# The Value of Student-led Field Trials for Agronomic Industry Training

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## Abstract

Maximising student employability on graduation by ensuring they have the discipline knowledge as well as the 'soft skills' required by employers is an important focus of university courses. Following completion of an Agribusiness or Agricultural Science degree, many students enter the workforce in industries where they are required to run their own field trials to test new products or varieties, or to research agronomic best practise. One of the approaches highlighted in this paper is to incorporate Work Integrated Learning (WIL), including authentic assessment, into unit learning outcomes where the practical component of a unit is focused on developing industry required skills, such as field trial management, data collection, analysis and report writing, as well as embedding core discipline knowledge. Students, working in small groups, are required to run their own research field trial over a semester, having been guided to develop their research question based on a current industry issue on a pre-sown crop, identify the measurements required to answer the question, and then plan their semester. At the end of the semester, the students present their work to the class and submit a conference-style research paper. Success is measured in relation to a clear hypothesis, measurements and analysis that addresses their hypothesis, and results related to the industry issue. Anecdotal feedback from students is that they enjoy the experience and responsibility of running their own trials, are able to add a skill to their *curriculum vitae*, and have increased confidence in their ability when entering the industry. The aim of this paper is to present an example of unit-level WIL, including authentic assessment that contains the application of discipline skills in crop science.

## Introduction

Transitioning from student to employee is an important focus of university courses, with universities frequently advertising that graduating students are job-ready or ready-to-work. To achieve this outcome, it is important to define the skills that graduates should possess and to define how the opportunity to learn these skills can be provided within units in a course, including the authentic assessment of the acquired skills. Authentic assessment can be defined as an assessment set up to conduct learning through 'real world' tasks in which students are required to utilise their discipline knowledge and skills in an industry-relevant context (Swaffield, 2011). Suleman (2018) states that the concept of employability is underpinned by core competencies and includes assumptions about graduate attributes as well as job requirements. Employees require so-called 'soft skills' as well as a multi-contextualised core of discipline knowledge 'hard skills' (Andrews & Higson, 2008; McQuaid & Lindsay, 2005; Yorke, 2006). There are clear benefits to the student in achieving these skills including increased employability, a faster and smoother transition from student to employee, and less additional training on commencing employment. Agriculture-specific skills required by agricultural science or agribusiness students who wish to enhance their employability, include research planning and implementation, field trial management, results analysis and reporting, as well as the more generic 'soft skills' such as problem solving and critical thinking. This group of skills forms a component of the Threshold Learning Outcomes for Agriculture (Acuna, Able, & Bobbi, 2015; Botwright Acuña et al., 2014), and are expanded upon in the

Good Practise Guide for Agriculture (Botwright Acuna & Able, 2016; Low & Bennett, 2016). They are particularly important for employment in agricultural industries because graduates are often working in isolation in remote areas and do not have ready access to more experienced staff or literature resources. They are also defined as completed competencies (listed as Graduate Attributes, Graduate Capabilities or Course Learning Outcomes) on completion of agricultural courses, and which are assessed by the Tertiary Education Quality and Standards Agency (TEQSA), which provides an 'independent national quality assurance and regulatory agency for higher education' (TEQSA, 2021).

A large number of graduating students from the Bachelor of Agribusiness at Curtin University enter their first job in the industry as agronomists, research trial officers for research trial companies, state department agencies and grower groups, or chemical company research officers. In all of these positions they are expected to set up field trials to investigate either issues in the industry or evaluate new products. Introducing final year students to the concept and practice of field trials to record and report on an industry problem and working with them as partners in the research project, therefore provides them with some experience and confidence when they are required to set up their own trials in future employment (Loveys, Riggs, & Able, 2016). In particular it enables them to develop skills in: a) problem solving - how best to set up a field trial to answer the question, and b) critical thinking - how do they build or improve on current knowledge. An added benefit to staff, and to students looking to complete honours or continue into research careers, is the potential opportunity to publish the results on completion of the trial. Botwright Acuna et al. (2014) have listed these as skills that are frequently listed as required graduate attributes in course descriptions, as well as being defined by industries as required skills on entering employment, and as such form one of the Threshold Learning Outcomes for Agriculture. Their definition, practise in education and relevance to industry is developed further in Low and Bennett (2016).

There are few examples of building work-integrated learning (WIL) into units that are also focussed on core skill development, particularly WIL in the field rather than in the laboratory. See Botwright Acuna and Able (2016) for some listed case studies within each Threshold Learning Outcome. WIL is typically integrated into courses as work experience, either as a requirement for graduation where students are required to complete work experience in the industry on top of completing their university units (Low & Bennett, 2018), or as an independent work experience unit. However, there is continued pressure upon universities to reduce contact hours, and with changes in course structure and focus, as well as degree timeframes, this element of the course is under threat. Student graduate capabilities have also changed with an increased focus on critical thinking and problem solving, in response to the amount of information available through the internet (Low & Bennett, 2016, 2018). Field-based project management therefore fills a critical need in modern courses and provides an avenue for authentic assessment of these 'soft skills'.

This paper describes one example of unit-integrated WIL that is a key component of a unit, including authentic assessment, that also contains the application of discipline skills in crop science.

## Approach

The aim of the semester-long research project is to introduce students to research using small-scale field trials to provide them with the opportunity to gain some experience in field trial design, on-going plant recording, analysis of field trials, presentation of results, and working

as a research team. It is hypothesised that exposing students to investigating real agricultural industry issues using research through small-scale field trials will increase their confidence in running field trials in their first employment, and provide them with an additional skill they can add to their *curriculum vitae*.

Prior to the start of semester, staff at local agricultural industries in Western Australia, such as State Government agriculture agencies, plant breeding companies, and agricultural chemical providers, as well as Curtin University-based Research Centres, are contacted to develop potential field-based research projects that can be set up at the Curtin University Field Trials Area. The aim is to identify at least one project for each of the main crops grown in Western Australia – wheat, barley and canola, a project involving a legume pulse crop, plus one to two projects using lesser grown crops. A weather station at the site provides students with the local weather data (hourly rainfall, temperature, humidity, and wind speed and direction) at the end of the season, and soil moisture from probes installed in some plots, that record data back to the weather station. The Field Trials Area is situated on the sandy soils of the Swan Coastal Plain (see Government of Western Australia, Department of Primary Industries and Regional Development, Agriculture and Food website: agric.wa.gov.au). These are some of the most infertile soils in the world and due to the low inherent organic matter, do not retain nutrients from one year to the next. Soil testing is also conducted on the plots in another unit of the course prior to sowing. The Field Trials Area has been set up to mimic a farm rotation with details provided to students of the crops that have been grown in every plot since the area was set up and first planted in 2013. Although the area is set up with irrigation, where possible planting and management follows the years' growing season with minimal additional irrigation.

The project field trials are planned and sown at the start of the growing season and managed until the start of Semester 2 when students commence their studies in their final year cropping systems unit. A timeline is presented for the field trials (Figure 1), detailing periods of management outside of the student semester and when students are engaged in the management. From experience, it has been found beneficial to spend the first week of the semester in the laboratory describing the different research trials on each of the crops, the Field Trials Area and background to the crop rotation that has been applied. A partnering approach is taken where students select the crop/research project they wish to work on, and then working in groups, are provided with more detailed information regarding their specific trial and crop, the industry issue it is investigating and the management decisions that have been made to date. They then work with the teaching staff in the unit to discuss and plan their experiment for the semester. The remainder of the first practical session is spent developing and discussing the skills they will need to run a successful research trial. These include setting clear research questions, planning how to conduct the research to answer the research questions, trial design including the importance of blocks and replicates, identifying the parameters that need to be measured, how they will take them and how often, and setting up a spreadsheet to record the data through the semester. Students are encouraged to critically evaluate what has been published in relation to their research question, and how authors have addressed and researched the issue. Each group's plans are checked and discussed with the teaching staff to ensure that they will enable them to answer their research question, that the suggested measurements are applicable, can be undertaken using the resources available, and will fit into the time they have available within the unit. From this point onwards the students are responsible for the trial over the semester, including completing all required measurements, as well as managing the trial, advising if fertiliser is required, if disease and pest management spraying should be undertaken, and to maintain the trial weed free.

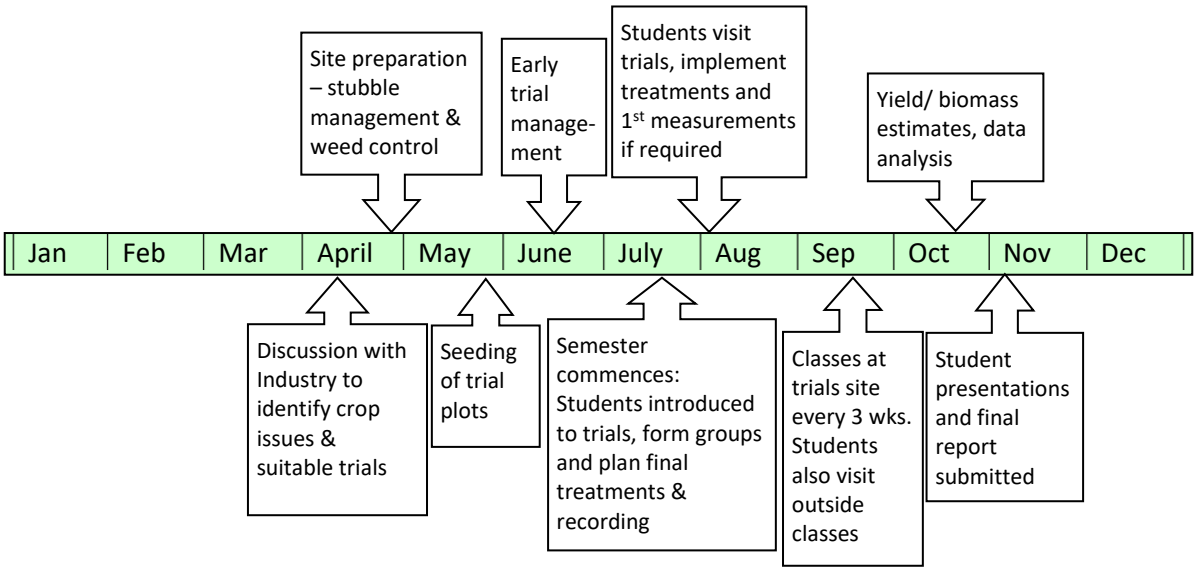


**Figure 1. Timeline of student-led field trials showing industry engagement, pre-season management prior to the commencement of teaching semester and student involvement during the semester**

Practical sessions are typically planned at the site every three weeks over the semester, but students are expected to visit the site to complete measurements as often as is required for their research trial. The planned sessions are used to teach students particular skills that can be utilised in the field, and that may be useful when entering the industry. These include using NDVI (normalised difference vegetation index) meters, PAR (photosynthetically-active radiation) meters, familiarity with using Zadoks (Zadoks, Chang, & Konzak, 1974) and other decimal crop growth scores, crop yield estimation, disease and weed identification etc. As a result of the timing of the university semester, and dependent on the growing season in any particular year, students may need to complete the practical component of the trial prior to the ideal time for harvest. This is unfortunate, and requires students who wish to publish their results, to return at harvest time to complete the final measurements. For those students wishing to enter a research career this is usually willingly undertaken.

The unit timetable is planned so that students have a final date in which all plant harvests, dry matter measurements and yield estimates are completed. A laboratory session is planned for students to work on the statistical analysis of their trials. Students in the 2nd year of their studies have completed a unit on statistical methods used in biology, which is based around using R-Studio (RStudio Team, 2019), and they are required to use it in subsequent semesters in both 2nd and 3rd year. The students are therefore expected to be able to set up their data spreadsheets correctly, to analyse the data and interpret the results. The specified data analysis laboratory session is planned so that assistance can be provided where required.

On completion of the trial, students are required to present the results as a group presentation and as an individually written conference paper (similar to the requirements of the Australian Agronomy Society Conference (2019)). The presentation component of the assessment is run as a mini-conference, with each group presenting their research trial and associated results in a 15 minute presentation, followed by time for questions. Industry personnel who have been involved in the trials are invited onto campus to listen to the presentations, and students are expected to attend all presentations and encouraged to be active participants by asking

questions of their fellow students. Marks are awarded not only on the presentation, but also on participation in the conference. The conference paper provides the opportunity for individual students to show their understanding of the industry issue, how their trial has addressed the research questions, and what the results mean for the industry and to guide future research.

## Outcomes

One of the differences between agriculture and other sciences is that agriculture has a requirement to focus on applying knowledge, rather than just gaining knowledge. This can be challenging for teachers, especially in relation to developing authentic activities and subsequent assessment (Loveys et al., 2016), but enables students to contextualise their learning, especially when using real-world problems (Meyer & Land, 2005). Learning tasks that closely resemble those that will be found in the workplace, known as authentic assessments, also help to ensure that students are better prepared for entering the workforce and are more employable. This paper provides an example of embedding real-world problems with learning tasks that resemble those that will be found in the workplace, into student learning within a unit.

It was hypothesised that exposing students to the investigation of real agricultural industry issues using research through field trials will increase their confidence in running field trials in their first employment, and provide them with an additional skill they can add to their *curriculum vitae*. Graduated agribusiness students working in the agribusiness industry have commented on the value of the research trial project and assessment activities on entering their first employment. The semester-long research project successfully introduces students to research using small scale field trials that provide them with the opportunity to gain some experience in field trial design, on-going plant recording, analysis of field trials, and presentation of results. Students not only gain experience over the semester of running a field trial, and collecting the required data to answer the industry issue, but also take ownership of the research within their group ensuring that data is collected with rigour. Analysis of trials that do not have pre-determined results further ensures that students critically review current literature to write the discussion for their conference paper. These are all critical WIL components for students entering employment in many cropping related industries, listed earlier in the paper, where they will be required to develop, run and report on investigative field trials. These skills are further enhanced by working as small groups to conduct their experiment. Volkov and Volkov (2015) highlighted the importance of teamwork when investigating questions as it promotes discussion, creativity and the development of problem-solving abilities, which enables students to take responsibility for their own learning. Teamwork is also an important WIL skill that will be required and used in the industry (Jones et al. 2016). Kirkup (2013) found that students are better engaged in the learning process when using open-ended, real-world problems, leading to active learning or inquiry-orientated learning, where students are required to work towards solving problems, explain their results and in the process, actively discuss the concepts that are required.

Kirkup and Johnson (2013) identified that there is a risk that students too early in their course do not have the critical core knowledge required to respond well to open-ended questions. The authentic assessment using inquiry orientated learning described in this paper, is embedded in a final third-year unit where students have already developed a solid grounding in agricultural knowledge and are starting to work across the higher-level thinking skills from Bloom's Taxonomy (Anderson et al., 2001). To further assist them and ensure they do not end up feeling lost (Kirkup & Johnson, 2013), the students are provided with the required direction to the

industry-focussed problems in the initial session when developing their research questions, and how they are going to set out the experiment and associated measurements to answer the question. Further direction is provided to the students when the whole cohort, including the lecturer, meet at the site every three weeks throughout the semester.

Active learning and authentic assessment, as described above, has been shown to lead to better retention of agricultural and related knowledge (Bauerle & Park, 2012; Dresner, de Rivera, Fuccillo, & Chang, 2013) and confidence when describing their skills in job interviews, as well as when asked to undertake similar skills on entering the workforce. McSweeney and Rayner (2011) also reported that a students' ability to apply knowledge to problem-solving in real life was essential to their success as a graduate. A workshop held as part of Botwright Acuña et al. (2014) identified a consistent message from industry participants – that they wanted graduates who were able to use knowledge gained through their course, and also, that they knew how to find further information that would help them in their job, i.e. that students have developed the skills for them to become life-long learners. Feedback from students on completion of the unit further supports this message, and the paper's hypothesis, that the knowledge gained in developing, managing, running and reporting on their field trials has provided significant learning outcomes that they see as relevant for future employment. For example;
*'There is great relevance of the ... practicals for future employment or research.'*

This paper provides one of the few examples of embedding WIL as authentic field activities into units. The Good Practice section of the WIL Guide for Science (ACDS, 2021), states that for WIL activities to be meaningful and effective, they need to be authentic and clearly linked to both the Graduate Capabilities (Course Learning Outcomes) and the Unit Learning Outcomes, as well as being effectively assessed. At Curtin University, a university-wide graduate capability is to be 'Industry connected and career capable'. These are linked to Unit Learning Outcomes, and subsequently to the assessments embedded within each unit. The final report of the Successful WIL in Science project (Johnson et al., 2019) lists six recommendations to increase student participation in WIL to increase employability. One of these is to increase opportunities for students to undertake WIL on campus within their course that is specifically targeted at learning equivalent to what is required in the workplace. This paper has provided an example within agriculture of an authentic WIL activity that is embedded into the course within a unit, has clear industry linkages and provides an authentic assessment through a conference style presentation and paper. It is included as one of the case studies in Low and Bennett (2016).

Finally, for students wishing to continue into Honours or higher-degree research courses, and thus into a research career, a research publication can significantly increase the opportunity to attract a scholarship in the current competitive market. A number of students completing the field-based experiment in the unit have subsequently had the opportunity to present their work at conferences, e.g. Lamont and Bennett (2019), or their trials have been incorporated into research publications, e.g. Bennett, Lee, and Sharma (2019), which they have been able to include in scholarship applications, increasing their opportunity to highlight skills already developed that will be essential in a research career.

## Conclusion

To conclude, exposing students to field trial-based research experiments in their final year of study, provides students with WIL embedded within a unit, and thus experience they can list on their *curriculum vitae*. Students are very receptive to the projects, taking ownership of

'their' experiments, ensuring they are correctly managed and that measurements are taken on time. As such, the exercise should provide them with the confidence to run robust small-scale research trials in their first year of employment. The research trials are set up with industry engagement providing real-life problems, that are assessed using authentic assessment and that students, in an active learning environment, can apply and build on their agricultural knowledge gained throughout their course.

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