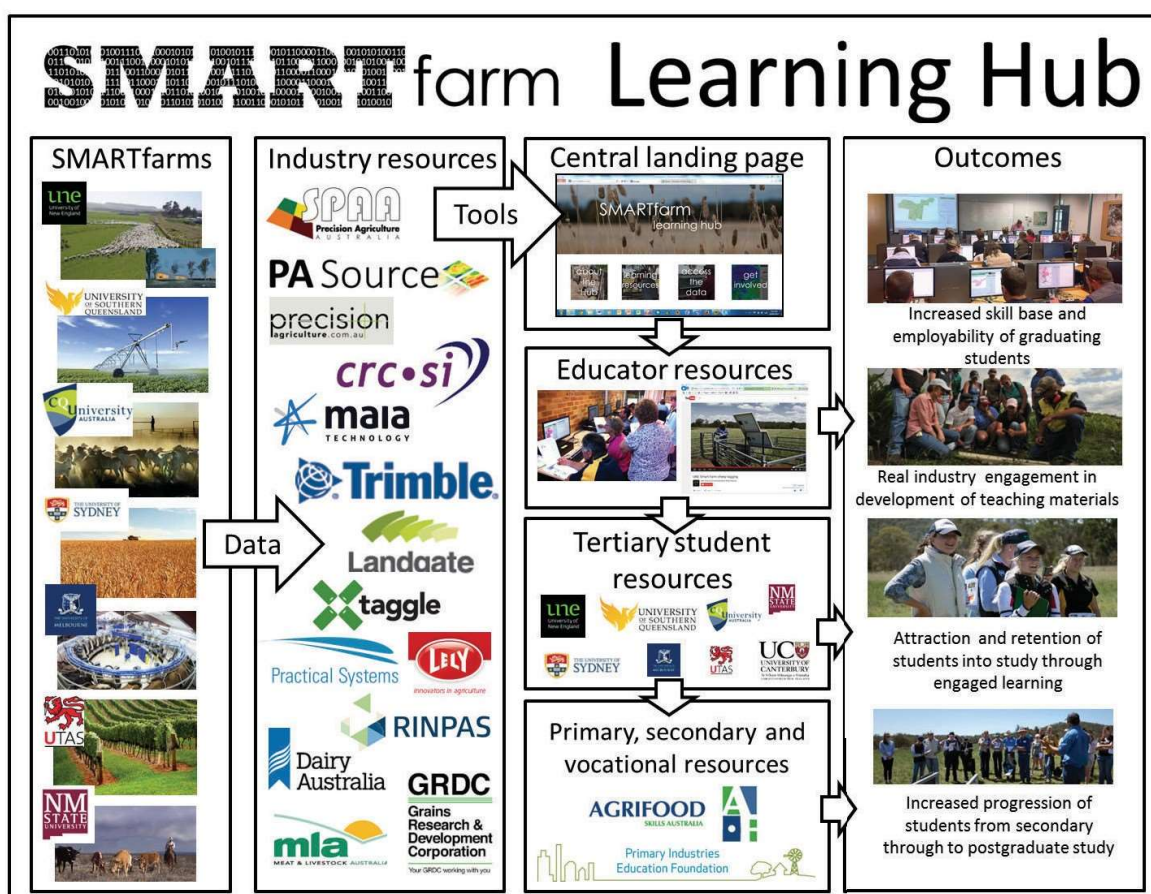
Figure 1: The SMARTfarm Learning Hub. Real working farms linked with established industry tools to provide unique learning experiences for students

The intended impacts of the project were to provide students with both the theoretical and practical skills in new and emerging technologies in agricultural industries and expand their learning experience by providing access to data and systems not currently available to them, and their institutional relevance are in attracting and retaining students and enabling progression from undergraduate to postgraduate study. This project was also timely because of the curriculum review of Bachelor of.

Critical to the SmartFarm Learning Hub project was the pedagogical evaluation and review evaluating the learning modules that are being used by university academics and students. The learning modules have been evaluated through surveys, interviews, and discussion groups. Providing general feedback and assessment will provide future users with resources and a model for other industries.

Target points included improving institutional pathways across higher education with the upskilling of students, improving attrition rates, and attracting new students, together with the correlation between industry and educational providers, including teachers and their students.

Improving employability skills has been a major priority of the project. This has been achieved by blending academic theory and practical learning while building reciprocal relationships with industry. There were seven universities committed to the project.

The SmartFarm Learning Hub has not only improved the employability skills of tertiary students but will enable vocational, secondary, and primary educators to have the opportunity of accessing a broader range of resources than what was currently available. This will increase the flow of students from school through to tertiary study in agriculture.

The SmartFarm Learning Hub has created a website with links to a variety of industry and learning resources. There are also links to social media platforms such as Facebook.

The materials are retained by the Commonwealth Government but available for use and amendment under a Creative Commons Attribution-ShareAlike licence.

One case study was conducted with secondary school students from Farrer Memorial Agricultural High School. A vocational education and training (VET) sector case study was developed in collaboration with Central Queensland University (CQU) and Food and Agribusiness Australia (formerly Agri-Food Skills Australia) to explore opportunities within the vocational education sector.

There are two PhD scholarships linked to the project, which will continue beyond the life of the project. One PhD student is focusing on encouraging students who study agriculture in high schools to go on to further education in agricultural sciences. The second PhD student is evaluating resources and tools for farmers.

Overall, the project website contains resources to assist tertiary academics in teaching agriculture, resources for their students, and resources for school teachers and their students.

Project aims

The aim of the SMARTfarm Learning Hub was to blend theoretical learning with the development of practical, problem solving and analytical skills to improve student employability. Research was undertaken to determines perceptions of the value of certain skills gained by students through participation in SMARTfarm Learning Hub modules. This involved quantitative assessment of users' perceptions as well as qualitative assessment of the perceived value. The outputs were published in various avenues.

The project aimed to link real industry technologies with educator resources and student learning packages. The SmartFarm Learning Hub provided higher education academics and their students online access to data and systems from commercial-scale SmartFarms across Australia. The project also created learning modules for high school teachers and their students, which are available and is currently (through the PhD students) going to provide technology resources and 'how to use these' for the farmers.

Project team roles

Each of the following seven institutions created learning modules for the project, the details of which appear as follows.

University of New England

Learning modules were developed based around data and industry tools from the University of New England's (UNE) SmartFarms 'Kirby' (a 2,900 ha grazing property) and 'Tullimbah' (a 1,000 head capacity feedlot). The modules were embedded into teaching materials in the Precision Agriculture units offered at UNE and general agricultural units such as rural science, natural resources, and grazing systems. Learning modules were also developed based on Meat & Livestock Australia's (MLA) BeefSpecs platform. Resources were developed around the StockTrack research platform, based on data from CQU, The University of Sydney (USyd), and UNE. In addition, UNE developed learning modules for undergraduate courses in agriculture, physics, and electronics and secured two PhD students based on the SmartFarm Learning Hub (with university-sponsored scholarships). UNE also led action learning research protocols.

Central Queensland University

CQU's Belmont research farm (a 4,000 ha farm running 800 breeding cattle) was also used to develop learning materials. Furthermore, CQU developed material for integration into the VET sector dual-degree program.

University of Tasmania

Learning modules for technology were developed by the University of Tasmania (UTas), in addition to modules based on UTas farms, which were integrated into Agricultural Technology and Innovation units. Moreover, modules were developed from the resources of the Tasmanian Institute of Agriculture. UTas also developed modules based on Learning and Teaching Academic Standards Statement for Agriculture (AgLTAS).

The University of Sydney

USyd developed learning modules based on Nowley Farm (a 2,083 ha cereal grain production and cattle breeding and fattening farm), in addition to developing a comprehensive education module for the Australian Grains Industry.

University of Southern Queensland

The University of Southern Queensland (USQ) developed learning materials in relation to precision agriculture sensors and equipment.

The University of Melbourne

The University of Melbourne (UMelb) integrated emerging research into extension strategies and developed modules based on their 'Dookie' dairy farm, focusing on automated milking systems.

New Mexico State University

New Mexico State University (NMSU) developed learning modules based on their ranches and in the evaluation of international linkages.

Evaluation strategy

Table 1 provides an evaluation guide for the development of the project, which expressly explored external opportunities to extend and cascade the outcomes beyond the immediate scope of the project.

Table 1: Project evaluation strategy

Year	2016	2017			2018
Activity **Quarter**	**1–6**	**2**	**4**	**6**	**1–3**
Develop evaluation plan in consultation with project leaders	X				
Interim project evaluation reports (six monthly and yearly)	X				
Ongoing management of project evaluation		X	X	X	
Analysis of data generated through evaluation strategies			X	X	X
Interim project evaluation reports (six monthly and yearly)			X	X	
Summative evaluation report submitted					X

Table 2 provides an overview of the project plan and the outcomes achieved. This plan was part of the project submission and all outcomes have been achieved.

Table 2: Project plan and outcomes

Activity	2016				2017				2018
Quarter	1	2	3	4	5	6	7	8	
A. Establishment of infrastructure and systems									
1. SmartFarm Learning Hub web landing page									
1.1 Scoping of Hub website content COMPLETED Web designer has made numerous updates to the website discussed below. Animated video has also been completed and uploaded to the website.	●	●	●	●	●	●	●		
1.2 Initial development and launch (linkage with social media platforms) COMPLETED Web designer has been regularly updating the Facebook page with updated content.	●	●	●	●	●	●	●		
1.3 Ongoing refinement of website and social media	●	●	●	●	●	●	●		

Activity	2016				2017				2018
Quarter	1	2	3	4	5	6	7	8	
COMPLETED Person contracted to go through the whole website and undertake a comprehensive analysis of the content and links. Part of the report is attached (see Figure 2).									
2. Industry tools established and available for use by students across selected SmartFarms									
2.1 Workshop to establish and prioritise tools COMPLETED The workshop was not held; however, one-to-one meetings with several industry representatives have occurred.		●		●					
2.2 Initial industry system engagement and establishment of protocols for educational use COMPLETED Initial industry engagement has occurred and the establishment of protocols for educational use have been discussed and progressed. All universities now have a tool to use for their learning module.		●	●	●					
2.3 Ongoing development of industry tool integration COMPLETED Development of agreements with Pastures from Space, NRM Spatial Hub, and Pasture.io for educational purposes.				●	●	●			
B. Development of learning materials									
3. Developed case study learning packages for tertiary students									
3.1 Workshop to establish initial design scope COMPLETED		●							
3.2 Formalisation of design brief for learning modules through participant review COMPLETED		●							
3.3 Initial collaborative development of learning modules with each university participant COMPLETED Each university delivered their developed learning module in 2017.			●	●	●	●	●		
3.4 Refinement of learning modules and development of new resources as opportunity arises COMPLETED Refinement of learning modules based on student feedback has been completed and modules for teachers and school students developed.				●	●	●	●		●
4. Secondary resource development and engagement workshops (Primary Industries Education Foundation Australia [PIEFA])									
4.1 Workshop with PIEFA COMPLETED				●					

Activity	2016				2017				2018
Quarter	1	2	3	4	5	6	7	8	
An alternative workshop with NSW DET teachers was held in August 2016 and the learning modules trialled at this day are currently being developed for use in secondary schools. Also, one of the people employed to work on the project will be attending PIEFA 2018, representing the SmartFarm Learning Hub and promoting the project, and also providing a two-hour workshop.			●						●
4.2 Ongoing collaboration (external funds dependent) NO EXTERNAL FUNDS RECEIVED BY PROJECT NSW DET were developing a resource after attending workshop in August 2016.				●					
5. Vocational sector resource development and engagement workshops									
5.1 Workshop with Agri-Food Skills Australia (includes report) COMPLETED This has changed to work with Queensland Agricultural Training Colleges (QATC)/CQU as Agri-Food Skills no longer exists. A report on how to integrate VET and higher education learning outcomes into learning modules has been completed by CQU.						●	●		●
5.2 Ongoing collaboration (external funds dependent) NO EXTERNAL FUNDS RECEIVED BY PROJECT									
C. Development of methodologies to facilitate extension									
6. Methodology for educators seeking to create modules around new industry tools developed									
6.1 Development of survey process to collect critical features from participants COMPLETED Survey/interview questions were developed.		●							
6.2 Ongoing collection of feedback COMPLETED Informal feedback was continuously received. Survey/interview data has formalise this.			●	●	●	●	●	●	
6.3 Final guidelines developed and made available on Hub COMPLETED and uploaded to the website								●	
7. A set of guidelines for industry seeking to make their tools available for educational use									
7.1 Development of protocol for capturing industry/educator interaction COMPLETED					●				
7.2 Ongoing collection of data COMPLETED			●	●	●	●			

Activity	2016				2017				2018
Quarter	1	2	3	4	5	6	7	8	
Informal feedback was continuously received. Survey/interview data has formalised this. COMPLETE							●		
7.3 Final guidelines developed and made available on Hub COMPLETED								●	
D. Pedagogical evaluation and review									
8. Evaluation of the learning modules									
8.1 Evaluation/action research methodology established COMPLETED Survey and protocol delivered and approved by ethics. UNE ethics amended. Same survey was sent to all participating universities to put through their ethics committees.		●							
8.2 PhD student appointed. COMPLETED Two PhD students have been employed in the project. One expected to complete in July 2021 and the other in December 2021.					●	●	●		
8.3 Data collection and feedback to module developers COMPLETED There was very little uptake by university students to complete the surveys. 2017 UNE Data collected on two Pastures from Space (PfS) and MaiaGrazing learning modules. Data in the process of being collected for ProductionWise. Other universities are also in the process of collecting survey data.		●	●	●	●	●	●		
8.4 Final reporting of results COMPLETED Each university has posted their findings in this report.									●
9. Evaluation of the perceived value of skills from the SmartFarm Learning Hub to employers									
9.1 Survey methodology established and implemented COMPLETED			●	●		●			
9.2 Final report COMPLETED									●
E. Package dissemination and extension									
10. Updates to be presented at relevant conferences									
10.1 Society of Precision Agriculture (SPAA) COMPLETED Presented at International Conference on Precision Agriculture 2016. COMPLETED			●		●	●			

Activity	2016				2017				2018
Quarter	1	2	3	4	5	6	7	8	
Presented at the 2017 SPAA Townsville Precision Agriculture Expo. COMPLETED Presented at the Agronomy Conference, Ballarat, 2017. COMPLETED						●			
10.2 Deans of Agriculture update COMPLETED Email update sent to Deans of Agriculture Secretary Jim Pratley. COMPLETED						●			
10.3 General industry updates as opportunity arises COMPLETED		●	●	●	●	●	●		
11. SmartFarm Learning Hub Symposium									
11.1 Digital Rural Futures Conference session project update COMPLETED			●						
11.2 Digital Rural Futures SmartFarm Learning Hub Launch COMPLETED No Digital Rural Futures Conference in 2017. Replaced with individual launches at individual universities (e.g., seminar, presentation at university T&L conferences). COMPLETED Launch to occur at PIEFA Conference in April 2018. COMPLETED	●					●	●	●	●
F. Progress and final reporting									
Mid-term progress report COMPLETED			●			●			
Final report COMPLETED									●

Chapter 2

SmartFarm Learning Hub website evaluation

Analysis of the SmartFarm Learning Hub website, https://smartfarmhub.education/, was undertaken. Each page was explored to ensure links, grammar, navigation, and learning modules were correct. The report stated that the website is a wealth of usable knowledge that incorporates engaging resources to not only excite students but also ignite passion in teachers. The website map follows, including a graphic of navigation (see Figure 2).

Site map

- SmartFarm Hub
  - Home
    - SmartFarm Link
    - Learning Modules
    - Registration
    - For Schools
  - About
    - Precision Agriculture Link
    - SmartFarm Link
  - Learning Modules
    - Pastures from Space
      - Student Materials
        - Precision Pastures Practical
        - Pastures from Space Overview
        - Charting Paddock Data
        - Satellite Imagery Tutorial
        - Stocking Rate Calculator
        - Additional
          - Nationwide Data
          - UNE SmartFarm Data
      - Educator Material
    - International Plant Nutrition Institute
      - iOS Version Link
      - IPNI Website Link
    - Farm Map 4D
      - Farm Map Website Link
      - Student Materials
        - Lecture Notes
        - Farm Map 4D Practical
        - Future Challenges NRM Video
        - Video Tutorials
          - NRM Spatial Hub How to Guides
      - Educator Materials
        - Download Resources
        - Reading Materials
          - Stocking Rates Article
          - Grazing Patterns Article

- Additional Readings
  - NRM Hub
  - NM State University Link
- NRM Spatial Hub Video
- EBV Simulator
  - Log in to External Link
- Automatic Milking and Precision Dairy Technology
  - Overview Video
  - Data Analysis
    - Herd Overview
    - Individual Cows
  - More Videos
    - Use of Data in the Dairy
    - NSW DPI Pasture Based Automatic Milking System
  - Tutorials
    - Robotic Dairy Software
  - Resources
    - NSW DPI Dairy Link
- Scheduling Irrigation Diary
  - The Knowledge Management System for Irrigation (KMSI) Link
  - The Scheduling Irrigation Diary Link
  - Student Materials
    - Scheduling Irrigation Diary Practical
    - Knowledge Management System for Irrigation Link
    - Android/iOS Usage Link
    - Tutorial Video
  - Educator Materials
    - Lesson Plan
    - Resources
      - Irrigation of Sugarcane Manual
    - AgLTAS Outcomes
      - Academic Standards & Statements for Agriculture
  - Scheduling Irrigation Diary Review Video
- ProductionWise
  - ProductionWise Link
  - Student Materials
    - ProductionWise Practical
    - Video Tutorials
      - How to Guides
  - Educator Materials
    - ProductionWise Overview Video
- MLA Calculator & Tools
  - MLA Website Link
- Educator Resources
  - Dookie Dairy
  - Additional Resources
    - Videos for the Dairy Industry
- Log Out
- Contact
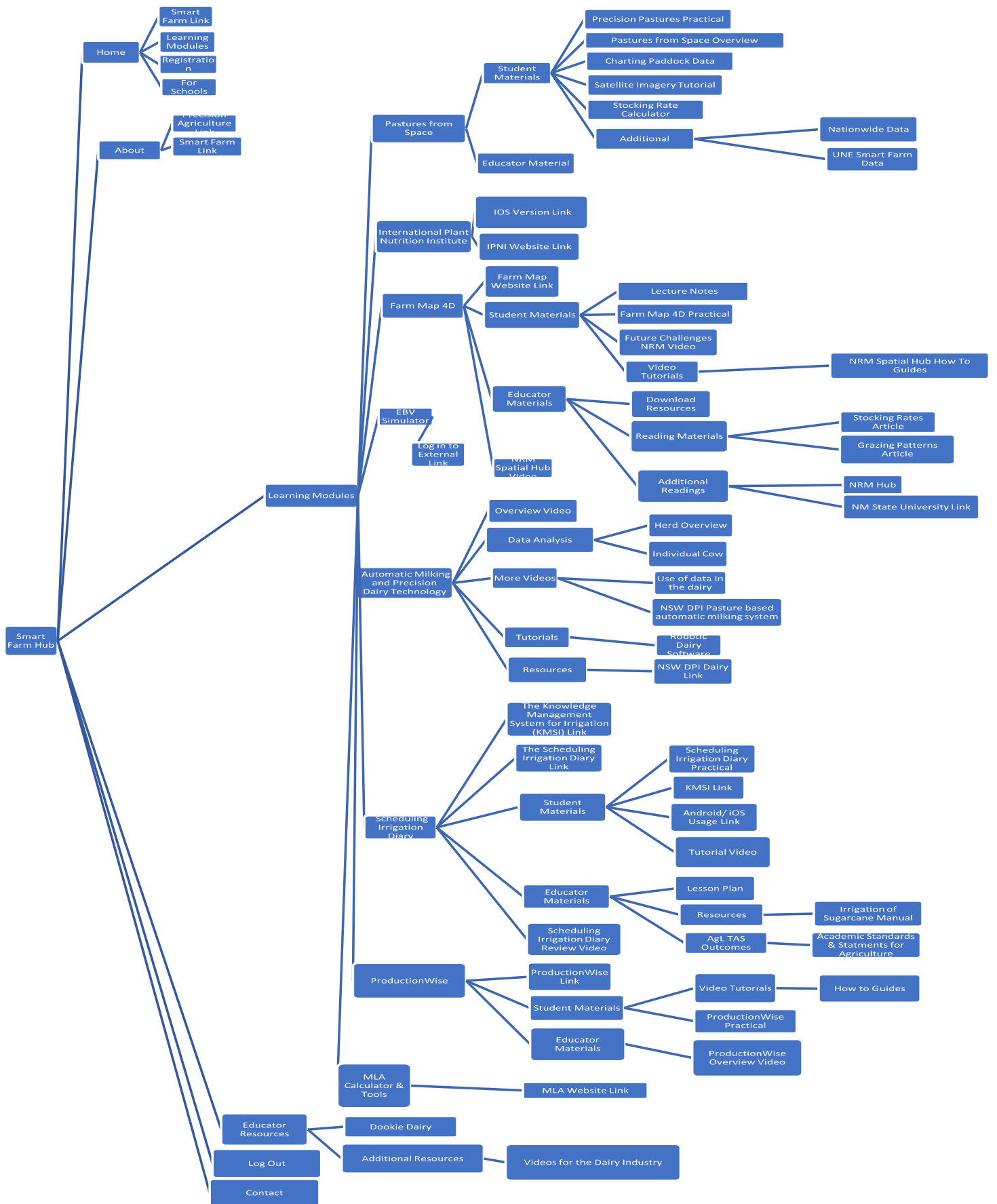
Figure 2: Site map

Chapter 3

Appendices D, E, F, G provide a variety of surveys that were provided to university students, school students and high school students. These were presented to various groups at the conclusion of workshops.

University reports

Agriculture is an important industry to the Australian economy, with farm production worth A\$63.8 billion in 2016–2017 (Australian Bureau of Agricultural and Resource Economics and Sciences [ABARES], 2017). The future competitiveness of the sector in a global economy requires continual improvement in agricultural production that is underpinned by rapid technological change. Agricultural professionals with contemporary knowledge and skills are then critical to ensuring that these new practices are adopted in farm businesses. However, only 8 per cent of the agricultural workforce has a tertiary qualification compared with 25 per cent of the broader population (Senate Standing Committees on Education, Employment and Workplace Relations, 2012), with an estimated four jobs available for every tertiary agricultural graduate (Pratley & Botwright Acuña, 2015). Consequently, this raises two issues. First, that the learning outcomes of graduates from Australian universities reflects the technology and data needs of contemporary farming practice. Second, that more students are encouraged to consider a future career in agriculture.

The SmartFarm Learning Hub (https://smartfarmhub.education/) aims to address these issues by developing learning modules that use authentic farm data in a real industry technology learning system (RITLS). Farms in the hub represent a varied range of agricultural enterprises and geographical locations (Cosby et al., 2017). Following are reports from each of the institutions involved in the project, outlining their achievements and the learning modules that were developed for the project.

University of New England

The **ProductionWise®** learning module was developed by Dr Richard Flavel, crop lecturer at UNE (see Figure 3, with Dr Flavel in action teaching), and was taught to third-year agronomy students in August 2016 and 2017. ProductionWise® is an online crop management tool developed by GrainGrowers for farmers (see https://productionwise.com.au/#main). The learning module that students completed asked them to use the mapping and CropTracker tools available to model the expected performance of the then current winter crops and explore the impacts of management decisions on these modelled yields. This tool was used to critically investigate the complex interactions between management decisions, crop physiology, and environmental factors such as available soil moisture, fertiliser applications, and thermal drivers. Students were provided with scenarios that they might expect as an agronomy consultant and asked to provide explanation and recommendations to manage the cropping system in the context of a farming enterprise.
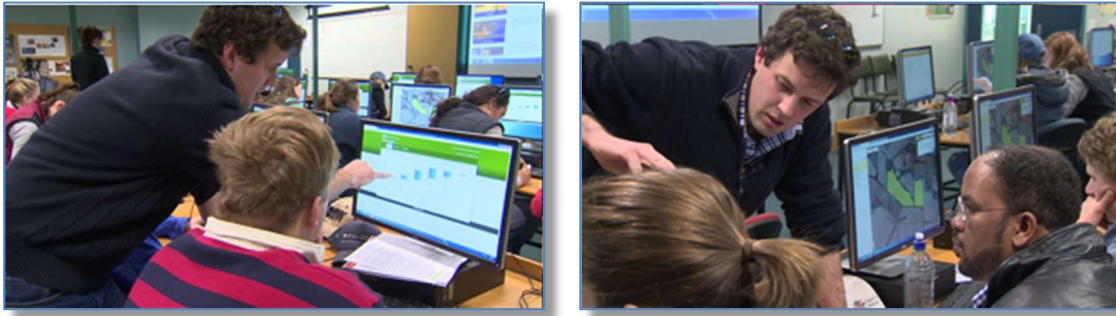
Figure 3: Teaching ProductionWise®

At the conclusion of the practical, students were invited to complete an online survey (see Appendix D). Sixteen students studying rural science, agriculture, and agribusiness degrees at UNE completed the survey. The questions that focused on learning outcomes were derived from the threshold learning outcomes (TLOs) that form AgLTAS (Botwright Acuña & Able, 2016; Pratley & Botwright Acuña, 2015). These were developed using a consensus approach to address the need for skilled graduates in agriculture with academic, industry, and student input (Botwright Acuña, Roberts, Rawnsley, Penrose, & Cosby, 2017). Students were asked to respond to questions based on the AgLTAS TLOs using a Likert scale (Likert, 1932).

A selection of responses from students in relation to the TLOs is provided in Figure 4. With 94 per cent of students strongly agreeing or agreeing, it is clear that the practical improved student knowledge of contemporary issues in agriculture. The results of the survey indicate that there are places in the ProductionWise module where amendments could be made to strengthen the prevalence of the TLOs. Nearly half of the students had a neutral response to whether the module equipped them to communicate what was learnt. The addition of questions where students are asked to briefly outline how they would communicate their theory to a grower if they were an agronomist could improve this aspect of the three-hour practical. Recommendations from the first-years' responses were implemented into the practical for the following year.

GrainGrowers have withdrawn their support for the use of their program in developing a student training program; as a result, the publishing of the learning module has been abandoned.
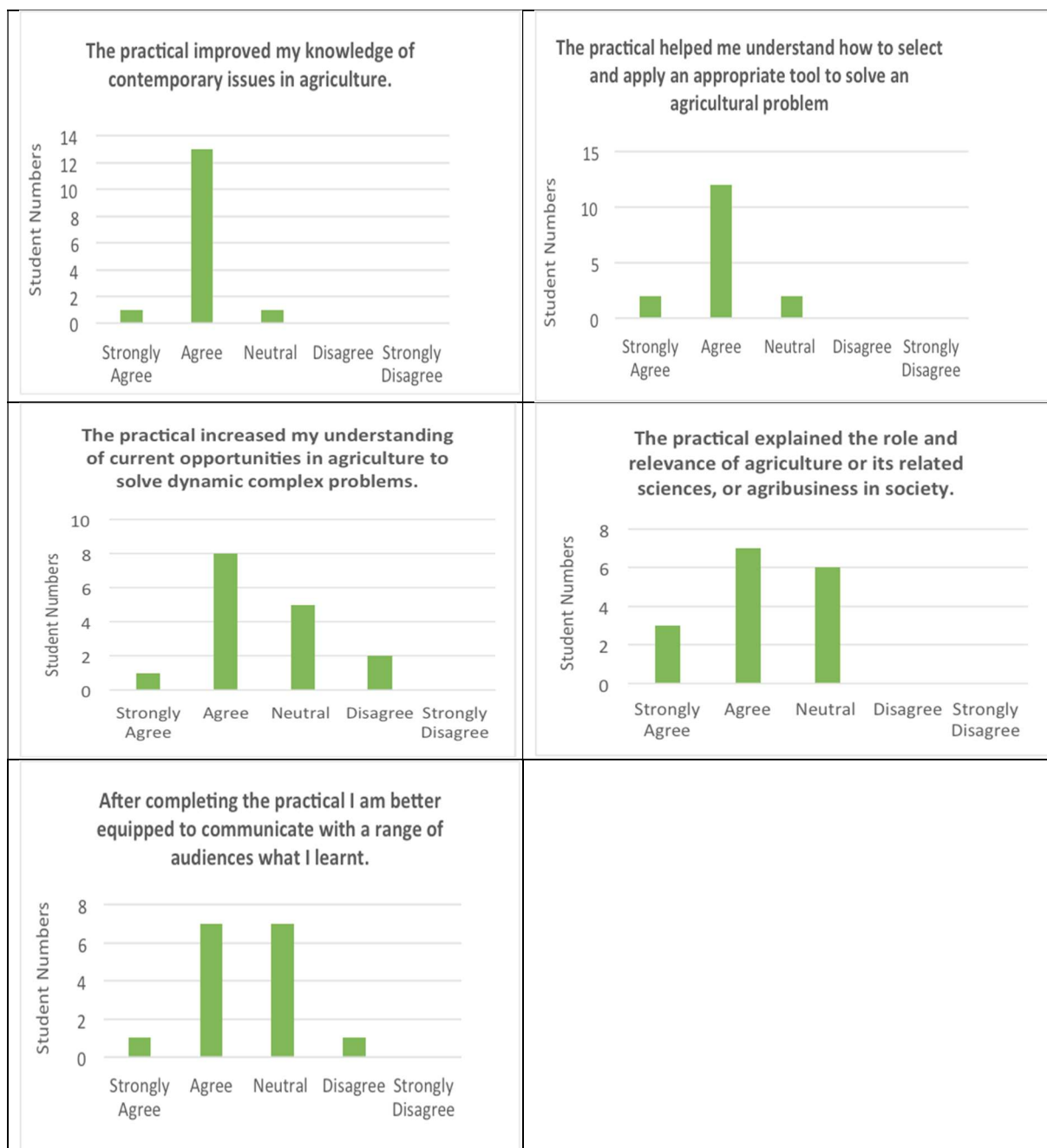
Figure 1: Student responses to learning outcome questions after completion of the ProductionWise learning module

The PA Source module was delivered by Dr Jamie Barwick to UNE students enrolled in RSNR120, a first-year unit completed by students studying agriculture and environmental-based degrees. This module was delivered as a practical class where students interrogated data from the UNE SmartFarm. This PA Source practical class exposed students to a web-based geographical information system (GIS) allowing them to look at data such as paddock boundaries, elevation across the farm, soil electrical conductivity, and a GreenSeeker survey examining plant health. The second component of this module required students to create their own digital farm map, digitising in paddock boundaries of a property they were familiar with. This second component proved extremely valuable for student engagement, as it allowed students to relate what they were learning to a real-life example and provided

an actual map that they could take back to their own properties and use.

Overall, this module introduces students to some basic precision agriculture concepts and tools, providing them with skills that are increasingly being demanded by the workforce. One of the great benefits of PA Source is its simplicity of use, and this was reflected in the student feedback. In the future, this module will be reliant on the availability of the PA Source platform and will likely require updating in line with website changes. It has the potential to be further adapted to different learning levels given the program's range in functionality and this could be developed in the future.

Pastures from Space (PfS) is a widely used teaching resource at UNE. The PfS module combines many agricultural concepts, including pasture growth rate (PGR), climatic variability, remote sensing, and food on offer, into a practical and user-friendly program. Within this module, students were required to compare PGRs across different shires and also between years. This allowed students to identify the variability in growth patterns across Australia and also investigate the regular and irregular feed gaps. The second component of this module exposed students to the full functionality of PfS through interrogating data from the UNE SmartFarm. This involved remotely sensed imagery to derive a plant index (NDVI) and combining that with the regional PGR, providing an overall paddock-level food on offer value (FOO).

The student feedback was positive overall in terms of the program's usability and layout of the learning module. As many students are from rural backgrounds, the practicality of the tool was questioned given the limitations of the PfS platform. The new generation PfS Plus has addressed some of these concerns, and the incorporation of the stocking rate calculator has considerably improved students' understanding of why FOO and PGR are important. It would be good to see both the PfS Plus and stocking rate calculator utilised in future learning modules. In the future, this module will likely require redevelopment due to the privatisation of Landgate who provides the PfS service.

Central Queensland University

The CQU **EBV Simulator** module was developed by Professor David Swain with input from Dr Jess Roberts (CQU) and Mrs Salena McBride from the Queensland Agricultural Training Colleges (QATC). This learning module was developed to be taught into the CQU first-year subject AGRI11007 – Agricultural Breeding Strategies, which integrates with the VET unit of competency AHCLSK503 – Develop and Implement a Breeding Strategy. The EBV Simulator module is hosted on Canvas, an online learning management system that allows students to work through all of the material online (see Figure 5). It also allows CQU and QATC staff to quickly make changes to the module and monitor usage. The module outlines the AgLTAS TLOs and VET competencies students will achieve after completing this module. Students first work through a series of lecture notes that provide background information to genetics and the use of estimated breeding values (EBVs) in the northern beef industry. There is also a short video tutorial that shows students how to use the EBV simulator. There are four case studies, and students choose to focus on one when using the EBV simulator to help the farmer achieve their genetic goals. The EBV simulator allows students to sell, buy, and select cattle based on EBVs and observe the genetic gain over 20 years (see Figure 6).

Figure 2: Student view of the homepage on Canvas for the EBV Simulator module

Year	Breeder Herd	% Bulls to Cows	Animals Sold	Animals Died	Calving Percentage	Mean Fertility EBV	Mea Grow EB
1	2348	1.92	434	238	56	58	17
2	2131	2.11	484	219	46	58	17
3	1924	2.34	498	212	50	58	17
4	1666	2.7	1195	268	55	58	17
5	1398	3.22	1089	274	60	58	17
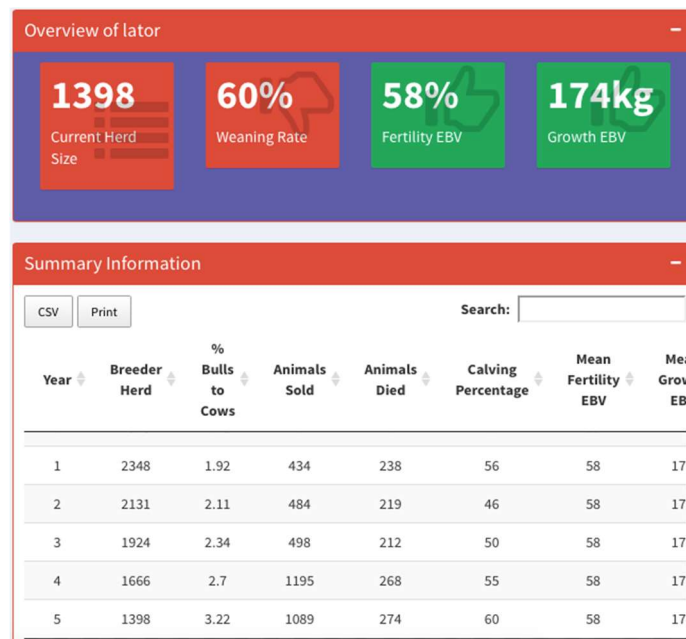
Figure 3: Results of five years of EBV Simulator and key statistics on herd

Method of evaluation

The initial development of the EBV Simulator occurred in consultation with first-year Bachelor of Agriculture students; however, at this stage, the supporting learning materials were not completed. Unfortunately, CQU was not able to trial the complete learning module with a cohort of students as it was not finalised when the unit was delivered. Instead, a group of five staff members not involved in the development of the module completed the EBV Simulator module and completed the evaluation survey developed by UNE (see Appendix E). The EBV Simulator module will be taught in 2018 to first-year CQU Bachelor of Agriculture students and evaluated again at this time.

Results of evaluation survey
Figure 7 displays the results of four questions from the evaluation survey related to some of the employability and TLO questions, and preliminary results demonstrate that the module

has the potential to allow students to achieve the desired outcomes.

Comments made in answer to employability questions were:

- *Evidence that there is knowledge of EBVs and animal breeding on performance information*

- *If I was going to get into a career like this, I think it would be handy to be able to say I have used tools like this*

- *I think a longer term understanding of how EBVs cause the herd to change in production would be helpful*

Comments made in answer to the TLOs questions were:

- *Did not address the lack of uptake of 'genetic improvement' in northern Australia*

- *… the commentary regarding low use of EBVs in northern herds is a current issue that came up.*

- *Yes, it definitely showed how complex a long term selection strategy can be*
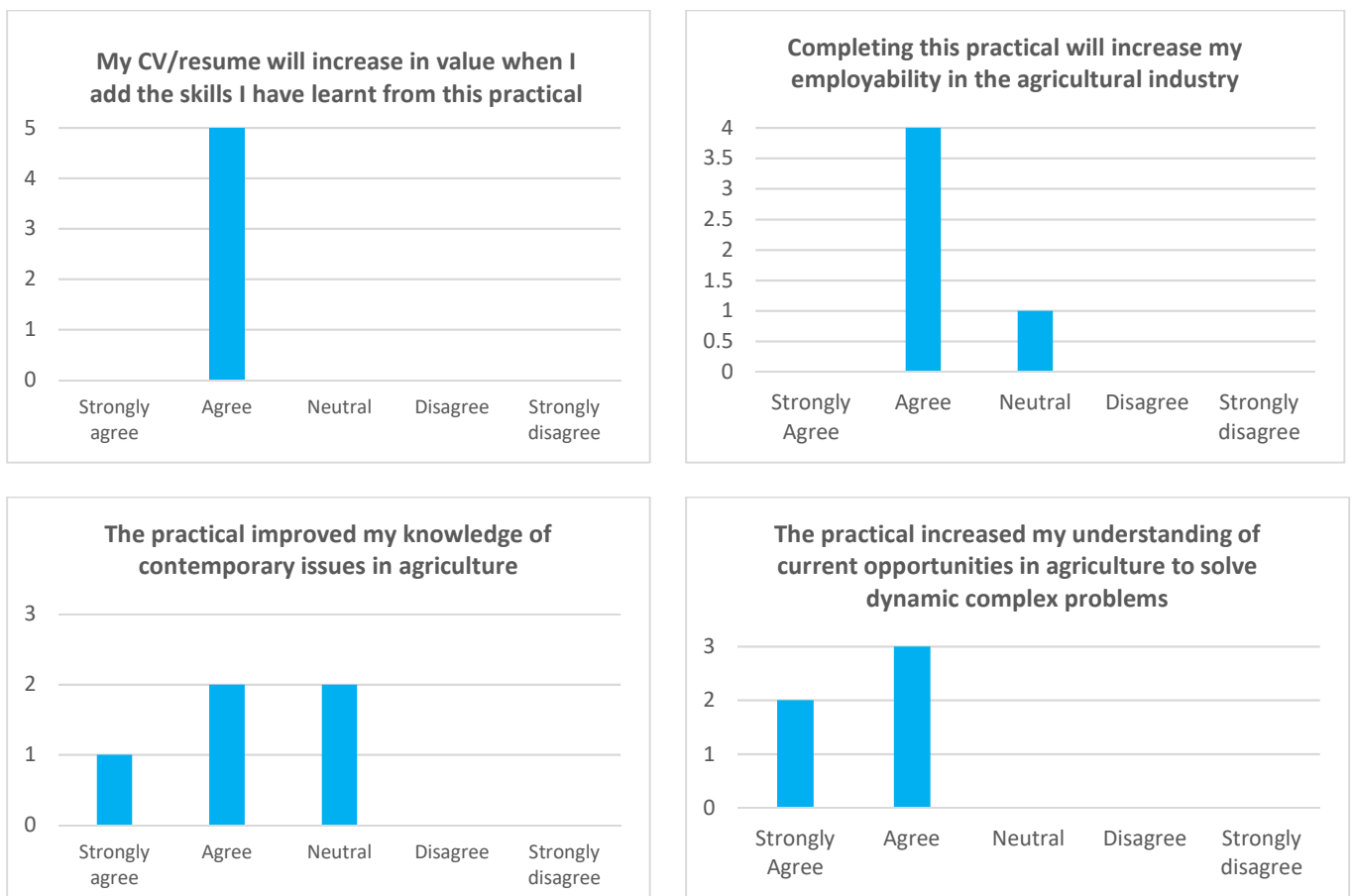
Figure 4: Results of select questions from initial feedback survey evaluating EBV Simulator learning module

Discussion

The feedback from the initial evaluation indicates that the EBV Simulator module is meeting its objective of increasing employability skills and AgLTAS TLOs. However, there are areas where improvement can be made, including:

- Incorporate basic information on genetics (e.g., phenotype and genotype)

- Expand the EBV Simulator to beef production systems in southern Australia

- Increase discussion of the current lack of uptake of EBVs in northern Australia and link this to the need for programs like the EBV Simulator.

The suggested improvements to content can be made easily and will be incorporated before the module is taught to students. However, significant work is required to expand the simulator to encompass southern beef production systems. This may include the addition of another property students can choose to explore that is located in southern Australia. This will occur at a later time when additional resources (time and money) become available.

University of Tasmania

UTas report on the development and delivery of an RITLS based on the online decision support platform *Pasture.io* (https://pasture.io/). Using real-time data from dairy farms in north-west Tasmania, the tool can assist users to understand the complex nature of pasture management and dairy feed rations. The tool allows users to explore both tactical (short-term) and strategic (long-term) on-farm decisions. Supporting resources include a lesson plan, an instructional video for teachers, and notes for both students and teachers for a three-hour practical session, which was delivered in the unit KLA211/438 Pasture and Animal Science to 64 students in 2017.

The RITLS module was evaluated as part of an action research cycle (McTaggart, 1991) providing research outcomes and feedback to improve the learning materials. At the conclusion of the practical, students were invited to complete a survey (see Appendix D) consisting of 29 Likert-scale questions. Questions include whether students perceived that the learning outcomes were achieved, whether they were engaged with the content and learning experience, the applicability of the learning module to future employment, ICT skills, and their demographic details.

Student responses indicate that the majority (75 per cent) regarded the practical would improve their knowledge of contemporary issues in agriculture. Similarly, a high number of respondents (79 per cent) agreed or strongly agreed that the practical helped them to understand how to select and apply an appropriate tool to solve an agricultural problem (see Table 3 for an overview of results).

Student responses indicate that they believe the use of industry tools in teaching is important for their future career, with 76 per cent of respondents (see Table 3) indicating they would use the knowledge derived from completing the Pasture.io practical in their future employment. This is consistent with only a small number of students (16 per cent) identified as living on a rural property when not attending university; those who did tended to derive less knowledge from the practical particularly if they were from a dairy farm. Some

students pragmatically stated that their future use of the tool would depend on their career path; for example, 'only if employers are using the same program'.

Table 3: Selected student responses to survey on use of Pasture.io module

Question	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Student learning experience					
The content of the practical is accurate and up-to-date	39%	55%	5%	0%	0%
The practical improved my knowledge of contemporary issues in agriculture	16%	59%	18%	5%	2%
The practical helped me understand how to select and apply an appropriate tool to solve an agricultural problem	16%	63%	16%	5%	0%
Employability					
Completing this practical will increase my employability in the agricultural industry	13%	64%	18%	4%	2%
I am likely to use the knowledge I have developed from this practical in my future employment	31%	45%	16%	6%	2%

Consistent with their year of study, the module was pitched for the second-year students at an intermediate and not graduate level. These students are in the process of attaining the graduate-level knowledge, understanding, and skills in agriculture, as described in the Learning and Teaching Academic Standards for the discipline (Botwright Acuña et al., 2014). Thus, we anticipate differences in how this student cohort articulates their attainment of employability skills about the use of technology in agriculture compared with students in the final year of their course. Overall, this indicates the importance of assisting students to understand the nature of transferrable skills and their contribution to life-long learning (Anderson et al., 2011.

The project was launched to the university community through a showcase presentation at the UTas Teaching Matters conference in November 2017 (Acuña et al., 2017). The next steps for the project are to revise the practical for delivery and evaluation in 2018 and, as appropriate, develop an assessable component aligned with the unit learning outcomes. Additional communication activities planned for 2018 include presentations at the inaugural AgNET conference (Australian Agriculture Index), The Australian Conference on Science and Mathematics Education, and at the Annual Conference of the Grassland Society of Southern Australia. Collated data from the 2017–2018 module offering will be prepared for submission to a suitable scholarly journal towards the end of 2018. Project partners at UMelb have expressed an interest in using the Pasture.io practical in relevant courses.

The University of Melbourne

Precision management technologies are increasingly being used in the dairy industry. Precision dairy farming is defined by Eastwood, Chapman, and Paine (2012) as the use of information technologies (ICT) for assessment of fine-scale animal and physical resource variability aimed at improved management strategies for optimizing economic, social, and

environmental farm performance. A range of technologies are included in this, such as **automatic milking systems** (AMS) and sensors collecting data on milk yield and components, cow activity and rumination, pasture mass, and soil moisture. In this module four precision dairy technologies are investigated:

- automatic milking systems

- individualised cow feeding

- mastitis detection

- automated heat detection.

A learning module was created titled 'Automatic Milking and Precision Dairy Technologies', which utilised the data from UMelb Dookie Dairy located in northern Victoria. The farm is a pasture-based production system that milks a herd of approximately 150 cows using three Lely Astronaut robotic milking machines. The aim was to develop resources that would allow students who cannot access the farm to become familiar with the technologies used, and provide a tool where students could interrogate the data from the farm to further their understanding of the technologies used. Interviews with the farm manager are included in the module to provide a practical insight into how the technologies are used on the farm.

The learning module consists of four videos, a web-based interactive data graphing package, and a worksheet that the students complete. The resources can be found at the SmartFarm Learning Hub website: http://smartfarmhub.education/education/automatic-milking-and-precision-dairy-technologies/.

One limitation of the module was that the students could not be provided with direct access to the farm management software because this would have allowed the students to change management settings on the farm. Providing students with access to the farm data, via the graphing package, was used to work around this issue.

Results of learning module evaluation

The Automatic Milking and Precision Dairy Technologies learning module was piloted with 13 students in the Master of Agricultural Sciences course at UMelb in September 2017. The students were studying the 'Dairy Systems' subject at the time they evaluated the module.

The survey results are presented in Table 4. The results indicated that the information presented in the module was useful, up to date, and relevant to the agricultural industries. The learning materials themselves were practical and easy to follow. Approximately 40 per cent of the students agreed that completing the module would increase their employability and increase the value of their curriculum vitae (CV)/resume, and 60 per cent agreed that they would be likely to use the knowledge developed in their future employment.

Comments made by the students on the survey indicated that they enjoyed the mix of materials (videos, graphing) used in the module. The following comments from students highlight these points:

> *The content is clear and easy to understand, made much simpler with videos.*

Practical knowledge of relationships between factors will help, e.g., feeding and milk production.

However, one student commented that the module did not provide enough practical experience of the software (see following quote). This highlighted one of the challenges in development of the module whereby the students could not be allowed direct access to the software.

Do not really get a hands on learning on the software used by the farmers.

In addition, some specific suggestions from the students about improving the graphing package were incorporated into the module.

Table 4: Evaluation of the AMS and Precision Dairy module by Masters of Agricultural Sciences students at UMelb

Question	Number of respondents				
	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Completing this practical will increase my employability in the agricultural industry		5	8		
I am likely to use the knowledge I have developed from this practical in my future employment	1	7	3	2	
My CV/resume will increase in value when I add the skills I have learnt from this practical		6	7		
The content of the practical is easily understood	5	7	1		
The content of the practical is accurate and up to date	8	4	1		
The level of content is appropriate to my knowledge and experience	6	5		2	
The practical explained the role and relevance of agriculture, or its related sciences, or agribusiness in society	2	7	1	3	
The practical improved my knowledge of contemporary issues in agriculture	6	5	1	1	
The practical increased my understanding of current opportunities in agriculture to solve dynamic, complex problems	3	7	3		
The practical helped me understand how to select and apply an appropriate tool to solve an agricultural problem	2	7	3	1	
After completing the practical I am better equipped to communicate with a range of audiences what I have learnt	3	5	5		
My skill level with respect to information and communications technology (ICT) in		5	7	1	

	1	2	3	4	5
general prior to commencing my current course was high					
My skill level with respect to ICT has improved as a result of completing this practical		7	4	2	
I found that I had sufficient internet connectivity to complete his practical	4	8	1		
I had access to the required computing equipment to complete this practical	5	6	2		
I think that I would like to use this practical frequently	1	5	5	2	
I found the practical unnecessarily complex		2		9	2
I thought the practical was easy to use	1	10	2		
I think that I would need the support of a technical person to be able to get the most out of this practical		3	4	4	2
I found the various functions in the practical were well integrated	1	10	2		
I thought there was too much inconsistency in this practical			2	8	3
I imagine that most people would learn to use this practical very quickly	3	8	1		
I found the practical very awkward to use			2	7	3
I felt very confident using the practical	2	7		3	
I needed to learn a lot of things before I could get going with this practical	1	1		7	3

Summary of the SmartFarm launch at The University of Melbourne

The SmartFarm launch at UMelb will be held at the Faculty of Veterinary and Agricultural Sciences 'Teaching and Learning Day' planned for 2018. This will ensure that a broad range of academics in the faculty are made aware of the resources developed in the SmartFarm project.

The University of Sydney

This module was developed to assist with teaching about the role of the broad-scale integration of remote sensing data into a product that a farmer (in this case, a grazier) can apply in managing both the pasture and livestock aspects of their property in close to real time (up to one week behind). It does this using the platform **PfS PLUS**, a subscription service that is run by Landgate (a WA Government department that is tasked with collecting and distributing a range of spatial data), which takes remotely sensed data and produces data that is both meaningful to the farmer and readily available (i.e., via the web). Landgate calculates the Normalised Difference Vegetation Index (NDVI) (derived from Landsat 7 and 8 imagery that is made freely available by the US Government) and then 'predicts' pasture biomass based on previously developed calibration curves between pasture biomass and NDVI plant index. These calibration curves were developed from a collaborative research project undertaken by the WA Department of Agriculture and CSIRO in the mid-1990s to mid-2000s. The prediction of pasture biomass, aka FOO (or the pasture biomass available for livestock to graze), is calculated each week. In addition, PGR or the difference in FOO

between successive weeks is also shown. Each of the three variables, NDVI plant index, FOO, and PGR, are shown at a paddock scale for the farm of interest (see Figure 8). Rainfall data can also be plotted for the farm (based on the closest Bureau of Meteorology weather station). All variables (including rainfall) are available for a 14-year period (i.e., from 2004 to 2014 inclusive), and all years and rainfall can easily be plotted for a single paddock.
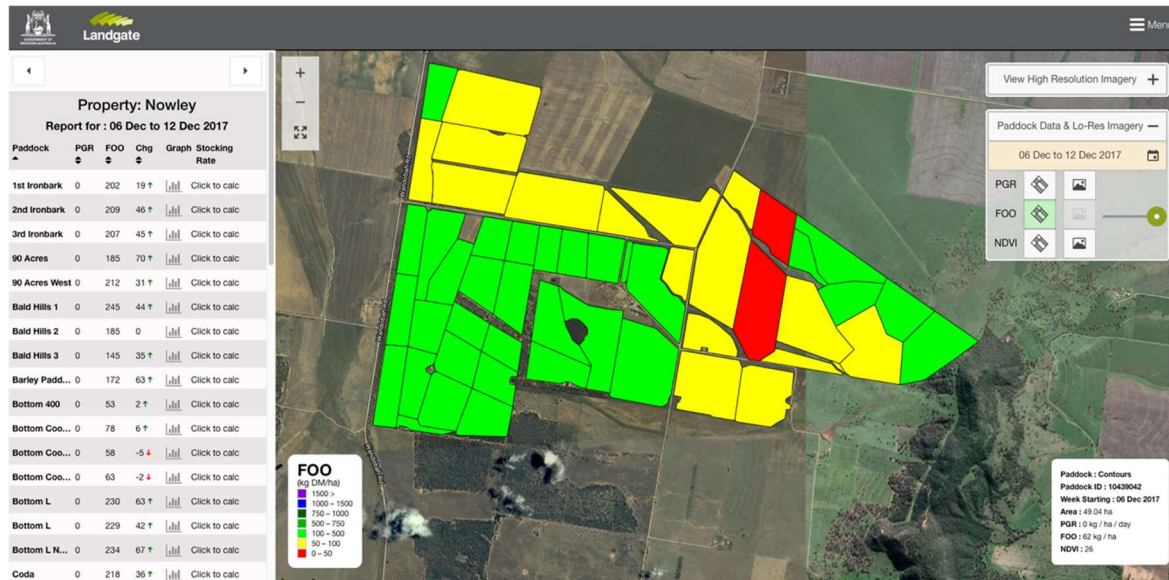
Figure 5: Map of a University of Sydney farm showing food on offer (FOO; pasture biomass) rates in early December, 2017

The module produced developed the following:

- *Practical instruction material.* A presentation discussed how some of the new technologies can provide a range of (previously) unavailable information for farmers and how it improves on what was previously available to farmers. It explained how the technology works (for NDVI plant index), the scale(s) it can be measured at, and how we can then determine biomass and some of the pitfalls. Reading materials (scientific articles) were provided as a resource for students to accompany the practice instructional materials.

- *A practical assessment task.* Students were asked to look at a given paddock and see how it has responded to a range of different years that have had very different rainfall (both amounts and timing) histories and how this impacts pasture productivity; determining if a continuously set-stocked or rotationally grazed system would be best, both in terms of animal productivity or ensuring that an appropriate amount of groundcover was maintained; determining what the differences in NDVI plant index between different locations (across Australia) may represent; and some of the limitations of the use of these measurements for managing a property. Students were allowed to do the assessments either in class or as a take-home assessment task, as substantial notes were provided to help explain the assessment task.

Results and discussion of evaluation

In conversations with the class prior to practical task being undertaken, it was apparent that although the students had some knowledge of the technology behind PfS (from previous teaching), there was still a lack of how this data could then be used to provide 'on-the-ground' data as well as the limitations of the use of the data. However, in marking the assessment tasks it was obvious that students had greatly improved their understanding of the use of these technologies in grazing systems.

Summary of SmartFarm Learning Hub Launch at the University of Sydney

The development of this module allowed students to explore a number of facets of pasture and animal interactions. In the first instance, students were able to, using data from both research and commercial properties, look at the impact that different climatic and management decisions have on pasture productivity – in the short and long term – and how this then impacts on animal productivity. That this can be taken in close to real time and using historical data is also of great value, as agriculture (almost by definition) is based on historical practices/history. As such, the website was able to bring to life many of the aspects taught to students in the pasture agronomy classes, and give students a more realistic understanding of the issues facing farmers.

Chapter 4

Survey results

Following are the results of student feedback (*n* = 71) in relation to their perceived employability after undertaking SmartFarm learning module tasks, their TLOs, and the types of degrees versus the students' knowledge developed from the practical (see Tables 5, 6, and 7). Table 8 provides an overview of student demographics.

Table 5: Employability (*n* = 71)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Completing this practical will increase my employability in the agricultural industry	16.9%	53.5%	28.2%	1.4%	0.0%
I am likely to use the knowledge I have developed from this practical in my future employment	15.5%	62.0%	16.9%	4.2%	1.4%
My CV/resume will increase in value when I add the skills I have learnt from this practical	4.2%	56.3%	32.4%	4.2%	2.8%

Table 6: Threshold learning outcomes (*n* = 71)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The practical improved my knowledge of contemporary issues in agriculture	22.5%	57.7%	14.1%	5.6%	0.0%
The practical explained the role and relevance of agriculture, or its related sciences, or agribusiness in society	14.1%	59.2%	19.7%	7.0%	0.0%
The practical increased my understanding of current opportunities in agriculture to solve dynamic, complex problems	22.5%	53.5%	16.9%	4.2%	2.8%
The practical helped me understand how to select and apply an appropriate tool to solve an agricultural problem	12.7%	52.1%	28.2%	4.2%	2.8%
After completing the practical I am better equipped to communicate with a range of audiences what I learnt	11.3%	43.7%	40.8%	1.4%	2.8%

It was hypothesised that the type of degree a student is studying would have an impact on whether they believed they would utilise the knowledge developed in this practical in their future employment.

Table 7: Type of degree vs. likelihood of using the knowledge developed from this practical in future employment (*n* = 71)

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Response count	*p* value
Agriculture and rural science	18.5% (5)	81.5% (22)	0.0% (0)	0.0% (0)	0.0% (0)	27	
AgBusiness/ agEconomics	26.7% (4)	46.7% (7)	26.7% (4)	0.0% (0)	0.0% (0)	15	
Engineering technology	0.0% (0)	33.3% (3)	22.2% (2)	33.3% (3)	11.1% (1)	9	
Environmental science and sustainability	11% (2)	56.6% (10)	33.3% (6)	0.0% (0)	0.0% (0)	18	0.006
Other	0.0% (0)	100% (2)	0.0% (0)	0.0% (0)	0.0% (0)	2	
Response count	11	44	12	3	1	71	

Table 8: Demographics of students who completed the evaluation survey (*n* = 71)

Gender	Response count	Response percentage
Female	28	39%
Male	42	59%
Other	1	1%
Age	**Response count**	**Response percentage**
18–21	27	38%
22–31	26	37%
32–41	13	18%
42–51	5	7%
52–61	0	0%
62+	0	0%
Place of residence when not attending university	**Response count**	**Response percentage**
Rural – living on land/property	26	37%
Rural town – less than 5,000 people	11	16%
Town – 5,000–18,000 people	12	17%
Major city – 50,000–250,000 people	15	21%
Capital city – 250,000+ people	7	10%

Exploring results across student demographics

The following tables explore any influence certain demographic factors, such as age, place of residence, and degree studied, have on a student's response to certain questions. It was hypothesised that the age of the student may have an influence on the value they placed on the skills obtained from the PA Source practical on their CV, with an older student potentially closer to looking for a job and therefore paying more attention to this idea. A chi-square test of independence was performed and no statistical difference (*p* > 0.05) (see Table 9) was found between the age groups and the value score of a CV. As this was a first-year subject, it may be that all students who completed the practical are still too early on in their degree to be thinking about adding value to their CV.

Table 9: Age vs. practical contributing to increased value of CV

Age (yr)	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Response count	p value
18–21	3.7% (1)	55.6% (15)	37.0% (10)	0.0% (0)	3.7% (1)	27	
22–31	3.9% (1)	57.7% (15)	26.9% (7)	7.7% (2)	3.9% (1)	26	
32–41	7.7% (1)	53.9% (7)	38.5% (5)	0.0% (0)	0.0% (0)	13	0.977
42–51	0.0% (0)	60.0% (3)	20.0% (1)	20.0% (1)	0.0% (0)	5	
Response count	3	40	23	3	2	71	

It was hypothesised that the type of degree a student is studying would have an impact on whether they believed they would utilise the knowledge developed in this practical in their future employment. A chi-square test of independence was performed, and indeed a statistically significant relationship ($p < 0.05$) (see Table 10) was found between the type of degree a student is studying and the likelihood they will utilise the knowledge in their future employment.

Students studying agricultural and rural science degrees are most likely to believe they would use the knowledge derived from the PA Source practical in their future employment, with 18.5 per cent strongly agreeing and 81.5 per cent agreeing with the statement (see Table 10). This is not surprising as the practical focused on observing data layers that were applicable to an agricultural enterprise (e.g., NDVI plant index, soil apparent electrical conductivity).

One student who was neutral in their response commented that they '*won't be employed in the ag industry*' and another believing it would be '*tricky when I now live in the city*'. A small number of engineering technology students completed the survey, but of those who did, 33 per cent (3) disagreed, and 11.1 per cent (1) strongly disagreed that they would use the knowledge derived from the practical. It is probable that these students will learn or have already learnt about other mapping software that is more applicable to their future employment. As this practical was taught into a first-year introductory subject compulsory for a range of degrees, it was difficult to find a tool that all students would find applicable to their future career.

Table 10: Type of degree vs. likelihood of using the knowledge developed from this practical in future employment

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Response count	*p* value
Agriculture and rural science	18.5% (5)	81.5% (22)	0.0% (0)	0.0% (0)	0.0% (0)	27	
AgBusiness/ agEconomics	26.7% (4)	46.7% (7)	26.7% (4)	0.0% (0)	0.0% (0)	15	
Engineering technology	0.0% (0)	33.3% (3)	22.2% (2)	33.3% (3)	11.1% (1)	9	
Environmental science and sustainability	11% (2)	56.6% (10)	33.3% (6)	0.0% (0)	0.0% (0)	18	0.006
Other	0.0% (0)	100% (2)	0.0% (0)	0.0% (0)	0.0% (0)	2	
Response count	11	44	12	3	1	71	

The researchers were interested in knowing whether students with a place of residence when not at university that was rural (living on land/property) were more likely to find that the practical had helped them understand how to select and apply an appropriate tool to solve an agricultural problem, given that they were possibly already involved in the everyday management of an agricultural enterprise. A chi-square test of independence was performed, and no statistical difference ($p > 0.05$) (see Table 11) was found between a student's place of residence and the understanding they developed as a result of completing the PA Source practical.

Table 11: Place of residence vs. increased understanding of how to select and apply an appropriate tool to solve an agricultural problem

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Response count	*p* value
Rural – living on land/property	7.7% (2)	53.9% (14)	26.9% (7)	7.7% (2)	3.9% (1)	26	
Rural town – less than 5,000 people	18.2% (2)	36.4% (4)	45.5% (5)	0% (0)	0% (0)	11	
Town – 5,000– 18,000 people	0% (0)	83.3% (10)	16.7% (2)	0% (0)	0% (0)	12	0.58
Major city – 50,000– 250,000 people	26.7% (4)	46.7% (7)	26.7% (4)	0% (0)	0% (0)	15	

Capital city – 250,000+ people	14.3% (1)	28.6% (2)	28.6% (2)	14.3% (1)	14.3% (1)	7	29
Response count	9	37	20	3	2	71	

Chapter 5

Dissemination

Promotional materials can be found in Appendix C.

List of events attended/presented on behalf of the SmartFarm Learning Hub

Cosby, A. (2017, January). *SmartFarm Learning Hub*. In 2017 Global Learning in Agriculture Conference, The Pennsylvania State University. *Online recorded presentation; 8 questions/comments received on presentation.*

Cosby, A., Flavel, R., Botwright Acuña, T., Fasso, W., Gregory, S., & Trotter, M. (2017, September). Implementing a 'real industry technology learning systems' module in agronomy within higher education systems. In G. J. O'Leary, R. D. Armstrong, & L. Hafner (Eds.), *Doing More With Less: Proceedings of 18th Australian Agronomy Conference* (pp. 1–4). Ballarat, Australia: Online Community Publishing.

Cosby, A., Flavel, R., McDonnell, S., Gregory, S., & Trotter, M. (2017, October). *Real industry technology learning systems for tertiary teaching*. Paper presented at the 7th Asian-Australasian Conference on Precision Agriculture, Hamilton, New Zealand.

Cosby, A., Flavel, R., Gregory, S., Botwright Acuña, T., Fasso, W., & Trotter, M. (2017, July). *Pastures from Space® Plus for teaching precision pasture management*. Paper presented at Precision Management of Grassland and Grazing Livestock Satellite Meeting of the 11th European Conference on Precision Agriculture, Edinburgh, Scotland. (pp. 888) https://www.cambridge.org/core/services/aop-cambridge-core/content/view/5D824A738D0878E678B642CF1D7FD741/S2040470017001522a.pdf/abs_volume_8_issue_3_cover_and_front_matter.pdf *Presented to an audience of approx. 50–60.*

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Invited speaker

Auburn University, staff seminar for College of Agriculture staff, 18 November 2016, Auburn, AL, USA. *Presented to an audience of approx. 20.*

Cosby, A. (2017). Livestock monitoring and grazing management technologies in the SmartFarm Learning Hub: Next generation technologies for agricultural education. SPAA Precision Agriculture Expo, 14–15 March 2017, Townsville, Qld, Australia. *Presented to an audience of approx. 80.*

Food, Fibre and Agricultural Educators Conference, 9 January 2017, Brisbane, Qld, Australia. *Presented to an audience of approx. 50.*

National Association of Agricultural Educators Convention, 1 December 2016, Las Vegas, NV, USA*. Presented to an audience of approx. 25*. *Nineteen people completed an evaluation of presentation and received a score of 4.21 out of 5.*

NSW STEM Action Schools Conference, keynote speaker, 23 February 2017, Port Macquarie, NSW, Australia. *Presented to an audience of approx. 40*.

PIEFA Conference, 1–3 May 2016, Canberra, ACT, Australia. *Presented to an audience of approx. 30.*

Conferences attended

ASCILITE2017 University of Southern Queensland, Toowoomba, *Next generation technologies for Agricultural Education*. Gregory, S., Lamb, D., Cowley, F., Flavel, R., Barwick, J., Swain, D. Fasso, W., Rawnsley, R., Mohammed., C., Acuna, T., Hardie, M., Tscharke, M., Jensen, T., Nettle, R., Cullen, B., Ingram, L., Whelan, B., Baliley, D. http://2017conference.ascilite.org/wp-content/uploads/2017/11/ASCILITE2017PosterGREGORY.pdf

ABARES Outlook, 7–8 March 2016, Canberra, ACT. Met with NRM Spatial Hub personnel; filmed video. Spoke with government, industry, and university staff regarding SmartFarm Learning Hub and the potential to participate or utilise resources.

Conference presentations and networking report

Dr Cosby, project Research Fellow, presented at the ***European Seminar on Extension and Education*** where the theme was *Transformative learning: New directions in agricultural extension and education* (see Figure 9). There was a lot of interest in the SmartFarm Learning Hub project, and feedback on the presentation was positive with approximately 25–30 people attending the session. Many interesting papers were presented at the conference, particularly about the different research methods that are used to evaluate extension projects with farmers. These methods could be applied to research in agricultural education with educators and students. Many researchers were met who were at various

stages of their career and willing to discuss the project and their research interests to offer ideas and guidance.

The *Precision Management of Grassland and Grazing Livestock satellite meeting* was held as part of the *European Conference on Precision Agriculture*. Dr Cosby presented on the high school teacher work undertaken as part of the SmartFarm Learning Hub project to approximately 50–60 people. This presentation was also well received, with many in the audience indicating that their respective educational institutions should also be doing similar work. Questions were raised about how the learning materials will be kept current post project and also how software updates will be handled. The conference also highlighted several other technologies that could be used as the basis of further learning modules.
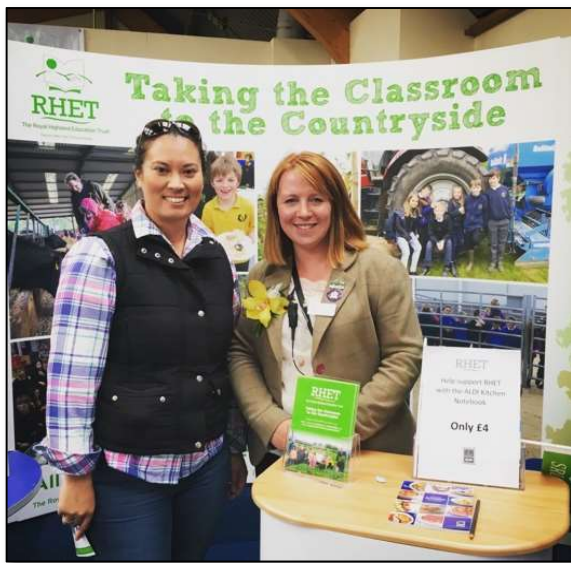
Figure 6: Presentation at the European Seminar on Extension and Education

Figure 7: Royal Highland Show, Edinburgh

Dr Cosby met with Ms Sara Smith from the Royal Highland Education Trust (RHET) (https://www.rhet.org.uk) at the *Royal Highland Show* in Edinburgh, Scotland (see Figure 10). The RHET uses a network of volunteer farmers to deliver to school children structured on-farm visits. There are 12 RHET project cocoordinators across Scotland who coordinate these visits, develop resources, and provide professional learning opportunities for both primary and secondary teachers. Dr Cosby found learning about their programs and how they recruit and use volunteer farmers to deliver lessons invaluable. The geography of Scotland enables 'city' kids to visit a working farm within a short drive (which is different to Australia), allowing the city–country divide to be addressed. Discussed was how the learning modules on the SmartFarm Learning Hub could be adapted and utilised by RHET to show students an Australian agricultural perspective.

At the show, the RHET run a comprehensive program on Thursday and Friday where schools can book in to bring a class of students to participate in a structured program. On the Saturday and Sunday, the exhibition is open to the public to participate in hands-on activities related to food, fibre, and forestry. Dr Cosby also attended the junior sheep judging, demonstrating a different way young people participate in the show.

Dr Cosby met with Deidre O'Shea at the Dublin Zoo to talk about the work of **AgriAware** (http://agriaware.ie), the main agricultural education body in Ireland. The objective of AgriAware is to 'improve the image and understanding of agriculture, farming and the food industry among the general public'. Deidre provided a tour of the 'Family Farm' display at the Dublin Zoo, which has over 1 million visitors per year. She spoke about how important it is to have this display in such a prominent attraction in Dublin and the many events that are hosted promoting agriculture in Ireland.

There was a lot to learn about agricultural education in Ireland, including that 14,000 students study senior agriculture. The EU subsidises agriculture and they support many campaigns and programs (and farmers) across Ireland. Networking included a meeting with an intern who is an agricultural teacher on exchange from the USA who spoke to about the differences between the USA and Ireland. AgriAware also develop numerous resources used in schools, and one of particular importance is the farm safety series, which is a serious issue in Ireland. Ms Deidre O'Shea was informed about the SmartFarm Learning Hub project. Also discussed was how Ms Sara Smith's staff may be able to utilise some of the SmartFarm Learning Hub modules to demonstrate the use of technology in agriculture. AgriAware also has a close relationship with TEAGSC, one of the Irish agricultural colleges. Ms Smith will speak to her contacts to make them aware of the SmartFarm Learning Hub.

Dr Cosby also met with Ms Fay Grace, a councillor with the **Yorkshire Agricultural Society** (YAS) (http://yas.co.uk) who is involved with the charitable activities of the society. This section of the Yorkshire Agricultural Society is involved with a number of education activities including the Discovery Zone at the Great Yorkshire Show (GYS), Countryside Days, and many more. A tour of the Great Yorkshire Show was provided, which outlined the many hands-on activities that children can take part in. A session was delivered by the Pigs in Schools program where two young pig farmers gave a presentation on what it is like to be a pig farmer and what occurs on a pig farm from paddock to plate. This session was attended by people of all ages. These farmers decided to do this presentation to try and educate the general public, thereby endeavouring to improve the perception of pig farming.

The Charitable Activities Committee of the Yorkshire Agricultural Society is also involved with the Future Farmers of Yorkshire and numerous farmer discussion groups. Ms Grace is keen to promote the SmartFarm Learning Hub to these groups, as she believes participants would benefit greatly from accessing learning modules that can upskill farmers and make them aware of the technology available to them and how it can be applied on the farm.

Dr Cosby attended the inaugural **School Farms Network Education Alliance** conference (https://www.farmgarden.org.uk/school-farms-network) at the Royal Agricultural University (see Figure 11). The attendees at the conference ranged from high school agriculture teachers, university and college staff, and agricultural education officers. Dr Cosby attended a range of different sessions, including how school farms are used for learning in schools (there is no formal agricultural curriculum in the UK), how to attract students to land-based careers, and how to obtain funding for school farm projects. She was given the opportunity to talk about the SmartFarm Learning Hub in one session where the topic was 'How do schools connect school farms with the curriculum?'. Many teachers present at this workshop asked for the details of the SmartFarm Learning Hub website and were keen to explore how they may use the learning modules in their teaching or develop their own.

Figure 8: Royal Agricultural University

The **AgriSpin** project (http://agrispin.eu) held their end-of-project symposium the day before the **, Ecological Economics (ESEE) Conference** started. Dr Cosby attended this meeting and learnt a lot about how the project was designed, implemented and evaluated. The AgriSpin project developed a method to determine best practice for innovation and support systems in agriculture across Europe and the UK.

One of the highlights of this meeting was participating in an activity on the 'innovation spiral'. This involved breaking off into small groups and discussing a certain aspect of the innovation spiral and presenting the ideas discussed to the larger group. It was clear that although there was issues along the way, strong leadership and commitment from the team meant that the project was a success.

As many of the attendees at this meeting were also attending the ESEE conference it was a valuable opportunity to meet with other researchers in the area to learn about their research and speak about the SmartFarm Learning Hub project.

Chapter 6: Future directions

The SmartFarm Learning Hub has been a great initiative to develop and share resources across universities. However, the resources could quickly become obsolete if they are not maintained (e.g., updating websites and passwords, and maintaining website if institutional arrangements change). There will also be continued development of new applications that could be incorporated in the SmartFarm Learning Hub. In 2018, it would be interesting to expand the assessment task to explore how different practices (management, grazing, fertiliser addition, etc.) on the same property can have important and both immediate and/or long-lasting effects on pasture productivity.

An area that would significantly improve student interest and value was if it were possible for them to be able to access a number of farms, as at the moment students are limited in this regard, with some resources accessing only one farm. A major assessment task is to undertake a case study of a property; in addition, the ability to access long-term records would be of great value to students in better understanding both past management history and how they could then go about potentially improving management. Unfortunately, Landgate, who provided a subscription-based service, announced in late 2017 that it will no longer be providing PfS as of September, 2018. It is not clear at this point if PfS will be taken over by another (presumably private) provider (it was previously available through a commercial provider). In the event that it is not, then unfortunately it is unlikely that this module will be available to be used to teach this aspect of technology – farming interaction.

Commercial software is not made for use in teaching. Money should be made available in any future projects for software development (e.g., to create temporary accounts for students, mirror educator account). Formal agreements should be developed between software/agri-tech companies and educators to clearly outline the expectations from both parties from the outset. As these programs are made for commercial use and are based on real farm data, there is often no concrete and/or correct answer. Students struggle with this, but it is the situation they will face when they are working in the agricultural industry and thus need to be exposed to these types of scenarios at university. Changes to software and the need to update data/scenarios (on at least an annual basis) requires the learning modules to be regularly updated, and the onus is on the educator to do this.

Two members of the SmartFarm Learning Hub team, Professor David Lamb and Associate Professor Sue Gregory, have recently been successful in securing a grant from the U.S. National Science Foundation and Department of Agriculture titled *Enhancing small and mid-level farm viability through a systems-based research network: Linking technology and sustainable development and practice*, as a result of this project. This new project will build on knowledge created and learned from this SmartFarm project.

The SmartFarm Learning Hub has invested in the sustainability of the project and taken out 5–10-year licences on the website and several industry partners to enable the project to continue. The web designer is also willing to undertake contract work to update the website from time to time. However, the project lead also has the ability to update the website on an as-needs basis as the project web designer created a comprehensive manual to enable anyone to update the resources.

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Appendix A

Certification by Deputy Vice-Chancellor

I certify that all parts of the final report for this OLT grant provide an accurate representation of the implementation, impact and findings of the project, and that the report is of publishable quality.

Name:

Professor Heiko Daniel   Date: 10 April 2018

Appendix B: External evaluator report

SMARTfarm Learning Hub Evaluation Report

This evaluation report has been prepared on the format initially outlined for the project. The template provides for a repetition of much of what is documented elsewhere and if included in this report would not add any value to the overall outcomes. Therefore, these elements will be in summary form and readers seeking more detail are referred to the main report.

1. Background to the Project

The project aimed to increase learning and teaching about digital technology in agriculture in the school, vocational and university sectors by creating a collaboration across all sectors

2. Context of the project's operation

The project worked across institutions and sectors with the greatest focus on university teaching

3. Purpose of the Evaluation

The purpose of the evaluation was to have external oversight of the project by an independent person.

As evaluator I found that my role was to assist, and at times facilitate, given the major changes which occurred during the life of the project.

This final report is an overview of the project's performance and a validation of the integrity of the final report given my knowledge of the project.

4. Consideration of stakeholder input

Stakeholder input was sought at the time the project was created and during the project. The earlier was the most important stage.

There was limited direct stakeholder input during the project because once the project die was cast there was limited need for input.

I was however aware of the extensive and ongoing liaison undertaken by Dr Cosby on a one to one basis with stakeholders.

5. Key Evaluation Questions
6. Effectiveness of the project processes
i. *Were the various project tasks completed in a timely manner?*

Yes, in general. There was some time slippage but once the project was underway the timelines were largely held to.
ii. *Were there any variations from the processes that were initially proposed, and if so, why?*

There were some but these were due to reasons beyond the control of project management. Details are contained in the final report.

iii. *What factors helped and hindered in the achievement of the outcomes?*

Decision making between, and within, universities was a factor in slowing down processes as well as decisions by companies having control over the IP of various technologies.

Poor student responses to surveys – this is not uncommon and is a difficult area to address

iv.   Were the project tasks completed on budget?

Yes

v.   Did the project make effective use of the project budget?

Yes

7. Effectiveness of learning modules in addressing project aims

Given the constraints, the learning modules were effective

8. Effectiveness of dissemination strategies

Given the constraints the dissemination strategies were effective.

9. How might the project be improved?

Difficult to identify because the factors which hindered the project were to do with external changes beyond the control of project management. These included changes to the administration of the project and relationships with the university structure, changes in the industry and the availability of resources.

10.   Information gathering sources and techniques for the evaluation

The evaluation is qualitative and the information used in the evaluation has been collected through attendance at the project management meetings and close liaison with project management and operation.

a. Criteria for judgments

i.   To what extent have the intended outcomes been achieved?

Largely achieved

ii.   Are the project outcomes relevant and effective?

Yes

iii.   Have the project outcomes being adopted by the key stakeholders?

Generally, yes, but it is probably too early to fully tell

iv.   Which aspects of the project are deemed worthy of sustaining?

The most important aspect is to maintain a means of continuing liaison between educators and educators; and between educators and industry.

11.   Summary of Findings
- The Final Report by the University of New England is an accurate representation of the project.
- The project was successful but was hindered by changes in staffing beyond the control of any individual or organisation.
- This area of teaching is fraught with much greater complexity than other areas because it is closely aligned to developments in the private sector and has greater intellectual property implications that any other area of undergraduate teaching and learning.

- It is an area where the teaching content is changing rapidly so there is a great challenge for educators to remain abreast of developments and to gain access to the most recent technology for themselves, let alone their students.
- The project was established on the assumption that there would be access to certain products and services – changes in personnel in collaborating public and private sector organisations meant that technology that was assumed to be accessible turned out to be no longer available for teaching.
- Version updates of individual programs need to be allowed for in future project planning
- The importance of real data and on farm activities which ground truth the learnings for students was a recurring theme. The value of the UNE Smart farm is noted. If a teaching program has not got this type of access the relevance of the teaching to students is diminished and hence its effectiveness.
- There is an underlying assumption by some in industry that students need to graduate with job ready skills in areas of technology. This is neither desirable nor feasible – their minds need to be opened to the opportunities therein so they can then adapt to the needs of the work place and their employer. The project clearly demonstrated that it is impossible to do the former but there is great opportunity to open the minds of students to a future in digital agriculture using available resources provided they are carefully selected so that they can be accessed by students during their course in a real world situation.

12. List of Recommendations

That:

- A means be found to enable ongoing collaboration between educators and industry on digital technology in agriculture
- The website that has been developed be continued for as long as possible https://smartfarmhub.education/
- Industry and software developers be encouraged to create versions of their software that are suitable for teaching
- Budgets need to allow for payment for access to certain products even though the premise is on open access. If some companies see the benefits of students accessing their products they may then make arrangements for access to be opened up support for teaching
- Those involved with the project should continue collaboration, particularly if a CRC is established on digital technology for farming.

13. Involvement in the project by the Evaluator

The evaluation included travel to the University of New England on four occasions involving meetings with senior staff and the project team and one meeting at Tocal with Associate Professor Trotter, who had established the project but relinquished its leadership due to his departure to Central Queensland University.

Armidale meetings were held on the following dates:

- 9-10 August 2016
- 8-9 February 2017
- 5-6 June 2017
- 23-24 October 2017

The Tocal meeting with A/P Trotter was on:

- 20 December 2016

Close contact was maintained with Dr Cosby throughout the project and I was kept abreast of all developments. The inability of the project to undertake some of what was specified in the original application became apparent quite early and Dr Cosby was able to make the necessary adjustments before too much project time was lost.

The first meeting with the project team also involved a teleconference with the steering committee.

Subsequent meetings at UNE involved staff who were directly involved in the project and in implementing the programs into their teaching. This gave a valuable insight into the challenges facing teachers who are attempting to use cutting edge technology and programs in their teaching.

14.   About the Evaluator

AC Archer BSc Agr (Hons) BEd Stud MEd PhD PSM AM

Dr Cameron Archer was Principal of Tocal Agricultural College for 28 Years and has spent his career in agriculture and agricultural education. He is Conjoint Professor with the Tom Farrell Institute, University of Newcastle.

He has led many projects and serves on a number of State and National Boards and Committees.

Dr Cameron Archer   6579aca@gmail.com   0427 202 948

Appendix C: Project promotional materials

Real working farms linked with established industry to provide unique learning experiences for students
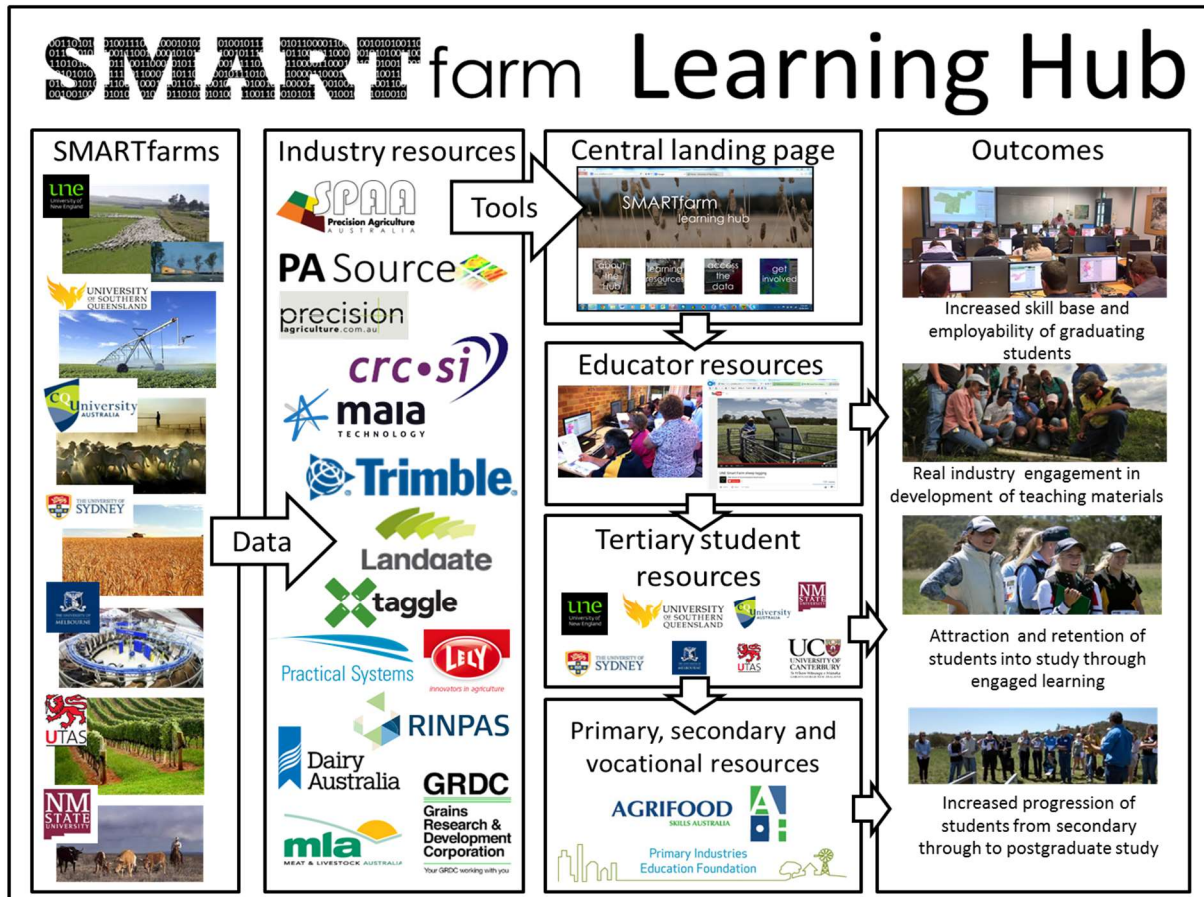
Key issues – Australian Agricultural Education

- 7.8% of the agricultural industry have tertiary qualifications compared with 25% for other industries.
- There may already be insufficient capacity in the rural sector to develop and adopt innovations at the desired rate.
- There is shortage of appropriately skilled and qualified people for the jobs currently available.
- Those employed in the agricultural industry struggle to access the skills they need to support the adoption of new technologies.
- Numbers of students studying agriculture in high school and at university is declining.

Appendix D: Survey questions for tertiary students

Introductory Questions

1. What is your gender?

Male
Female
Other

2. What is your age?

18 to 21
22 to 31
32 to 41
42 to 51
52 to 61
62 +

3. My place of residence when not attending university is

Rural – living on land/property
Rural Town – less than 5,000 people
Town – 5,000-18,000 people
Major City – 50,000-250,000 people
Capital City – 250,000+ people

4. What degree are you studying?

Bach ag/ Bach bus
Rural Science
Rural science
Bachelor of agriculture
Bachelor of ag and business
Rural Science
Bachelor Rural Science
Bach Ag
Rural Science
Bachelor of Rural Science
Animal Science
agriculture
B. Rural Science
Bachelor of Rural Science

5. What is your mode of study in this unit?

Internal
External

6. Are you currently employed in the agricultural industry?

Yes
No
Comments………

7. Did you study agriculture at high school?

Yes
No
Comments………

1. Completing this practical will increase my employability in the agricultural industry

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

2. This practical has encouraged me to consider Honours or postgraduate study in this field

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

3. I am likely to use the knowledge I have developed from this practical in my future employment

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

4. My CV/resume will increase in value when I add the skills I have learnt from this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

5. The content of the practical is easily understood

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

6. The content of the practical is accurate and up-to-date

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

7. The level of content is appropriate to my knowledge and experience

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

8. The practical improved my knowledge of contemporary issues in agriculture

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

9. The practical explained the role and relevance of agriculture, or its related sciences, or agribusiness in society

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

10. The practical increased my understanding of current opportunities in agriculture to solve dynamic, complex problems

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

11.   The practical helped me understand how to select and apply an appropriate tool to solve an agricultural problem

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

12.   After completing the practical I am better equipped to communicate with a range of audiences what I learnt

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

13.   My skill level with respect to Information and Communications Technology (ICT) in general prior to commencing my current course was high

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

14.   My skill level with respect to Information and Communications Technology (ICT) has improved as a result of completing this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

15.   I found that I had sufficient internet connectivity to complete his practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

16.   I had access to the required computing equipment to complete this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

17.   I think that I would like to use this practical frequently

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

18.   I found the practical unnecessarily complex

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

19.   I thought the practical was easy to use

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments…………………………………………………………………………………………………

20.   I think that I would need the support of a technical person to be able to get the most out of this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

21.   I found the various functions in the practical were well integrated

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

22.   I thought there was too much inconsistency in this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

23.   I found the practical very awkward to use

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

24.   I felt very confident using the practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

25.   I needed to learn a lot of things before I could get going with this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

Appendix E: Survey questions for high school teachers

Introductory Questions

1. Gender

Male
Female
Other

2. Number of years teaching

1-3 years
4-7 years
8-15 years
16 years +

3. My role is

Classroom Agriculture Teacher
Classroom Science Teacher
Head Teacher Agriculture
Head Teacher Science
NSW Education Department Curriculum Developer
Other (please specify)

4. My school is

Rural Town – less than 5,000 people
Town – 5,001-18,000 people
City – 18,001-50,000 people
Major City – 50,001-250,000 people
Capital City – 250,001+ people
N/A

1. What year level/s do you teach?

Year 7
Year 8
Year 9
Year 10
Year 11
Year 12
VET
N/A

Practical Content

1. I easily understood the content of the practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

2. The content of the practical is accurate and up-to-date

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

3. The level of content is appropriate to my knowledge and experience

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

4. The practical explained the role and relevance of agriculture or its related sciences, or agribusiness in society

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

5. The practical improved my knowledge of contemporary issues in agriculture

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

6. The practical had strong links to the current curriculum

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

7. I could easily integrate this practical into my teaching

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

Technical aspects

1. My skill level with respect to Information and Communications Technology (ICT) in general is high

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

2. My skill level with respect to ICT will improve as a result of completing this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

3 I think that I would like to use this practical frequently in the classroom

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

4. I found the instructional steps for the practical unnecessarily complex

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

5. I thought the technology in this practical was easy to use

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

    Comments…………………………………………………………………………………………………

6. I think that I would need the support of a technical person to be able to get the most out of this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

    Comments…………………………………………………………………………………………………

Appendix F: Interview script with high school teachers

Telephone Script

Hi my name is XX from the University of New England.

I am calling to speak to you about a research project, the SmartFarm Learning Hub, as per the information letter you were emailed, being conducted with funding from the Office of Learning and Teaching. Ethics approval for this research has being received from the Human Ethics Research Committee at the University of New England.

- Have you read the information contained in the Information Sheet for Participants?
- Have any questions you have asked been answered to your satisfaction?
- Do you agree to participate in this activity, realising that you may withdraw at any time?
- Do you agree that research data gathered for the study may be quoted and published using a pseudonym?
- Do you agree to having your interview audio recorded and transcribed?
- Would like to receive a copy of the transcription of the interview?
- Can you please confirm that you are older than 18 years of age?

Thank you for your consent.

Are you happy to start the interview now? It should take between 15-20 minutes to complete.

Interview Questions

- How many years have you been teaching?
- What is your level of experience teaching agriculture?
- What current resources do you use which may aid your teaching with respect to agricultural technologies?
- Are there advantages of having a greater focus on agricultural technologies in your teaching?
- What are these advantages?
- Are there barriers to including agricultural technologies in your teaching?
- What are these barriers?
- What, if any, training do you need to comfortably teach your students about current technologies in agriculture?

Appendix G: SmartFarm Learning Hub survey questions for high school students

You have recently completed the practical [INSERT PRACTICAL NAME]. Please answer the following questions reflecting on your experience when completing the practical.

Introductory Questions

1. Gender

Male
Female
Other

2. Year level

Year 9
Year 10
Year 11
Year 12

3. When I finish school I intend on going

To university to study agriculture
To TAFE to study agriculture
Straight into the agricultural workforce
To TAFE/university **not** to study agriculture
Straight into the workforce
On a gap year (if so, what do you intend to do after this year)
Other (please specify)

4. My place of residence is: (Please choose one)

Rural – living on land/property
Rural Town – less than 5,000 people
Town – 5,000-18,000 people
City – 18,000-50,000 people
Major City – 50,000-250,000 people
Capital City – 250,000+ people

Practical Content

1. Completing this practical will encourage me to undertake tertiary study in agriculture

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

2. Completing this practical will encourage me to pursue a career in the agricultural industry after secondary school.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

3. I easily understood the content of the practical.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

4. I found the content of the practical to be accurate and up-to-date

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

5. The level of content is appropriate to my knowledge and experience.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

6. The practical improved my knowledge of current issues in agriculture.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

7. The practical will help me understand how to select and apply an appropriate tool to solve an agricultural problem

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

8. Compared to other classes at school, I found this practical to be very interesting.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

9. Compared to other classes at school, I found this practical to be very enjoyable.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

Technical aspects

1. My skill level with respect to Information and Communications Technology (ICT) in general is high.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

2. My skill level with respect to Information and Communications Technology (ICT) has improved as a result of completing this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

3. I found that I had sufficient internet connectivity to complete his practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments……

4. I had access to the required computing equipment to complete this practical

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

Comments………

System Usability Scale

1. I think that I would like to use this practical frequently.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

2. I found the practical unnecessarily complex.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

3. I thought the practical was easy to use.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

4. I think that I would need the support of a technical person to be able to get the most out of this practical.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

5. I found the various functions in the practical were well integrated.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

6. I thought there was too much inconsistency in this practical.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

7. I imagine that most people would learn to use this practical very quickly.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

8. I found the practical very awkward to use.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

9. I felt very confident using the practical.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree

10.   I needed to learn a lot of things before I could get going with this practical.

Strongly Agree   Agree   Neutral   Disagree   Strongly Disagree