SMARTfarm Learning Hub: Next Generation Precision Agriculture Technologies for Agricultural Education

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Abstract.

The industry demands on higher education agricultural students are rapidly changing. New precision agriculture technologies are revolutionizing the farming industry but the education sector is failing to keep pace. This paper reports on the development of a key resource, the SMARTfarm Learning Hub (www.smartfarmhub.com) that will increase the skill base of higher education students using a range of new agricultural technologies and innovations. The Hub is a world first; it links real industry technologies with educator resources and student learning packages. This gives higher education providers and their student's online access to data and systems from commercial scale smart-farms across Australia and the world.

The SMARTfarm Learning Hub is based around a central landing page which provides links to cloud based technologies that are running over various university properties predominantly across Australia and the globe. Participating universities have farms with a diverse range of enterprises and environmental conditions from highly productive dairy systems in Tasmania to tropical beef

production in North Queensland and the arid rangelands of New Mexico. This is real data from real agricultural landscapes, and is matched with learning materials developed to challenge student's critical thinking and problem solving skills.

Utilization of the SMARTfarm Learning Hub is tracked using the Square Space metrics tools. The SMARTfarm Learning Hub website was launched in mid-December 2015 and since this time has reached 535 unique visitors an average of 107 per month.

Introduction

The industry demands on higher education agricultural students are rapidly changing. New technologies are revolutionizing the farming industry but the education sector is failing to keep pace. In their recent report, the Senate Standing Committee on Education, Employment and Workplace Relations identified that despite the increased complexity of modern agricultural industries, it has one of the lowest proportion of workers with post-secondary qualifications across the economy (Parliament of Australia, 2012). It is estimated that around 7.8% of the agricultural industry had tertiary qualifications compared with 25% for the wider community (Pratley, 2012). Reports have suggested that the combination of an ageing research workforce and evidence of an increasing skills deficit, there may already be insufficient capacity in the rural sector to develop and adopt innovations at the desired rate (Rural Research and Development Council, 2011).

This project will develop a key resource, the SMARTfarm Learning Hub (Figure 1) that will increase the skill-base of higher education students using a range of new agricultural technologies and innovations. The Hub is a world first; it will link real industry technologies with educator resources and student learning packages. This will give higher education providers and their student's online access to data and systems from commercial scale smart-farms across Australia.

While several projects have investigated the potential and value of online technologies for education, these have generally focused on the development or use of generic resources such as wiki's, image sharing, social media and podcasts (Gray et al., 2009). 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 revolutionizing the linkage of industry and learning institutes across the Australian education sector.

The two key issues this project seeks to address are: 1. Students are graduating from educational institutions without the necessary skills and knowledge required to work in agriculture given the highly technical and rapidly evolving nature of the field. Students need a theoretical understanding of new technologies and a practical ability to use them in an analytical and problem solving context; and 2. The integration of new technologies into current teaching at younger ages may encourage students to follow a career path in agriculture through secondary to tertiary and onto postgraduate study.

Blending academic and practical learning

The development of the SMARTfarm Learning Hub will provide graduates with skills and knowledge in the use and application of some of the leading cloud based systems currently being used and developed in the agricultural industry. A key outcome of the SMARTfarm Learning Hub is the blending of academic and practical learning experiences with a particular focus on developing high level problem solving and analytical skills, an attribute that has been highlighted as important by industry (Acuna et al., 2014). Graduates are equipped with the understanding of how new technologies work and are then provided the hands on experience in processing data and making decisions and solving problems using the various cloud based management systems (see, for example, Figure 2).
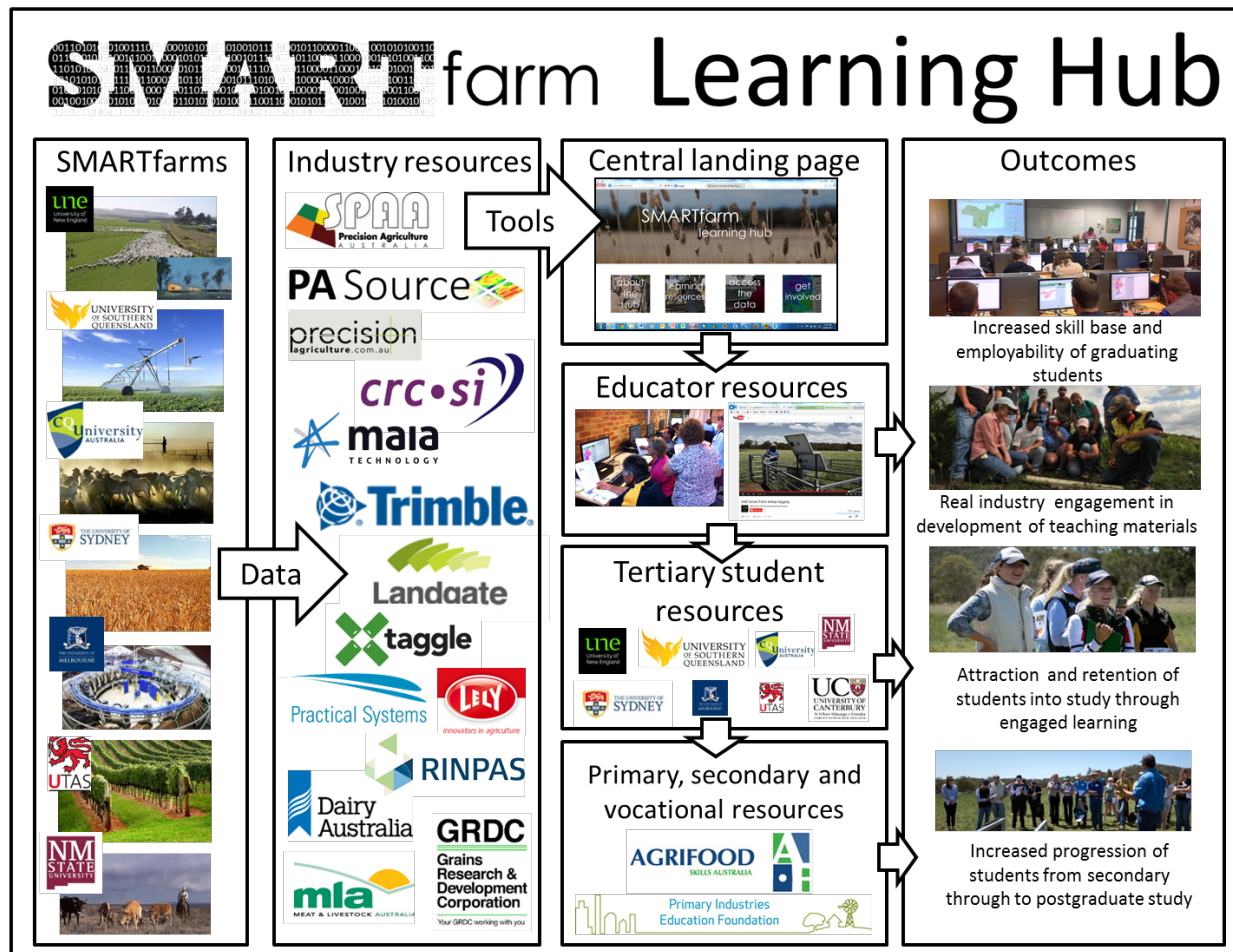
Figure 1. The proposed SMARTfarm Learning Hub. Real working farms will be linked with established industry tools to provide unique learning experiences for student

For example, the Pastures from Space learning package (developed by the University of New England (UNE)) uses a combination of theoretical information and real-time satellite data streaming from the UNE SMARTfarm (http://pfs.landgate.wa.gov.au/pfs_lite/landgate_pfs_lite_v2.asp?accept=1&intFarmID=10192000) to teach students about biomass monitoring across grazing landscapes and how this can be applied in determining grazing management decisions. Educational activities focused on SMARTfarm technologies have been demonstrated to engage students and consistently rate highly in student assessments and feedback (Cosby & Trotter, 2014; Trotter, 2014).

Building reciprocal industry relationships

Numerous agriculture information technology development (Ag-ITD) entities and industry bodies have committed to providing their innovative cloud based systems to be integrated into the SMARTfarm Teaching Platform, including: PAsource (farm mapping and data management, Figure 2); Precision Agriculture.com (leading Precision Agriculture (PA) consultancy); Practical Systems (livestock management system); Rangelands NRM Hub (property mapping platform); Grain Growers - Production Wise (remote sensing and crop growth modelling); Trimble Agriculture (sensor networks and farm spatial data management); Landgate (remote sensing); Dairy Australia (DairyBase industry benchmarking tool), Meat and Livestock Australia (stocking rate calculator and phosphorus

management tool) and the Society for Precision Agriculture Australia (SPAA) who will be providing various resources and student awards.

These are real reciprocal collaborative relationships in which the technology providers are interested in gaining feedback from students and educators on the operation of their systems. The teaching materials will be developed to include video interviews with the Directors of these companies explaining how and why the tools were developed. Because the teaching materials will be based on the use of actual industry tools, graduates at all levels will benefit through gaining work ready skills and training. Further video interviews demonstrating how farmers and other industry end users (e.g. corporate agribusinesses, consultants and government agencies) are using these various systems will be developed as part of the teaching packages. The case studies developed in the SMARTfarm Learning Hub will be industry focused and demonstrate a strong problem solving component and focus on the skills that employers are seeking.

Figure 2 Students engaged in a farm remote sensing exercise using the cloud based software package PASource, enabled by the SMARTfarm Learning Hub.

Improving institutional pathways across higher education

Although the focus of this project is on employability skills, it also has impact and implications for improving institutional pathways. The SMARTfarm Learning Hub will provide a significant impact well beyond the university sector with interest expressed from vocational, secondary and even primary educators seeking new and innovative resources (see details in letters of support from Primary Industries Education Foundation of Australia (PIEFA) and Agrifood Skills Australia). The

SMARTfarm Learning Hub encourages inter-institutional and cooperative partnerships across a number of teaching entities. There will be a particular focus on developing modules that can be fine-tuned for deployment across a range of tertiary levels. A case study learning module is being developed at Central Queensland University (CQU) that will specifically explore the integration of the SMARTfarm Learning Hub with the vocational courses run at this institution. A workshop will be run in collaboration with Agrifood Skills Australia to explore the opportunity to extend the SMARTfarm Learning Hub resources into the VET sector. The project will also run a workshop between key participants and the PIEFA to outline the proposed resources and seek opportunities to extend outcomes further into the secondary and primary schools system.

When fully developed, we expect the SMARTfarm Learning Hub will maximize transitions from secondary to tertiary study as it will become a point of commonality between different Australian Qualifications Framework (AQF) levels with student familiarity providing confidence to move to the next level.

In time, it is planned that specific learning packages will engage high school agriculture teachers in the development of their own landscape resources. Packages will be tailored so that schools are able to deploy some of the sensor platforms and technologies on their school farms or on a local property to which they have ready access for field evaluation. There will be a strong focus on providing information regarding potential progression of study within the teaching materials developed.

Project outputs

The SMARTfarm Learning Hub project will deliver several key outcomes integrating the critical infrastructure (website and industry tools) with the development of case study learning modules, methodologies and templates to enable project extension. This will be undertaken in an action research context providing both research outcomes and critical feedback to improve the learning modules, educator and student experience.

Figure 3 The SMARTfarm Learning Hub website provides links to industry technologies and learning packages and has been developed in the Squarespace web design platform.

SMARTfarm Learning Hub web landing page
There will be a central website (a SMARTfarm Learning Hub landing page) with links to participating SMARTfarms, learning resources and cloud based industry platform resources (see separate 1 page schematic). The SMARTfarm Learning Hub website (see Figure 3) will provide an overview of the project including video summary outlining the role and functions of the resource. The Hub will be linked with selected social media platforms (Facebook, Twitter and Instagram):

Industry tools established and available for use by students across selected SMARTfarms
Selected industry cloud based farm monitoring/sensing/managing technology systems will be established for each SMARTfarm. Key data from each farm will be collected including GPS boundary files and where appropriate EM38 soil survey and historical satellite imagery. Selected research data streams will be identified for targeted development of learning modules. Interviews with system developers will be undertaken to collect background information for learning materials.

Developed case study learning packages for tertiary students (University focus)
A learning module will be developed for a minimum of one industry tool running over each university SMARTfarm. The learning modules will consist of a combination of theoretical material and a practical exercise in which students will log into the industry tool or download data for interrogation. The development of the learning packages will be an iterative process applying action research principles. Each learning module will be accompanied by an instruction package for educators providing the critical resources to facilitate utilization of the new teaching materials.
For selected universities (e.g. UNE and CQU), integrated learning modules will be developed where cross institutional resources will be used in single case study learning modules. This means that single learning modules will access data from different SMARTfarms and exploit the different climate and agro-ecosystems to enable students to compare and contrast systems. Selected universities will develop learning modules that are based around research tools and data streams. The learning modules will be mapped against the recently developed published AgLTAS statement and catalogued in meta-data sites (e.g. Scootle).

Secondary resource development and engagement
One case study learning package will be developed for secondary students and teachers (UNE) and a workshop will be held with Primary Industries Education Foundation of Australia (PIEFA) to explore extension of the hubs resources and integration of the SMARTfarm Learning Hub with primary and secondary curriculum.

Vocational education and training sector resource development and engagement
A further case study learning package will be developed for VET sector students and teachers (in collaboration with CQU through its dual sector program (formally Central Queensland TAFE)). A workshop will be held with Agri-food Skills Australia to explore integration of the SMARTfarm Learning Hub into vocational sector training materials.

A methodology for educators seeking to create modules around new industry tools developed
This will involve the generation of guidelines and templates enabling educators seeking to develop their own learning module based on new industry tools as they enter the market. The guidelines will provide a work flow and process template providing ideas to optimize student engagement and interaction with the developer of the industry tool. This methodology will be based on the learning and feedback gained from the development of case study modules (and action research) within the project. The output will be a short handbook detailing these guidelines and a process for submission and review of the module to the SMARTfarm Learning Hub website.

A set of guidelines for industry seeking to make their tools available for development as an educational resource

We expect that industry interest in being involved in the SMARTfarm learning hub will grow over the life of the project with more entities seeking to have their tools integrated. To facilitate this, we will develop a set of guidelines for industry bodies so that they can better understand the needs of educators and students. Key attributes of online tools will be highlighted and techniques for optimizing student engagement and experience will be described. This output will be in the form of a short downloadable guide. A section of the SMARTfarm Learning Hub website will be dedicated to providing a virtual marketplace for industry offering resources to educators.

Evaluation of the learning modules

Selected learning modules will be evaluated under an action research methodology. Student engagement and attitudes will be assessed during delivery of learning modules in real classroom situations as they are integrated into teaching units through pre and post surveys and semi-structured interviews. UNE will undertake research in the newly developed UNE Virtual Institute for Teaching and Learning (UNE VITAL) and the Science, Technology, Mathematics, Medicine Education (StemmEd) Classroom which offers leading and state of the art tools for pedagogical research. Partner institutions will participate in evaluation programs designed around online data collection. The outcomes of this research will be presented in a final report and submitted for publication in refereed journals.

Evaluation of the perceived value of skills derived from the SMARTfarm Learning Hub to prospective employers

The aim of the SMARTfarm Learning Hub is to blend theoretical learning with the development of practical problem solving and analytical skills to improve student employability. A study will be undertaken which determines employer perceptions of the value of certain skills gained by students through participation in SMARTfarm Learning Hub modules. This will involve quantitative assessment of employers' perceptions through ranking of student CV's (with and without various skills gained from the Hub) as well as qualitative assessment of the perceived value of these skills.

Results to date

Utilization of the SMARTfarm Learning Hub is tracked using the Square Space metrics tools (Figures 4 & 5). The SMARTfarm Learning Hub website was launched in mid December 2015 and has reached 535 unique visitors, on average each of these has visited the site 1.4 times and examined an average of 3.6 pages.
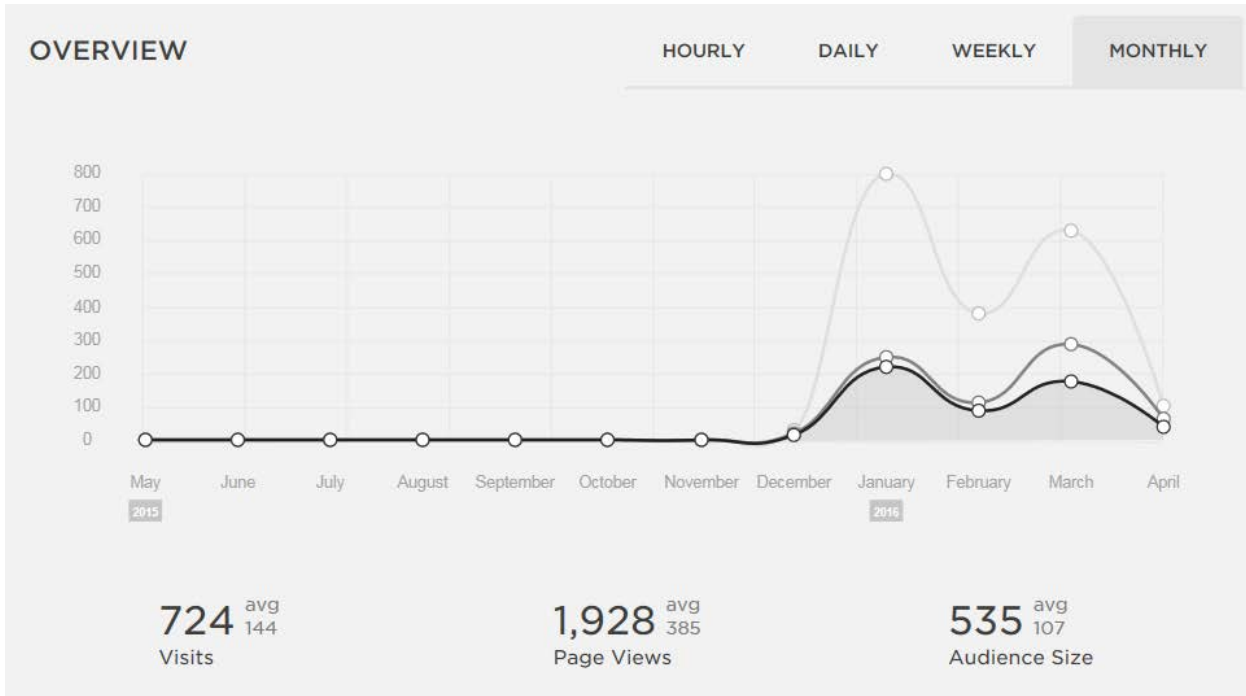
Figure 4 Utilization statistics of the SMARTfarm Learning Hub since inception.

Figure 5 Utilization statistics for the SMARTfarm Learning Hub on a weekly basis since March 2016. The increased activity during peak times relates to University teaching activities which utilize the Hub's resources.

Project sustainability

The SMARTfarm Learning Hub website will be specifically designed to enable maintenance for at least five years beyond the 2 year life of this project. The development of the learning design framework and template for the development of teaching materials will mean that the SMARTfarm Learning Hub is not only maintained but expanded.

Upon completion of the SMARTfarm Learning Hub project, the responsibility for maintenance will be taken on by a committee formed under the Research and Innovation Network in Precision Agriculture Systems. Several Research and Development Corporations (RDC) have expressed interest in providing ongoing funding to further develop the SMARTfarm Learning Hub beyond the term of this project.

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