Agricultural Science 2025 v1.2

General senior syllabus

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Queensland Government
Queensland Curriculum & Assessment Authority
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For all Queensland schools

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Contents

Queensland syllabuses for senior subjects

In Queensland, a syllabus for a senior subject is an official 'map' of a senior school subject. A syllabus's function is to support schools in delivering the Queensland Certificate of Education (QCE) system through high-quality and high-equity curriculum and assessment.

Syllabuses are based on design principles developed from independent international research about how excellence and equity are promoted in the documents teachers use to develop and enliven the curriculum.

Syllabuses for senior subjects build on student learning in the Prep to Year 10 Australian Curriculum and include General, General (Extension), Senior External Examination (SEE), Applied, Applied (Essential) and Short Course syllabuses.

More information about syllabuses for senior subjects is available at www.qcaa.qld.edu.au/senior/senior-subjects and in the 'Queensland curriculum' section of the *QCE and QCIA policy and procedures handbook*.

Teaching, learning and assessment resources will support the implementation of a syllabus for a senior subject. More information about professional resources for senior syllabuses is available on the QCAA website and via the QCAA Portal.

Course overview

Rationale

At the core of all scientific endeavour is the inquiry into the nature of the universe. Science uses a systematic way of thinking, involving creative and critical reasoning, in order to acquire better and more reliable knowledge. Scientists recognise that knowledge is not fixed, but is fallible and open to challenge. As such, scientific endeavour is never conducted in isolation, but builds on and challenges an existing body of knowledge in the pursuit of more reliable knowledge. This collaborative process, whereby new knowledge is gained, is essential to the cooperative advancement of science, technology, health and society in the 21st century.

Tertiary study in any field will be aided by the transferable skills developed in this senior Science subject. It is expected that an appreciation of, and respect for, evidence-based conclusions and the processes required to gather, scrutinise and use evidence will be carried forward into all aspects of life beyond the classroom.

The purpose of senior Science subjects in Queensland is to introduce students to a scientific discipline. Students will be required to learn and apply aspects of the knowledge and skill of the discipline (thinking, experimentation, problem-solving and research skills), understand how it works and how it may impact society.

Upon completion of the course, students will have an appreciation for a body of scientific knowledge and the process that is undertaken to acquire this knowledge. They will be able to distinguish between claims and evidence, opinion and fact, and conjecture and conclusions.

In each of the senior Science subjects, students will develop:

- a deep understanding of a core body of discipline knowledge
- aspects of the skills used by scientists to develop new knowledge, as well as the opportunity to refine these skills through practical activities
- the ability to coordinate their understandings of the knowledge and skills associated with the discipline to refine experiments, verify known scientific relationships, explain phenomena with justification and evaluate claims by finding evidence to support or refute the claims.

Agricultural Science is an interdisciplinary science subject suited to students who are interested in the application of science in a real-world context. They understand the importance of using science to predict possible effects of human and other activity, and to develop management plans or alternative technologies that minimise these effects and provide for a more sustainable future. Agricultural Science provides students with a suite of skills and understandings that are valuable to a wide range of further study pathways and careers. A study of Agricultural Science can allow students to transfer learned skills to studies of other subject disciplines in the school environment.

The primary industries sector of the Australian economy is facing many challenges, and the ability of Australia to meet these challenges depends on a well-informed community and highly skilled people working in all sectors of primary industries.

Agricultural Science provides opportunities for students to engage with agricultural production systems as they constantly adapt to meet the changing needs of society. As human activities and resource demands increase and diversify, agricultural scientists, managers and producers encounter opportunities and challenges associated with the sustainable management of resources and production of food and fibre. In Unit 1, students examine the plant and animal science required to understand agricultural systems, their interactions and their components. In Unit 2, students examine resources and their use and management in agricultural enterprises, the implications of using and consuming these resources, and associated management approaches. In Unit 3, students investigate how agricultural production systems are managed through an understanding of plant and animal physiology, and how they can be manipulated to ensure productivity and sustainability. In Unit 4, students consider how environmental, social and financial factors can be used to evaluate production systems, and how research and innovation can be used and managed to improve food and fibre production.

Agricultural Science aims to develop students':

- interest in Agricultural Science and their appreciation of how interdisciplinary knowledge can be used to understand contemporary issues in food and fibre production
- understanding and appreciation of agriculture as a complex and innovative system, and how it relates to sustainable production decisions now and into the future
- understanding that agricultural science knowledge is used in a variety of contexts and is influenced by social, economic, cultural and ethical considerations
- ability to conduct a variety of field, research and laboratory investigations involving collection and analysis of qualitative and quantitative data, and interpretation of evidence
- ability to critically evaluate agricultural science concepts, interpretations, claims and conclusions, with reference to evidence
- ability to communicate understandings and justify findings and conclusions related to agricultural production systems, using appropriate representations, modes and genres.

Syllabus objectives

The syllabus objectives outline what students have the opportunity to learn.

1. **Describe ideas and findings.**

   Students use scientific representations and language in appropriate genres to give a detailed account of scientific phenomena, concepts, theories, models and systems.

2. **Apply understanding.**

   Students use scientific concepts, theories, models and systems within their limitations. They use algebraic, visual and graphical representations of scientific relationships and data to determine unknown scientific quantities or features. They explain phenomena, concepts, theories, models, systems and modifications to methodologies.

3. **Analyse data.**

   Students consider scientific information from primary and secondary sources to identify trends, patterns, relationships, limitations and uncertainty. In qualitative data, they identify the essential elements, features or components. In quantitative data, they use mathematical processes and algorithms. They identify data to support ideas, conclusions or decisions.

4. **Interpret evidence.**

   Students use their understanding of scientific concepts, theories, models and systems and their limitations to draw conclusions and develop scientific arguments. They deduce, extrapolate, infer, justify and make predictions based on their analysis of data.

5. **Evaluate conclusions, claims and processes.**

   Students critically reflect on the available evidence and make judgments about its application to research questions. They extrapolate findings to support or refute claims. They use the quality of the evidence to evaluate the validity and reliability of inquiry processes and suggest improvements and extensions for further investigation.

6. **Investigate phenomena.**

   Students develop rationales and research questions for experiments and investigations. They modify methodologies to collect primary data and select secondary sources. They manage risks, environmental and ethical issues and acknowledge sources of information.

Designing a course of study in Agricultural Science

Syllabuses are designed for teachers to make professional decisions to tailor curriculum and assessment design and delivery to suit their school context and the goals, aspirations and abilities of their students within the parameters of Queensland's senior phase of learning.

The syllabus is used by teachers to develop curriculum for their school context. The term *course of study* describes the unique curriculum and assessment that students engage with in each school context. A course of study is the product of a series of decisions made by a school to select, organise and contextualise subject matter, integrate complementary and important learning, and create assessment tasks in accordance with syllabus specifications.

It is encouraged that, where possible, a course of study is designed such that teaching, learning and assessment activities are integrated and enlivened in an authentic setting.

Course structure

Agricultural Science is a General senior syllabus. It contains four QCAA-developed units from which schools develop their course of study.

Each unit has been developed with a notional time of 55 hours of teaching and learning, including assessment.

Students should complete Unit 1 and Unit 2 before beginning Units 3 and 4. Units 3 and 4 are studied as a pair.

More information about the requirements for administering senior syllabuses is available in the 'Queensland curriculum' section of the *QCE and QCIA policy and procedures handbook*.

Curriculum

Senior syllabuses set out only what is essential while being flexible so teachers can make curriculum decisions to suit their students, school context, resources and expertise.

Within the requirements set out in this syllabus and the *QCE and QCIA policy and procedures handbook*, schools have autonomy to decide:

- how and when subject matter is delivered
- how, when and why learning experiences are developed, and the context in which learning occurs
- how opportunities are provided in the course of study for explicit and integrated teaching and learning of complementary skills.

These decisions allow teachers to develop a course of study that is rich, engaging and relevant for their students.

Assessment

Senior syllabuses set out only what is essential while being flexible so teachers can make assessment decisions to suit their students, school context, resources and expertise.

General senior syllabuses contain assessment specifications and conditions for the assessment instruments that must be implemented with Units 3 and 4. These specifications and conditions ensure comparability, equity and validity in assessment.

Within the requirements set out in this syllabus and the *QCE and QCIA policy and procedures handbook*, schools have autonomy to decide:

- specific assessment task details
- assessment contexts to suit available resources
- how the assessment task will be integrated with teaching and learning activities
- how authentic the task will be.

In Unit 1 and Unit 2, schools:

- develop at least two but no more than four assessments
- complete at least one assessment for each unit
- ensure that each unit objective is assessed at least once.

In Units 3 and 4, schools develop three assessments using the assessment specifications and conditions provided in the syllabus.

More information about assessment in senior syllabuses is available in 'The assessment system' section of the *QCE and QCIA policy and procedures handbook*.

Subject matter

Each unit contains a unit description, unit objectives and subject matter. Subject matter is the body of information, mental procedures and psychomotor procedures (see Marzano & Kendall 2007, 2008) that are necessary for students' learning and engagement with the subject. Subject matter itself is not the specification of learning experiences but provides the basis for the design of student learning experiences.

Subject matter has a direct relationship with the unit objectives and provides statements of learning that have been constructed in a similar way to objectives.

Aboriginal perspectives and Torres Strait Islander perspectives

The QCAA is committed to reconciliation. As part of its commitment, the QCAA affirms that:

- Aboriginal peoples and Torres Strait Islander peoples are the first Australians, and have the oldest living cultures in human history
- Aboriginal peoples and Torres Strait Islander peoples have strong cultural traditions and speak diverse languages and dialects, other than Standard Australian English
- teaching and learning in Queensland schools should provide opportunities for students to deepen their knowledge of Australia by engaging with the perspectives of Aboriginal peoples and Torres Strait Islander peoples
- positive outcomes for Aboriginal students and Torres Strait Islander students are supported by successfully embedding Aboriginal perspectives and Torres Strait Islander perspectives across planning, teaching and assessing student achievement.

Guidelines about Aboriginal perspectives and Torres Strait Islander perspectives and resources for teaching are available at www.qcaa.qld.edu.au/k-12-policies/aboriginal-torres-strait-islander-perspectives.

Where appropriate, Aboriginal perspectives and Torres Strait Islander perspectives have been embedded in the subject matter.

Complementary skills

Opportunities for the development of complementary skills have been embedded throughout subject matter. These skills, which overlap and interact with syllabus subject matter, are derived from current education, industry and community expectations and encompass the knowledge, skills, capabilities, behaviours and dispositions that will help students live and work successfully in the 21st century.

These complementary skills are:

- literacy — the knowledge, skills, behaviours and dispositions about language and texts essential for understanding and conveying English language content
- numeracy — the knowledge, skills, behaviours and dispositions that students need to use mathematics in a wide range of situations, to recognise and understand the role of mathematics in the world, and to develop the dispositions and capacities to use mathematical knowledge and skills purposefully
- 21st century skills — the attributes and skills students need to prepare them for higher education, work, and engagement in a complex and rapidly changing world. These skills include critical thinking, creative thinking, communication, collaboration and teamwork, personal and social skills, and digital literacy. The explanations of associated skills are available at www.qcaa.qld.edu.au/senior/senior-subjects/general-subjects/21st-century-skills.

It is expected that aspects of literacy, numeracy and 21st century skills will be developed by engaging in the learning outlined in this syllabus. Teachers may choose to create additional explicit and intentional opportunities for the development of these skills as they design the course of study.

Additional subject-specific information

Additional subject-specific information has been included to support and inform the development of a course of study.

Science understanding

The science understanding subject matter in each unit develops students' understanding of the key concepts, models and theories that underpin the subject, and of the strengths and limitations of different models and theories for explaining and predicting complex phenomena. It uses cognitions from Objectives 1–4.

The science understanding subject matter from Units 3 and 4 will be assessed by the external assessment.

Science as a human endeavour (SHE)

Each Queensland senior science subject requires students to learn and apply aspects of the knowledge and skill of the discipline. However, it is recognised that students should also develop an appreciation for the *nature* and *development* of science, and its *use* and *influence* on society.

While this appreciation is not directly assessed, the syllabus provides guidance as to where it may be developed. Importantly, this guidance draws students' attention to the way in which science operates, both in relation to the development of understanding and explanations about the world and to its influence on society.

Students should become familiar with the following SHE concepts:

- Science is a global enterprise that relies on clear communication, international conventions, peer review and reproducibility.
- Development of complex models and/or theories often requires a wide range of evidence from multiple individuals and across disciplines.
- Advances in science understanding in one field can influence other areas of science, technology and engineering.
- The use and acceptance of scientific knowledge is influenced by social, economic, cultural and ethical contexts.
- The use of scientific knowledge may have beneficial and/or harmful and/or unintended consequences.
- Scientific knowledge can enable scientists to offer valid explanations and make reliable predictions.
- Scientific knowledge can be used to develop and evaluate projected economic, social and environmental impacts and to design action for sustainability.
- ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of datasets with which scientists work.
- Models and theories are contested and refined or replaced when new evidence challenges them, or when a new model or theory has greater explanatory power.
- Scientific knowledge can be used to inform the monitoring, assessment and evaluation of risk.
- Science can be limited in its ability to provide definitive answers to public debate; there may be insufficient reliable data available, or interpretation of the data may be open to question.
- International collaboration is often required when investing in large-scale science projects or addressing issues for the Asia–Pacific region.

To support the development of these concepts, this syllabus identifies SHE subject matter in each unit. This highlights opportunities for teachers to contextualise the associated science understanding and science inquiry subject matter and provides stimulus for the development of claims and research questions for investigation.

Additional opportunities include:

- practicals provide opportunities for students to witness the *nature* of science
- the student experiment provides opportunity for students to experience how the *development* of new science knowledge is built upon existing knowledge
- the research investigation provides opportunity for students to appreciate the *use* and *influence* of scientific evidence to make decisions or to contribute to public debate about a claim.

Science inquiry

Defining *inquiry* in science education

In order to support the school's task of aligning their chosen pedagogical framework with the curriculum and assessment expectations outlined in this syllabus, some guidance has been provided in the form of clarification of the use of the term *inquiry* and the articulation of a framework to describe the process of inquiry. The purpose of this guidance is to prevent misunderstandings and problematic conflations and their subsequent negative impact on student learning. As Abrams, Southerland and Silva (2008, p. xv) stated in their book, *Inquiry in the Classroom: Realities and opportunities*:

> Inquiry in the classroom can be conceived as a complex set of ideas, beliefs, skills, and/or pedagogies. It is evident that attempting to select a singular definition of inquiry may be an insurmountable and fruitless task. Any single definition of inquiry in the classroom would necessarily reflect the thinking of a particular school of thought, at a particular moment in time, or a particular goal, and such a singular definition may serve to limit legitimate and necessary components of science learning. **However, operating without a firm understanding of the various forms of inquiry leaves science educators often 'talking past' one another, and often results in very muddled attempts in the classroom** [emphasis added].

Uses of the term *inquiry*

Common phrases involving the term *inquiry* have been listed below:

- science inquiry
- science inquiry skills
- the inquiry process
- inquiry-based learning.

This syllabus refers to the first three uses listed above. The first, *science inquiry*, defines the practical work of a scientist (Harlen 2013). The second, *science inquiry skills*, refers to the skills required to do the work of a scientist (Harlen 2013). The third, *the inquiry process*, is a framework that can be used to describe the process of asking a question and then answering it.

The final phrase, *inquiry-based learning*, refers to a variety of teaching and learning strategies an educator may choose to use within their school's pedagogical framework. Although a school may choose to adopt an inquiry-based pedagogy, this syllabus is *not* intended to endorse or recommend an inquiry-based learning approach.

Framework to describe the inquiry process

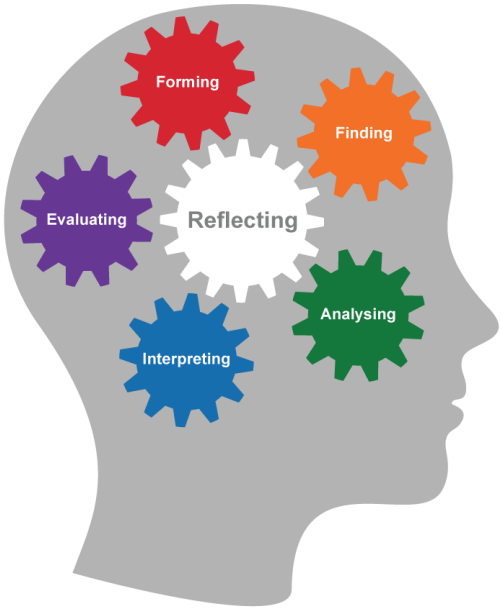
In order to support student engagement in activities involving inquiry, it is useful to establish a common language or framework to distinguish between stages of the process.

The stages involved in any inquiry are:

- forming and describing the inquiry activity
- finding valid and reliable evidence for the inquiry activity
- analysing the evidence collected
- interpreting the evidence selected
- evaluating the conclusions, processes or claims.

This framework uses reflection as the connection between, and driver of, all the stages. The progression through the inquiry process requires reflection on the decisions made and any new information that has emerged during the process to inform the next stage. Each stage of the inquiry process is worthy of reflection, the result of which may be the revision of previous stages (Marzano & Kendall 2007).

Figure 1: Stages of inquiry process



Science inquiry and science inquiry skills

Science inquiry involves identifying and posing questions and working to answer them. It is concerned with evaluating claims, investigating ideas, solving problems, reasoning, drawing valid conclusions and developing evidence-based arguments. It can easily be summarised as the 'work of a scientist' (Hackling 2005).

Within this syllabus, it is expected that students will engage in *aspects* of the work of a scientist by engaging in scientific inquiry (Tytler 2007). This expectation can be seen, for example, by the inclusion of practicals and investigations in the subject matter, and in the internal assessments for Units 3 and 4.

Science inquiry skills are the skills required to do the work of a scientist. They include writing research questions, planning, conducting, recording information, and reflecting on investigations; processing, analysing and interpreting evidence; evaluating conclusions, processes and claims; and communicating findings (ACARA 2015).

It is expected that students are explicitly taught science inquiry skills (Krajcik et al 2000), a number of which are outlined throughout the syllabus. Some science inquiry skills will be used to complete the listed practicals and investigations. The selection, application and coordination of science inquiry skills will be required in the student experiment and research investigation.

It is the prerogative of the educator to determine how listed practicals and investigations are used as opportunities to:

- develop, rehearse and refine science inquiry skills
- engage students in scaffolded or open-ended science inquiry tasks
- formatively assess science inquiry skills.

Science inquiry skills

Throughout the course of study, students will:

- identify, research and construct questions for investigation
- predict possible outcomes from investigations
- design investigations, including the procedure/s to be followed, the materials required, and the type and amount of primary and/or secondary data required to obtain valid and reliable evidence, e.g.
  - distinguish between different types of investigations: descriptive, comparative, correlational, experimental, secondary data investigations
  - consider replicates, sample size, number of data points and quality of sources
  - identify the types of errors, extraneous or confounding factors that are likely to influence results and implement strategies to minimise systematic and random error
- identify and implement strategies to manage risks, ethics and environmental impact, e.g.
  - ethical guidelines
  - cultural guidelines, protocols for working with the knowledges of First Nations peoples
  - material safety data sheets
  - workplace health and safety guidelines
  - appropriate disposal methods
  - standard operating procedures
  - acknowledgment of sources and referencing

- use appropriate equipment, techniques, procedures and sources to systematically and safely collect primary and secondary data, e.g.
  - ecosystem surveying techniques: quadrats, transects
  - laboratory and field techniques: measurement, equipment calibration, species identification
  - models and simulations
  - ICTs, scientific texts, databases, online sources
- use scientific language and representations to systematically record information, observations, data and measurement error, e.g.
  - symbols, units and prefixes
  - scale and magnification
  - indicators of measurement uncertainty
  - tables, graphs and diagrams
  - charts and maps
  - logbooks
- translate information between graphical, numerical and/or algebraic forms
- use descriptive statistics to allow identification of relevant trends, patterns, relationships, limitations and uncertainty in comparative and correlational investigations: mean, standard deviation, standard error of the mean, confidence intervals
- select and construct appropriate representations to present data and communicate findings, e.g.
  - summary tables
  - column graphs (with error bars)
  - scatterplots (with trendline and r or r^2)
  - profile diagrams
  - scientific drawings
  - indexes and summary statistics
- analyse data by
  - selecting a technique appropriate to the research question
  - identifying trends, patterns and relationships
  - recognising error, uncertainty and limitations of evidence
- use inferential statistics to infer the presence or absence of statistical differences between sample means (confidence intervals, standard error of the mean, Student's t-test) and relationships between variables (regression analysis, p-value from correlation coefficient)
- select, synthesise and use evidence to construct scientific arguments and draw conclusions
- extrapolate findings to determine unknown values, predict outcomes and evaluate claims

- use data and reasoning to discuss and evaluate the validity and reliability of evidence, e.g.
  - discuss ways in which measurement error, instrumental uncertainty, the nature of the procedure, sample size or other factors influence uncertainty and limitations in the data
  - evaluate information sources and compare ideas, information and opinions presented within and between texts
  - compare findings to theoretical models or expected values
- suggest improvements and extensions to minimise uncertainty, address limitations and improve the overall quality of evidence.

Science inquiry subject matter uses cognitions from across all objectives, and is primarily assessed through the internal assessments for Units 3 and 4. To support the development of these science inquiry skills, this syllabus identifies suggested practicals and investigations for each unit. These highlight opportunities for students to directly experience the associated science understanding subject matter and provide stimulus for student experiments and research investigations.

It is expected that approximately five hours of fieldwork will be required to develop the associated science inquiry skills. Fieldwork can allow students to engage in science inquiry by offering authentic real-world learning. It offers students an opportunity to gather primary data to analyse and respond to questions they pose.

Safety and ethics

Workplace health and safety

Agricultural Science is designed to expose students to the practical components of science through practical experiences in the laboratory and the field. These experiences expose students to a variety of hazards, from biological and poisonous substances to injury from equipment. Besides a teacher's duty of care that derives from the *Education (General Provisions) Act 2006*, there are other legislative and regulatory requirements, for example the *Work Health and Safety Act 2011*, that will influence the nature and extent of practical work.

All practical work must be organised with student safety in mind. The *Department of Education and Training (DET) Policy and Procedure Register* (https://ppr.qed.qld.gov.au) provides guidance about current science safety protocols.

It is the responsibility of all schools to ensure that their practices meet current legislation requirements.

Care and use of animals for scientific purposes

Governing principles

The QCAA recognises that school personnel involved in the care and use of animals for scientific purposes have legal obligations under the *Animal Care and Protection Act 2001* (the Act). Queensland schools intending to use animals for scientific purposes must apply for and receive animal ethics approval from the Queensland Schools Animals Ethics Committee (QSAEC) prior to conducting these activities. The purpose of the Act is to promote the responsible care and use of animals, provide standards for the care and use of animals, protect animals from unjustifiable, unnecessary or unreasonable pain, and ensure that the use of animals for scientific purposes is accountable, open and responsible.

The Act also requires mandatory compliance with the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2013 (8th edition)*, available from the National Health and Medical Research Council's publications website.

It should be recognised that animal experiments provide unique opportunities for promoting depth of understanding in the issues of animal welfare and best practice production methods for this large part of agriculture in Australia.

Separate to the Act and ethical approval, best practice includes referring to the *3Rs* principle of animal welfare:

- **replacement** — any investigations involving animals should initially consider replacing the animals with cells, plants or computer simulations
- **refinement** — refinement of the investigation should aim to alleviate any harm or distress to the animals used
- **reduction** — reduce the number of animals used.

Respect for animals must underpin all decisions and actions involving the care and use of animals. The responsibilities associated with this obligation apply throughout the animal's lifetime, including acquisition, transport, breeding, housing, husbandry and the use of animals in a project. Experiments that require the endpoint as the death of any animal (e.g. lethal dose LD_{50}) are unacceptable.

Animal dissections

There is no requirement for students to witness or carry out a dissection of any animal, invertebrate or vertebrate in this course. If animal dissections are chosen by the teacher as an important educational experience, the *3Rs* principle of animal welfare should be applied (i.e. replacement, refinement and reduction — see above for more information). Teachers should always discuss the purpose of the dissection and allow any student, without requirement for explanation, to opt out if they wish. Teachers should be respectful of the variety of reasons students may have for choosing not to participate.

Strategies for retaining and recalling information for assessment

The following practices[1] can support preparation for senior assessment in Agricultural Science.

The spacing effect

The spacing effect draws on research about forgetting and learning curves. By recalling and revisiting information at intervals, rather than at the end of a study cycle, students remember a greater percentage of the information with a higher level of accuracy. Exposing students to information and materials numerous times over multiple spaced intervals solidifies long-term memory, positively affecting retention and recall.

Teachers should plan teaching and learning sequences that allow time to revisit previously taught information and skills at several intervals. These repeated learning opportunities also provide opportunities for teachers to provide formative feedback to students.

The retrieval effect

The retrieval effect helps students to practise remembering through quick, regular, low-stakes questioning or quizzes that exercise their memories and develop their ability to engage in the deliberate act of recalling information. This has been shown to be more effective at developing long-term memories than activities that require students to search through notes or other resources.

Students may see an inability to remember as an obstacle, but they should be encouraged to understand that this is an opportunity for learning to take place. By trying to recall information, students exercise or strengthen their memory and may also identify gaps in their learning. The more difficult the retrieval practice, the better it can be for long-term learning.

Interleaving

Interleaving involves interspersing the concepts, categories, skills or types of questions that students focus on in class or revision. This is in contrast to blocking, in which these elements are grouped together in a block of time. For example, for concepts A, B and C:

- Blocking A A A A A B B B B B C C C C C
- Interleaving A B C B C A B A C A C B C A B

Studies have found that interleaving in instruction or revision produces better long-term recall of subject matter. Interleaving also ensures that spacing occurs, as instances of practice are spread out over time.

Additionally, because exposure to one concept is interleaved with exposure to another, students have more opportunities to distinguish between related concepts. This highlighting of differences may explain why studies have found that interleaving enhances inductive learning, where participants use exemplars to develop an understanding of broader concepts or categories. Spacing without interleaving does not appear to benefit this type of learning.

Interleaving can seem counterintuitive — even in studies where interleaving enhanced learning, participants often felt that they had learnt more with blocked study. Despite this, their performance in testing indicated greater learning through the interleaving approach.

[1] Based on Agarwal, Roediger, McDaniel & McDermott (2020); Birnbaum, Kornell, Ligon Bjork & Bjork (2013); Carpenter & Agarwal (2020); Chen, Paas & Sweller (2021); Ebbinghaus (1885); Rohrer (2012); Taylor & Rohrer (2010).

Reporting

General information about determining and reporting results for senior syllabuses is provided in the 'Determining and reporting results' section of the *QCE and QCIA policy and procedures handbook*.

Reporting standards

Reporting standards are summary statements that describe typical performance at each of the five levels (A–E).

A
The student accurately describes a variety of concepts, theories, models and systems, and their limitations. They give clear and detailed accounts of a variety of concepts, theories, models and systems by making relationships, reasons or causes evident. The student communicates effectively by using scientific representations and language accurately and concisely within appropriate genres. They efficiently collect, collate and process relevant evidence. The student accurately applies their understanding of scientific concepts, theories, models and systems within their limitations to explain a variety of phenomena, and predict outcomes, behaviours and implications. They accurately use representations of scientific relationships and data to determine a variety of unknown scientific quantities and perceptively recognise the limitations of models and theories when discussing results. The student analyses systematically and effectively by identifying the essential elements, features or components of qualitative data. They use relevant mathematical processes to appropriately identify trends, patterns, relationships, limitations and uncertainty in quantitative data. They interpret evidence insightfully by using their knowledge and understanding to draw justified conclusions based on their thorough analysis of evidence and established criteria. The student critically evaluates conclusions, claims and processes by insightfully scrutinising evidence, extrapolating credible findings, and discussing the reliability and validity of experiments. They investigate phenomena by carrying out effective experiments and research investigations.
B
The student accurately describes concepts, theories, models and systems, and their limitations. They give clear and detailed accounts of concepts, theories, models and systems by making relationships, reasons or causes evident. The student communicates accurately by using scientific representations and language within appropriate genres to present information. They collect, collate and process relevant evidence. The student accurately applies their understanding of scientific concepts, theories, models and systems within their limitations to explain phenomena and predict outcomes, behaviours and implications. They accurately use representations of scientific relationships and data to determine unknown scientific quantities, and accurately recognise the limitations of models and theories when discussing results. The student analyses effectively by identifying the essential elements, features or components of qualitative data. They use mathematical processes to appropriately identify trends, patterns, relationships, limitations and uncertainty in quantitative data. They interpret evidence by using their knowledge and understanding to draw reasonable conclusions based on their accurate analysis of evidence and established criteria. The student evaluate processes, claims and conclusions by scrutinising evidence, applying relevant findings and discussing the reliability and validity of experiments. They investigate phenomena by carrying out effective experiments and research investigations.

C
The student describes concepts, theories, models and systems, and their limitations. They give detailed accounts of concepts, theories, models and systems by making relationships, reasons or causes evident. The student communicates using scientific representations and language within appropriate genres to present information. They collect, collate and process evidence. The student applies their understanding of scientific concepts, theories, models and systems within their limitations to explain phenomena and predict outcomes, behaviours and implications. They use representations of scientific relationships and data to determine unknown scientific quantities and recognise the limitations of models and theories when discussing results. The student analyses by identifying the essential elements, features or components of qualitative data. They use mathematical processes to identify trends, patterns, relationships, limitations and uncertainty in quantitative data. They interpret evidence by using their knowledge and understanding to draw conclusions based on their analysis of evidence and established criteria. The student evaluates processes, claims and conclusions by describing the quality of evidence, applying findings, and describing the reliability and validity of experiments. They investigate phenomena by carrying out experiments and research investigations.
D
The student describes and gives accounts of aspects of concepts, theories, models and systems. The student uses scientific representations or language to present information. They use rudimentary representations of scientific relationships or data to determine unknown scientific quantities or variables. The student analyses by identifying the elements, features or components of qualitative data. They use parts of mathematical processes to identify trends, patterns, relationships, limitations or uncertainty in quantitative data. They interpret evidence by drawing conclusions based on evidence or established criteria. The student considers the quality of evidence and conclusions and discusses processes, claims or conclusions. They carry out aspects of experiments and research investigations.
E
The student describes scenarios and communicates by referring to representations of information. They discuss physical phenomena and evidence. They follow established methodologies in research situations. They discuss evidence. The student carries out elements of experiments and research investigations.

Determining and reporting results

Unit 1 and Unit 2

Schools make judgments on individual assessment instruments using a method determined by the school. They may use the reporting standards or develop an instrument-specific marking guide (ISMG). Marks are not required for determining a unit result for reporting to the QCAA.

The unit assessment program comprises the assessment instrument/s designed by the school to allow the students to demonstrate the unit objectives. The unit judgment of A–E is made using reporting standards.

Schools report student results for Unit 1 and Unit 2 to the QCAA as satisfactory (S) or unsatisfactory (U). Where appropriate, schools may also report a not rated (NR).

Units 3 and 4

Schools mark each of the three internal assessment instruments implemented in Units 3 and 4 using ISMGs.

Schools report a provisional mark by criterion to the QCAA for each internal assessment.

Once confirmed by the QCAA, these results will be combined with the result of the external assessment developed and marked by the QCAA.

The QCAA uses these results to determine each student's subject result as a mark out of 100 and as an A–E.

Units

Unit 1: Agricultural systems

In Unit 1, students explore the ways agricultural science describes and explains agricultural plants and animals through an understanding of anatomy and physiology, and how plants and animals are components of larger, interconnected agricultural systems. Students investigate phenomena associated with the growth and development of agricultural plants and animals. They examine and analyse evidence generated by plant and animal systems, enterprises, industries and organisations.

Contexts for the investigation of this unit include specific agricultural plants and animals of local, regional and national significance. Through these contexts, students explore the successful management of agricultural systems within plant and animal enterprises.

Participation in a range of experiments and investigations will allow students to progressively develop their suite of science inquiry skills while gaining an enhanced appreciation of the complexity of food and fibre production. Collaborative experimental work also helps students to develop communication, interaction and self-management skills.

Throughout the unit, students develop skills in investigating agricultural systems and enterprises. They analyse evidence and evaluate processes, claims and conclusions to describe and explain the anatomy and physiology of agricultural plants and animals, and how they are components of larger, interconnected agricultural systems.

Unit objectives

1. Describe ideas and findings about agricultural enterprises, and animal and plant production.
2. Apply understanding of agricultural enterprises, and animal and plant production.
3. Analyse data about agricultural enterprises, and animal and plant production.
4. Interpret evidence about agricultural enterprises, and animal and plant production.
5. Evaluate processes, claims and conclusions about agricultural enterprises, and animal and plant production.
6. Investigate phenomena associated with agricultural enterprises, and animal and plant production.

Subject matter

Topic 1: Agricultural enterprises A (4 hours)

Science understanding

- Describe the difference between open, closed and isolated systems in terms of the flow of energy and matter.
- Describe agriculture as a system that is made up of inputs, outputs, boundaries, subsystems, processes, interactions, feedback and monitoring.
- State the features of both intensive and extensive animal and plant industries.
- State the important animal and plant enterprises in local and regional areas of Queensland as well as those of national significance.
- Describe physical resources, including soil and water, machinery and infrastructure and human and biological resources (including animals and plants) for an agricultural enterprise.
- Describe different business structures for property, including partnerships, companies, land tenure, family farms and succession.
- Analyse data from sources such as the Australian Bureau of Statistics (ABS) or the Queensland Department of Agriculture and Fisheries (DAF) to compare the features (including land use, employment numbers and gender, level of input ($/ha), yield and industry values) of major and minor industries.
- Interpret data on physical and biological resources of a production unit including soil, climate, vegetation and topography.

Science as a human endeavour (SHE)

- Recognise that
  - farming systems can be described using an input–output model that draws on a wide range of evidence from multiple disciplines
  - agricultural systems can be simulated, constructed or represented using appropriate model/s and contextualised using a relevant local example.

Science inquiry

- Investigate
  - the physical and biological resources of a production unit by observing, collecting and recording information on resources including soil, climate, vegetation and topography
  - a range of industries by analysing and interpreting data on changes in production over time, e.g. years.
- Explore appropriate models for an agricultural system (contextualised using a relevant local example) by simulating, constructing or representing a model showing inputs, outputs, boundaries, subsystems, processes and interactions between subsystems.

Topic 2: Animal production A (19 hours)

Science understanding

Animal identification, anatomy and physiology

- Describe animal husbandry.
- Describe the concept of a breed in terms of agriculture.
- State agricultural animals of regional significance.
- Compare the physical characteristics of different types of agricultural animals (e.g. features of *Bos taurus indicus* versus *Bos taurus taurus* for cattle production in tropical climates) and discuss the significance of any differences back to their natural environment/feeding behaviour.
- State the functions of the main organelles in animal cells, including plasma membrane, nucleus, cytoplasm, mitochondria, ribosomes.
- State the hierarchical structure of organisation of cells, tissues, organs and systems in body systems, including the digestive, reproductive and musculoskeletal systems.
- Explain the terms *monogastric* and *ruminant*.
- Explain the function of the main structures within the monogastric and ruminant digestive systems, including teeth, oesophagus, stomach, rumen, reticulum, omasum, abomasum, small and large intestine, and caecum.
- State the function of accessory digestive organs, including tongue, salivary glands, pancreas, liver and gall bladder.
- Compare the digestive systems of a monogastric and a ruminant animal, using real or virtual examples and discuss the significance of similarities and differences in terms of feed management.
- Explain the main structures and their functions for a mammalian and one other agricultural animal reproductive system, including both male and female systems.
- Explain the factors that affect reproduction in agricultural animals, i.e. genetics, environment, nutrition, pests/disease and management.
- Explain the function and interaction of reproductive hormones (i.e. testosterone, oestrogen, progesterone, prostaglandin, follicle-stimulating hormone, luteinising hormone and oxytocin) in agricultural animals.
- Interpret reproductive data for agricultural production animals to compare the link between reproduction and other external factors.
- Describe the main structures of the musculoskeletal system, including bones, muscles, joints, tendons and ligaments.

Genetics and inheritance of traits (animals/plants)

- Explain the effect of environment and genotype on the phenotype of an animal.
- Discuss how an animal producer can modify or control the environment to have less of an impact on an animal's phenotype.
- Explain the impact of heritability on breeding programs with the use of a heritability table of data.
- Explain the phenomenon known as hybrid vigour or heterosis.
- Draw conclusions about market suitability of agricultural products by analysing data about phenotypic variation.

Animal breeding and reproductive technologies

- Explain breeding systems that are important to animal production, including crossbreeding, line breeding, continuous and seasonal breeding.
- Describe animal genetic tools, including breed plans, estimated breeding values (EBV) and SNP (singular nucleotide polymorphisms) technology.
- Discuss advantages and disadvantages of using different genetic tools, including breed plans, EBVs and SNP technology, to assist in improving animal production.
- Describe assisted animal reproductive technologies and management techniques, including artificial insemination and embryo transfer in terms of oestrous synchronisation, superovulation and embryo harvest.
- Discuss advanced animal reproductive technologies, including cloning and genetic engineering.
- Draw conclusions about the selection of breeding stock for specific breeding objectives by analysing qualitative and quantitative data to make decisions.

Science as a human endeavour (SHE)

- Recognise that
  - graziers collect reproductive data to monitor and evaluate animal performance in terms of economic and environmental sustainability
  - multicultural practices in Australia have led to the development and use of new breeds of animals in agricultural production
  - the use of digital tools (EBVs and molecular value predictions (MVPs)) has dramatically increased the size, accuracy and geographic scope of the genetic datasets that producers use.
- Consider how the development of new genetic technologies in animal production can lead to improved animal performance.

Science inquiry

- Investigate
  - the main structures and accessory organs within the digestive systems of a monogastric and a ruminant animal, using real or virtual examples
  - different types of animal cells or tissues, using microscopes to display cellular structures and link cell structure to the function of the tissues in the system to which they belong.
- Interpret data and draw conclusions about animal reproduction by using appropriate safe handling and management techniques for the care and welfare of agricultural animals.
- Examine
  - the process of selecting breeding stock for specific breeding objectives by analysing qualitative and quantitative data to make decisions
  - reproductive soundness on a variety of livestock using qualitative and/or quantitative assessment
  - phenotypic variation in agricultural products and analyse this data to make judgments about market suitability
  - secondary production data to make judgments about animal reproduction
  - primary or secondary production data to make judgments about genetic inheritance.
- Investigate the reproductive system of an agricultural animal using real or virtual examples.

Topic 3: Plant production A (22 hours)

Science understanding

Agricultural plants

- State examples of different types of regional agricultural and horticultural production plants, including grasses, legumes, fibre crops, fruit, nuts, vegetables and ornamentals.
- Describe the physical characteristics of plants that belong to monocots and dicots.
- Describe the concepts of species, variety and cultivar.
- Explain the plant characteristics used by a plant classification key for a range of broadacre and horticultural crops, pastures and weed species.

Plant anatomy and physiology

- Describe the level of organisation from individual cells to plant systems.
- State the functions of the main cellular structures of plant cells, including cell wall, cell membrane, nucleus, mitochondria, chloroplasts and ribosomes.
- Explain the main tissue types found in plants, including vascular (xylem and phloem) and meristematic (apical and lateral meristems).
- Explain the process of photosynthesis (and the role of chloroplasts).
- Explain the process of cellular respiration (and the role of mitochondria).
- Explain the process of transpiration.
- Explain the factors that influence photosynthetic and respiration processes.

- Discuss photosynthetic and respiration processes and how they may be used to increase plant growth and development in an agricultural enterprise.
- State the function of the main structures associated with the reproductive system in plants, including pistil, stamen, stigma, style, ovary and anther.
- Analyse and interpret photosynthetic and respiration data.

Plant growth and development

- Explain the range of factors including nutrition, genetics, climate and weather, disease and management practices that influence plant growth and development.
- Explain a life cycle for a selected regionally significant agricultural crop, i.e. germination, vegetative and reproductive growth stages.
- Compare the stages of development (i.e. germination, vegetative and reproductive growth stages) in different plants.
- Describe the function of plant hormones (auxins and gibberellins) involved in plant growth.
- Interpret data in relation to factors affecting plant growth and development, e.g. germination, vegetative and reproductive growth stages.
- Describe the concept of tropism.
- Describe how tropisms, including phototropism, geotropism, thigmotropism and hydrotropism, can affect plant growth and development.

Plant nutrition

- State the major nutrients (i.e. carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium, sulphur) and minor nutrients (i.e. boron, iron, molybdenum, zinc, copper, chlorine, cobalt and manganese) that are required for plants to achieve optimum growth and development.
- Describe the difference between major and trace amounts in terms of quantity of nutrient required by a plant.
- Describe visual deficiencies of nitrogen, phosphorus and potassium in plants.
- Explain how a deficiency of a plant nutrient can cause changes in plant growth and development.
- Compare commercial fertiliser labels.
- Calculate fertiliser application rate, i.e.

$$\text{application rate (kg/ha)} = \frac{\text{amount of nutrient required } \left(\frac{\text{kg}}{\text{ha}}\right) \times 100}{\text{amount of nutrient in fertliser}}$$

- Determine the appropriate fertiliser application type and/or rate for application on agricultural plants in a given situation, e.g. crop, school market garden.

Science as a human endeavour (SHE)

- Recognise that
  - an understanding of plant anatomy and physiology has allowed farmers to select more appropriate plant species for use on their properties
  - advances in the use of transgenic organisms can provide economic benefits to agricultural producers and alleviate malnutrition in developing countries
  - a knowledge of plant hormones can be used to modify plant production stages leading to increased production and/or minimising risk.
  - an understanding of plant nutrient requirements will allow application of recommended levels of plant nutrients to optimise plant growth and increase net income as well as minimise environmental pollution
- Appreciate that the development of genetically modified organisms has involved research by many international science institutions.

Science inquiry

- Classify a range of broadacre and horticultural crops, pastures and weed species to a plant family name level by using a plant classification key.
- Conduct a plant survey, including
  - observations about each plant
  - sketches of the main distinguishing features of several plants
  - conclusions about the group of plants or plant family to which they belong.
- Investigate agricultural seeds (e.g. germination) under different environmental conditions and interpret data to show any relationship between size of seed (energy reserves), structure of seed (e.g. dormancy) and optimum environmental conditions for germination and plant establishment.
- Interpret data collected from a respiration or photosynthesis experiment.
- Determine the action of a growth hormone on plants, e.g. use various commercial hormone products on a selection of cuttings to propagate new plants.
- Determine the appropriate fertiliser application type and rate for a given situation (e.g. crop growth) to use on agricultural plants (e.g. a school market garden).
- Collect and analyse data in response to the application type and rate, i.e. record measurements for height/vegetative growth.
- Examine
  - different types of plant cells and tissues using microscopes to display cellular structures and link structure to the function of the tissues in the system they belong to, e.g. transportation of water and plant nutrients to xylem and phloem
  - plant structures (i.e. flowers, root system, stems and leaves) using appropriate dissection techniques.

Unit 2: Resources

In Unit 2, students explore the variety of resources, including soil, water, biota and technologies that are required for sustainable agricultural production. An understanding of resources and ecosystems is essential for appreciating sustainable resource use and justifying management decisions in agricultural enterprises. Students conduct experiments and investigations in water quality, soil properties and climatic variables. They examine how agricultural innovations and technologies can affect agricultural enterprises, and make recommendations about research, innovation and management practices.

Contexts that could be investigated in this unit include managing ecosystems and renewable resources, using renewable resources, soil properties and classification, climate and weather, and agricultural innovations and technologies. Through the investigation of these contexts, students explore how this understanding can be applied in agricultural enterprises.

Participation in a range of experiments and investigations allows students to progressively develop their suite of science inquiry skills while gaining an enhanced appreciation of the diverse range of resources that are essential to a successful and sustainable agricultural enterprise. Collaborative experimental work also helps students to develop communication, interaction and self-management skills.

Throughout the unit, students develop skills in classifying, measuring, analysing, evaluating and justifying across the range of contexts that are investigated.

Unit objectives

1. Describe ideas and findings about management of renewable resources; physical resource management; and agricultural management, research and innovation.
2. Apply understanding of management of renewable resources; physical resource management; and agricultural management, research and innovation.
3. Analyse data about management of renewable resources; physical resource management; and agricultural management, research and innovation.
4. Interpret evidence about management of renewable resources; physical resource management; and agricultural management, research and innovation.
5. Evaluate processes, claims and conclusions about management of renewable resources; physical resource management; and agricultural management, research and innovation.
6. Investigate phenomena associated with management of renewable resources; physical resource management; and agricultural management, research and innovation.

Subject matter

Topic 1: Management of renewable resources (12 hours)

Science understanding

Managing ecosystems and renewable resources

- Explain the cycling of nutrients, including water, carbon and nitrogen.
- Explain how ecosystems and their management contribute to the development and use of a range of products and services in an agricultural context
  - harvestable resources, including water, edible biota, biofuels and forestry products
  - renewable resources, including provisioning of food, fibre, fuel, water and pharmaceuticals for human and veterinary use and consumption
  - regulating services, including carbon sequestration and climate control
  - supporting services, including nutrient and water cycling, air and water purification.
- Discuss the impact of an agricultural activity by comparing water quality from different sources.

Use of renewable resources

- Describe current renewable resource consumption trends (including two of the following: food, fibre, forestry, fisheries or water) and assess their sustainability in relation to national and global population growth.
- Explain how the availability and quality of fresh water at a local and regional level is influenced by
  - human activities, including provisioning of dams, urbanisation, resource extraction and pollution
  - natural processes, including salinity, siltation, drought and algal blooms
  - government policy, i.e. water buybacks
  - water use efficiency measures on farms.
- Interpret data to draw conclusions about the use of biota.

Science as a human endeavour (SHE)

- Understand that
  - scientific knowledge can be used to develop efficient animal waste management technology and resource management in order to improve projected economic, social and environmental impacts and design action for sustainability
  - scientific knowledge about sustainable harvesting of aquacultural species in native fisheries can be used to develop and evaluate projected economic, social and environmental impacts and to design action for the sustainability of species and the relevant fishing industries
  - human activities like resource extraction (e.g. coal seam gas (CSG)) and natural processes like salinity are major reasons for the loss of agricultural land and potential food and fibre production
  - finding solutions to climate change in different countries are global issues that will require clear communication and cooperation between international organisations and governments.

- Explore how an interdisciplinary understanding of carbon sequestration can influence how producers reduce greenhouse gas emissions.
- Recognise information collected by the Murray–Darling Basin Authority can be used to develop complex models from a wide range of evidence to make management decisions about water quality and salinity to maintain the health of the rivers and wetlands.
- Examine traditional Aboriginal methods and Torres Strait Islander methods of sustainable harvesting and management of Australian biota.

Science inquiry

- Investigate water quality using different sources to assess the impact of agricultural activity.

Topic 2: Physical resource management (18 hours)

Science understanding

Soil properties and classification

- Describe Australian soils and their general characteristics, including old, nutrient poor, geologically stable and structurally unstable soils.
- Describe a typical soil profile, including A, B, C and D horizons.
- Explain the following properties of soil
  - biological, including organic matter, invertebrates and humus
  - physical, including soil texture, soil structure, porosity, infiltration, water holding capacity, compaction
  - chemical, including pH, cation exchange capacity, nutrient levels and nutrient availability.
- Classify soils based on their biological, chemical and physical properties using a system for identification of soils, e.g. Australian Soil Classification System (Isbell 2016).
- Explain how the physical, chemical and biological properties of soil are a good indicator of soil health and connected agricultural productivity.
- Apply a land use classification system.
- Infer production capacity and intended land use for local or regional areas based on measurements of soil properties (including organic content, pH, moisture content, soil texture and structure) from soil sample data.

Climate and weather

- Distinguish between the terms *weather* and *climate*.
- Explain climatic factors (including temperature, precipitation, humidity, wind, evaporation, radiation) and how they influence agricultural production.
- Explain how climatic factors may be modified in agriculture (e.g. through the use of greenhouses, hail netting, shade structures, barns and sheds) to produce microclimates that are better suited to production.
- Compare the causes and effects of El Niño and La Niña at local and global levels, including the Southern Oscillation Index (SOI) and the Indian Ocean Dipole (IOD).
- Interpret weather and climate data about El Niño and La Niña patterns and make reasoned decisions about their effect on agricultural production.

- Discuss extreme weather events (e.g. cyclones, flooding and droughts) and their impact on agricultural production.
- Describe the possible causes of climate change.
- Explain the possible effects of climate change on future agricultural production.
- Interpret data for climatic variables (including temperature, rainfall, humidity and wind speed) at different locations and compare the suitability of these locations for animal and/or plant production.

Science as a human endeavour (SHE)

- Consider how meteorology relies on clear communication and international conventions.
- Recognise
  - the development of the El Niño, La Niña, Southern Oscillation Index (SOI) and the Indian Ocean Dipole (IOD) models requires a wide range of evidence from multiple individuals and across scientific disciplines
  - data can be collected about weather patterns to enable scientists to offer valid explanations and make reliable predictions in relation to El Niño, La Niña, Southern Oscillation Index (SOI) and the Indian Ocean Dipole (IOD)
  - data collected from research can be used to predict how crops will change as a result of climate changes.
- Appreciate that accurate weather forecasting is vital to agricultural producers to provide severe weather warnings and to inform decision-making in agriculture, forestry and marine industries.
- Understand that
  - biological soil crusts play an important role in soil fertility and protect the soil surface from erosion and evaporation
  - knowledge of physical and chemical characteristics of different local or regional soil types is used to develop sustainable farming and urban development practices as well as lessen the effect of human activities on the environment.

Science inquiry

- Investigate soil properties (including organic content, pH, moisture content, soil texture and structure) from collected soil sample data.
- Investigate data (e.g. field-based or satellite imagery data) to draw conclusions about the relationships between indicator plant species and land use with specific soil types.
- Determine the soil texture and soil structure of a number of soil types and link the data to water movement, soil stability and potential for use in agricultural production systems.
- Investigate climatic variables (including temperature, rainfall, humidity and wind speed) at different locations and compare the suitability of these locations for animal and/or plant production.
- Explore software to compare major soil types and biological, chemical and physical characteristics of each.
- Examine data
  - generated by technologies used to assess land capability
  - including ocean temperature, air pressure, rainfall and SOI, to identify El Niño and La Niña patterns.

Topic 3: Agricultural management, research and innovation (15 hours)

Science understanding

Enterprise management

- Describe factors affecting property management decisions, including
  - sources of risk associated with agricultural production, e.g. workplace health and safety, natural hazards and economics
  - market suitability (in terms of consumer trends, sustainability of product, environmental suitability, location to markets and processing options)
  - chemical usage
  - environmental and geographic factors
  - animal welfare requirements
  - human resources
  - availability of technology and technological expertise
  - financial considerations.
- Describe management practices (e.g. crop rotation, cell grazing, paddock rotation, water harvesting) and their benefits for agricultural production.

Developments in agricultural technologies

- Explain the research and development process in an agricultural context.
- State existing and emerging technologies of regional importance.
- Discuss two existing and/or emerging technologies that may assist across agricultural enterprises. Consider issues (e.g. funding sources, patents, plant breeders' rights, animal welfare and legislation) related to the research and development of the chosen technology.

Adopting technologies in agriculture

- Discuss the use of an existing or emerging technology for an agricultural enterprise.

Science as a human endeavour (SHE)

- Recognise that
  - agricultural science is a global enterprise that relies on clear communication and access to peer-reviewed sources of information to make informed decisions
  - the use of information and communication technologies (ICT) and new technologies to collect farm data has allowed producers to make informed decisions and improve the profitability of their enterprise
  - the development of new sustainable farming systems or models requires a wide range of evidence from multiple sources such as the Department of Agriculture and Fisheries (DAF), Commonwealth Scientific and Industrial Research Organisation (CSIRO) and universities that carry out research and development in agricultural production
  - technology assists in mitigating risk in agricultural production systems.
- Appreciate that
  - the agricultural research and development process involves research organisations, including private enterprises, being central to seeking out and providing alternatives to meet changing demands in agricultural production and consumption
  - the use and acceptance of animal welfare requirements is influenced by social, economic, cultural and ethical perceptions
  - international perspectives are required for effective innovation in agriculture.
- Understand that different technologies can be adopted in agricultural enterprises to manage the available physical and biological resources.

Science inquiry

- Investigate an existing or emerging technology for an agricultural enterprise using a case study approach, including the following steps
  - identify and explain the issue
  - identify and analyse possible technological solutions
  - assess the impact of the technologies in terms of environmental, financial and social factors
  - determine the best technological solution for the issue
  - justify the reasons for adopting the chosen technology.

Unit 3: Agricultural production

In Unit 3, students explore the ways agricultural science is used to describe and explain how the anatomy and physiology of agricultural plants and animals influences agricultural production. An understanding of the anatomy and physiology of plants and animals is needed to appreciate their influence on production and justify management decisions. Students design and conduct experiments and investigations on anatomical and physiological phenomena and analyse their effect on production.

Contexts that could be investigated in this unit include animal nutrition, animal growth and development and animal/plant health and animal welfare. This can be applied to agricultural production systems of local, regional and national significance. Through the investigation of these contexts, students may explore how an application of science can be used to maximise production.

Participation in a range of experiments and investigations will allow students to progressively develop their suite of science inquiry skills while gaining an enhanced appreciation of the influence of anatomy and physiology on production. Collaborative experimental work also helps students to develop communication, interaction and self-management skills.

Throughout the unit, students develop skills in describing, explaining, applying, investigating, analysing, evaluating processes, claims and conclusions and communicating understandings, findings, arguments and conclusions.

Unit objectives

1. Describe ideas and findings about animal and plant production, and agricultural enterprises.
2. Apply understanding of animal and plant production, and agricultural enterprises.
3. Analyse data about animal and plant production, and agricultural enterprises.
4. Interpret evidence about animal and plant production, and agricultural enterprises.
5. Evaluate processes, claims and conclusions about animal and plant production, and agricultural enterprises.
6. Investigate phenomena associated with animal and plant production, and agricultural enterprises.

Subject matter

Topic 1: Animal production B (26 hours)

Science understanding

The following subject matter can be assessed in the external assessment.

Animal nutrition

- Explain the components of nutrition, including uses and types of food, digestibility and palatability, diet and ration.
- Explain nutritional feed sources commonly used in intensive and extensive animal industries.
- Explain the importance of minerals and vitamins in animal nutrition.
- Describe energy metabolic pathways, including gross, digestible, metabolisable, net, maintenance and production energy.
- Explain the process of protein, carbohydrate and fat digestion in ruminant and monogastric animals.
- Explain the function of the end products of protein, carbohydrate and fat digestion in ruminant and monogastric animals.
- Explain protein metabolism in ruminants and its importance to animal production with reference to protein sources, including microbial protein, crude protein, and non-protein nitrogen.
- Describe the microscopic organisms (i.e. bacteria, protozoa and anaerobic fungi) found in ruminant digestive systems and the function they play in animal nutrition.
- Explain how physical characteristics (e.g. mouth structure) and physiological characteristics (e.g. digestive system) of an animal can improve utilisation of available feed sources (i.e. increase animal production).
- Interpret information on feed labels (e.g. chick starter, pullet grower, laying mash/pellets) to make decisions for different agricultural animals at various growth or production stages.
- Discuss the impact that animal nutrition can have on the quality and quantity of product from an animal.
- Analyse data about the nutritional content of animal food, including crude protein (CP), metabolisable energy (ME) and dry matter (DM).
- Draw conclusions about appropriate animal rations for a selected scenario.
- Calculate and analyse feed conversion ratios for different animals, using
  $\text{feed conversion ratio} = \frac{\text{mass of food eaten (kg)}}{\text{mass gained by the animal (kg)}}$

Animal growth and development

- State examples of intensive and extensive Queensland animal industries.
- Distinguish the difference between animal growth and development.
- Describe the principles that underpin animal growth and development.
- Explain how factors (i.e. nutrition, genetics, animal health and management) will affect animal growth and development.

- Compare the different stages of growth and development, including conception, birth, puberty and maturity for an animal, using a variety of visual representations.
- Interpret data to compare relative growth rates at different stages of an animal's development.
- Explain different markets for animals (i.e. domestic and export) based on meeting market minimum requirements.
- Explain market specifications for an agricultural animal (e.g. Meat Standards Australia (MSA), Authority for Uniform Specification Meat and Livestock (AUS-MEAT), Australian Pork Ltd (APL)) and the relevance to consumers.
- Interpret data on the proportions of bone, muscle and fat at various stages of development in an animal and discuss in relation to market requirements.
- Analyse and discuss the use of hormones and antibiotics in animal production.
- Analyse carcass data to discuss suitability based on market specifications.
- Compare the bone, muscle and fat percentages of different carcasses or cuts that are commercially available.

Animal health

- Explain the terms *pest* and *disease*.
- Explain the following four types of disease: metabolic, genetic, microbial and metazoal.
- Describe the health and economic effects of two diseases of regional significance.
- Explain different types of control measures for animal pests and diseases
  - chemical control, including vaccinations, inorganic and organic pesticides
  - physical control
  - biological control
  - management, including vaccination and spraying programs, feral animal eradication programs
  - integrated pest management (IPM).
- Describe the life cycles, effects on animal production and control measures (chemical, physical, biological and management) for a local or regional pest and/or disease for a selected production animal.
- Interpret data to assess different chemical control measures for a selected animal pest or disease.
- Describe the characteristics of a successful biological control method.
- Explain examples of biological control, e.g. dung beetles to control buffalo fly, rabbit haemorrhagic disease to control rabbits.
- Analyse the features of both intensive and extensive animal industries and their impact on the management of animal pests and diseases.
- Explain the terms *exotic disease*, *notifiable disease, endemic disease* and *biosecurity*.
- Predict the potential impact of an exotic or notifiable disease on an agricultural production system.

Animal ethics and welfare

- Explain the difference between animal welfare and animal ethics.
- Describe the main considerations for the ethical treatment of animals in a production enterprise.
- Discuss the elements of standard operating procedures for selected animals and the impact it has on production for selected animals.
- Explain an animal welfare issue associated with production practices such as mulesing, live export, battery-cage egg production or use of farrowing crates.
- Discuss how consumer trends/demands have impacted on animal welfare in a production system.

Science as a human endeavour (SHE)

The following subject matter may be assessed in the internal assessments.

- Recognise that
  - an understanding of the ruminant digestive system can help farmers make decisions to maximise animal growth
  - a knowledge of growth rate and carcass development can be used to make decisions about appropriate feed sources needed to meet production goals
  - a knowledge of pest and disease life cycles can assist farmers in making decisions about when to spray animals to achieve the greatest economic and environmental benefits
  - integrated pest management strategies can be used to develop and evaluate effective pest and disease control and protect the environment.
- Appreciate that
  - the development of animal nutrition models requires a wide range of evidence from multiple disciplines
  - science is limited in its ability to provide definitive answers to public debate on animal welfare issues
  - international collaboration is often required when investigating biosecurity issues.
- Consider advances in vaccination protocols can inform the monitoring, assessment and evaluation of the risk posed by animal diseases.
- Reflect on
  - how models of sustainable animal production systems are refined and replaced based on new evidence associated with animal welfare considerations in food and fibre production
  - how current community perceptions are influencing the systems used to produce animal products, e.g. eggs.

Science inquiry

The following subject matter may be assessed in the internal assessments.

- Investigate pastures or use data from satellite images (including vegetation maps) to make decisions about the quality and quantity of available food.
- Explore suitable rations to supply for a selected animal using appropriate safe handling and management techniques.
- Investigate the bone, muscle and fat percentages of different carcasses or cuts that are commercially available to make judgments about market requirements.
- Explore physical aspects of the environment of a selected animal.
- Investigate growth data to draw conclusions about animal nutrition.
- Consider ‘on-the-hoof judgments’ about the suitability of an animal for a selected market.
- Explore biosecurity and disease management in animal production and the impact it has on management strategies.
- Examine
  - graphs of animal developmental stages, including bone, muscle and fat proportions, and summarise the information for a producer
  - carcass feedback data and assess the correlation with ‘on-the-hoof judgments’, e.g. the practice of accurately aging an animal based on their body characteristics and proportions.

Topic 2: Plant production B (15 hours)

Science understanding

The following subject matter can be assessed in the external assessment.

Plant production

- Explain important agronomic practices, such as
  - planting requirements (sowing rate, seed depth, plant spacing)
  - water management
  - nutrient management, including nutrient cycles (carbon and nitrogen)
  - cultural practices
  - management of plant pests and diseases, including chemical, biological, physical and integrated pest management (IPM) approaches.
- Explain how soil management techniques (e.g. use of legumes, soil additives and tillage practices) can support sustainable plant production.
- Explain the impact of hormones (including ethylene) on plant production.
- Draw conclusions about the use of hormones to manipulate plant production.
- Explain processes in post-harvest technologies, e.g. post-harvest transport, ripening and product handling.
- Interpret data on a factor that affects plant production.

Plant health

- Explain the terms *pesticide*, *insecticide*, *herbicide*, *fungicide* and *nematicide*.
- Describe integrated pest management (IPM), integrated disease management (IDM) and integrated weed management (IWM).
- Describe two pests and diseases that are significant to an important regional plant industry, e.g. wheat, sugar cane.
- Explain different types of control measures for plant pests, weeds and diseases, including
  - chemical, including inorganic and organic pesticides
  - physical, including cultivation
  - biological
  - management, including IPM, IDM and IWM
  - plant breeding.
- Describe the life cycles, effects on plant production and control measures for at least one important pest and disease for a selected agricultural plant.
- Describe the role of beneficial organisms in plant production systems.

Plant reproduction and breeding

- Describe asexual propagation methods (including tissue culture, cuttings, budding and grafting) used in agriculture and horticulture.
- Discuss plant varieties and their selection and use in production systems to increase yields.
- Explain genetic techniques used in breeding new plant varieties, including
  - crossbreeding
  - tissue culture
  - hybridisation
  - genetic modification.

Science as a human endeavour (SHE)

The following subject matter may be assessed in the internal assessments.

- Recognise that
  - water buyback schemes can affect economic, social and environmental activity in communities
  - the acceptance of genetic modification in a variety of crops can be influenced by social and cultural factors as well as potential damage to the environment.
- Understand that
  - the use of applications (apps) is allowing agricultural producers to quickly assess plant production issues (e.g. pest identification) to solve problems
  - water allocation models for farms in catchments (e.g. the Murray–Darling River Basin and Barron River) are contested and refined by organisations including industry and government bodies
  - global positioning software (GPS) and other technologies in modern tractors can allow farmers to plant crops with increasing accuracy and cause less damage to the physical properties of soil.
- Consider
  - information gathered from checking crops for plant health can assist farmers to monitor, assess and evaluate risk
  - how advances in IPM and IDM strategies can influence pest and disease control and their environmental impacts.
- Appreciate the
  - contribution of Gerharda Wilbrink, who was the first person to produce interspecific hybrids of sugar cane
  - work of Jennifer Doudna and Emmanuelle Charpentier, who won the 2020 Nobel Prize for their work on CRISPR-Cas9.

Science inquiry

The following subject matter may be assessed in the internal assessments.

- Draw a conclusion about the effect of a factor (e.g. environmental, agronomic) on plant production by analysing collected primary data from a plant trial.
- Examine different crops being grown on different sites to discuss plant variety selection and the importance of these crops to the regional area.
- Investigate the effect of different types of fertilisers on the yield of a crop plant.
- Identify the relationship between a nutrient and crop yield.
- Determine the optimum sowing rate for a selected crop.
- Investigate the impacts that plant hormones have on production.

Topic 3: Agricultural enterprises B (4 hours)

Science understanding

The following subject matter can be assessed in the external assessment.

- Describe examples of agricultural products (including raw, processed and value-added products) and where they go after they leave the 'property gate' (including domestic and export markets).
- Identify marketing techniques for agricultural products.
- Explain what is meant by the 'clean and green image' of Australian agricultural production and how Australia's global position is enhanced through marketing and quality assurance.
- Explain how quality assurance processes align products to market specifications of agricultural production systems.
- Explain the law of supply and demand, including elasticity of supply and demand and equilibrium price.
- Identify supply and demand factors that cause market values to fluctuate, affecting the price of agricultural products.
- Identify and analyse trends in market price for an agricultural commodity over a period of time. Link fluctuations in price to variations in supply and demand.
- Describe how the trade of agricultural products affects local and international economies, e.g. imports, exports.
- Interpret demand and supply data for a specific agricultural product to make predictions.
- Draw conclusions about the effect of post-harvest handling of fresh plant products and its impact on product quality.

Science as a human endeavour (SHE)

The following subject matter may be assessed in the internal assessments.

- Recognise that
  - the use of agricultural knowledge is influenced by economic considerations such as the law of supply and demand
  - the use and acceptance of new agricultural products is influenced by consumer demands
  - advances in food and fibre production can be used to develop and evaluate Australia's food security and economy.

Science inquiry

The following subject matter may be assessed in the internal assessments.

- Assess the effect of post-harvest handling on a selected fresh plant product and its impact on product quality.
- Interpret survey data determine factors affecting demand for an agricultural product.

Unit 4: Agricultural management

In Unit 4, students explore the ways agricultural science is used to describe, explain and analyse the sustainability of agricultural enterprises. An understanding of environmental, financial and social impacts on agricultural enterprises is essential to appreciate the changing future of agricultural production. Students conduct investigations and examine them from an environmental, financial and social perspective to make judgments about improved sustainability as a result of innovation.

Contexts that could be investigated in this unit include human activities, sustainable use of natural resources, population changes and consumer influences on food and fibre production. Through the investigation of these contexts, students may explore decisions about how food and fibre are sustainably produced.

Participation in a range of investigations will allow students to progressively develop their suite of science inquiry skills while gaining an enhanced appreciation of the relationship between decision-making and sustainable enterprise management practices and food and fibre production.

Collaborative practical work also helps students to develop communication, interaction and self-management skills.

Throughout the unit, students develop skills in collecting, analysing and interpreting primary and secondary data on environmental, financial and social factors that affect the sustainability of an agricultural enterprise and applying secondary data to help make decisions in property management to ensure a sustainable future.

Unit objectives

1. Describe ideas and findings about enterprise management and evaluation of an agricultural enterprise.
2. Apply understanding of enterprise management and evaluation of an agricultural enterprise.
3. Analyse data about enterprise management and evaluation of an agricultural enterprise.
4. Interpret evidence about enterprise management and evaluation of an agricultural enterprise.
5. Evaluate processes, claims and conclusions about enterprise management and evaluation of an agricultural enterprise.
6. Investigate phenomena associated with enterprise management and evaluation of an agricultural enterprise.

Subject matter

Topic 1: Enterprise management (14 hours)

Science understanding

The following subject matter can be assessed in the external assessment.

Data for decision-making

- Explain methods of agricultural recordkeeping for physical and financial data, including
  - field notebooks
  - inventories
  - financial reports, i.e. partial budgets, complete budgets and development budgets. Other examples could include cash flow statements, profit-and-loss statements and gross income
  - computer spreadsheets, databases and applications (apps).
- Calculate gross margins for a range of agricultural enterprises, using:
  Gross margin = total income – variable costs
- Contrast gross margins for different agricultural enterprises.
- Analyse data about plant or animal production to make justified management decisions.

Decision-making in property management

- Describe factors affecting property management decisions, including
  - market suitability, including consumer trends, sustainability of product, environmental suitability, location to markets and processing options
  - level of chemical usage
  - environmental and geographic factors
  - animal welfare requirements
  - human resources
  - workplace health and safety
  - availability of technology and technological expertise
  - financial considerations.
- Identify sources of risk associated with agricultural production.
- Describe risk management strategies for common identified risks.
- Apply risk-management strategies for property management.
- Discuss management practices, e.g. crop rotation, cell grazing, paddock rotation, water harvesting.
- Discuss the risk associated with an agricultural enterprise on a selected area in the school or on a local property using the prevention, preparedness, response, recovery (PPRR) model and make justified recommendations for improvements.

Science as a human endeavour (SHE)

The following subject matter may be assessed in the internal assessments.

- Recognise that
  - agricultural producers who keep accurate and extensive farm records can make valid explanations and reliable predictions that improve the efficiency and profitability of their enterprise
  - the use of different software packages can increase the size, accuracy and temporal scope of datasets that influence the decision-making process
  - the use and acceptance of animal welfare requirements is influenced by social, economic, cultural and ethical perceptions
  - the development of new sustainable agricultural systems and models requires a wide range of evidence from multiple sources such as DAF, CSIRO and universities that carry out research and development in agricultural production.
- Understand that
  - agricultural science is a global enterprise that relies on clear communication and access to peer-reviewed sources of information to make informed decisions
  - technology assists in mitigating risk in agricultural production systems
  - the use of information and communication technologies (ICTs) and new technologies for collecting farm data has allowed producers to make informed decisions and improve the profitability of their enterprise.

Science inquiry

The following subject matter may be assessed in the internal assessments.

- Examine databases using agricultural business software to keep a record of agricultural physical resources.

Topic 2: Evaluation of an agricultural enterprise's sustainability (31 hours)

Science understanding

The following subject matter can be assessed in the external assessment.

Environmental factors

- Explain how the sustainable use of a resource (i.e. water, soil, biota) depends on its abundance and replenishment rate.
- Discuss the opportunity for sustainable practices in an agricultural production system using the criteria of
  - physical resource management
  - biological resource management
  - waste management.
- Explain how natural resources are influenced by human activities, including mining, irrigation and land clearing.
- Make predictions and propose solutions relating to dryland salinity, erosion, drought and water quality.
- Interpret data on key issues that impact on agricultural production, including dryland salinity, erosion, drought and water quality.

Financial factors

- Explain risk-avoidance strategies (including diversification, alternative sources of income and capital investment) for agricultural producers, using examples.
- Analyse and draw conclusions about different farming enterprises by using a range of financial documents, including budgets, profit-and-loss statements, cash flow statements and inventories.
- Describe types of agricultural enterprises.
- Discuss different methods of production of the same agricultural product.
- Discuss free trade agreements, including competition and import and export agreements.
- Discuss the advantages and disadvantages of different ownership structures, including succession planning and its impact on agricultural enterprises.
- Explain the impact of government decisions and policies on agricultural enterprises.
- Draw conclusions about the impact of free trade agreements on agricultural products.

Social factors

- Discuss the opportunity for sustainable social practices in an agricultural production system, using the criteria of
  - labour, i.e. employment
    - quality of work environment
    - required skills for innovative agricultural production
    - encouraging a diverse workforce
  - infrastructure
    - health facilities
    - transport networks
    - utilities and telecommunications
  - social licence for food and fibre production
    - food security
    - global demand
    - production methods that meet consumer expectations.

Science as a human endeavour (SHE)

The following subject matter may be assessed in the internal assessments.

- Consider that foreign ownership may provide a potential ownership model for sustainable agricultural production in Australia.
- Recognise that
  - the live export of animals is important to global trade in the Asia–Pacific region
  - working visas are important to agricultural enterprises in Queensland
  - government decisions have a significant effect on free trade agreements
  - the live animal trade between Australia and countries in the Asia–Pacific region will rely on international collaboration.

Assessment

Internal assessment 1: Data test (10%)

Students respond to items using qualitative data and/or quantitative data derived from practicals, activities or case studies relevant to Unit 3 subject matter.

Assessment objectives

2. Apply understanding of animal production, plant production or agricultural enterprises to given algebraic, visual or graphical representations of scientific relationships and data to determine unknown scientific quantities or features.
3. Analyse data about animal production, plant production or agricultural enterprises to identify trends, patterns, relationships, limitations or uncertainty in datasets.
4. Interpret evidence about animal production, plant production or agricultural enterprises to draw conclusions based on analysis of datasets.

Specifications

The teacher provides an examination that may ask students to respond using:

- single words
- sentences (up to 150 words per question)
- calculations.

Question specifications

The examination must be aligned to the specifications provided in the table below.

Focus of question	Mark allocation (± 2%)	Objective	In these questions, students:
Unknown scientific quantities or features of datasets	~ 30%	2	calculate using algorithms, determine, identify, use
Trends, patterns, relationships, limitations or uncertainty in datasets	~ 30%	3	categorise, classify, compare, contrast, identify, organise, sequence
Conclusions based on analysis of datasets	~ 40%	4	deduce, determine, draw (a conclusion), extrapolate, infer, interpolate, justify, predict

Stimulus specifications

The teacher provides unseen stimulus that:

- uses qualitative data and/or quantitative data from the listed practicals, activities or case studies from Unit 3
- contains between two and four datasets.

Conditions

- Time allowed
  - Perusal time: 5 minutes
  - Working time: 60 minutes
- This is an individual supervised task.
- Students are permitted a QCAA-approved graphics or scientific calculator.

Mark allocation

Criterion	Assessment objectives	Marks
Data test	2, 3, 4	10
	Total marks:	10

Instrument-specific marking guide (IA1)

Data test	Cut-off	Marks
The student response has the following characteristics:		
• consistent demonstration, across a range of scenarios, of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct and appropriate use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions	> 90%	10
	> 80%	9
• consistent demonstration of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions	> 70%	8
	> 60%	7
• adequate demonstration of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual and graphical representations of scientific relationships and data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations and uncertainty – correct interpretation of evidence to draw valid conclusions	> 50%	6
	> 40%	5
• demonstration of elements of – selection and correct application of scientific concepts, theories, models and systems to predict outcomes, behaviours and implications – correct calculation of quantities through the use of algebraic, visual or graphical representations of scientific relationships or data – correct use of analytical techniques to correctly identify trends, patterns, relationships, limitations or uncertainty – correct interpretation of evidence to draw valid conclusions	> 30%	4
	> 20%	3
• demonstration of elements of – application of scientific concepts, theories, models or systems to predict outcomes, behaviours or implications – calculation of quantities through the use of algebraic or graphical representations of scientific relationships and data – use of analytical techniques to identify trends, patterns, relationships, limitations or uncertainty – interpretation of evidence to draw conclusions.	> 10%	2
	> 1%	1
The student response does not match any of the descriptors above.	≤ 1%	0

Internal assessment 2: Student experiment (20%)

Students modify (i.e. refine, extend or redirect) an experiment relevant to Unit 3 subject matter to address their own related hypothesis or question. This assessment provides opportunities to assess science inquiry skills.

Assessment objectives

1. Describe ideas and experimental findings about animal production, plant production or agricultural enterprises.
2. Apply understanding of animal production, plant production or agricultural enterprises.
3. Analyse experimental data about animal production, plant production or agricultural enterprises.
4. Interpret experimental evidence about animal production, plant production or agricultural enterprises.
5. Evaluate experimental processes and conclusions about animal production, plant production or agricultural enterprises.
6. Investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment.

Specifications

This task requires students to:

- identify an experiment to modify
- develop a research question to be investigated
- research relevant background scientific information to inform the modification of the research question and methodology
- conduct a risk assessment and account for risks in the methodology
- conduct the experiment
- collect relevant qualitative data and/or quantitative data to address the research question
- process and present the data appropriately
- analyse the evidence to identify trends, patterns or relationships
- analyse the evidence to identify uncertainty and limitations
- interpret the evidence to draw conclusion/s to the research question
- evaluate the reliability and validity of the experimental process
- suggest possible improvements and/or extensions to the experiment
- communicate findings in an appropriate scientific genre, e.g. report, poster presentation, journal article, conference presentation.

Scientific inquiry is a non-linear, iterative process. Students will not necessarily complete these steps in the stated order; some steps may be repeated or revisited.

It is recommended that this task is designed so that students can develop a response in approximately 10 hours of class time.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.
- The following aspects of the task may be completed as a group
  - identifying an experiment
  - developing a research question
  - conducting a risk assessment
  - conducting the experiment
  - collecting data.
- Students use a practical or simulation performed in class as the basis for their methodology and research question.

Response requirements

One of the following:

- Multimodal (at least two modes delivered at the same time): up to 11 minutes
- Written: up to 2000 words

Mark allocation

Criterion	Assessment objectives	Marks
Forming	1, 2, 6	5
Finding	1, 6	5
Analysing	2, 3	5
Interpreting and Evaluating	4, 5	5
	Total marks:	20

Instrument-specific marking guide (IA2)

Forming	Marks
The student response has the following characteristics:	
• a considered rationale for the experiment • justified modifications to the methodology • a specific and relevant research question • a methodology that enables the collection of sufficient and relevant data • appropriate use of genre and referencing conventions	4–5
• a reasonable rationale for the experiment • feasible modifications to the methodology • a relevant research question • a methodology that enables the collection of relevant data • use of basic genre and referencing conventions	2–3
• a vague or irrelevant rationale for the experiment • inappropriate modifications to the methodology • an inappropriate research question • a methodology that causes the collection of insufficient and irrelevant data • inadequate use of genre and referencing conventions.	1
The student response does not match any of the descriptors above.	0

Finding	Marks
The student response has the following characteristics:	
• considered management of risks/ethical issues/environmental issues • collection of sufficient and relevant raw data • fluent and concise use of scientific language and representations	4–5
• management of risks/ethical issues/environmental issues • collection of relevant raw data • competent use of scientific language and representations	2–3
• inadequate management of risks/ethical issues/environmental issues • collection of insufficient and irrelevant raw data • simplistic use of language and representations.	1
The student response does not match any of the descriptors above.	0

Analysing	Marks
The student response has the following characteristics:	
• correct and relevant processing of data • thorough identification of relevant trends/patterns/relationships • thorough and appropriate identification of the uncertainty and limitations of evidence	4–5
• basic processing of data • identification of obvious trends/patterns/relationships • basic identification of uncertainty and/or limitations of evidence	2–3
• incorrect or irrelevant processing of data • identification of incorrect or irrelevant trends/patterns/relationships • incorrect or insufficient identification of uncertainty and limitations of evidence.	1
The student response does not match any of the descriptors above.	0

Interpreting and Evaluating	Marks
The student response has the following characteristics:	
• justified conclusion/s linked to the research question • justified discussion of the reliability and validity of the experimental process • suggested improvements and extensions to the experiment that are logically derived from the analysis of evidence	4–5
• reasonable conclusion/s relevant to the research question • reasonable description of the reliability and/or validity of the experimental process • suggested improvements and/or extensions to the experiment that are related to the analysis of evidence	2–3
• inappropriate or irrelevant conclusion/s • cursory or simplistic statements about the reliability and validity of the experimental process • ineffective or irrelevant suggestions.	1
The student response does not match any of the descriptors above.	0

Internal assessment 3: Research investigation (20%)

Students gather evidence related to a research question to evaluate a claim relevant to Unit 4 subject matter. This assessment provides opportunities to assess science inquiry skills and science as a human endeavour (SHE) subject matter.

Assessment objectives

1. Describe ideas and findings about enterprise management or evaluation of an agricultural enterprise.
2. Apply understanding of enterprise management or evaluation of an agricultural enterprise.
3. Analyse research data about enterprise management or evaluation of an agricultural enterprise.
4. Interpret research evidence about enterprise management or evaluation of an agricultural enterprise.
5. Evaluate research processes, claims and conclusions about enterprise management or evaluation of an agricultural enterprise.
6. Investigate phenomena associated with enterprise management or evaluation of an agricultural enterprise.

Specifications

This task requires students to:

- select a claim to be evaluated, from a list provided by the teacher
- identify the relevant scientific concepts associated with the claim
- conduct research to gather evidence from scientifically credible sources to evaluate the claim
- pose a research question that addresses an aspect of the claim
- identify relevant evidence to answer the research question
- identify the trends, patterns or relationships in the evidence
- analyse the evidence to identify limitations
- interpret the evidence to construct scientific arguments
- interpret the evidence to form a conclusion to the research question
- discuss the quality of the evidence
- evaluate the claim by applying the findings of the research to the claim
- suggest improvements and/or extensions to the investigation
- communicate findings in an appropriate scientific genre, e.g. report, journal article, essay, conference presentation.

Scientific inquiry is a non-linear, iterative process. Students will not necessarily complete these steps in the stated order; some steps may be repeated or revisited.

Evidence must be obtained by researching scientifically credible sources, such as:

- books and podcasts by well-credentialed scientists
- ‘popular’ science websites or magazines
- websites of governments, universities, independent research bodies or science and technology manufacturers
- scientific journals.

It is recommended that this task is designed so that students can develop a response in approximately 10 hours of class time.

Conditions

- Students can develop their responses in class time and their own time.
- This is an individual task.
- The following aspects of the task may be completed as a group
  - selecting a claim
  - identifying the relevant scientific concepts associated with the claim
  - conducting research.

Response requirements

One of the following:

- Multimodal (at least two modes delivered at the same time): up to 11 minutes
- Written: up to 2000 words

Mark allocation

Criterion	Assessment objectives	Marks
Forming and Finding	1, 2, 6	5
Analysing	3	5
Interpreting	1, 4	5
Evaluating	5	5
	Total marks:	20

Instrument-specific marking guide (IA3)

Forming and Finding	Marks
The student response has the following characteristics:	
• a considered rationale identifying clear development of the research question from the claim • a specific and relevant research question • selection of sufficient and relevant sources • appropriate use of genre conventions • acknowledgment of sources of information through appropriate use of referencing conventions	4–5
• a reasonable rationale that links the research question and the claim • a relevant research question • selection of relevant sources • use of basic genre conventions • use of basic referencing conventions	2–3
• a vague or irrelevant rationale for the investigation • an inappropriate research question • selection of insufficient or irrelevant sources • inadequate use of genre conventions • inadequate acknowledgment of sources.	1
The student response does not match any of the descriptors above.	0

Analysing	Marks
The student response has the following characteristics:	
• the identification of sufficient and relevant evidence • thorough identification of relevant trends/patterns/relationships in evidence • thorough and appropriate identification of limitations of evidence	4–5
• the identification of relevant evidence • identification of obvious trends/patterns/relationships in evidence • basic identification of limitations of evidence	2–3
• the identification of insufficient and irrelevant evidence • identification of incorrect or irrelevant trends/patterns/relationships in evidence • incorrect or insufficient identification of limitations of evidence.	1
The student response does not match any of the descriptors above.	0

Interpreting	Marks
The student response has the following characteristics:	
• justified scientific argument/s • justified conclusion linked to the research question • fluent and concise use of scientific language/representations	4–5
• reasonable scientific argument/s • reasonable conclusion relevant to the research question • competent use of scientific language/representations	2–3
• inappropriate or irrelevant argument/s • inappropriate or irrelevant conclusion • incorrect use of language/representations.	1
The student response does not match any of the descriptors above.	0

Evaluating	Marks
The student response has the following characteristics:	
• justified discussion of the quality of evidence • extrapolation of credible findings of the research to the claim • suggested improvements and extensions to the investigation that are considered and relevant to the claim	4–5
• reasonable description of the quality of evidence • application of relevant findings of the research to the claim • suggested improvements and/or extensions to the investigation that are relevant to the claim	2–3
• cursory or simplistic statements about the quality of evidence • application of insufficient or inappropriate findings of the research to the claim • ineffective or irrelevant suggestions.	1
The student response does not match any of the descriptors above.	0

External assessment: Examination — combination response (50%)

External assessment is developed and marked by the QCAA. The external assessment in Agricultural Science is common to all schools and administered under the same conditions, at the same time, on the same day.

Assessment objectives

1. Describe ideas and findings about animal and plant production, agricultural enterprises, enterprise management, and evaluation of an agricultural enterprise.
2. Apply understanding of animal and plant production, agricultural enterprises, enterprise management, and evaluation of an agricultural enterprise.
3. Analyse data about animal and plant production, agricultural enterprises, enterprise management, and evaluation of an agricultural enterprise to identify trends, patterns, relationships, limitations or uncertainty.
4. Interpret evidence about animal and plant production, agricultural enterprises, enterprise management, and evaluation of an agricultural enterprise to draw conclusions based on analysis.

Specifications

This examination:

- includes two papers. Each paper consists of a number of different types of questions relating to Units 3 and 4
- may ask students to respond using
  - multiple choice
  - single words
  - sentences or paragraphs
- may ask students to
  - calculate using algorithms
  - interpret unseen stimulus, including graphs, tables or diagrams.

Conditions

Paper 1

- Mode: written
- Time allowed
  - Perusal time: 5 minutes
  - Working time: 90 minutes
- Students may use a QCAA-approved graphics or scientific calculator.

Paper 2

- Mode: written
- Time allowed
  - Perusal time: 5 minutes
  - Working time: 90 minutes
- Students may use a QCAA-approved graphics or scientific calculator.

Glossary

The syllabus glossary is available at www.qcaa.qld.edu.au/downloads/senior-qce/common/snr_glossary_cognitive_verbs.pdf.

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Version history

Version	Date of change	Information
1.0	January 2024	Released for familiarisation and planning (with implementation starting in 2025)
1.1	July 2024	Released for implementation with minor updates
1.2	October 2024	ISBN removed