Stage 5 agricultural technology – Technology and cattle production

## Summary

This unit of work demonstrates a range of ways that the syllabus content can be covered using a beef cattle enterprise as the primary teaching tool. Each content area includes a theory component with content and questions or activities that students can complete from a classroom. To add to this, each content area also includes a range of practical or digital activities that also covers the content and can supplement the theory work or replace it. The practical and digital activities cover a range of on-farm and hands-on experiences, laboratory work, use of industry standard software and online activities or research. The program is designed for teachers to tailor lessons to their school resources and student interests. All activities in each section are not intended on being completed unless the scope and sequence allows for this amount of time to be allocated to one enterprise and program.

## Duration

10 - 20 Weeks (3 hours per week timetabled lessons)

## Outcomes

A student:

* **AG5-7** explains and evaluates the impact of management decisions on animal production enterprises
* **AG5-8** evaluates the impact of past and current agricultural practices on agricultural sustainability
* **AG5-9** evaluates management practices in terms of profitability, technology, sustainability, social issues, and ethics
* **AG5-10** implements and justifies the application of animal welfare guidelines to agricultural practices
* **AG5-12** collects and analyses agricultural data and communicates results using a range of technologies
* **AG5-13** applies Work Health and Safety requirements when using, maintaining, and storing chemicals, tools, and agricultural machinery
* **AG5-14** demonstrates plant and/or animal management practices safely and in collaboration with others.

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## Unit overview

This unit focuses on content in ‘Animal production 2’ and provides students with opportunities to gain a more in-depth understanding of animal production in the context of a beef cattle enterprise. Students investigate environmental sustainability, financial viability, available technologies, and ethical considerations of beef enterprises.

Students are provided with opportunities to gain firsthand practical experiences in STEM within the agriculture field.

## Resources overview

The resources and links listed below are referenced within the program but is not an exhaustive list of resources available. Teachers can add to these resources as needed.

###  Physical resources

* computer, printer, smart phone, or another suitable device
* practical equipment
	+ Beef cattle of any class, breed, or size
	+ WHS and animal welfare compliant cattle yards and holding pens
	+ Cattle crush and head bale (optional)
	+ Cattle weigh scales
	+ RFID scanner and tags (optional)
	+ Drenching equipment, oral applicator or pour on applicator
	+ Personal protective equipment, including gloves, goggles, face shield, earmuffs/plugs, leather boots, overalls
	+ Examples of feed rations
	+ Dehydrator or science incubator
	+ 30cm X 30cm quadrats
	+ Scissors and paper bags
	+ Small kitchen or science scales
	+ Receipts from purchases made for the beef enterprise
	+ Microscopes and other faecal egg count equipment
	+ GPS collars for cattle (optional)
	+ Irrigation system for paddock or garden bed (optional)
	+ 25 small containers
	+ Measuring cylinders
* technology and cattle production student workbook

### Websites

* Managing an AI program, Future Beef: [futurebeef.com.au/knowledge-centre/managing-an-ai-program/](https://futurebeef.com.au/knowledge-centre/managing-an-ai-program/)
* Breeding values: your tool for looking under the hood of your next sire: [futurebeef.com.au/knowledge-centre/breeding-values-your-tool-for-looking-under-the-hood-of-your-next-sire/](https://futurebeef.com.au/knowledge-centre/breeding-values-your-tool-for-looking-under-the-hood-of-your-next-sire/)
* How to shop for a high-performing bull: [futurebeef.com.au/knowledge-centre/how-to-shop-high-performing-bull/](https://futurebeef.com.au/knowledge-centre/how-to-shop-high-performing-bull/)
* What difference can genetics make to temperate herds?: [genetics.mla.com.au/temperate/](https://genetics.mla.com.au/temperate/)
* Mapping with Datafarming: [womeninagri-tech.com/kelly-soenario/](https://womeninagri-tech.com/kelly-soenario/)
* Radio frequency identification (RFID) or electronic identification (eID) for livestock management: [womeninagri-tech.com/samantha-jarrett/](http://womeninagri-tech.com/samantha-jarrett/)
* Smart tracker on the move: [mla.com.au/news-and-events/industry-news/smart-tracker-on-the-move/](https://www.mla.com.au/news-and-events/industry-news/smart-tracker-on-the-move/)
* GPS Cows: [gpscows.com/](https://www.gpscows.com/)
* NSW Animals in Schools: [nswschoolanimals.com/](http://nswschoolanimals.com/)
* NSW Animals in schools; Cattle activities: [nswschoolanimals.com/cattle/cattle-activities/](http://nswschoolanimals.com/cattle/cattle-activities/)
* ArcGIS Online: [gpscows.maps.arcgis.com/home/index.html](https://gpscows.maps.arcgis.com/home/index.html)
* Australian Animal Welfare Standards and Guidelines for Cattle: [animalwelfarestandards.net.au/files/2011/01/Cattle-Standards-and-Guidelines-Endorsed-Jan-2016-061017\_.pdf](http://www.animalwelfarestandards.net.au/files/2011/01/Cattle-Standards-and-Guidelines-Endorsed-Jan-2016-061017_.pdf)
* AgriWebb Livestock Farm Management Software: [AgriWebb Livestock Farm Management Software](https://portal.agriwebb.com/login) (this software requires an account to be set up. Please register here and contact mailto:farmsuccess@agriwebb.com for access to the free academic subscription).
* Add livestock, AgriWebb: [help.agriwebb.com/en/articles/3186461-add-livestock](https://help.agriwebb.com/en/articles/3186461-add-livestock)
* Record keeping, AgriWebb: [help.agriwebb.com/en/articles/3153249-record-keeping](https://help.agriwebb.com/en/articles/3153249-record-keeping)
* Tasks, AgriWebb: [help.agriwebb.com/en/articles/3153532-tasks](https://help.agriwebb.com/en/articles/3153532-tasks)
* Drawing a paddock: [help.agriwebb.com/en/articles/3186547-drawing-a-paddock](https://help.agriwebb.com/en/articles/3186547-drawing-a-paddock)
* Livestock cost of production and gross margins: [help.agriwebb.com/en/articles/3288458-livestock-cost-of-production-and-gross-margin](https://help.agriwebb.com/en/articles/3288458-livestock-cost-of-production-and-gross-margin)
* Operational planner, AgriWebb: [help.agriwebb.com/en/articles/1656390-operational-planner](https://help.agriwebb.com/en/articles/1656390-operational-planner)
* Farmsafe induction tool: farmsafe.org.au/Farmsafe-Induction-App
* Visualising movement of Australian livestock, Integrity Systems: [movement.integritysystems.com.au](http://movement.integritysystems.com.au)
* Weight goals, Integrity Systems: [help.agriwebb.com/en/articles/1307817-weight-goals](https://help.agriwebb.com/en/articles/1307817-weight-goals)
* DIY worm egg counting: [dpi.nsw.gov.au/\_\_data/assets/pdf\_file/0006/749292/DIY-worm-egg-counts-livestock-incl-poultry.pdf](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/749292/DIY-worm-egg-counts-livestock-incl-poultry.pdf)
* Basic ruminant anatomy, Ag Solutions Australia: [agsolutions.com.au/2017/09/28/basic-ruminant-anatomy/](https://agsolutions.com.au/2017/09/28/basic-ruminant-anatomy/)
* Copernicus: an agricultural helper from space: [coalaproject.eu/news/blog/copernicus-an-agricultural-helper-from-space/](https://www.coalaproject.eu/news/blog/copernicus-an-agricultural-helper-from-space/)
* COALA H2020 project: [coalaproject.eu/](https://www.coalaproject.eu/)
* Welcome to Sentinel Online: [sentinel.esa.int/web/sentinel/home](https://sentinel.esa.int/web/sentinel/home)

### YouTube clips:

* + [How an AI technician inseminates a cow](https://www.youtube.com/watch?time_continue=106&v=si-1Cc_h854&feature=emb_title) (duration 1:54)
	+ [Geolocation and GPS](https://education.abc.net.au/home#!/media/3246866/geolocation-and-gps) (duration 2:30)
	+ [AgriWebb introduction](https://www.youtube.com/watch?time_continue=55&v=H4VqqIzJ-8g) (duration 3:29)
	+ [Risk and how to use a risk matrix](https://www.youtube.com/watch?v=-E-jfcoR2W0) (duration 5:28)
	+ [Tips from our team – cattle and parasites](https://www.youtube.com/watch?v=rPV_pmP80oY) (duration 4:03)
	+ [Raising the steaks – the science of cattle breeding](https://www.youtube.com/watch?v=wtP7q6W8cvY&t=75s) (duration 23:18)

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| **Content** | **Teaching and learning** | **Evidence of learning**  | **Adjustments and registration** |
| identify hazards, apply control measures, and use PPE when working with chemicals, tools, and agricultural machineryconduct a hazard identification and risk assessment task when undertaking animal husbandry tasks | **Workplace health and safety****Teacher*** Describe the range of hazards that can be found on a farm and relate to the students work on the school farm.

**Teacher and students*** Work through the [Farmsafe online induction](https://www.farmsafe.org.au/Farmsafe-Induction-App) as a class, discussing which points are relevant to the school farm and which ones are not.

**Teacher*** Define the terms hazard and risk.
* Identify the different types of hazards in an agricultural workplace.

**Teacher and students*** Investigate the range of personal protective equipment (PPE) available for use in agriculture, identifying contexts in which they would be used, how they are worn and how they should be maintained. Provide opportunities for students to try on the equipment where appropriate.

**Teacher*** Explain what a risk assessment is and why they are conducted.
* Demonstrate how to complete a simple risk assessment for an agricultural activity using a risk assessment template.
* Watch [risk and how to use a risk matrix](https://www.youtube.com/watch?v=-E-jfcoR2W0) to demonstrate how to determine the risk level for the risk assessment template.

**Students*** Conduct a risk assessment for working with cattle in the yards. Identify three possible hazards, the severity of the risk and outline two ways this hazard could be eliminated/controlled/minimised.
 | * Students can participate in a classroom discussion about safety on the school farm.
* Students can identify relevant farm PPE and articulate a range of scenarios where it would be recommended to use different items.
* Students identify a range of hazards in the cattle yards and can accurately assign a level of risk to develop a simple risk assessment.
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| investigate Australian animal welfare codes and their effect on the management of intensive and extensive systemsimplement and document practices in accordance with animal welfare codes | **Australian animal welfare codes****Teacher*** Define the term ‘animal welfare’ and provide examples of good animal welfare practices when conducting a beef enterprise.
* Outline the five freedoms for animal welfare and lead a class discussion on what these would look like in a beef enterprise both commercially and on the school farm.

**Students*** Complete a table describing ways that each of the five freedoms can be upheld in a beef cattle enterprise.

**Teacher*** Outline what legislation is relevant to livestock in NSW with a particular focus on cattle enterprises.
* Describe a range of Acts, Codes and Guidelines that need to be adhered to by beef cattle producers.

**Students*** Work in small groups to develop a set of rules or points that need to be carried out according to the standards and guidelines of the [Australian Animal Welfare Standards and Guidelines for Cattle.](http://www.animalwelfarestandards.net.au/files/2011/01/Cattle-Standards-and-Guidelines-Endorsed-Jan-2016-061017_.pdf) Each group is to work on collating the checklist for one standard, at the end combining the class effort to develop a whole document.
* Use the completed checklist to evaluate the facilities and practices for the schools’ beef enterprise.
* As a group or class, develop a set of recommendations for the school farm based on the evaluation conducted.

**Teacher and students*** Read through section 10 of [Australian Animal Welfare Standards and Guidelines for Cattle](http://www.animalwelfarestandards.net.au/files/2011/01/Cattle-Standards-and-Guidelines-Endorsed-Jan-2016-061017_.pdf) and highlight the similarities and differences between feedlot cattle enterprises and grazing systems.
* Discuss why there is a need for explicit guidelines for feedlot enterprises.

**Teacher*** Explain the types of records that need to be kept in accordance with animal welfare codes, including, but not limited to, types and number of livestock, husbandry records, movement tracking, feed records and biosecurity plans.
* Discuss the different ways that these records can be kept and the advantages and disadvantages of these systems.

**Teacher and students*** Watch [AgriWebb introduction](https://www.youtube.com/watch?time_continue=55&v=H4VqqIzJ-8g) (duration 3:29) and discuss the advantages and disadvantages of using this software for record keeping on a farm.
* Demonstrate the use and features of [AgriWebb Livestock Farm Management Software](https://www.agriwebb.com/au/) (academic version).
* Direct students in:
* setting up a map and [drawing a paddock](https://help.agriwebb.com/en/articles/3186547-drawing-a-paddock) of the schools paddocks, including fence boundary lines.
* entering the cattle from the beef enterprise, including tag numbers and location on the farm (allocate to a paddock). Use the [add livestock](https://help.agriwebb.com/en/articles/3186461-add-livestock) help sheet for step by step instructions.
* entering husbandry records and weight records for each animal during practical activities on the farm. Use the [record keeping](https://help.agriwebb.com/en/articles/3153249-record-keeping) help sheet for step by step instructions.
* Creating and completing tasks for the farm. Use the [tasks](https://help.agriwebb.com/en/articles/3153532-tasks) help sheet for step by step instructions.
 | * Students can articulate examples of good animal welfare practices.
* Students can communicate with peers to work collaboratively in small groupwork.
* Students can recognise welfare standards that need to be adhered to on the school farm and use these to develop a simple checklist to evaluate the site.
* Students can follow instructions to set up a model school farm and enter livestock data on appropriate software.
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| select and use technologies to assist effective animal management practices | **Animal management technologies****Teacher*** Describe the National Livestock Identification System (NLIS) in Australia and explain why it is important to the red meat industry.

**Teacher and students*** Access the [Visualising movement of Australia livestock interactive traceability tool](http://movement.integritysystems.com.au) to view NLIS data in a graphical representation for cattle, sheep and goat movements.
* Investigate the movement of cattle from producer PICs to saleyards over a three-month period.
* Identify trends in data for cattle moving between saleyards and abattoirs for a 12-month period and draw connections between peaks and lows to external factors such as weather.
* Discuss how this technology could be used by farmers to inform their on-farm management practices.

**Teacher and students*** Use the [Radio frequency identification (RFID) or electronic identification (eID) for livestock management resource](http://womeninagri-tech.com/samantha-jarrett/) to complete the following activities.
* Describe how RFID or eID technology works and where it is used in agriculture.
* Discuss how RFID/eID improves data collection on farms for management practices.

**Teacher and students*** Set up and use an RFID handheld or fixed scanner to collect data on the school’s cattle enterprise.
* Discuss as a class an appropriate or ideal weight target for the herd and set it as the weight goal in the software management system.
* Import data to the [AgriWebb livestock management software](https://www.agriwebb.com/au/) ‘weight goals tool’, weekly, for a period of six weeks.

**Students*** Identify animals that are on track to meet the set targets and those that were performing above or below the target using the graphs displayed from the software.
* Describe possible management strategies that could improve the lower performers of the herd.
* Discuss how this combination of technology can be used together to improve animal management practices on farms.
 | * Students can identify trends in visual data presentations.
* Students can explain how technologies that present data in graphical representations assist farmers in making management decisions.
* Students can safely set up and collect firsthand data.
* Students can follow a set of instructions to upload data and use software to manipulate it to find trends.
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| analyse nutritional requirements for the production cycle of an animal | **Livestock nutrition****Teacher*** Outline the structure and function of the ruminant digestive system and draw comparisons with monogastrics.

**Student*** Investigate [Basic ruminant anatomy](https://agsolutions.com.au/2017/09/28/basic-ruminant-anatomy/) to develop a table of organs and their functions for the ruminant digestive system.

**Teacher*** Explain the five essential nutrients required in a feed ration for beef cattle and where they are used within the animals’ body.
* Discuss feed intake and dry matter percentage of feeds. Outline how the quality of feed affects the amount of dry matter required by the animal.
* Model calculations to determine how much dry matter is required by cattle grazing on different pastures.

**Teacher and students*** Collect samples of pasture from paddocks used to graze school cattle and determine the dry matter percentage of the feed.
* Alternatively, samples of grain, hay or silage can also be used to compare the dry matter percentage across different rations used.
* Weigh the school cattle and calculate the total dry matter required for each animal based on body weight, and type of ration they are fed.
* Calculate how many kilograms of the ration they will require daily.
* Formulate a ration for the school herd based on class, weight, and available feeds. Ensure students are looking at dry matter content, energy requirements and protein requirements for the livestock involved.
 | * Students can articulate differences between the ruminant digestive system and a monogastric system.
* Students accurately calculate the dry matter percentage of feed samples.
* Students accurately calculate the amount of feed required for an identified animal based on dry matter and current ration.
* Students actively participate in discussions about developing an appropriate ration for school livestock.
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| investigate profitability using financial tools | **Farm finance****Teacher*** Outline the reasons for budgets on farms and identify the different types of budgets farmers use.
* Explain gross margins and how they are calculated.

**Teacher and students*** Calculate fixed and variable costs for the case study farm based on the data included in the student workbook.
* Calculate the total profit of the case study farm as presented in the student workbook.
* Calculate the gross margin per hectare for the case study farm.
* Collate data on the schools’ beef cattle enterprise, including feed costs, transport costs and other purchases. Only include variable costs.
* Investigate current market prices and calculate potential proceeds from sales of stock from the school farm.
* Calculate the gross margin in hectares for the school’s beef enterprise.

**Teacher and students*** Use the AgriWebb software set up for your school beef enterprise and input real farm costs and details for livestock treatments, feeds, sales, purchases, and other key events on the farm. [Calculate costs of production and gross margins for the enterprise using the software.](https://help.agriwebb.com/en/articles/3288458-livestock-cost-of-production-and-gross-margin)
* Compare the use of written records and digital records.
 | * Students accurately calculate fixed and variable costs for data given.
* Students accurately calculate total profit and gross margins for data given.
* Students accurately identify variable costs associated for the schools’ beef cattle enterprise.
* Students can identify a sales report and suitable class for selling school stock.
* Students can identify the benefits and disadvantages of using technology in financial record keeping.
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| investigate timing and impact of relevant operations in an animal production cycle | **Internal parasite control****Teacher*** Describe internal parasites that may be present in beef cattle and the range of different control methods available to producers.
* Outline the types of drenches, highlighting the advantages and disadvantages of using these for internal parasite control.
* Explain the concept of chemical resistance and how this can occur in an enterprise through poor management.

**Students*** Develop an integrated pest management plan using workbook information and [Tips from our team – cattle and parasites.](https://www.youtube.com/watch?v=u1R4Q3lecy8)

**Teacher and students*** Follow the instructions on the [DIY worm egg counting](https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/749292/DIY-worm-egg-counts-livestock-incl-poultry.pdf) sheet to collect, prepare and calculate the worm burden of individual animals in your herd.
* Analyse data collected and make management recommendations based on this for the herd.

**Teacher and students*** Teachers demonstrate how to read a chemical label to identify relevant PPE for chemical use.
* Students follow written and verbal instructions to prepare chemicals, equipment, and livestock safely and correctly for drenching.
* Students follow written and verbal instructions to safely and correctly clean up after oral drenching activities have concluded.

**Students*** Upload relevant data for animal care records onto the [AgriWebb livestock management software](https://www.agriwebb.com/au/).
* Use the [operational planner](https://help.agriwebb.com/en/articles/1656390-operational-planner) on AgriWebb to set up a management group for individual animals or the herd as a group. Identify your region from the map and plan the calendar. This is a full production cycle calendar that future management practices can be planned for.
* Use the calendar to plan practical activities on the farm throughout the term with students.
 | * Students can articulate the need for internal parasite control within a cattle enterprise.
* Students develop a logical sequence of control methods used in an integrated pest management program.
* Students can follow instructions to safely collect and analyse faeces samples for worm eggs.
* Students clearly articulate a plan of management for the herd based on data collected.
* Students safely demonstrate preparation of chemicals and equipment for oral drenching of cattle.
* Students work collaboratively to calculate dose rates for cattle and administer drench orally.
* Students identify relevant information required for animal care records.
* Students follow instructions to develop a digital calendar of operations for the enterprise.
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| identify some of the programs, techniques and tools used in animal breeding and analyse their impact on production. | **Artificial breeding in cattle production****Teacher*** Explain what is artificial insemination in the cattle industry and why is it used?
* Outline the stages of the oestrus cycle in cows.
* Explain oestrus, the visual signs of oestrus in cows and how farmers use this knowledge to inform their artificial insemination programs.
* Discuss how does the cows oestrous cycle plays a role in a successful artificial insemination program?
* Outline the range of mechanical heat detection tools available to farmers.

**Students*** Research the parts and functions of the cow’s reproductive system.
* Research the different reproductive hormones in cows and create a timeline depicting the oestrus cycle.
* Develop a heat detection guide for farmers and link this to the timeline of the oestrus cycle to identify the best time to inseminate.

**Teacher and students*** Research techniques involved in oestrus synchronisation used on Australian farms.
* Explore current and emerging technologies used for oestrus detection in cattle.
* Watch a cow being artificially inseminated and draw a flow diagram to show the sequence of tasks that are undertaken in this activity.
* Discuss the benefits and disadvantages of using an artificial insemination program on a farm.
* Make an overall evaluation about the use of artificial insemination for breeding programs on beef cattle farms.

**Estimated breeding values for accelerated herd performance****Teacher and students*** Watch a range of resources from the industry body, Meat and Livestock Australia (MLA) to define what an estimated breeding value is, how they are calculated and why they can be used within breeding programs on beef enterprises.
* Identify the advantages and disadvantages of using estimated breeding values in breeding programs and identify situations where their use could improve production.

**Students*** Use the information and skills learnt to identify important breeding objectives for a case study farm and decide on appropriate bulls for purchase based on these values.

**Extension*** Research one other breeding program or tool and analyse its impact on breeding programs in the beef cattle industry in Australia.
* Watch [Raising the steaks – the science of cattle breeding](https://www.youtube.com/watch?v=wtP7q6W8cvY&t=75s) and discuss how the use of estimated breeding values, artificial insemination and other on farm practices influence the farmers’ decision making process in the resource. Create a concept map to show the relationship between the farm practices.
 | * Students can identify the different parts of the mammal reproductive systems and their functions.
* Students demonstrate an understanding of how animal hormones affect heat and how detection of heat is used in reproductive management.
* Students can use industry specific terminology to participate in discussions about breeding objectives.
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| examine and analyse data from a range of sourcescommunicate an understanding of trends, patterns, and relationships in data to a specified audiencedraw conclusions from evidence and analysis of dataformulate a solution to an agricultural problem | **GPS technology in livestock production****Teacher*** Explain how GPS is used in precision agriculture.
* Explain what GPS is and how it works, using the video clip, [Geolocation and GPS](https://education.abc.net.au/home#!/media/3246866/geolocation-and-gps) from ABC Education.

**Students*** Draw a diagram to explain how GPS position is located using satellites.
* Read the article [Smart tracker on the move](https://www.mla.com.au/news-and-events/industry-news/smart-tracker-on-the-move/) and list the benefits of using GPS trackers on livestock from the article.
* Discuss as a class the potential disadvantages of using GPS trackers on livestock in Australia.

**Teacher and students*** Discuss a suitable aim for a research task using GPS collars on cattle in the schools’ paddock (or alternative if not available).
* Research and make a list of best handling practices using the [NSW Animals in Schools](http://nswschoolanimals.com/cattle/) website. Consider both work health and safety practices for student safety and animal welfare requirements when restraining cattle to attach collars.
* Conduct a risk assessment for working in the yards to attach and detach the GPS collars to livestock.
* Use the instructions given at [GPS Cows](https://www.gpscows.com/) or in the GPS Cows Advanced workshop, to set up and fit GPS collars to the cattle safely.
* Collect data for an allocated period for one or more animals prior to removing the collars.

**Teacher and students (optional)*** The following activities will need to be completed to allow for data analysis to be conducted. Ideally students would see through the whole process of collecting, cleaning, and manipulating data to identify trends.
* Alternative: teacher downloads, cleans and presents data for students to analyse.
* Download and save the data from each device.
* Create a paddock boundaries file for the area in the research activity using [ArcGIS online](https://gpscows.maps.arcgis.com/home/index.html).
* Clean the raw data from the downloaded files, beginning with the first complete day of data collection to the final complete day of data collection, removing ‘bad data’ also.
* Import the GPS data files onto the paddock boundary layer created in the ArcGIS files.
* Calculate density to create images of a ‘density map’ to determine areas of high utilisation within the paddock.
* Create a cluster map to determine areas that animals spend prolonged periods of time.
* Additional – assess paddock elevation and animal location data to determine if elevation impacts paddock utilisation or create graphs and pie charts to display data in a different form.

**Students*** Outline trends identified during the data analysis.
* Illustrate the three areas of greatest use by livestock within the paddocks.
* Make firsthand observations in the paddock of the three areas of greatest use.
* Determine if the research question was answered, use data to support the claim.
* Formulate a solution/recommendation/feedback for a farmer based on the data collected.

**Extension*** Brainstorm further questions that arise from the data, or could be explored, related to the original experimental aim. Choose one question to explore and develop a method to answer this question.
* Conduct the research required to answer the question.
 | * Students use diagrams to explain their understanding of how GPS locations are determined.
* Students can identify uses of GPS in agriculture and discuss the advantages and disadvantages of the technology.
* Students can articulate a suitable aim for a research project that uses GPS data and livestock.
* Students use prior knowledge and further research to identify welfare considerations for using livestock for research purposes.
* Students demonstrate prior knowledge to conduct a risk assessment.
* Students can follow instructions to set up an animal research trial to collect firsthand data, identify trends and analyse results to answer an aim.
* Students can recognise trends in data and compare them to physical differences observed.
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| identify emerging technologies that affect sustainabilitycompare short-term and long-term effects of agricultural production systems on sustainability | **Normalised difference vegetation index****Teacher*** Explain what normalised difference vegetation index (NDVI) is.
* Outline how satellites create NDVI images and how these images can be used in agricultural production.
* Explore precision agriculture and how measuring plant health can be used in precision agriculture.

**Teacher and students*** Use the [mapping with Datafarming](https://womeninagri-tech.com/kelly-soenario/) resource to follow instructions and complete the following activities.
* Use online technology to create outlines of either a school paddock, oval or farming business. Overlay these paddocks with NDVI imagery.
* Interpret NDVI images for a paddock.
* Convert NDVI images into variable rate zoning.

**Students*** Use NDVI images with variable rate zoning to collect and analyse pH of soil samples from each zone.
* Compare pH data to NDVI data, noting any relationships that can be identified.

**Teacher and students*** Discuss if soil pH affects plant health according to correlations between the soil samples and NDVI imagery.
* Examine how this basic technique could be applied to a larger scale farm, identifying relationships between NDVI imagery, soils, and plant growth.

**Teacher*** Define sustainability and link to enterprises studied previously. Include examples of sustainable practices and unsustainable practices and link them to economic, social, and environmental viability.

**Students*** Compare the short term and long-term effects of two different uses of NDVI for a farm. Link these to economic, social, and environmental viability for the enterprise.

**Variable rate irrigation****Teacher*** Explain what variable rate irrigation technology is and how it works.

**Teacher and students*** Collect catch can water samples from the school’s irrigator/sprinklers to determine how much water is distributed in mm/hr.
* Identify areas of low distribution and areas of high distribution and outline causes for the trends.
* Create an irrigation schedule to suit the crop or pasture.

**Extension*** Read the UNSW blog [Copernicus: an agricultural helper from space](https://www.coalaproject.eu/news/blog/copernicus-an-agricultural-helper-from-space/) to investigate how Sentinel imagery can be combined with other data to improve sustainability of agricultural land.
* Use the [Copernicus for sustainable agriculture in Australia (COALA)](https://www.coalaproject.eu/news/blog/copernicus-an-agricultural-helper-from-space/) interactive resource to investigate how using Earth observations from the ESA Sentinel 2 Satellite can assist Australian irrigated agriculture systems in the Murray-Darling Basin. Complete stage 5 agriculture activities from the site.
 | * Students can follow instructions to create satellite images of selected paddocks and overlay NDVI data.
* Students can identify trends in visual representations of data and use this to group areas.
* Students can articulate relationships between NDVI images and soil sample data from corresponding areas.
* Students demonstrate understanding of both short- and long-term effects of farm management practices on sustainability.
* Students can explain how variable rate irrigation a sustainable farming practice is.
* Students identify links between the use of NDVI and VRI and articulate how these used together is precision agriculture.
* Students follow instructions to build and code a model irrigation system with soil moisture probe.
* Students follow instructions to calculate application of water over an area from a sprinkler.
* Students use data to create an irrigation schedule.
* Students can identify differences in satellite imagery.
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## Evaluation

Evaluation of learning activities should be an ongoing process that happens throughout the delivery of this unit. Teachers should document their evaluation of learning activities throughout the program. The space provided below is to evaluate the overall unit of work.

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