Agricultural Science 2019 v1.3

General Senior Syllabus

This syllabus is for implementation with Year 11 students in 2019.

Queensland Government | Queensland Curriculum & Assessment Authority

For all Queensland schools

220805

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1 Course overview

1.1 Introduction

1.1.1 Rationale

At the core of all science 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.

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.

Urban communities are now less connected with rural Australia than they have ever been. More than ever, Australia is in needs of people who understand where food and other necessities of life come from and how they are produced. 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.

Assumed knowledge, prior learning or experience

The Australian Curriculum: Science P–10 is assumed knowledge for this syllabus. Agricultural Science also draws on prior learning across a range of other P–10 Australian Curriculum subjects.

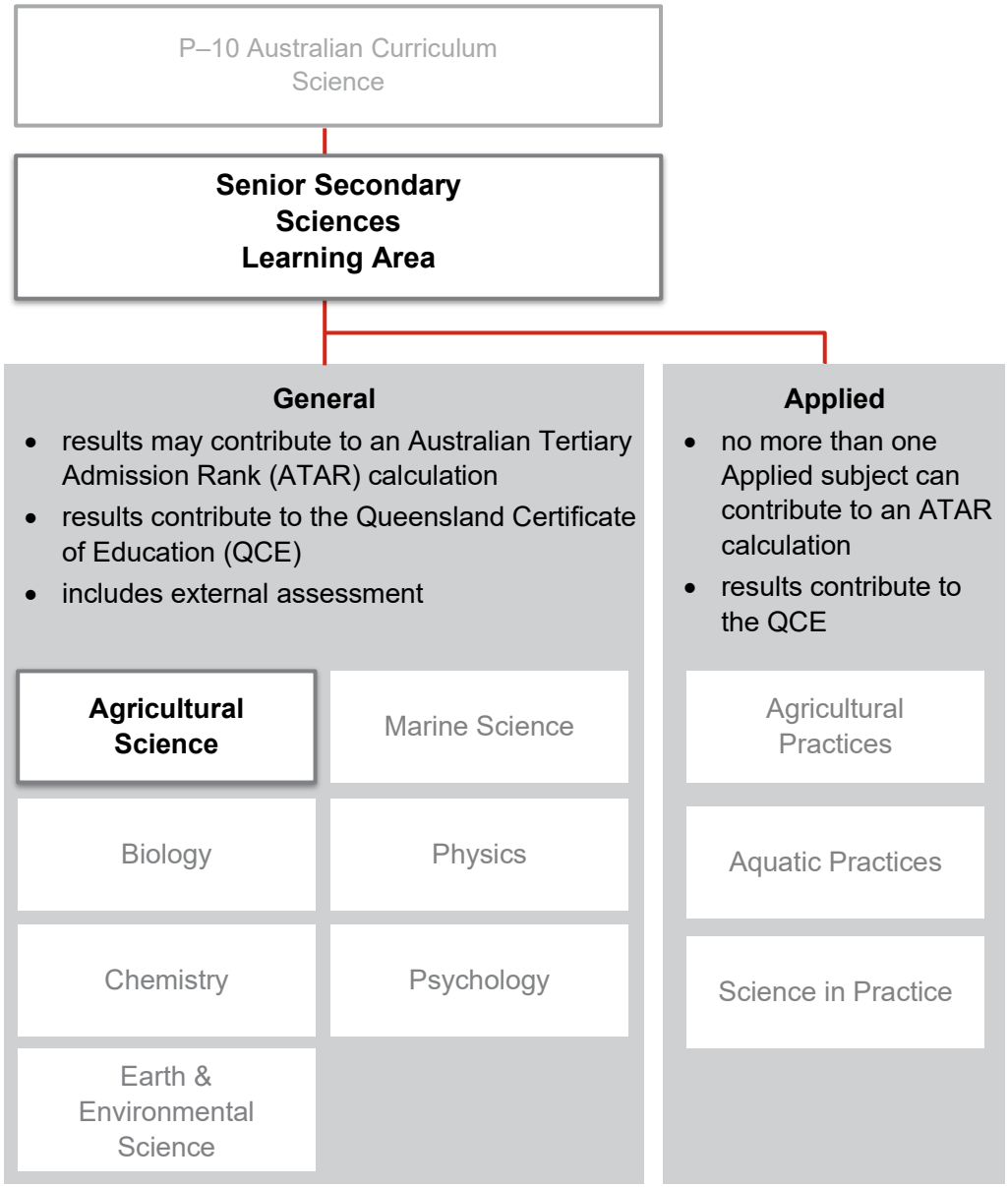
Pathways

Agricultural Science is a General subject suited to students who are interested in pathways beyond school that lead to tertiary studies, vocational education or work. A course of study in Agricultural Science can establish a basis for further education and employment in the fields of agriculture, horticulture, agronomy, ecology, food technology, aquaculture, veterinary science, equine science, environmental science, natural resource management, wildlife, conservation and ecotourism, biotechnology, business, marketing, education and literacy, research and development.

1.1.2 Learning area structure

All learning areas build on the P–10 Australian Curriculum.

Figure 1: Learning area structure



1.1.3 Course structure

Agricultural Science is a course of study consisting of four units. Subject matter, learning experiences and assessment increase in complexity from Units 1 and 2 to Units 3 and 4 as students develop greater independence as learners.

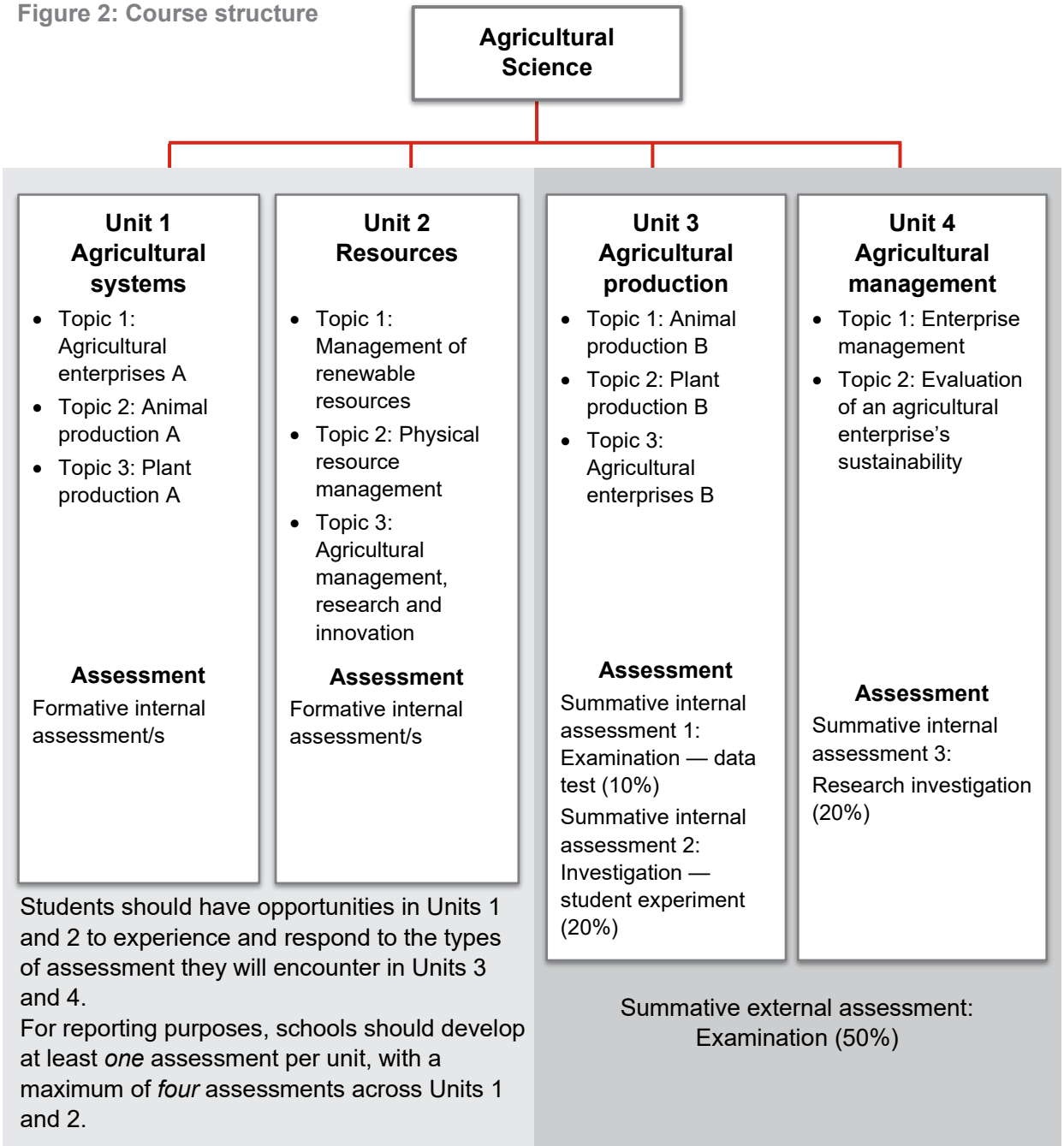
Units 1 and 2 provide foundational learning, which allows students to experience all syllabus objectives and begin engaging with the course subject matter. Students should complete Units 1 and 2 before beginning Units 3 and 4.

Units 3 and 4 consolidate student learning. Only the results from Units 3 and 4 will contribute to ATAR calculations.

Figure 2 outlines the structure of this course of study.

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

Figure 2: Course structure



1.2 Teaching and learning

1.2.1 Syllabus objectives

The syllabus objectives outline what students have the opportunity to learn. Assessment provides evidence of how well students have achieved the objectives.

Syllabus objectives inform unit objectives, which are contextualised for the subject matter and requirements of the unit. Unit objectives, in turn, inform the assessment objectives, which are further contextualised for the requirements of the assessment instruments. The number of each objective remains constant at all levels, i.e. Syllabus objective 1 relates to Unit objective 1 and to Assessment objective 1 in each assessment instrument.

Syllabus objectives are described in terms of actions that operate on the subject matter. Students are required to use a range of cognitive processes in order to demonstrate and meet the syllabus objectives. These cognitive processes are described in the explanatory paragraph following each objective in terms of four levels: retrieval, comprehension, analytical processes (analysis), and knowledge utilisation, with each process building on the previous processes (see Marzano & Kendall 2007, 2008). That is, comprehension requires retrieval, and knowledge utilisation requires retrieval, comprehension and analytical processes (analysis).

By the conclusion of the course of study, students will:

Syllabus objective	Unit 1	Unit 2	Unit 3	Unit 4
1. describe and explain scientific concepts, theories, models and systems and their limitations	•	•	•	•
2. apply understanding of scientific concepts, theories, models and systems within their limitations	•	•	•	•
3. analyse evidence	•	•	•	•
4. interpret evidence	•	•	•	•
5. investigate phenomena	•	•	•	•
6. evaluate processes, claims and conclusions	•	•	•	•
7. communicate understandings, findings, arguments and conclusions.	•	•	•	•

1. describe and explain scientific concepts, theories, models and systems and their limitations

When students describe and explain scientific concepts, theories, models and systems and their limitations, they give a detailed account of a concept, theory, model or system by making relationships, reasons or causes evident. They reflect on relevant social, economic, ethical and cultural factors.

2. apply understanding of scientific concepts, theories, models and systems within their limitations

When students apply their understanding of scientific concepts, theories, models and systems within their limitations, they explain local, regional and global phenomena and determine outcomes, behaviours and implications. They use algebraic, visual and graphical representations of scientific relationships and data to determine unknown scientific quantities or variables. They recognise the limitations of models and theories when discussing results.

3. **analyse evidence**

   When students analyse evidence, they recognise the variety of forms of evidence, and distinguish between quantitative, qualitative, primary and secondary evidence. When students analyse evidence in the form of qualitative data, they identify the essential elements, features or components of the data. When students analyse evidence in the form of quantitative data, they use mathematical processes to identify trends, patterns, relationships, limitations and uncertainty in the data.

4. **interpret evidence**

   When students interpret evidence, they use their knowledge and understanding of scientific concepts, theories, models and systems and their limitations to draw conclusions based on their analysis of qualitative and quantitative evidence and established criteria.

5. **investigate phenomena**

   When students investigate phenomena, they plan and carry out experimental and/or research activities in order to obtain evidence for the purpose of reaching a conclusion. They collect, collate and process evidence. Students ensure that relevant ethical, environmental and safety considerations have been incorporated into their practice.

6. **evaluate processes, claims and conclusions**

   When students evaluate processes, claims and conclusions, they critically reflect on the available evidence and make judgments about its application to a research question, and its use to inform further investigation. When students evaluate processes, they use the quality of the evidence to evaluate the validity and reliability of the method used, the appropriateness of assumptions made and possible refinements required. When students evaluate claims, they identify the evidence that would be required to support or refute the claim. They scrutinise evidence for bias, conjecture, alternatives or inaccuracies. When students evaluate conclusions, they consider the credibility of the supporting evidence.

7. **communicate understandings, findings, arguments and conclusions**

   When students communicate, they use scientific representations and language within appropriate genres to present information. They use technology to share knowledge by exchanging information and creating information products.

1.2.2 Underpinning factors

There are three skill sets that underpin senior syllabuses and are essential for defining the distinctive nature of subjects:

- literacy — the set of knowledge and skills about language and texts essential for understanding and conveying Agricultural Science 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 skill sets, which overlap and interact, 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.

Together these three skill sets shape the development of senior subject syllabuses. Although coverage of each skill set may vary from syllabus to syllabus, students should be provided with opportunities to learn through and about these skills over the course of study. Each skill set contains identifiable knowledge and skills that can be directly assessed.

Literacy in Agricultural Science

The skills of literacy in science (distinct from 'scientific literacy') are essential for successful scientific inquiry (Douglas et al. 2006, Saul 2004, Yore et al. 2003). In any scientific inquiry activity, literacy skills support students by enabling them to grapple with ideas, conduct research, discuss their thoughts, enhance conceptual understanding and solve problems (Krajcik & Southerland 2010).

The literacy skills important to this subject are those related to the comprehension and composition of texts that provide information, describe and explain events and phenomena, report on experiments, present and analyse data, and offer opinions or claims (ACARA 2015a). Agricultural Science students comprehend and compose multimedia texts, such as reports, charts, graphs, diagrams, pictures, maps, animations, models and other visual media. They understand and apply language structures that are used to link information and ideas, give descriptions and explanations, formulate research questions and construct evidence-based arguments capable of expressing an informed position (ACARA 2015a).

Students learn these skills by having opportunity to engage with:

- rich and varied science and media texts
- class activities that use literacy as a tool for learning
- strategies for reading scientific texts (Moore 2009).

The learning opportunities described above can be integrated with stimulus questions, Science as a Human Endeavour subject matter and mandatory practicals. Students could be asked to:

- explain links between new ideas and prior knowledge and experiences
- engage in learning experiences directed by a question that is meaningful to their lives
- connect multiple representations of a concept, e.g. written texts, formulas, graphs or diagrams of the same concept
- use scientific ideas to compose evidence-based conclusions in the mandatory practicals
- engage with the discourses of science such as those found in scientific literature and media texts (Krajcik & Southerland 2010).

These strategies will promote students' ability to read, write and communicate about science so that they can engage with science-related issues throughout their lives.

These aspects of literacy knowledge and skills are embedded in the syllabus objectives, unit objectives and subject matter, and instrument-specific marking guides (ISMGs) for Agricultural Science.

Numeracy in Agricultural Science

The skills of numeracy in Agricultural Science are essential for successful scientific inquiry. In any scientific inquiry activity, numeracy skills support students by enabling them to make and record observations; order, represent and analyse data; and interpret trends and relationships (ACARA 2015b).

The numeracy skills important to this subject are those related to the interpretation of complex spatial and graphical representations, and the appreciation of the ways in which scientific concepts, theories, systems and models are structured, communicated, interact or change across spatial and temporal scales (ACARA 2015b). Students will use knowledge and skills in areas such as:

- graphing
- ratio and proportion
- converting from one unit to another
- scientific notation
- an understanding of place in number (significant figures)
- estimation and calculation in order to analyse data
- determining the reliability of data
- interpreting and manipulating mathematical relationships in order to calculate and predict values (ACARA 2009, 2015).

Students will learn these skills as they:

- measure and record data during the mandatory practicals
- use or interpret meaning from formulas
- interpret graphical information presented in science and media texts
- undertake class activities that use numeracy as a tool for learning
- use mathematics or equations as justification or evidence for conclusions
- interpret and represent information in a variety of forms.

These opportunities will promote students' ability to develop and use numeracy skills in Agricultural Science.

These aspects of numeracy knowledge and skills are embedded in the syllabus objectives, unit objectives and subject matter, and ISMGs for Agricultural Science.

21st century skills

The 21st century skills identified in this syllabus reflect a common agreement, both in Australia and internationally, on the skills and attributes students need to prepare them for higher education, work and engagement in a complex and rapidly changing world.

21st century skills	Associated skills	21st century skills	Associated skills
critical thinking	• analytical thinking • problem-solving • decision-making • reasoning • reflecting and evaluating • intellectual flexibility	creative thinking	• innovation • initiative and enterprise • curiosity and imagination • creativity • generating and applying new ideas • identifying alternatives • seeing or making new links
communication	• effective oral and written communication • using language, symbols and texts • communicating ideas effectively with diverse audiences	collaboration and teamwork	• relating to others (interacting with others) • recognising and using diverse perspectives • participating and contributing • community connections
personal and social skills	• adaptability/flexibility • management (self, career, time, planning and organising) • character (resilience, mindfulness, open- and fair-mindedness, self-awareness) • leadership • citizenship • cultural awareness • ethical (and moral) understanding	information and communication technologies (ICT) skills	• operations and concepts • accessing and analysing information • being productive users of technology • digital citizenship (being safe, positive and responsible online)

Agricultural Science helps develop the following 21st century skills:

- critical thinking
- creative thinking
- communication
- collaboration and teamwork
- personal and social skills
- information and communication technologies (ICT) skills.

These elements of 21st century skills are embedded in the syllabus objectives, unit objectives and subject matter, and ISMGs for Agricultural Science.

1.2.3 Aboriginal perspectives and Torres Strait Islander perspectives

The QCAA is committed to reconciliation in Australia. 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.

1.2.4 Pedagogical and conceptual frameworks

Defining *inquiry* in science education

This syllabus provides guidance to support schools in aligning a chosen pedagogical framework with the curriculum and assessment expectations outlined in this syllabus. This guidance clarifies the use of the term *inquiry* and articulates 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**.

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.

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 science inquiry (Tytler 2007). This expectation can be seen, for example, in the inclusion of the student experiment, research investigation, and mandatory practicals.

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 taught science inquiry skills (Krajcik et al. 2000). The syllabus outlines a number of these skills in the subject matter. Some science inquiry skills will be used to complete the mandatory and suggested practicals. The selection, application and coordination of science inquiry skills will be required in the student experiment and research investigation.

Teachers decide how the science inquiry skills are to be developed. For example, teachers will determine how mandatory practicals 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.

Framework to describe the inquiry process

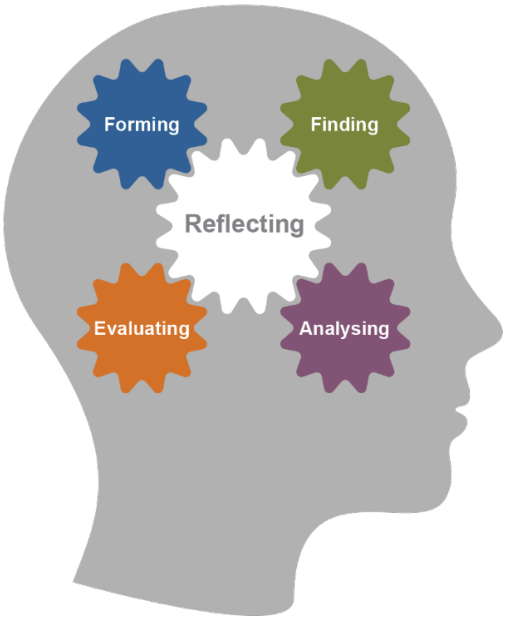
In order to support student engagement in activities involving inquiry, it is useful to establish a common language or framework to distinguish between stages of the process.

The stages involved in any inquiry are:

- forming and describing the inquiry activity
- finding valid and reliable evidence for the inquiry activity
- analysing and 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 3: Stages of inquiry process



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* provides guidance about current science safety protocols.

It is the responsibility of all schools to ensure that their practices meet current legislation requirements. References to relevant legislation and regulations are supported by the Reference list located on the Agricultural Science subject page of the QCAA website.

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 'Guidelines and publications' section of the National Health and Medical Research Council website.

It should also be recognised that school personnel and students are not carrying out essential, groundbreaking research. Therefore, standards in schools should be more stringent than those used in universities and research and development organisations.

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, best practice should be emulated at all times by referring to the *3Rs* principle of animal welfare (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 choose not to participate.

1.2.5 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 Agricultural Science. It is particular to each unit in the course of study and provides the basis for student learning experiences.

Subject matter has a direct relationship to the unit objectives, but is of a finer granularity and is more specific. These statements of learning are constructed in a similar way to objectives. Each statement:

- describes an action (or combination of actions) — what the student is expected to do
- describes the element — expressed as information, mental procedures and/or psychomotor procedures
- is contextualised for the topic or circumstance particular to the unit.

Organisation of subject matter

The subject matter is organised as topics within each unit.

The subject matter indicates the required knowledge and skills that students must acquire. Students should experience the mandatory practicals. It is expected that approximately five hours will be required to complete the mandatory practicals that involve fieldwork.

The subject matter from Units 3 and 4 will be assessed by the external examination.

Science as a Human Endeavour

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 will not be 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 Science as a Human Endeavour (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 guidance in each topic. This highlights opportunities for teachers to contextualise the associated subject matter and provides stimulus for the development of claims and research questions for investigation.

Additional opportunities include:

- the mandatory and suggested practicals provide opportunity 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
- a research investigation that 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.

Finally, the SHE statements at the end of each topic may be used to support the development and interrogation of claims, and be useful as a starting point for the research investigation.

Guidance

The guidance included with each topic is designed to clarify the scope of the subject matter and identify opportunities to integrate science inquiry skills and SHE strands into the subject matter. A number of tags are used to highlight aspects of the guidance:

- **Notional time:** the depth of subject matter coverage is indicated by the amount of time needed to cover this subject matter in the sequence presented in the syllabus.
- **Formula:** defines a formula described in the subject matter.
- **SHE:** identifies an opportunity to integrate an aspect of the Science as a Human Endeavour strand and may also be used as a starting point for a research investigation.
- **Suggested practical:** identifies an opportunity for inquiry skills to be developed and may be used as a starting point for a student experiment.
- **Syllabus links:** identifies links between syllabus units.

1.3 Assessment — general information

Assessments are formative for Units 1 and 2, and summative for Units 3 and 4.

Assessment	Unit 1	Unit 2	Unit 3	Unit 4
Formative assessments	•	•		
Summative internal assessment 1			•	
Summative internal assessment 2			•	
Summative internal assessment 3				•
Summative external assessment			•	•

1.3.1 Formative assessments — Units 1 and 2

Formative assessments provide feedback to both students and teachers about each student's progress in the course of study.

Schools develop internal assessments for each senior subject based on the learning described in Units 1 and 2 of the subject syllabus. Each unit objective must be assessed at least once.

For reporting purposes, schools should devise at least *two* but no more than *four* assessments for Units 1 and 2 of this subject. At least *one* assessment must be completed for *each* unit.

The sequencing, scope and scale of assessments for Units 1 and 2 are matters for each school to decide and should reflect the local context.

Teachers are encouraged to use the A–E descriptors in the reporting standards (Section 1.5) to provide formative feedback to students and to report on progress.

1.3.2 Summative assessments — Units 3 and 4

Students will complete a total of *four* summative assessments — three internal and one external — that count towards their final mark in each subject.

Schools develop *three* internal assessments for each senior subject, based on the learning described in Units 3 and 4 of the syllabus.

The three summative internal assessments will be endorsed and the results confirmed by the QCAA. These results will be combined with a single external assessment developed and marked by the QCAA. The external assessment results for Agricultural Science will contribute 50% towards a student's result.

Summative internal assessment — instrument-specific marking guides

This syllabus provides ISMGs for the three summative internal assessments in Units 3 and 4.

The ISMGs describe the characteristics evident in student responses and align with the identified assessment objectives. Assessment objectives are drawn from the unit objectives and are contextualised for the requirements of the assessment instrument.

Criteria

Each ISMG groups assessment objectives into criteria. An assessment objective may appear in multiple criteria or in a single criterion of an assessment.

Making judgments

Assessment evidence of student performance in each criterion is matched to a performance-level descriptor, which describes the typical characteristics of student work.

Where a student response has characteristics from more than one performance level, a best-fit approach is used. Where a performance level has a two-mark range, it must be decided if the best fit is the higher or lower mark of the range.

Authentication

Schools and teachers must have strategies in place for ensuring that work submitted for internal summative assessment is the student's own. Authentication strategies outlined in QCAA guidelines, which include guidance for drafting, scaffolding and teacher feedback, must be adhered to.

Summative external assessment

The summative external assessment adds valuable evidence of achievement to a student's profile. External assessment is:

- common to all schools
- administered under the same conditions at the same time and on the same day
- developed and marked by the QCAA according to a commonly applied marking scheme.

The external assessment contributes 50% to the student's result in Agricultural Science. It is not privileged over the internal assessments.

1.4 Reporting standards

Reporting standards are summary statements that succinctly describe typical performance at each of the five levels (A–E). They reflect the cognitive taxonomy and objectives of the course of study.

The primary purpose of reporting standards is for twice-yearly reporting on student progress. These descriptors can also be used to help teachers provide formative feedback to students and to align ISMGs.

Reporting standards

A
The student accurately describes and explains 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 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 evidence 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 investigates phenomena by carrying out effective experiments and research investigations. They efficiently collect, collate and process relevant evidence. They critically evaluate processes, claims and conclusions by insightfully scrutinising evidence, extrapolating credible findings, and discussing the reliability and validity of experiments. The student communicates effectively by using scientific representations and language accurately and concisely within appropriate genres.
B
The student accurately describes and explains 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 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 evidence by effectively 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 investigates phenomena by carrying out effective experiments and research investigations. They collect, collate and process relevant evidence. They evaluate processes, claims and conclusions by scrutinising evidence, applying relevant findings and discussing the reliability and validity of experiments. The student communicates accurately by using scientific representations and language within appropriate genres to present information.

C
The student describes and explains 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 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 evidence 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 investigates phenomena by carrying out experiments and research investigations. They collect, collate and process evidence. They evaluate processes, claims and conclusions by describing the quality of evidence, applying findings, and describing the reliability and validity of experiments. The student communicates using scientific representations and language within appropriate genres to present information.
D
The student describes and gives accounts of aspects of concepts, theories, models and systems. They use rudimentary representations of scientific relationships or data to determine unknown scientific quantities or variables. The student analyses evidence 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 carries out aspects of experiments and research investigations. They discuss processes, claims or conclusions. They consider the quality of evidence and conclusions. The student uses scientific representations or language to present information.
E
The student describes scenarios and refers 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. The student communicates information.

2 Unit 1: Agricultural systems

2.1 Unit description

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.

2.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective must be assessed at least once.

Students will:

1. describe and explain agricultural enterprises, and animal and plant production
2. apply understanding of agricultural enterprises, and animal and plant production
3. analyse evidence about agricultural enterprises, and animal and plant production
4. interpret evidence about agricultural enterprises, and animal and plant production
5. investigate phenomena associated with agricultural enterprises, and animal and plant production
6. evaluate processes, claims and conclusions about agricultural enterprises, and animal and plant production
7. communicate understandings, findings, arguments and conclusions about agricultural enterprises, and animal and plant production.

2.3 Topic 1: Agricultural enterprises A

In this topic, students will:

Subject matter	Guidance
• recall 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 • describe the features of both intensive and extensive animal and plant industries • identify the important animal and plant enterprises in local and regional areas of Queensland as well as those of national significance • identify and describe physical resources, including soil, water, machinery, infrastructure and human and biological resources (including animals and plants) of an agricultural enterprise • identify and describe different business structures for property, including partnerships, companies, land tenure, family farms and succession • identify and describe examples of employment and economic opportunities in agricultural production systems across a range of industries • analyse secondary 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. • **Mandatory practical:** Observe, collect and record information on the physical and biological resources of a production unit including soil, climate, vegetation and topography.	• **Notional time:** 4 hours • In the study of agricultural science, theories and models are used to represent processes. Students should understand the difference between models of processes and the actual process, including the limitations of models. • Refer to the glossary for definitions of system, intensive industries and extensive industries. • Students could study intensive and extensive plant and animal industries relevant to their local area. • Business management and ownership structures vary, with roles and responsibilities differing across enterprises. A brief discussion to illustrate differences between different types of enterprise structures could include partnerships, companies, land tenure, family properties and succession. • The mandatory practical can be completed on the school grounds or using an external site (e.g. property/farm). The recorded information should include primary and secondary data. • **SHE:** Farming systems can be described using an input–output model that draws on a wide range of evidence from multiple disciplines. • **Suggested practical:** Graph secondary data for a range of industries and interpret the changes in level of production over time (e.g. years). • **Suggested practical:** Simulate, construct or represent appropriate model/s for an agricultural system (contextualised using a relevant local example) showing inputs, outputs, boundaries, subsystems, processes and interactions between subsystems. • **Syllabus link:** Unit 3: Agricultural production.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• **SHE:** Agricultural systems can be simulated, constructed or represented using appropriate model/s and contextualised using a relevant local example.

2.4 Topic 2: Animal production A

In this topic, students will:

Subject matter	Guidance
What is an agricultural animal? • identify the different types of agricultural production animals • define animal husbandry • define the term breed in terms of agriculture • identify a range of agricultural animals of regional significance • recognise the adaptive physical features of different types of agricultural animals for their natural environments (e.g. features of *Bos taurus indicus* versus *Bos taurus taurus* for cattle production in tropical climates) • explain and compare the physical characteristics of different types of agricultural animals and relate them back to their environment/feeding behaviour.	• **Notional time:** 1 hour • Agricultural production animals could include – invertebrates — crustaceans, bees – vertebrates — cattle, sheep, pigs, poultry, horses. • A discussion of agricultural production animals could focus on regionally significant animals. • Refer to the glossary for definitions of animal husbandry and breed.
Animal anatomy and physiology • recall and describe the functions of the main organelles in animal cells, including plasma membrane, nucleus, cytoplasm, mitochondria, ribosomes • recall and describe the hierarchical structure of organisation of cells, tissues, organs and systems. Reference to systems should include, but are not limited to, the digestive, reproductive and musculoskeletal systems • define and describe the terms monogastric and ruminant • identify and describe 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, caecum, rectum and anus • identify and describe the function of accessory digestive organs, including tongue, salivary glands, pancreas, liver and gall bladder • identify and describe the main structures and function of a mammalian and one other agricultural animal reproductive system, including both male and female systems • identify and describe the main structures of the musculoskeletal system, including bones, muscles, joints, tendons and ligaments.	• **Notional time:** 5 hours • Ensure any work with animals, either live or dead, is conducted in accordance with Animal Use Guidelines (see Section 1.2.4). • A discussion of cell organelles could include cell respiration in reference to energy metabolism in carbohydrate and fat digestion. • Refer to the glossary for definitions of musculoskeletal, monogastric and ruminant. • Students could sketch or produce models to create visual representations of a ruminant and a monogastric digestive system. • Other agricultural animal reproductive systems suitable for investigation could include avian, fish or crustacean. • A description of the main structures of the musculoskeletal system does not need to include specific names of any bone, muscle, joint, tendon and ligament. • **Syllabus link:** The relationship between the musculoskeletal system and animal production links to Unit 3 Topic 1: Animal Production B.

Subject matter	Guidance
• **Mandatory practical:** Investigate and compare the digestive systems of a monogastric and a ruminant animal, using real or virtual examples.	• Students could also study a third digestive system (e.g. poultry or aquatic species) in a production unit on school grounds or an external site, such as property or farm, if these resources are available. • Students could develop an understanding of digestive systems through comparing and contrasting different animals. • **Suggested practical:** Investigate 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. • **Suggested practical:** Investigate the reproductive system of an agricultural animal using real or virtual examples. • **Syllabus link:** Animal anatomy and physiology links to Unit 3 Topic 1: Animal production B.
Animal reproduction • identify and explain the factors that affect reproduction in agricultural animals (i.e. genetics, environment, nutrition, pests and disease and management) • describe and explain the function and interaction of reproductive hormones (i.e. testosterone, oestrogen, progesterone, prostaglandin, follicle-stimulating hormone, luteinising hormone and oxytocin) in agricultural animals • analyse primary or secondary reproductive data for agricultural production animals to compare the link between reproduction and other external factors.	• **Notional time:** 3 hours • Discussion of reproductive cycles should include oestrous and could also include sexual maturity, pregnancy and lactation and their associated effect on management decisions. • Analysis of reproductive data could include data on birthing percentages for areas that have experienced natural hazards (e.g. drought). • **SHE:** Graziers collect reproductive data to monitor and evaluate animal performance in terms of economic and environmental sustainability. • **Suggested practical:** Assess reproductive soundness on a variety of livestock using qualitative and/or quantitative assessment. • **Suggested practical:** Analyse primary or secondary production data to make judgments about animal reproduction.

Subject matter	Guidance
Genetics and inheritance of traits (animals/plants) • describe a dihybrid cross and polygenetic inheritance • 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 • describe and explain the impact of heritability on breeding programs with the use of a heritability table of data • describe the phenomenon known as hybrid vigour or heterosis. • **Mandatory practical:** Assess phenotypic variation in agricultural products and evaluate this data to make judgments about market suitability.	• **Notional time:** 4 hours • Genetics and inheritance of traits could be taught in the context of either animal or plant production. • Symbolise the phenotype of an animal by describing the relationship between environment and genotype as follows (phenotype = environment + genotype). • A discussion about hybrid vigour could include its application in a commercial animal enterprise of regional importance (pigs, poultry, beef, etc.). • In the mandatory practical, produce can be obtained by producing or purchasing animal/plant products. Eggs, cheese and tomatoes are suitable examples of products for this practical. • **Suggested practical:** Analyse primary or secondary production data to make judgments about genetic inheritance. • **Syllabus link:** Genetics and inheritance of traits links to the development of plant varieties and their use in production systems to increase yields in Unit 1 Topic 3: Plant production A.
Animal breeding and reproductive technologies • describe and explain breeding systems that are important to animal production, including crossbreeding, line breeding, continuous and seasonal breeding • define and describe animal genetic tools, including breed plans and estimated breeding values (EBV) • compare advantages and disadvantages of using different genetic tools, including breed plans and EBVs 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 and evaluate advanced animal reproductive technologies, including cloning and genetic engineering. • **Mandatory practical:** Analyse representations of both qualitative and quantitative data to make decisions about selection of breeding stock for specific breeding objectives.	• **Notional time:** 6 hours • Reproductive technologies can be used to increase variation, improve characteristics and develop new breeds. • Refer to the glossary for definitions of breed plan and estimated breeding values. • In the mandatory practical, sales catalogues are an appropriate source of both qualitative and quantitative data. Qualitative representations are visual and quantitative representations could include EBVs. • **SHE:** 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.

Subject matter	Guidance
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• Influences of multicultural practices in Australia have led to the development and use of new breeds of animals in agricultural production. • The development of new genetic technologies in animal production can lead to improved animal performance.

2.5 Topic 3: Plant production A

In this topic, students will:

Subject matter	Guidance
Agricultural plants • identify the different types of agricultural and horticultural production plants, including grasses, legumes, fibre crops, fruit, nuts, vegetables and ornamentals • recall the six main anatomical parts of a plant, including roots, stems, leaves, flowers, fruits and seeds • apply a plant classification system • define the terms monocotyledon and dicotyledon • describe the physical characteristics of plants that belong to monocots and dicots • define the terms species, variety and cultivar • identify and classify a range of agricultural plants of regional importance. • **Mandatory practical:** Use a key to classify a range of broadacre and horticultural crops, pastures and weed species to a plant family name level.	• **Notional time**: 4 hours • Refer to an authoritative glossary for plant classification terminology. • Refer to the glossary for definitions of monocotyledon and dicotyledon. • Students could create a visual representation to distinguish differences between the main groups of agricultural plants. • Refer to the glossary for definitions of species, variety and cultivar. • Plant classification systems could be based on structure, end product or growth. • The focus of the mandatory practical is the use of a range of identification keys in the development of classification skills. • **Suggested practical:** Conduct a plant survey of the school grounds and surrounds and collect a number of prominent plants. Make observations about each plant, sketch the main distinguishing features of several plants and draw conclusions about the group of plants or plant family to which they belong.
Plant anatomy and physiology • recall and describe the level of organisation from individual cells to plant systems • recall and describe the functions of the main cellular structures of plant cells, including cell wall, cell membrane, nucleus, cytoplasm, mitochondria, chloroplasts, vacuoles and ribosomes • describe and explain the process of photosynthesis (and the role of chloroplasts) • describe and explain the process of cellular respiration (and the role of mitochondria) • describe the main tissue types found in plants, including vascular (xylem and phloem) and meristematic (apical and lateral meristems) • describe and explain the process of transpiration	• **Notional time:** 9 hours • An understanding of light and dark reactions in photosynthesis is not required. • Refer to the glossary for definitions of respiration, transpiration and photosynthesis. • A discussion about transpiration could look at the water transport system of plants. • Factors that can be manipulated to influence the respiration and photosynthetic process and investigated in the mandatory practical include temperature, carbon dioxide concentration, light intensity, oxygen concentration, the amount of respirable material and light wavelength. • **SHE:** An understanding of plant anatomy and physiology has allowed farmers to select more appropriate plant species for use on their properties.

Subject matter	Guidance
• identify and explain the factors that influence photosynthetic and respiration processes • evaluate photosynthetic and respiration processes and how they may be used to increase production in an agricultural enterprise • identify and describe the function of the main structures associated with the reproductive system in plants, including pistil, stamen, stigma, style, ovary, anther and sepal. • **Mandatory practical:** Conduct an investigation into either respiration or photosynthesis.	• **Suggested practical:** Investigate 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). • **Suggested practical:** Dissect plant structures (i.e. flowers, root system, stems and leaves). • **Syllabus link:** Plant anatomy and physiology links to Unit 3 Topic 2: Plant production B.
Plant growth and development • identify and describe the range of factors including nutrition, genetics, climate and weather, disease and management practices that influence plant growth and development • describe and explain a life cycle for a selected regionally significant agricultural crop (i.e. germination, vegetative and reproductive growth stages) • compare and discuss the stages of development (germination, vegetative and reproductive growth stages) in different plants • identify and describe (at a basic level) the function of hormones involved in plant growth, reproduction and fruit ripening growth hormones as an example (e.g. gibberellins) • analyse and evaluate primary or secondary data in relation to factors affecting plant growth and development (e.g. germination, vegetative and reproductive growth stages) • define tropism • describe how tropisms, including phototropism, geotropism, thigmotropism and hydrotropism, can affect plant production.	• **Notional time:** 5 hours • An explanation of different crop life cycles could include a broadleaf crop (non-legume), legume crop or cereal crop and could be contextualised to the local/regional area. • Students could draw visual representations of different plant life cycles and compare environmental requirements (e.g. water, soil nutrients, solar radiation) at each stage of growth. • Management strategies to maximise flowering and fruit set could be discussed and further developed in Unit 3 Topic 2: Plant production B. • Suggested practicals could include pot, field or laboratory trials and should be started with appropriate timing in mind. • Factors for investigation could include light, water, temperature, nutrition, and growing media. • Examples of commercial hormone products could include Rootex and gibberellic acid. • Manipulation of plant production could include the use of hormones to influence internode length, flower set, fruit drop and ripening. • **SHE:** A knowledge of plant hormones can be used to modify plant production stages leading to increased production and or minimising risk. • **Suggested practical:** Germinate agricultural seeds under different environmental conditions and analyse primary 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.

Subject matter	Guidance
	• **Suggested practical:** Investigate the action of a growth hormone on plants (e.g. use various commercial hormone products on a selection of cuttings to propagate new plants). • **Syllabus link:** Plant growth and development links to Unit 3 Topic 2: Plant production B.
Plant nutrition • identify 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 • understand the difference between major and trace amounts in terms of quantity of nutrient required by a plant • recognise deficiencies and toxicities of major and minor nutrients by visual or chemical analysis • describe how deficiencies or toxicities can cause changes in plant growth and development • analyse and compare commercial fertiliser labels • calculate fertiliser application rate for a given area. • **Mandatory practical:** Determine the appropriate fertiliser application type and rate for a given situation (e.g. crop) 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/yield).	• **Notional time:** 4 hours • Discussion of minor nutrients could include the use of the industry term trace elements. • **Formula:** Fertiliser application rate: application rate (kg/ha) = $\frac{\text{amount of nutrient required } \left(\frac{\text{kg}}{\text{ha}}\right) \times 100}{\text{amount of nutrient in fertliser}}$ • **SHE:** 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. • **Syllabus link:** Plant nutrition links to Unit 3 Topic 2: Plant production B.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• Development of genetically modified organisms has involved research by many international science institutions. • Advances in the use of transgenic organisms can provide economic benefits to agricultural producers and alleviate malnutrition in developing countries.

2.6 Assessment guidance

In constructing assessment instruments for Unit 1, schools should ensure that the objectives cover, or are chosen from, the unit objectives. If one assessment instrument is developed for a unit, it must assess all the unit objectives; if more than one assessment instrument is developed, the unit objectives must be covered across those instruments.

It is suggested that student performance on Unit 1 is assessed using techniques modelled on the techniques used in Unit 3:

- a student experiment
- an examination that includes some items modelled on the data test.

3 Unit 2: Resources

3.1 Unit description

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.

3.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective must be assessed at least once.

Students will:

1. describe and explain 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 evidence 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. investigate phenomena associated with management of renewable resources; physical resource management; and agricultural management, research and innovation
6. evaluate processes, claims and conclusions about management of renewable resources; physical resource management; and agricultural management, research and innovation
7. communicate understandings, findings, arguments and conclusions about management of renewable resources; physical resource management; and agricultural management, research and innovation.

3.3 Topic 1: Management of renewable resources

In this topic, students will:

Subject matter	Guidance
Managing ecosystems and renewable resources • recall and describe the cycling of nutrients (including water, carbon and nitrogen) • identify and describe renewable resources, including water, edible biota, biofuels and forestry products • 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 • explain how agricultural industries can be managed, through consideration of legislative requirements relevant to aesthetics, air quality, biodiversity and effluent management, to reduce their impact on other ecosystems. • **Mandatory practical:** Compare water quality from different sources and assess the impact of an agricultural activity.	• **Notional time:** 6 hours • Students could construct visual representations of the water, nitrogen and carbon cycles to show the flow of energy and matter between the Earth systems. • Refer to the glossary for definitions of renewable resources, edible biota and carbon sequestration. • Renewable resources could include pharmaceuticals and biochemicals refined from plants and animals such as poppies, snake anti-venom, tea-tree oil, and manuka honey. • A study of air and water purification could include effluent management (e.g. ponding, methane harvest and air quality) in intensive industries (e.g. poultry and pigs). • **SHE:** 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. • **SHE:** An interdisciplinary understanding of carbon sequestration can influence how producers reduce greenhouse gas emissions. • In the mandatory practical – water quality samples can be artificially manufactured, if required – the impact of an agricultural activity could be modelled by the addition of salt, manure, soil, fertiliser and metals.

Use of renewable resources • describe current renewable resource consumption trends (including two of the following: food, fibre, forestry, fisheries or water) and evaluate their sustainability in relation to national and global population growth • describe traditional Aboriginal methods and Torres Strait Islander methods of sustainable harvesting and management of Australian biota • 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 • analyse secondary data to evaluate the use of biota.	• **Notional time:** 6 hours • Discussion of current renewable resource consumption trends could include the commercial production of traditional Aboriginal food sources and traditional Torres Strait Islander food sources. • Food consumption issues include seasonality of products, food miles, food wastage and using the whole resource. This could include the investigation of the scope for sustainable production using the seasonal calendars of Aboriginal peoples and Torres Strait Islander peoples. • A discussion about fibre consumption issues could include fast fashion and waste, traceability and supply chain transparency. • The sustainable use of renewable resources could consider issues such as overharvesting of biota and water and monocultures. This could include exploration of traditional Aboriginal methods and traditional Torres Strait Islander methods of sustainable harvesting and management, such as – Aboriginal peoples' connection to Country and Torres Strait Islander peoples' connection to Place, which incorporates a sustainable environmental mindset – the intricate way that a community's culture and Country/Place (land, sea, sky and waterways) is part of who they are (e.g. highlight links between the task of land management and how the oral tradition of storytelling enables survival of a community) – the local knowledge of community regarding sustainable hunting, protection and recordkeeping for animals, fish and birds. • Students could use secondary data relating to traditional Aboriginal methods and Torres Strait Islander methods of sustainable land management, such as – Aboriginal peoples' and Torres Strait Islander peoples' connection to Country/Place, which incorporates a sustainable environmental mindset – the knowledge of local community regarding sustainable hunting, protection and recordkeeping for animals, fish and birds. • Refer to the glossary for definitions of sustainable use, biota, monoculture and urbanisation. • **SHE:** 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.

Subject matter	Guidance
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• 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.

3.4 Topic 2: Physical resource management

In this topic, students will:

Subject matter	Guidance
Soil properties and classification • describe Australian soils and their general characteristics, including old, nutrient poor, geologically stable and structurally unstable • describe a typical soil profile, including A, B, C and D horizons • describe and 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 identification keys and the *Australian Soil Classification* (Isbell 2016) system for identification of soils • explain how the physical, chemical and biological properties of soil are a good indicator of soil health and connected agricultural productivity • define and apply a land use classification system • identify and describe technologies that are used to assess land capability. • **Mandatory practical:** Use local soil samples to measure soil properties (including organic content, pH, moisture content, soil texture and structure) to classify and assess production capacity and intended land use.	• **Notional time:** 9 hours • A discussion of soil profile could include parent material of local soils. • Students could compare physical characteristics in soil horizons found in different soil profiles during fieldwork or from online sources. • Students are not required to recall the names of different soil types. • Fieldwork could be used to develop scientific skills, collect data and to develop student understanding of soil properties, soil and land use classification. • Land use classification systems could include Queensland's land evaluation schemes and Agricultural Land Class (ALC) approach and the Australian Land Use and Management (ALUM) Classification. • Students could be exposed to a variety of technologies used to assess land use (e.g. Queensland Globe) and use the data to justify decisions about land uses. • Technologies could include satellite imagery, global positioning system (GPS)-based sensors and precision management tools. • In the mandatory practical, the measurement of moisture content does not include water infiltration rate, capillary action and water holding capacity and field capacity. • **Formula:** Percentage (%) organic matter = $\frac{\text{weight of organic matter}}{\text{weight of soil}} \times 100$ • **Suggested practical:** 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. • **Suggested practical:** Use software to compare major soil types and biological, chemical and physical characteristics of each. • **Suggested practical:** Interpret data generated by technologies used to assess land capability. • **Suggested practical:** Collect and interpret data to make connections between indicator plant species and land use with specific soil types (e.g. field-based or satellite imagery data).

Subject matter	Guidance
Climate and weather • define the terms weather and climate • identify and 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 (through the use of either greenhouses, hail netting, shade structures, barns and sheds) to produce microclimates that are better suited to production (e.g. greenhouses, hail netting, shade structures, sheds) • 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) • analyse secondary weather and climate data about El Niño and La Niña patterns and make reasoned decisions about the effect on agricultural production • identify and discuss extreme weather events and their impact on agricultural production • analyse management strategies for extreme weather events of regional significance • identify the possible causes of climate change • explain the possible effects of climate change on future agricultural production. • **Mandatory practical:** Measure 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.	• **Notional time:** 9 hours • Refer to the glossary for definitions of weather and climate. • Examples of how climatic factors can affect agricultural production could be contextualised to local and regional production areas (e.g. seasonal rainfall on dryland cropping, cereal, cotton and sugar cane areas). • Students could research the possible contribution of agricultural production to the causes of climate change and how agriculture might contribute to solutions. • A discussion of climate change and its impact on agricultural production could include limitations on crop and animal production; increases in pests and diseases; changes to plant growth; changes to what, where and how food and fibre is produced; and changes to farming technology and practices. • A discussion around the impact of extreme weather events on agricultural production could include floods, cyclone, drought and hail. • In the mandatory practical, measurement of climatic variables could include – plant production (e.g. inside and outside a greenhouse frost barriers) – animal production (e.g. under shade or full sun) • **SHE:** Examine how meteorology relies on clear communication and international conventions. • **SHE:** 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. • **Suggested practical:** Interpret secondary data, including ocean temperature, air pressure, rainfall and SOI, to identify El Niño and La Niña patterns.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• 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. • Knowledge and data can be collected about weather patterns to enable scientists to offer valid explanations and make reliable predictions in relation to

Subject matter	Guidance
	El Niño, La Niña, Southern Oscillation Index (SOI) and the Indian Ocean Dipole (IOD). • Accurate weather forecasting is vital to agricultural producers to provide severe weather warnings and to inform decision-making in agriculture, forestry and marine industries. • Data collected from research can be used to predict how crops will change as a result of climate changes.

3.5 Topic 3: Agricultural management, research and innovation

In this topic, students will:

Subject matter	Guidance
Enterprise management • identify and 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. • identify and describe management practices (e.g. crop rotation, cell grazing, paddock rotation, water harvesting).	• **Notional time:** 5 hours • Sources of information could include research organisations, and private and government enterprises (e.g. Department of Agriculture and Fisheries (DAF), Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities). • Students could use a case study on land use (e.g. mining, urbanisation, clearing of natural vegetation, land rights, environmental protection) to explore issues related to sustainable property management. • Refer to the glossary for definitions of crop rotation, cell grazing, paddock rotation and water harvesting. • **SHE:** Agricultural science is a global enterprise that relies on clear communication and access to peer-reviewed sources of information to make informed decisions. • **SHE:** The use and acceptance of animal welfare requirements is influenced by social, economic, cultural and ethical perceptions. • **Syllabus link:** Unit 4 Topic 1: Enterprise management.

Subject matter	Guidance
Developments in agricultural technologies • explain what the research and development process involves in an agricultural context • identify a range of existing and emerging technologies • describe and evaluate 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.	• **Notional time:** 5 hours • Agricultural technologies could include – alternative energy sources – satellite technologies, e.g. global imaging and global positioning systems (GPS), controlled traffic – computer technologies, e.g. climate/weather forecasting, remote sensing, laser technologies and computer recordkeeping systems – biotechnologies, e.g. genetically modified organisms – electronic identification systems, e.g. National Livestock Identification System (NLIS) – robotics, e.g. milking, shearing and machinery, greenhouses – autonomous vehicles, e.g. weed control, pickers and tractors – unmanned aerial vehicles (UAV), e.g. drones. • An evaluation of an existing or emerging technology could use the process and production skills outlined in the P–10 Australian curriculum: Design and Technologies. • **SHE:** 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.
Adopting technologies in agriculture • investigate an existing or emerging technology for an agricultural enterprise using a case study approach to solve an issue. The case study should include the following steps: – identify and explain the issue – identify and analyse possible technological solutions – evaluate 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.	• **Notional time:** 5 hours • **SHE:** Different technologies can be adopted in agricultural enterprises to manage the available physical and biological resources.
Science as a Human Endeavour (SHE)	

Subject matter	Guidance
• SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• 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. • International perspectives are required for effective innovation in agriculture. • Technology assists in mitigating risk in agricultural production systems.

3.6 Assessment guidance

In constructing assessment instruments for Unit 2, schools should ensure that the objectives cover, or are chosen from, the unit objectives. If one assessment instrument is developed for a unit, it must assess all the unit objectives; if more than one assessment instrument is developed, the unit objectives must be covered across those instruments.

It is suggested that student performance on Unit 2 is assessed using techniques modelled on the techniques used in Unit 4:

- a research investigation
- an examination that includes some items modelled on the data test.

4 Unit 3: Agricultural production

4.1 Unit description

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.

4.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective must be assessed at least once.

Students will:

Unit objective	IA1	IA2	EA
1. describe and explain animal and plant production, and agricultural enterprises			•
2. apply understanding of animal and plant production, and agricultural enterprises	•	•	•
3. analyse evidence about animal and plant production, and agricultural enterprises	•	•	•
4. interpret evidence about animal and plant production, and agricultural enterprises	•	•	•
5. investigate phenomena associated with animal and plant production, and agricultural enterprises		•	
6. evaluate processes, claims and conclusions about animal and plant production, and agricultural enterprises		•	
7. communicate understandings, findings, arguments and conclusions about animal and plant production, and agricultural enterprises.		•	

4.3 Topic 1: Animal production B

In this topic, students will:

Subject matter	Guidance
Animal production • recall the different types of agricultural production animals • recall definitions for animal husbandry and breed • recall a range of regionally significant agricultural animals • recall physical characteristics of different breeds of animals and how they relate to the environment and/or feeding behaviour of the animal • define and describe the range of factors that influence animal production – nutrition – genetics – climate and weather – disease – management practices.	• **Notional hours:** 3 hours • **Syllabus link:** Animal production links to Unit 1 Topic 2: Animal production A.
Animal nutrition • define and describe the components of nutrition, including uses and types of food, digestibility and palatability, diet and ration • identify the main nutrients (i.e. carbohydrates, protein, fat, vitamins, minerals and water) required by agricultural animals and their function in body systems • describe the physiological process of digestion, including protein, carbohydrates and fats • describe the microscopic organisms (i.e. bacteria, protozoa and anaerobic fungi) found in ruminant digestive systems and the function they play in animal nutrition • compare and analyse feed labels (e.g. chick starter, pullet grower, laying mash/pellets) for different agricultural animals at various growth or production stages. Consider the nutritional requirements based on demand (e.g. exercise level, maintenance and reproductive requirements) for the chosen examples	• **Notional time:** 8 hours • Refer to the glossary for a definition of nutrition. • An introductory explanation of protein, carbohydrate and fat digestion in terms of the end products for each nutrient that animals require is sufficient. It is not necessary to describe the actual chemical processes that occur (e.g. protein to amino acids). • Anatomical structures and physiological functions of animal systems determine the nutrient requirements and efficiency of animals. • Students could investigate examples of animal nutrient requirements for different types of animals (e.g. horses, cattle, poultry, fish) and level of metabolic demand. • **Formula:** Feed conversion ratio = $\frac{\text{mass of food eaten (kg)}}{\text{mass gained by the animal (kg)}}$

Subject matter	Guidance
• construct a labelled diagram to show metabolic pathways, including energy flows such as gross, digestible, metabolisable, net, maintenance and production energy • describe protein metabolism in ruminants and explain its importance to animal production with reference to protein sources, including microbial protein, crude protein, and non-protein nitrogen • describe the metabolism of carbohydrates and fats and their uptake in both monogastric and ruminant digestive systems • describe energy metabolic pathways • 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)) to make decisions about animal rations • calculate and analyse feed conversion ratios for different animals.	• Refer to the glossary for definitions of digestible energy, net energy, crude protein, microbial protein, ration and feed conversion ratio. • **SHE:** An understanding of the ruminant digestive system can help farmers make decisions to maximise animal growth. • **SHE:** Development of animal nutrition models requires a wide range of evidence from multiple disciplines. • **Suggested practical:** Survey pastures or use secondary data from satellite images (including vegetation maps) to analyse results to make reasoned judgments and make decisions about quality and quantity of available food. • **Suggested practical:** Formulate a ration for a selected animal.
Animal growth and development • define animal growth and development • identify and describe the principles that underpin animal growth and development • identify and describe the factors, including nutrition, genetics, animal health and management, that will affect animal growth and development • describe and compare the different stages of growth and development, including conception, birth, puberty and maturity, using a variety of visual representations • analyse primary and/or secondary data to compare relative growth rates at different stages of an animal's development • identify different markets for animals (i.e. domestic and export) • define and describe market specifications (e.g. Meat Standards Australia (MSA), Authority for Uniform Specification Meat and Livestock (AUS-MEAT), Australian Pork Ltd (APL)) • compare the proportions of bone, muscle and fat at various stages of development in an animal and relate these to market requirements • discuss and analyse the use of hormones and antibiotics in animal production • analyse carcass data to assess suitability based on market specifications.	• Notional time: 5 hours • Refer to the glossary for definitions of animal growth and development. • The topic should be developed by linking knowledge of tissues in terms of type and value to marketing of animal agricultural products. • Students should consider a marketing system for an animal of regional significance. • A discussion of hormones and antibiotics in animal production could include current claims about the use of growth promotants in cattle or antibiotics in meat chicken production. • In the mandatory practical, carcasses could include poultry, fish and cuts of meat that come from larger animals such as pigs, sheep or beef cattle. • **SHE:** A knowledge of growth rate and carcass development can be used to make decisions about appropriate feed sources needed to meet production goals. • **Suggested practical:** Analyse graphs of animal developmental stages, including bone, muscle and fat proportions, and summarise the information for a producer.

Subject matter	Guidance
• **Mandatory practical:** Compare the bone, muscle and fat percentages of different carcasses or cuts that are commercially available.	• **Suggested practical:** Analyse primary or secondary growth data to make judgments about animal nutrition. Students could analyse the growth data of animals in schools, ensuring that any work with animals is conducted in accordance with the 'Care and use of animals for scientific purposes' principles outlined in Section 1.2.4. • **Suggested practical:** Analyse carcass feedback data and assess correlation with 'on-the-hoof judgments' (the practice of accurately aging an animal based on their body characteristics and proportions).
Animal health • define the terms pest and disease • describe the following four types of disease: metabolic, genetic, microbial and metazoal • describe the health and economic effects of two diseases of regional significance • describe and 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 • analyse and evaluate secondary data to compare different chemical and biological control measures for animal pests and diseases, including vaccinations, inorganic and organic pesticides • explain an example of a successful and an unsuccessful biological control method (e.g. the use of dung beetles to control buffalo fly and the introduction of cane toads) • analyse the features of both intensive and extensive animal industries and their impact on the management of animal pests and diseases • define the terms exotic disease, notifiable disease and biosecurity	• **Notional time:** 6 hours • Refer to the glossary for definitions of pest and disease. • A discussion about disease could include environmental influences such as heat or cold stress and behaviour. • Regionally significant diseases with economic effects could include tick fever, clostridial disease and parasitic worms. • A discussion about diseases could include identification of a local or regional example for each type of disease. • Refer to glossary for definitions of exotic disease, notifiable disease and biosecurity. • Exotic diseases could include foot-and-mouth disease, mad cow disease, Newcastle disease and rabies. Information about exotic diseases can be found on the Queensland Department of Agriculture and Fisheries website: www.daf.qld.gov.au. • Notifiable diseases could include Bovine Johne's disease (BJD), Hendra virus, avian influenza, equine influenza and brucellosis. • A discussion about the biosecurity of animals could include the control of pest organisms such as weeds, introduced species, pathogens and parasites. • **SHE:** Advances in vaccination protocols can inform the monitoring, assessment and evaluation of the risk posed by animal diseases. • **SHE:** 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. • **SHE:** International collaboration is often required when investigating biosecurity issues.

Subject matter	Guidance
• evaluate the potential impact of an exotic or notifiable disease on an agricultural production system • investigate and evaluate biosecurity and disease management in animal production and the impact it has on management strategies.	
Animal ethics and welfare • define animal ethics • define animal 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 at least one animal welfare issue associated with production practices such as mulesing, live export, battery-cage egg production or use of farrowing crates • evaluate how consumer trends/demands have impacted on animal welfare in a production system.	• **Notional time:** 4 hours • Refer to the glossary for definitions of animal ethics and animal welfare. • In schools that have animals, students should review safe handling procedures before hands-on practical activities and any work with animals is conducted in accordance with the 'Care and use of animals for scientific purposes' principles outlined in Section 1.2.4. • Discussion of standard operating procedures could include model codes of practice for the welfare of animals. • A discussion of animal ethics and welfare could include the concept of animal rights and the influence of anthropomorphism. • **SHE:** Models of sustainable animal production systems are refined and replaced based on new evidence associated with animal welfare considerations in food and fibre production. • **SHE:** Current community perceptions are influencing the systems used to produce animal products (e.g. eggs). • **SHE:** Science can be limited in its ability to provide definitive answers to public debate on animal welfare issues. • **Suggested practical:** Select and perform appropriate safe handling and management techniques for the care and welfare of agricultural animals. • **Suggested practical:** Monitor and record the physical aspects of the environment of a selected animal.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• State and federal governments continue to develop and refine models to describe the type and level of response needed and to resource the appropriate authorities required to act in adverse conditions. • Integrated pest management strategies can be used to develop and evaluate effective pest and disease control and protect the environment.

4.4 Topic 2: Plant production B

In this topic, students will:

Subject matter	Guidance

Plant production
• describe and explain important agronomic practices
  – 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
• describe and 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 auxins, gibberellins, ethylene, cytokinins and abscisic acid) on production systems
• analyse and evaluate the use of hormones to manipulate plant production
• describe and explain processes in post-harvest technologies (e.g. post-harvest transport, ripening and product handling).
• **Mandatory practical:** Design and conduct a plant trial to collect and analyse primary data on a factor that affects plant production.
	• **Notional time:** 7 hours
	• A discussion about plant spacing could include intra-row and inter-row spacing.
	• The management of nutrient cycles (e.g. carbon, nitrogen) can influence plant health and productivity.
	• A discussion of water management could include measuring crop water requirements, irrigation types, scheduling and monitoring.
	• Refer to the glossary for a definition of cultural practices.
	• In the mandatory practical, factors that can be manipulated to influence plant production and investigated include planting requirements, water, nutrients, pest and disease management, and cultural practices.
	• The plant production topic could be covered by investigating a selected crop as a case study.
	• **SHE:** Water buyback schemes can affect economic, social and environmental activity in communities.
	• **SHE:** 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.
	• **SHE:** The use of applications (apps) is allowing agricultural producers to quickly assess plant production issues (e.g. pest identification) to solve problems.
	• **Suggested practical:** Analyse primary or secondary data to make judgments about the impact that plant hormones have on production.
	• **Syllabus link:** Plant production links to Unit 1 Topic 3: Plant production A.

Subject matter	Guidance

Plant health
• define and describe pesticide, insecticide, herbicide, fungicide and nematicide
• define integrated pest management (IPM), integrated disease management (IDM) and integrated weed management (IWM)
• identify and describe four pests and diseases that are significant to an important regional plant industry (e.g. wheat, sugar cane)
• describe and explain different types of control measures for plant pests, weeds and diseases
  – 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.
	• **Notional time:** 5 hours
	• Refer to the glossary for definitions of pesticide, insecticide, herbicide, fungicide, nematicide, integrated pest management (IPM), integrated disease management (IDM) and integrated weed management (IWM).
	• A discussion of plant breeding could include genetically modified varieties, such as Bollgard® cotton.
	• Students could research case studies of IPM in plant industries.
	• **SHE:** Information gathered from checking crops for plant health can assist farmers to monitor, assess and evaluate risk.
	• **SHE:** Advances in IPM and IDM strategies can influence pest and disease control and their environmental impacts.

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
• describe and explain genetic techniques used in breeding new plant varieties, including
  – crossbreeding
  – tissue culture
  – hybridisation
  – genetic modification.
	• **Notional time:** 3 hours
	• Plant propagation techniques could also include tubers, rhizomes, runners and marcotting.
	• **Suggested practical:** Visit sites where different crops are being grown to discuss plant variety selection and the importance of these crops to the regional area.

Subject matter	Guidance
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• 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. • 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.

4.5 Topic 3: Agricultural enterprises B

In this topic, students will:

Subject matter	Guidance
Agricultural products • identify and describe examples of agricultural products (including raw, processed and value-added products) and where they go once 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 • define and 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 how the trade of agricultural products affects local and international economies (e.g. imports, exports) • analyse demand and supply data for a specific agricultural product and make predictions. • **Mandatory practical:** Conduct an investigation into post-harvest handling of fresh plant products and its impact on product quality.	• **Notional time:** 4 hours • This topic is best completed within a context of animal and plant production rather than as a discrete unit. • Marketing techniques could include direct, online, auctions and forward-selling (futures). • Examples of quality assurance processes could include CattleMAP, SheepMAP, GrainCare, FIBREpak and Freshcare. • Refer to the glossary for a definition of the law of supply and demand. • Post-harvest handling could include ripening, packaging, storage and transport. • **SHE:** The use of agricultural knowledge is influenced by economic considerations such as the law of supply and demand. • **Suggested practical:** Design and conduct a survey in your class, school or community for a given agricultural product to determine factors influencing demand. Analyse and evaluate the survey results to make judgments. • **Suggested practical:** 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. • **Syllabus link:** Agricultural products links to Unit 3 Topics 1 and 2.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for a research investigation.	• Advances in food and fibre production can be used to develop and evaluate Australia's food security and economy. • The use and acceptance of new agricultural products is influenced by consumer demands.

4.6 Assessment

4.6.1 Summative internal assessment 1 (IA1): Data test (10%)

Description

This assessment focuses on the application of a range of cognitions to multiple provided items.

Student responses must be completed individually, under supervised conditions, and in a set timeframe.

Assessment objectives

This assessment technique is used to determine student achievement in the following 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 evidence 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.

Note: Objectives 1, 5, 6 and 7 are not assessed in this instrument.

Specifications

Description

Students respond to items using qualitative data and/or quantitative data derived from the mandatory or suggested practicals, activities or case studies from the unit being studied.

The data test contains two to four datasets and consists of a number of different types of items, which include:

- short response items requiring single-word, sentence or short paragraph responses
- calculating using algorithms
- interpreting datasets.

Mark allocations

Percentage of marks	Objective	Cognition and nature of response
~ 30%	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	Students calculate, identify, recognise and use evidence to determine unknown scientific quantities or features.
~ 30%	3. analyse evidence about animal production, plant production or agricultural enterprises to identify trends, patterns, relationships, limitations or uncertainty in datasets	Students categorise, classify, contrast, distinguish, organise or sequence evidence to identify trends, patterns, relationships, limitations or uncertainty in datasets.
~ 40%	4. interpret evidence about animal production, plant production or agricultural enterprises to draw conclusions based on analysis of datasets	Students compare, deduce extrapolate, infer, justify or predict using evidence to draw conclusions based on analysis of the datasets.

Conditions

- Time: 60 minutes plus 10 minutes perusal.
- Length: up to 500 words in total, consisting of
  - short responses, i.e. single words, sentences or short paragraphs (fewer than 50 words)
  - paragraphs, 50–250 words per item
  - other types of item responses (e.g. interpreting and calculating) should allow students to complete the response in the set time.
- Other:
  - QCAA-approved graphics calculator permitted
  - unseen stimulus.

Summary of the instrument-specific marking guide

The following table summarises the criteria, assessment objectives and mark allocation for the data test.

Criterion	Objectives	Marks
Data test	2, 3, 4	10
Total		**10**

Note: Unit objectives 1, 5, 6 and 7 are not assessed in this instrument.

Instrument-specific marking guide

Criterion: Data test

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 evidence 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

The student work has the following characteristics:	Cut-off	Marks
• consistent demonstration, across a range of scenarios about animal production, plant production or agricultural enterprises, 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, in scenarios about animal production, plant production or agricultural enterprises, 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, in scenarios about animal production, plant production or agricultural enterprises, 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 or uncertainty – correct interpretation of evidence to draw valid conclusions.	> 50%	6
	> 40%	5

The student work has the following characteristics:	Cut-off	Marks
• demonstration, in scenarios about animal production, plant production or agricultural enterprises, 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, in scenarios about animal production, plant production or agricultural enterprises, 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
• does not satisfy any of the descriptors above.	≤ 1%	0

4.6.2 Summative internal assessment 2 (IA2): Student experiment (20%)

Description

This assessment requires students to research a question or hypothesis through collection, analysis and synthesis of primary data. A student experiment uses investigative practices to assess a range of cognitions in a particular context. Investigative practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

2. apply understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies and process primary data
3. analyse experimental evidence about animal production, plant production or agricultural enterprises
4. interpret experimental evidence about animal production, plant production or agricultural enterprises
5. investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment
6. evaluate experimental processes and conclusions about animal production, plant production or agricultural enterprises
7. communicate understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises.

Note: Objective 1 is not assessed in this instrument.

Specifications

Description

In the student experiment, students modify (i.e. refine, extend or redirect) an experiment in order to address their own related hypothesis or question. It is sufficient that students use a practical performed in class or a simulation as the basis for their methodology and research question.

In order to complete the assessment task, students must:

- 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 sufficient and 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 the 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 extensions to the experiment
- communicate findings in an appropriate scientific genre (e.g. report, poster presentation, journal article, conference presentation).

*The steps indicated with an asterisk above may be completed in groups. All other elements must be completed individually.

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.

Conditions

- Time: 10 hours class time. This time will not necessarily be sequential. Students must perform the majority of the task during class time, including
  - performing background research and developing the methodology
  - conducting the experiment
  - processing and analysing evidence and evaluating the methodology
  - preparing and presenting the response (e.g. writing the scientific report, constructing and presenting the scientific poster).
- Length:
  - written (e.g. scientific report), 1500–2000 words

    or
  - multimodal presentation (e.g. scientific poster presentation), 9–11 minutes.
- Other:
  - students may work collaboratively with other students to develop the methodology and perform the experiment; all other stages (e.g. processing of data, analysis of evidence and evaluation of the experimental process) must be carried out individually
  - the response must be presented using an appropriate scientific genre (e.g. report, poster presentation, journal article, conference presentation) and contain
    - a research question
    - a rationale for the experiment
    - reference to the initial experiment and identification and justification of modifications to the methodology
    - raw and processed qualitative data and/or quantitative data
    - analysis of the evidence
    - conclusion/s based on the interpretation of the evidence
    - evaluation of the methodology and suggestions of improvements and extensions to the experiment
    - a reference list.

Summary of the instrument-specific marking guide

The following table summarises the criteria, assessment objectives and mark allocation for the student experiment.

Criterion	Objectives	Marks
Research and planning	2, 5	6
Analysis of evidence	2, 3, 5	6
Interpretation and evaluation	4, 6	6
Communication	7	2
Total		**20**

Note: Unit objective 1 is not assessed in this instrument.

Instrument-specific marking guide

Criterion: Research and planning

Assessment objectives

2. apply understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies and process primary data
5. investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment

The student work has the following characteristics:	Marks
• informed application of understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies demonstrated by – a considered rationale for the experiment – justified modifications to the methodology • effective and efficient investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by – a specific and relevant research question – a methodology that enables the collection of sufficient, relevant data – considered management of risks and ethical or environmental issues.	5–6
• adequate application of understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies demonstrated by – a reasonable rationale for the experiment – feasible modifications to the methodology • effective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by – a relevant research question – a methodology that enables the collection of relevant data – management of risks and ethical or environmental issues.	3–4

The student work has the following characteristics:	Marks
• rudimentary application of understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies demonstrated by – a vague or irrelevant rationale for the experiment – inappropriate modifications to the methodology • ineffective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by – an inappropriate research question – a methodology that causes the collection of insufficient and irrelevant data – inadequate management of risks and ethical or environmental issues.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Analysis of evidence

Assessment objectives

2. apply understanding of animal production, plant production or agricultural enterprises to modify experimental methodologies and process primary data
3. analyse experimental evidence about animal production, plant production or agricultural enterprises
5. investigate phenomena associated with animal production, plant production or agricultural enterprises through an experiment

The student work has the following characteristics:	Marks
• appropriate application of algorithms, visual and graphical representations of data about animal production, plant production or agricultural enterprises demonstrated by correct and relevant processing of data • systematic and effective analysis of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by – thorough identification of relevant trends, patterns or relationships – thorough and appropriate identification of the uncertainty and limitations of evidence • effective and efficient investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by the collection of sufficient and relevant raw data.	5–6
• adequate application of algorithms, visual and graphical representations of data about animal production, plant production or agricultural enterprises demonstrated by basic processing of data • effective analysis of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by – identification of obvious trends, patterns or relationships – basic identification of uncertainty and limitations of evidence • effective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by the collection of relevant raw data.	3–4

The student work has the following characteristics:	Marks
• rudimentary application of algorithms, visual and graphical representations of data about animal production, plant production or agricultural enterprises demonstrated by incorrect or irrelevant processing of data • ineffective analysis of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by – identification of incorrect or irrelevant trends, patterns or relationships – incorrect or insufficient identification of uncertainty and limitations of evidence • ineffective investigation of phenomena associated with animal production, plant production or agricultural enterprises demonstrated by the collection of insufficient and irrelevant raw data.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Interpretation and evaluation

Assessment objectives

4. interpret experimental evidence about animal production, plant production or agricultural enterprises
6. evaluate experimental processes and conclusions about animal production, plant production or agricultural enterprises

The student work has the following characteristics:	Marks
• insightful interpretation of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by justified conclusion/s linked to the research question • critical evaluation of experimental processes about animal production, plant production or agricultural enterprises demonstrated by – 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.	5–6
• adequate interpretation of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by reasonable conclusion/s relevant to the research question • basic evaluation of experimental processes about animal production, plant production or agricultural enterprises demonstrated by – reasonable description of the reliability and validity of the experimental process – suggested improvements and extensions to the experiment that are related to the analysis of evidence.	3–4
• invalid interpretation of experimental evidence about animal production, plant production or agricultural enterprises demonstrated by inappropriate or irrelevant conclusion/s • superficial evaluation of experimental processes about animal production, plant production or agricultural enterprises demonstrated by – cursory or simplistic statements about the reliability and validity of the experimental process – ineffective or irrelevant suggestions.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Communication

Assessment objective

7. communicate understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises

The student work has the following characteristics:	Marks
• effective communication of understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises demonstrated by – fluent and concise use of scientific language and representations – appropriate use of genre conventions – acknowledgment of sources of information through appropriate use of referencing conventions.	2
• adequate communication of understandings and experimental findings, arguments and conclusions about animal production, plant production or agricultural enterprises demonstrated by – competent use of scientific language and representations – use of basic genre conventions – use of basic referencing conventions.	1
• does not satisfy any of the descriptors above.	0

4.6.3 Summative external assessment (EA): Examination (50%)

General information

Summative external assessment is developed and marked by the QCAA. In Agricultural Science, it contributes 50% to a student's overall subject result.

Summative external assessment assesses learning from both Units 3 and 4.

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.

See Section 5.5.2.

5 Unit 4: Agricultural management

5.1 Unit description

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.

5.2 Unit objectives

Unit objectives are drawn from the syllabus objectives and are contextualised for the subject matter and requirements of the unit. Each unit objective must be assessed at least once.

Students will:

Unit objective	IA3	EA
1. describe and explain enterprise management and evaluation of an agricultural enterprise		•
2. apply understanding of enterprise management and evaluation of an agricultural enterprise	•	•
3. analyse evidence about enterprise management and evaluation of an agricultural enterprise	•	•
4. interpret evidence about enterprise management and evaluation of an agricultural enterprise	•	•
5. investigate phenomena associated with enterprise management and evaluation of an agricultural enterprise	•	
6. evaluate processes, claims and conclusions about enterprise management and evaluation of an agricultural enterprise	•	
7. communicate understandings, findings, arguments and conclusions about enterprise management and evaluation of an agricultural enterprise.	•	

5.3 Topic 1: Enterprise management

In this topic, students will:

Subject matter	Guidance
Data for decision-making • identify and describe 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 and analyse gross margins and the law of diminishing returns. • **Mandatory practical:** Analyse a range of primary and/or secondary data about plant or animal production to make justified management decisions. Data sources should include at least one of the following: estimated breeding values (EBVs), live weight gain data, milk production, or grain yield from different crop varieties.	• **Notional time:** 6 hours • **Formula:** Gross margin = total income – variable costs • **Formula:** $\text{Daily weight gain} = \frac{\text{(end weight – initial weight)}}{\text{number of days}}$ • **SHE:** 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. • **SHE:** The use of different software packages can increase the size, accuracy and temporal scope of datasets that influence the decision-making process. • **Suggested practical:** Students can create or access a database using agricultural business software (e.g. Livestocked, PS Stockbook, Phoenix) on an electronic device to keep a record of the agricultural physical resources at the school or another appropriate local external site.
Decision-making in property management • recall 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 • identify reliable sources of information that producers can use to make decisions	• **Notional time:** 8 hours • A discussion about the level of chemical usage could address decisions made by farmers to apply natural chemicals and seek organic accreditation. • Sources of information could include research organisations, and private and government enterprises (e.g. Department of Agriculture and Fisheries (DAF), Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities). • Identification and sources of risk in property management could include workplace health and safety, natural hazards and economics. • Students could use a case study on land use (e.g. mining, urbanisation, clearing of natural vegetation, land rights, environmental protection) to explore issues related to sustainable property management. • Refer to the glossary for definitions of crop rotation, cell grazing, paddock rotation and water harvesting.

Subject matter	Guidance
• describe and apply risk-management strategies for property management • describe and evaluate management practices (e.g. crop rotation, cell grazing, paddock rotation, water harvesting). • **Mandatory practical:** Assess 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.	• **SHE:** Agricultural science is a global enterprise that relies on clear communication and access to peer-reviewed sources of information to make informed decisions. • **SHE:** The use and acceptance of animal welfare requirements is influenced by social, economic, cultural and ethical perceptions. • **Syllabus link:** Decision-making in property management links to Unit 2 Topic 3: Agricultural management, research and innovation.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for the research investigation.	• 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. • 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.

5.4 Topic 2: Evaluation of an agricultural enterprise's sustainability

In this topic, students will:

Subject matter	Guidance

Environmental factors
• explain how the sustainable use of a resource (i.e. water, soil, biota) depends on its abundance and replenishment rate
• assess the opportunity for sustainable practices in an agricultural production system using the criteria of
  – resource management
  ▪ physical
  ▪ biological
  – 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
• understand key issues that impact on agricultural production, including dryland salinity, erosion, drought and water quality.
	• **Notional time:** 13 hours
	• Sustainability of renewable resources could be assessed from a local, regional, national or global scale (e.g. overuse of water allocation in irrigation schemes, use of alternative energies and biofuels, overharvesting of aquatic species from native fisheries).
	• Students could consider
	  – the connection that Aboriginal peoples have to Country and that Torres Strait Islander peoples have to Place that enables a sustainable environment
	  – the intricate way that culture and a community's Country or Place (land, environment) is part of who they are (e.g. highlight links between the task of land management and how the oral tradition of storytelling enables survival of a community).
	• Resource management could include
	  – physical
	  ▪ land management could include precision agriculture (e.g. controlled traffic, conservation tillage) and whole-farm planning (e.g. catchment management, fencing, wildlife corridors, land care, soil degradation)
	  ▪ water management could include on-farm storage, storage in the soil profile, irrigation, recycling water and managing catchments
	  – biological
	  ▪ plant and animal selection as important considerations for water efficiency (e.g. water-efficient crops, feed conversion ratio (FCR) of different industries)
	  ▪ effective plant and animal management practices leading to the sustainability of natural resources (e.g. vegetation management, pest management, crop rotation).
	• Waste management could include
	  – chemical and fertiliser residue and run-off
	  – plant residue and animal waste management for promoting nutrient cycling and efficient production (e.g. stubble management, composting, effluent

Subject matter	Guidance
	ponding and carbon sequestration) – on-farm energy production and use (e.g. solar production, methane and biofuel production). • **Syllabus link:** Environmental factors links to Unit 2: Resources.
Financial factors • describe and explain risk-avoidance strategies (including diversification, alternative sources of income and capital investment) for agricultural producers, using examples • analyse, evaluate and make judgments 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 • evaluate different methods of production of the same agricultural product • evaluate management and ownership structures, including sole trader, partnership, company and trusts • discuss free trade agreements, including competition and import and export agreements • describe, investigate and evaluate the advantages and disadvantages of different ownership structures, including succession planning and its impact on agricultural enterprises • describe and explain the impact of government decisions and policies on agricultural enterprises • analyse and evaluate the impact of free trade agreements on agricultural products.	• **Notional time:** 9 hours • Risk management and decision-making determine the short-term and long-term success of agricultural production systems (e.g. sustainability of production methods). • Types of agricultural enterprises could include small business, franchise, cooperative, multinational, corporate, share farming, contract farming. • **SHE:** Foreign ownership may provide a potential ownership model for sustainable agricultural production in Australia. • **SHE:** Live export of animals is important to global trade in the Asia–Pacific region. • **Syllabus link:** Financial factors links to Unit 2 Topic 3: Agricultural management, research and innovation.

Subject matter	Guidance
Social factors • assess the opportunity for sustainable social practices in an agricultural production system, using the criteria of – labour ▪ employment ▪ welfare – infrastructure – standard of living ▪ health and nutrition ▪ population distribution ▪ education ▪ income ▪ food quality ▪ food security.	• **Notional time:** 9 hours • Assessment of labour could include demand, availability and working conditions (e.g. backpacker labour, work visas, fair trade, implementation of technology). • Assessment of infrastructure could include social facilities and services, transport networks, utilities and telecommunications. • Assessment of standard of living could include worldwide health trends such as obesity, socioeconomic movement (e.g. increase in middle class population in market destinations such as China and India), food demand doubling by 2050, population growth, clean and green production and demand from contaminated environments (e.g. Northern Japan, Fukushima). • **SHE:** Working visas are important to agricultural enterprises in Queensland.
Science as a Human Endeavour (SHE) • SHE subject matter will not be assessed on the external examination but could be used in the development of claims and research questions for the research investigation.	• 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 upon international collaboration.

5.5 Assessment

5.5.1 Summative internal assessment 3 (IA3): Research investigation (20%)

Description

This assessment requires students to evaluate a claim. They will do this by researching, analysing and interpreting secondary evidence from scientific texts to form the basis for a justified conclusion about the claim. A research investigation uses research practices to assess a range of cognitions in a particular context. Research practices include locating and using information beyond students' own knowledge and the data they have been given.

Research conventions must be adhered to. This assessment occurs over an extended and defined period of time. Students may use class time and their own time to develop a response.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

2. apply understanding of enterprise management or evaluation of an agricultural enterprise to develop research questions
3. analyse research evidence about enterprise management or evaluation of an agricultural enterprise
4. interpret research evidence about enterprise management or evaluation of an agricultural enterprise
5. investigate phenomena associated with enterprise management or evaluation of an agricultural enterprise through research
6. evaluate research processes, claims and conclusions about enterprise management or evaluation of an agricultural enterprise
7. communicate understandings and research findings, arguments and conclusions about enterprise management or evaluation of an agricultural enterprise.

Note: Objective 1 is not assessed in this instrument.

Specifications

Description

In the research investigation, students gather secondary evidence related to a research question in order to evaluate the claim. The students develop their research question based on a number of possible claims provided by their teacher. Students work individually throughout this task.

Evidence must be obtained by researching scientifically credible sources, such as scientific journals, books by well-credentialed scientists and websites of governments, universities, independent research bodies or science and technology manufacturers.

In order to complete the assessment task, students must:

- select a claim to be evaluated
- identify the relevant scientific concepts associated with the claim
- pose a research question addressing an aspect of the claim

- conduct research to gather scientific evidence that may be used to address the research question and subsequently evaluate the claim
- analyse the data to identify sufficient and relevant evidence
- identify the trends, patterns or relationships in the evidence
- analyse the evidence to identify limitations
- interpret the evidence to construct justified scientific arguments
- interpret the evidence to form a justified conclusion to the research question
- discuss the quality of the evidence
- evaluate the claim by extrapolating the findings of the research question to the claim
- suggest improvements and 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.

Conditions

- Time: 10 hours class time. This time will not necessarily be sequential. Students must perform the majority of the task during class time, including
  - performing background research
  - developing the research question
  - collecting scientific evidence
  - analysing and interpreting evidence and evaluating the claim
  - preparing and presenting the response (e.g. writing the scientific essay).
- Length:
  - written (e.g. scientific essay), 1500–2000 words

    or
  - multimodal presentation (e.g. scientific conference presentation), 9–11 minutes.
- Other:
  - students are to work individually throughout this task
  - the response must be presented using an appropriate scientific genre (e.g. report, journal article, essay, conference presentation) and contain
    - a claim
    - a research question
    - a rationale for the investigation
    - justified scientific arguments using evidence
    - a conclusion to the research question based on the interpretation of the evidence
    - evaluation of the claim and suggestions of improvements and extensions to the investigation
    - a reference list.

Summary of the instrument-specific marking guide

The following table summarises the mark allocation for the objectives assessed in the research investigation.

Criterion	Objectives	Marks
Research and planning	2, 5	6
Analysis and interpretation	3, 4	6
Conclusion and evaluation	4, 6	6
Communication	7	2
Total		**20**

Note: Unit objective 1 is not assessed in this instrument.

Instrument-specific marking guide

Criterion: Research and planning

Assessment objectives

2. apply understanding of enterprise management or evaluation of an agricultural enterprise to develop research questions
5. investigate phenomena associated with enterprise management or evaluation of an agricultural enterprise through research

The student work has the following characteristics:	Marks
• informed application of understanding of enterprise management or evaluation of an agricultural enterprise demonstrated by a considered rationale identifying clear development of the research question from the claim • effective and efficient investigation of phenomena associated with enterprise management or evaluation of an agricultural enterprise demonstrated by – a specific and relevant research question – selection of sufficient and relevant sources.	5–6
• adequate application of understanding of enterprise management or evaluation of an agricultural enterprise demonstrated by a reasonable rationale that links the research question and the claim • effective investigation of phenomena associated with enterprise management or evaluation of an agricultural enterprise demonstrated by – a relevant research question – selection of relevant sources.	3–4
• rudimentary application of understanding of enterprise management or evaluation of an agricultural enterprise demonstrated by a vague or irrelevant rationale for the investigation • ineffective investigation of phenomena associated with enterprise management or evaluation of an agricultural enterprise demonstrated by – an inappropriate research question – selection of insufficient and irrelevant sources.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Analysis and interpretation

Assessment objectives

3. analyse research evidence about enterprise management or evaluation of an agricultural enterprise
4. interpret research evidence about enterprise management or evaluation of an agricultural enterprise

The student work has the following characteristics:	Marks
• systematic and effective analysis of qualitative data and/or quantitative data within the sources about enterprise management or evaluation of an agricultural enterprise demonstrated by – the identification of sufficient and relevant evidence – thorough identification of relevant trends, patterns or relationships – thorough and appropriate identification of limitations of evidence • insightful interpretation of research evidence about agricultural enterprise management or evaluation of an agricultural enterprise demonstrated by justified scientific argument/s.	5–6
• effective analysis of qualitative data and/or quantitative data within the sources about enterprise management or evaluation of an agricultural enterprise demonstrated by – the identification of relevant evidence – identification of obvious trends, patterns or relationships – basic identification of limitations of evidence • adequate interpretation of research evidence about agricultural enterprise management or evaluation of an agricultural enterprise demonstrated by reasonable scientific argument/s.	3–4
• rudimentary analysis of qualitative data and/or quantitative data within the sources about enterprise management or evaluation of an agricultural enterprise demonstrated by – the identification of insufficient and irrelevant evidence – identification of incorrect or irrelevant trends, patterns or relationships – incorrect or insufficient identification of limitations of evidence • invalid interpretation of research evidence about agricultural enterprise management or evaluation of an agricultural enterprise demonstrated by inappropriate or irrelevant argument/s.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Conclusion and evaluation

Assessment objectives

4. interpret research evidence about enterprise management or evaluation of an agricultural enterprise
6. evaluate research processes, claims and conclusions about enterprise management or evaluation of an agricultural enterprise

The student work has the following characteristics:	Marks
• insightful interpretation of research evidence about enterprise management or evaluation of an agricultural enterprise demonstrated by justified conclusion/s linked to the research question • critical evaluation of the research processes, claims and conclusions about enterprise management or evaluation of an agricultural enterprise demonstrated by – insightful 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.	5–6
• adequate interpretation of research evidence about enterprise management or evaluation of an agricultural enterprise demonstrated by reasonable conclusion/s relevant to the research question • basic evaluation of the research processes, claims and conclusions about enterprise management or evaluation of an agricultural enterprise demonstrated by – reasonable description of the quality of evidence – application of relevant findings of the research to the claim – suggested improvements and extensions to the investigation that are relevant to the claim.	3–4
• invalid interpretation of research evidence about enterprise management or evaluation of an agricultural enterprise demonstrated by inappropriate or irrelevant conclusion/s • superficial evaluation of the research processes, claims and conclusions about enterprise management or evaluation of an agricultural enterprise demonstrated by – 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.	1–2
• does not satisfy any of the descriptors above.	0

Criterion: Communication

Assessment objective

7. communicate understandings and research findings, arguments and conclusions about enterprise management or evaluation of an agricultural enterprise

The student work has the following characteristics:	Marks
• effective communication of understandings and research findings, arguments and conclusions about enterprise management or evaluation of an agricultural enterprise demonstrated by – fluent and concise use of scientific language and representations – appropriate use of genre conventions – acknowledgment of sources of information through appropriate use of referencing conventions.	2
• adequate communication of understandings and research findings, arguments and conclusions about enterprise management or evaluation of an agricultural enterprise demonstrated by – competent use of scientific language and representations – use of basic genre conventions – use of basic referencing conventions.	1
• does not satisfy any of the descriptors above.	0

5.5.2 Summative external assessment (EA): Examination (50%)

General information

Summative external assessment is developed and marked by the QCAA. In Agricultural Science, it contributes 50% to a student's overall subject result.

Summative external assessment assesses learning from both Units 3 and 4.

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.

Description

The examination assesses the application of a range of cognitions to multiple provided items — questions, scenarios and problems.

Student responses must be completed individually, under supervised conditions and in a set timeframe.

Assessment objectives

This assessment technique is used to determine student achievement in the following objectives:

1. describe and explain 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 evidence 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.

Note: Objectives 5, 6 and 7 are not assessed in this instrument.

Specifications

Description

This examination will include two papers. Each paper consists of a number of different types of possible items:

- multiple choice
- short response items requiring single-word, sentence or paragraph responses
- calculating using algorithms
- interpreting graphs, tables or diagrams
- responding to unseen data and/or stimulus
- extended response (300–350 words or equivalent).

Conditions

Paper 1

- Time: 90 minutes plus 10 minutes perusal.
- Other: QCAA-approved graphics calculator permitted.

Paper 2

- Time: 90 minutes plus 10 minutes perusal.
- Other: QCAA-approved graphics calculator permitted.

Instrument-specific marking guide

No ISMG is provided for the external assessment.

6 Glossary

Term	Explanation
A	
abscisic acid	often referred to as an inhibitory hormone; it is involved in the closure of stomata, bud and seed dormancy
accomplished	highly trained or skilled in a particular activity; perfected in knowledge or training; expert
accuracy	the condition or quality of being true, correct or exact; freedom from error or defect; precision or exactness; correctness; in science, the extent to which a measurement result represents the quantity it purports to measure; an accurate measurement result includes an estimate of the true value and an estimate of the uncertainty
accurate	precise and exact; to the point; consistent with or exactly conforming to a truth, standard, rule, model, convention or known facts; free from error or defect; meticulous; correct in all details
acknowledgment	recognition of the authority or validity of something
adept	very/highly skilled or proficient at something; expert
adequate	satisfactory or acceptable in quality or quantity equal to the requirement or occasion
agricultural enterprise	agronomic or husbandry management practices performed with financial decisions implemented in the pursuit of producing a plant or animal product
algebraic representation	a set of symbols linked by mathematical operations; the set of symbols summarises relationships between variables (ACARA 2015c)
algorithm	an effective procedure for solving a particular mathematical problem in a finite number of steps
analyse	dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences
analysis	examination of evidence to identify the essential features, components, elements or structure; identification of patterns, similarities and differences
analytical technique	a procedure or method for analysing data
animal ethics	the study of human–non-human relations; includes animal rights, animal welfare and animal conservation (Brown, Hindmarsh & McGregor 2015)

Term	Explanation
animal growth	the process of increasing in size and weight
animal husbandry	controlled cultivation, management, and production of domestic animals, including improvement of the qualities considered desirable by humans by means of breeding
animal welfare	the physical and psychological wellbeing of animals (Brown, Hindmarsh & McGregor 2015)
anomaly	something that deviates from what is standard, normal or expected (Taylor 1982)
application	the act of using knowledge and understanding in response to a given situation or circumstance; carrying out or using a procedure in a given or particular situation
applied learning	the acquisition and application of knowledge, understanding and skills in real-world or lifelike contexts that may encompass workplace, industry and community situations; it emphasises learning through doing and includes both theory and the application of theory, connecting subject knowledge and understanding with the development of practical skills
Applied subject	a subject whose primary pathway is work and vocational education; it emphasises applied learning and community connections; a subject for which a syllabus has been developed by the QCAA with the following characteristics: results from courses developed from Applied syllabuses contribute to the QCE; results may contribute to ATAR calculations
apply	use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation
appraise	evaluate the worth, significance or status of something; judge or consider a text or piece of work
appreciate	recognise or make a judgment about the value or worth of something; understand fully; grasp the full implications of
appropriate	acceptable; suitable or fitting for a particular purpose, circumstance, context; etc.
apt	suitable to the purpose or occasion; fitting, appropriate
area of study	a division of, or a section within a unit
argue	give reasons for or against something; challenge or debate an issue or idea; persuade, prove or try to prove by giving reasons
argument	process of reasoning; series of reasons; a statement or fact tending to support a point
artificial insemination	the process whereby semen is deposited in the female reproductive tract by a person using artificial insemination equipment
aspect	a particular part of a feature of something; a facet, phase or part of a whole

Term	Explanation
assess	measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something
assessment	purposeful and systematic collection of information about students' achievements
assessment instrument	a tool or device used to gather information about student achievement
assessment objectives	drawn from the unit objectives and contextualised for the requirements of the assessment instrument (see also 'syllabus objectives', 'unit objectives')
assessment technique	the method used to gather evidence about student achievement (e.g. examination, project, investigation)
astute	showing an ability to accurately assess situations or people; of keen discernment
ATAR	Australian Tertiary Admission Rank
authoritative	able to be trusted as being accurate or true; reliable; commanding and self-confident; likely to be respected and obeyed
auxin	a plant hormone that causes the elongation of cells in shoots, secondary thickening of stems and roots, fruit development and apical dominance (Brown, Hindmarsh & McGregor 2015)
B	
balanced	keeping or showing a balance; not biased; fairly judged or presented; taking everything into account in a fair, well-judged way
basic	fundamental
behaviour	in science, the action of any material; the action or activity of an individual
biological control	animal, pest and disease control methods that introduce a natural enemy or predator
biosecurity	procedures or measures designed to protect Australia's animal and plant industries and the natural environment from harmful biological or biochemical substances
biota	biological organisms that are either natural or propagated, that can be used for human consumption
breed	a stock of animals or plants in a species having a distinctive appearance and typically developed by deliberate selection
breed plan	a management tool used to improve the genetic merit of agricultural animals
broadacre	land suitable for farms practising large-scale crop operations
budding	a way of propagating plants; a bud is taken from one plant and grown on another

Term	Explanation
budgets	an estimate of costs, revenues, and resources over a specified period, reflecting a reading of future financial conditions and goals
C	
calculate	determine or find (e.g. a number, answer) by using mathematical processes; obtain a numerical answer showing the relevant stages in the working; ascertain/determine from given facts, figures or information
carbon sequestration	a natural or artificial process by which carbon dioxide is removed from the atmosphere and held in solid or liquid form (Brown, Hindmarsh & McGregor 2015)
cash flow statements	report the sources and uses of cash by operating activities, investing activities, financing activities and certain supplemental information for the period specified in the heading of the statement
categorise	place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate
cation exchange capacity	the number of exchangeable cations per dry weight that a soil is capable of holding, at a given pH value, and available for exchange with the soil water solution
cell grazing	a system of rotational grazing designed to maximise feed utilisation
challenging	difficult but interesting; testing one's abilities; demanding and thought-provoking; usually involving unfamiliar or less familiar elements
characteristic	a typical feature or quality
chemical control	the use of chemicals (inorganic or organic) to kill pests or inhibit their development
claim	an assertion made without any accompanying evidence to support it
clarify	make clear or intelligible; explain; make a statement or situation less confused and more comprehensible
clarity	clearness of thought or expression; the quality of being coherent and intelligible; free from obscurity of sense; without ambiguity; explicit; easy to perceive, understand or interpret
classify	arrange, distribute or order in classes or categories according to shared qualities or characteristics
clean and green image	refers to production systems that inhabit non-polluting spaces and/or that use reduced or no chemical inputs
clear	free from confusion, uncertainty, or doubt; easily seen, heard or understood
clearly	in a clear manner; plainly and openly, without ambiguity
climate	the average conditions of Earth's atmosphere based on records taken over at least thirty years

Term	Explanation
climate change	a long-term change in Earth's climate, especially a change due to an increase in the average atmospheric temperature
coherent	having a natural or due agreement of parts; connected; consistent; logical, orderly; well-structured and makes sense; rational, with parts that are harmonious; having an internally consistent relation of parts
cohesive	characterised by being united, bound together or having integrated meaning; forming a united whole
collate	to put together; to compare
collection	in science, a systematic approach to gathering and measuring evidence from a variety of sources in order to evaluate outcomes and make predictions
comment	express an opinion, observation or reaction in speech or writing; give a judgment based on a given statement or result of a calculation
communicate	convey knowledge and/or understandings to others; make known; transmit
compaction	the process by which the porosity of a given form of sediment is decreased as a result of its mineral grains being squeezed together by the weight of overlying sediment or by mechanical means
compare	display recognition of similarities and differences and recognise the significance of these similarities and differences
competent	having suitable or sufficient skills, knowledge, experience, etc. for some purpose; adequate but not exceptional; capable; suitable or sufficient for the purpose; having the necessary ability, knowledge or skill to do something successfully; efficient and capable (of a person); acceptable and satisfactory, though not outstanding
competently	in an efficient and capable way; in an acceptable and satisfactory, though not outstanding, way
complete budget	sometimes known as total budgeting; refers to preparing a budget for the farm as a whole; complete budgeting considers all the crops, livestock, methods of production and aspects of marketing in consolidated form and estimates costs and returns for the farm as a whole
complex	composed or consisting of many different and interconnected parts or factors; compound; composite; characterised by an involved combination of parts; complicated; intricate; a complex whole or system; a complicated assembly of particulars
comprehend	understand the meaning or nature of; grasp mentally
comprehensive	inclusive; of large content or scope; including or dealing with all or nearly all elements or aspects of something; wide-ranging; detailed and thorough, including all that is relevant

Term	Explanation
concept	in science, an idea or model explaining some natural phenomenon; a theoretical construct; a thought, idea, or notion
concise	expressing much in few words; giving a lot of information clearly and in a few words; brief, comprehensive and to the point; succinct, clear, without repetition of information
concisely	in a way that is brief but comprehensive; expressing much in few words; clearly and succinctly
conclusion	a judgment based on evidence (ACARA 2015c)
conduct	direct in action or course; manage; organise; carry out
consider	think deliberately or carefully about something, typically before making a decision; take something into account when making a judgment; view attentively or scrutinise; reflect on
considerable	fairly large or great; thought about deliberately and with a purpose
considered	formed after careful and deliberate thought
consistent	agreeing or accordant; compatible; not self-opposed or self-contradictory, constantly adhering to the same principles; acting in the same way over time, especially so as to be fair or accurate; unchanging in nature, standard, or effect over time; not containing any logical contradictions (of an argument); constant in achievement or effect over a period of time
construct	create or put together (e.g. an argument) by arranging ideas or items; display information in a diagrammatic or logical form; make; build
contrast	display recognition of differences by deliberate juxtaposition of contrary elements; show how things are different or opposite; give an account of the differences between two or more items or situations, referring to both or all of them throughout
control measures	a range of agricultural activities (e.g. chemical, biological, physical) that can be used to control an unwanted pest or disease
controlled	shows the exercise of restraint or direction over; held in check; restrained, managed or kept within certain bounds
controlled traffic	a management tool used to reduce the damage to soils caused by heavy or repeated agricultural machinery passes on the land
convincing	persuaded by argument or proof; leaving no margin of doubt; clear; capable of causing someone to believe that something is true or real; persuading or assuring by argument or evidence; appearing worthy of belief; credible or plausible
correct	conforming to fact or truth; accurate
course	a defined amount of learning developed from a subject syllabus

Term	Explanation
create	bring something into being or existence; produce or evolve from one's own thought or imagination; reorganise or put elements together into a new pattern or structure or to form a coherent or functional whole
creative	resulting from originality of thought or expression; relating to or involving the use of the imagination or original ideas to create something; having good imagination or original ideas
credible	capable or worthy of being believed; believable; convincing
criterion	the property or characteristic by which something is judged or appraised
critical	involving skilful judgment as to truth, merit, etc.; involving the objective analysis and evaluation of an issue in order to form a judgment; expressing or involving an analysis of the merits and faults of a work of literature, music, or art; incorporating a detailed and scholarly analysis and commentary (of a text); rationally appraising for logical consistency and merit
critique	review (e.g. a theory, practice, performance) in a detailed, analytical and critical way
crop rotation	the process of growing different crops on the same land from one year to the next (Brown, Hindmarsh & McGregor 2015)
crossbreeding	the mating of unrelated plants or animals of different breeds or the crossing of unrelated plants (Brown, Hindmarsh & McGregor 2015)
crude protein	the total protein content of a food source as determined by its nitrogen content
cultivar	a variety of a plant that has been developed under cultivation and does not occur naturally in the wild, but is a distinct subspecies (Stephens 1996)
cultural practices	agricultural practices that are used to enhance crop and livestock health and prevent weed, pest or disease problems without the use of chemical substances
cursory	hasty, and therefore not thorough or detailed; performed with little attention to detail; going rapidly over something, without noticing details; hasty; superficial
cuttings	a piece of a plant that is used in horticulture for vegetative (asexual) propagation; a piece of the stem or root of the source plant is placed in a suitable medium, such as moist soil
cytokinins	any of a class of plant hormones that promote cell division and growth and delay the senescence of leaves
D	
data	in science, measurements of an attribute or attributes; data may be quantitative or qualitative and be from primary or secondary sources (ACARA 2015c)

Term	Explanation
dataset	qualitative data and/or quantitative data (e.g. diagram, graph, image, map, photograph, table) derived from a practical, activity or case study
decide	reach a resolution as a result of consideration; make a choice from a number of alternatives
deduce	reach a conclusion that is necessarily true, provided a given set of assumptions is true; arrive at, reach or draw a logical conclusion from reasoning and the information given
defensible	justifiable by argument; capable of being defended in argument
define	give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities
demonstrate	prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition
derive	arrive at by reasoning; manipulate a mathematical relationship to give a new equation or relationship; in mathematics, obtain the derivative of a function
describe	give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something
design	produce a plan, simulation, model or similar; plan, form or conceive in the mind; in English, select, organise and use particular elements in the process of text construction for particular purposes; these elements may be linguistic (words), visual (images), audio (sounds), gestural (body language), spatial (arrangement on the page or screen) and multimodal (a combination of more than one)
detailed	executed with great attention to the fine points; meticulous; including many of the parts or facts
determine	establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution
develop	elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate; in Agricultural Science, to produce an improved version of an existing technique or variety of plant or animal
development	in animals, changes in development of body tissues (fat, bone and muscle) and systems from the birth of an animal to the point where it reaches adult maturity; in plants, changes in development of tissues and systems from germination of a plant to the point where it reaches adult maturity; relating to budgets, a detailed statement outlining estimated costs to support the agricultural activity
development budget	a detailed statement outlining estimated costs to support the agricultural activity.
Devise	think out; plan; contrive; invent

Term	Explanation
dicotyledon	a flowering plant with an embryo that bears two seed leaves, which are known as cotyledons
differentiate	identify the difference/s in or between two or more things; distinguish, discriminate; recognise or ascertain what makes something distinct from similar things; in mathematics, obtain the derivative of a function
digestible energy	the gross energy of a feed, minus the energy content of the faeces attributable to it
dihybrid cross	a hybrid that is heterozygous for alleles of two different genes
discerning	discriminating; showing intellectual perception; showing good judgment; making thoughtful and astute choices; selected for value or relevance
discriminate	note, observe or recognise a difference; make or constitute a distinction in or between; differentiate; note or distinguish as different
discriminating	differentiating; distinctive; perceiving differences or distinctions with nicety; possessing discrimination; perceptive and judicious; making judgments about quality; having or showing refined taste or good judgment
discuss	examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence
disease	a disorder of structure or function in an animal or plant, especially one that produces specific symptoms or that affects a specific location and is not simply a direct result of physical injury
disjointed	disconnected; incoherent; lacking a coherent order/sequence or connection
distinguish	recognise as distinct or different; note points of difference between; discriminate; discern; make clear a difference/s between two or more concepts or items
diverse	of various kinds or forms; different from each other
diversification	the risk-avoidance practice of producing a variety of outputs (crops or animals), or both, on one farm, as distinguished from specialising in a single commodity)
document	support (e.g. an assertion, claim, statement) with evidence (e.g. decisive information, written references, citations)
draw conclusions	make a judgment based on reasoning and evidence
dry matter	the material remaining after the removal of water
dryland salinity	an increase in soil salt concentration in the environment, watercourse or soil in unirrigated landscapes, being in excess of normal soil salt concentrations in dryland regions

Term	Explanation
E	
edible biota	organisms found naturally in a geographic region that can be used for human consumption
effective	successful in producing the intended, desired or expected result; meeting the assigned purpose
efficient	working in a well-organised and competent way; maximum productivity with minimal expenditure of effort; acting or producing effectively with a minimum of waste, expense or unnecessary effort
El Niño	a change in the normal atmospheric pressure patterns that allows warmer waters from the Australia–Indonesia region to move towards South America, resulting in droughts in Australia–Indonesia and flooding in South America (Pohl 2003)
element	a component or constituent part of a complex whole; a fundamental, essential or irreducible part of a composite entity
elementary	simple or uncompounded; relating to or dealing with elements, rudiments or first principles (of a subject); of the most basic kind; straightforward and uncomplicated
embryo harvest	the process of collection of embryos from donor animals
erroneous	based on or containing error; mistaken; incorrect
essential	absolutely necessary; indispensable; of critical importance for achieving something
estimated breeding values	an animal's breeding value is its genetic merit, half of which will be passed on to its progeny; exact breeding values are never known but estimates are made based on performance traits
evaluate	make an appraisal by weighing up or assessing strengths, implications and limitations; make judgments about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria
evidence	in science, evidence is data that has been selected as it is considered reliable and valid and can be used to support a particular idea, conclusion or decision; evidence gives weight or value to data by considering its credibility, acceptance, bias, status, appropriateness and reasonableness (ACARA 2015c)
examination	a supervised test that assesses the application of a range of cognitions to one or more provided items such as questions, scenarios and/or problems; student responses are completed individually, under supervised conditions, and in a set timeframe
examine	investigate, inspect or scrutinise; inquire or search into; consider or discuss an argument or concept in a way that uncovers the assumptions and interrelationships of the issue
exotic disease	infectious diseases that normally do not occur in the region

Term	Explanation
experiment	try out or test new ideas or methods, especially in order to discover or prove something; undertake or perform a scientific procedure to test a hypothesis, make a discovery or demonstrate a known fact in science, an investigation that involves carrying out a practical activity
experimental	relating to, derived from, or founded on experiment
explain	make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information
explicit	clearly and distinctly expressing all that is meant; unequivocal; clearly developed or formulated; leaving nothing merely implied or suggested
explore	look into both closely and broadly; scrutinise; inquire into or discuss something in detail
express	convey, show or communicate (e.g. a thought, opinion, feeling, emotion, idea or viewpoint); in words, art, music or movement, convey or suggest a representation of; depict
extend	in science, to extend an experiment is to modify the methodology to overcome limitations of the scope or applicability of the data
extended response	an open-ended assessment technique that focuses on the interpretation, analysis, examination and/or evaluation of ideas and information in response to a particular situation or stimulus; while students may undertake some research when writing the extended response, it is not the focus of this technique; an extended response occurs over an extended and defined period of time; an item on an examination may also require an extended response, either written or oral
Extension subject	a two-unit subject for which a syllabus has been developed by QCAA; it is an extension of one or more general or alternative sequence subject/s; studied concurrently with the final two units of that subject/s or after completion of, the final two units of that subject/s
extensions	in science, modifications to the investigation that could be used to further examine the claim
extensive	of great extent; wide; broad; far-reaching; comprehensive; lengthy; detailed; large in amount or scale
extensive industry	an agricultural production system that uses small inputs of labour, fertilisers and capital, relative to the land area being farmed; extensive agricultural properties are usually large in size
external assessment	summative assessment that occurs towards the end of a course of study and is common to all schools; developed and marked by the QCAA according to a commonly applied marking scheme

Term	Explanation
external examination	a supervised test, developed and marked by the QCAA, that assesses the application of a range of cognitions to multiple provided items such as questions, scenarios and/or problems; student responses are completed individually, under supervised conditions, and in a set timeframe
extrapolate	infer or estimate by extending or projecting known information; conjecture; infer from what is known; extend the application of something (e.g. a method or conclusion) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable
extrapolation	extension of a conclusion to a new situation, with the assumption that existing trends will continue
F	
factual	relating to or based on facts; concerned with what is actually the case; actually occurring; having verified existence
familiar	well-acquainted; thoroughly conversant with; well-known from long or close association; often encountered or experienced; common; (of materials, texts, skills or circumstances) having been the focus of learning experiences or previously encountered in prior learning activities
fast fashion	fashion styles made available to the general market in a very short space of time after the designer launches them, creating a more rapid turnover of fashion innovations than the traditional annual cycle of winter and summer
feasible	capable of being achieved, accomplished or put into effect; reasonable enough to be believed or accepted; probable; likely
feature	distinctive attribute, characteristic, property or quality of evidence
feed conversion ratio	a measure of an animal's efficiency in converting feed mass into increases of the desired output (e.g. animal live weight)
fibre	a natural or synthetic filament that may be spun into yarn, such as cotton or nylon
field capacity	the amount of water that remains in a soil profile, 24–48 hours after free drainage has occurred
fieldwork	research carried out in the field (i.e. beyond the classroom) which includes data collection
findings	in science, the outcomes of research, investigation or experimentation, including facts or principles established in these ways
fluent	spoken or written with ease; able to speak or write smoothly, easily or readily; articulate; eloquent; in artistic performance, characteristic of a highly developed and excellently controlled technique; flowing; polished; flowing smoothly, easily and effortlessly

Term	Explanation
fluently	in a graceful and seemingly effortless manner; in a way that progresses smoothly and readily
follicle-stimulating hormone	a hormone secreted by the anterior pituitary gland that promotes the formation of ova or sperm
food security	the state of having reliable access to a sufficient quantity of affordable, nutritious food
formative assessment	assessment whose major purpose is to improve teaching and student achievement
fragmented	disorganised; broken down; disjointed or isolated
free trade	international trade left to its natural course without tariffs, quotas or other restrictions
frequent	happening or occurring often at short intervals; constant, habitual, or regular
fundamental	forming a necessary base or core; of central importance; affecting or relating to the essential nature of something; part of a foundation or basis
fungicide	a chemical that destroys fungus
G	
General subject	a subject for which a syllabus has been developed by the QCAA with the following characteristics: results from courses developed from General syllabuses contribute to the QCE; General subjects have an external assessment component; results may contribute to ATAR calculations
generate	produce; create; bring into existence
genetically modified organism	organisms (i.e. plants, animals or microorganisms) in which the genetic material (DNA) has been altered in a way that does not occur naturally by mating and/or natural recombination
genre conventions	agreed and acceptable conditions; a style or category
geotropism	the growth of the parts of plants in response to the force of gravity (https://www.oxforddictionaries.com/definition/english/geotropism)
germination	the process by which a plant grows from a seed; the most common example of germination is the sprouting of a seedling from a seed of an angiosperm or gymnosperm
gibberellins	any of a group of plant hormones that stimulate stem elongation, germination and flowering
global imaging	provides satellite image data at different spatial, spectral and temporal resolutions for agriculture and crop assessment, crop health, change detection, environmental analysis, irrigated landscape mapping, yield determination and soils analysis

Term	Explanation
grafting	a horticultural technique whereby tissues of plants are joined so as to continue their growth together, the upper part of the combined plant is called the scion while the lower part is called the rootstock
graphical representations	in science, a visual representation of the relationship between quantities plotted with reference to a set of axes; also known as a graph (ACARA 2015c)
gross income	the amount of salary or wages paid to the individual by an employer, before any deductions are taken
gross margins	the difference between revenue and cost of goods sold
growth	the process of increasing in size
H	
herbicide	a chemical substance that is toxic to plants, used to control or prevent unwanted vegetation (e.g. weeds)
heritability	a statistical estimate of how much phenotypic variation in a population is due to genetic variation amongst individuals within that population
hormones	chemical substances produced by organisms that control and regulate the activity of targeted cells or tissues
horticulture	the branch of agriculture that deals with the art, science, technology, and business of growing fruits, vegetables, nuts, ornamentals and turf
human resources	the personnel of a business or organisation, who represent a significant asset in terms of skills and abilities
humidity	a measurement of the amount of water vapour present in a body of air at a certain temperature
hydrotropism	the growth or turning of plant roots and rhizomes towards or away from moisture
hypothesis	in science, a tentative explanation for an observed phenomenon, expressed as a precise and unambiguous statement that can be supported or refuted by experiment (ACARA 2015c)
hypothesise	formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds
I	
identify	distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature
IDM	integrated disease management; the practice of using a range of measures to prevent and manage diseases in crops
illogical	lacking sense or sound reasoning; contrary to or disregardful of the rules of logic; unreasonable

Term	Explanation
implement	put something into effect, e.g. a plan or proposal
implication	a likely consequence of something; a conclusion that may be drawn though it is implied rather than explicit
implicit	implied, rather than expressly stated; not plainly expressed; capable of being inferred from something else
improbable	not probable; unlikely to be true or to happen; not easy to believe
improvements	in science, modifications to an investigation that mitigate the limitations of the evidence, method or design
inaccurate	not accurate
inadequate	not satisfactory or acceptable in quality and/or quantity to the requirements of the situation
inappropriate	not suitable or proper in the circumstances
inconsistent	lacking agreement, as one thing with another, or two or more things in relation to each other; at variance; not consistent; not in keeping; not in accordance; incompatible, incongruous
incorrect	not conforming to fact or truth
independent	thinking or acting for oneself, not influenced by others
in-depth	comprehensive and with thorough coverage; extensive or profound; well-balanced or fully developed
Indian Ocean Dipole	IOD; an irregular oscillation of sea-surface temperatures in which the western Indian Ocean becomes alternately warmer and then cooler than the eastern part of the ocean
ineffective	not producing a result, or not producing any significant result; not producing the intended, desired or expected result
infer	derive or conclude something from evidence and reasoning, rather than from explicit statements; listen or read beyond what has been literally expressed; imply or hint at
informed	knowledgeable; learned; having relevant knowledge; being conversant with the topic; based on an understanding of the facts of the situation (of a decision or judgment)
infrastructure	the basic physical and organisational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of an enterprise
inheritance	the transmission of genetic information from parent to offspring
innovative	new and original; introducing new ideas; original and creative in thinking
insecticide	a chemical substance that is toxic to insects, used to control or prevent pest insects

Term	Explanation
insightful	showing understanding of a situation or process; understanding relationships in complex situations; informed by observation and deduction
instrument-specific marking guide	ISMG; a tool for marking that describes the characteristics evident in student responses and aligns with the identified objectives for the assessment (see 'assessment objectives')
insufficient	not enough; inadequate for the purpose
integral	*adjective* necessary for the completeness of the whole; essential or fundamental; *noun* in mathematics, the result of integration; an expression from which a given function, equation, or system of equations is derived by differentiation
integrated disease management	IDM; the practice of using a range of measures to prevent and manage diseases in crops
integrated pest management	IPM; an ecosystem-based strategy that focuses on long-term prevention of pests using a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties
integrated weed management	IWD; the practice of using a range of measures to prevent and manage weeds in crops
intended	designed; meant; done on purpose; intentional
intensive industry	in relation to industry; any industry that involves a comparatively higher level of inputs especially capital, labour and fertiliser per unit of land; characterised by low fallow ratios and higher yields
internal assessment	assessments that are developed by schools; summative internal assessments are endorsed by the QCAA before use in schools and results externally confirmed; contributes towards a student's final result
interpret	use knowledge and understanding to recognise trends and draw conclusions from given information; make clear or explicit; elucidate or understand in a particular way; bring out the meaning of, e.g. a dramatic or musical work, by performance or execution; bring out the meaning of an artwork by artistic representation or performance; give one's own interpretation of; identify or draw meaning from, or give meaning to, information presented in various forms, such as words, symbols, pictures or graphs
invalid	not sound, just or well-founded; not having a sound basis in logic or fact (or an argument or point); not reasonable or cogent; not able to be supported; not legitimate or defensible; not applicable

Term	Explanation
investigate	carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information
investigation	an assessment technique that requires students to research a specific problem, question, issue, design challenge or hypothesis through the collection, analysis and synthesis of primary and/or secondary data; it uses research or investigative practices to assess a range of cognitions in a particular context; an investigation occurs over an extended and defined period of time in science, a scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities (ACARA 2015c)
IPM	integrated pest management; an ecosystem-based strategy that focuses on long-term prevention of pests using a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties
irrelevant	not relevant; not applicable or pertinent; not connected with or relevant to something
ISMG	instrument-specific marking guide; a tool for marking that describes the characteristics evident in student responses and aligns with the identified objectives for the assessment (see 'assessment objectives')
isolated	detached, separate, or unconnected with other things; one-off; something set apart or characterised as different in some way
IWM	(integrated weed management) the practice of using a range of measures to prevent and manage weeds in crops
J	
judge	form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination
justified	sound reasons or evidence are provided to support an argument, statement or conclusion
justify	give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable
L	
La Niña	the reverse of an extreme of the Southern Oscillation that causes extreme rainfall in parts of Australia
land use classification system	used to classify and assess land characteristics and quality; provides information on land cover and the types of human activity involved in land use; it may also facilitate the assessment of environmental impacts on land, potential or alternative uses of land, and the suitability of land uses

Term	Explanation
law of diminishing returns	if successive units of inputs are added to a given production system, a point is reached when a maximum production occurs and then declines; a tipping point exists where the cost of adding additional units of inputs is more that the benefits gained by the increase in outputs
law of supply and demand	the law of supply states that the quantity of a good or service supplied (i.e. the amount producers offer for sale) rises as the market price rises, and falls as the price falls; conversely, the law of demand says that the quantity of a good or service demanded falls as the price rises and rises as the price falls
learning area	a grouping of subjects, with related characteristics, within a broad field of learning, e.g. the Arts, sciences, languages
legumes	any plant of the family *Leguminosae* (including the *Fabaceae*), especially those used for feed, food or soil-improving crop, such as beans, peas, lentils, etc.
limitation	a weak point or disadvantage that makes evidence less effective
line breeding	the selective breeding of animals for a desired feature by mating them within a closely related genetic line
link	anything serving to connect one part or thing with another
live weight gain	a measure of the mass (expressed in grams or kilograms) gained by an animal over a period of time
logical	rational and valid; internally consistent; reasonable; reasoning in accordance with the principles/rules of logic or formal argument; characterised by or capable of clear, sound reasoning; (of an action, decision, etc.) expected or sensible under the circumstances
logically	according to the rules of logic or formal argument; in a way that shows clear, sound reasoning; in a way that is expected or sensible
luteinising hormone	a hormone secreted by the anterior pituitary gland that stimulates ovulation in females and the synthesis of testosterone in males
M	
maintenance energy	the amount of energy needed to keep the animal alive and healthy, but does not allow for growth or production (Brown, Hindmarsh & McGregor 2015)
make decisions	select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position
management	handling, direction or control
management practices	application of management and economic principles that are used in the production, transformation and marketing of agricultural products
manipulate	adapt or change to suit one's purpose

Term	Explanation
marcotting	an asexual or vegetative method of plant propagation that induces a shoot or branch to take root while it is still attached to the parent plant
market specifications	the quality standards required by the buyers of a product
mental procedures	a domain of knowledge in Marzano's taxonomy, and acted upon by the cognitive, metacognitive and self-systems; sometimes referred to as 'procedural knowledge' there are three distinct phases to the acquisition of mental procedures — the cognitive stage, the associative stage, and the autonomous stage; the two categories of mental procedures are skills (single rules, algorithms and tactics) and processes (macroprocedures)
metabolisable energy	the energy available to the animal for use by the body
methodical	performed, disposed or acting in a systematic way; orderly; characterised by method or order; performed or carried out systematically
methodology	a systematic, ordered approach to gathering data in a scientific experiment or investigation
microbial protein	protein source from dead rumen microbes, usually forming 70% to 100% of the ruminant's supply of protein
minimal	least possible; small, the least amount; negligible
model	in science, a representation that describes, simplifies, clarifies or provides an explanation of the workings, structure or relationships within an object, system or idea (ACARA 2015c)
modifications	in science, changes to methodology to extend, refine or redirect the research focus
modify	change the form or qualities of; make partial or minor changes to something
molecular value predictions	MVP; a measure of molecular breeding value for selected production traits expressed in units of the trait
monocotyledon	flowering plant with an embryo that bears a single seed leaf also known as a cotyledon
monoculture	the cultivation of a single crop in a given area
monogastric	an organism with a single-chambered stomach
multimodal	uses a combination of at least two modes (e.g. spoken, written), delivered at the same time, to communicate ideas and information to a live or virtual audience, for a particular purpose; the selected modes are integrated so that each mode contributes significantly to the response
musculoskeletal	the combination of the muscular and skeletal systems working together; includes the bones, muscles, tendons and ligaments of the body

Term	Explanation
MVP	molecular value predictions; a measure of molecular breeding value for selected production traits expressed in units of the trait
N	
narrow	limited in range or scope; lacking breadth of view; limited in amount; barely sufficient or adequate; restricted
National Livestock Identification System	NLIS, Australia's system for the identification and traceability of cattle, sheep and goats
nematicide	a substance used to kill nematodes (roundworms)
net energy	the amount of feed energy actually available for animal maintenance, growth and production
notifiable disease	any disease that is required by law to be reported to government authorities
nuanced	showing a subtle difference or distinction in expression, meaning, response, etc.; finely differentiated; characterised by subtle shades of meaning or expression; a subtle distinction, variation or quality; sensibility to, awareness of, or ability to express delicate shadings, as of meaning, feeling, or value
nutrition	the process of providing or obtaining the food necessary for health and growth
O	
objectives	see ‘syllabus objectives’, ‘unit objectives’, ‘assessment objectives’
obvious	clearly perceptible or evident; easily seen, recognised or understood
oestrogen	a hormone that promotes the development and maintenance of female characteristics of the body
oestrous synchronisation	involves treating the females to be inseminated with hormones so they will all come into oestrus and ovulate at about the same time
oil seeds	in agriculture, seeds that can be used for their oil content
optimal	best, most favourable, under a particular set of circumstances
organic content	organic matter component of soil, consisting of plant and animal residues at various stages of decomposition
organise	arrange, order; form as or into a whole consisting of interdependent or coordinated parts, especially for harmonious or united action
organised	systematically ordered and arranged; having a formal organisational structure to arrange, coordinate and carry out activities
outcome	result of something; a consequence
outlier	a value that ‘lies outside’ (is much smaller or larger than) most of the other values in a set of data

Term	Explanation
outstanding	exceptionally good; clearly noticeable; prominent; conspicuous; striking
oxytocin	a hormone released by the pituitary gland that causes increased contraction of the womb during labour and stimulates milk production
P	
paddock rotation	rotating paddocks of similar size to allow for a rest period (Stephens 1996)
partial	not total or general; existing only in part; attempted, but incomplete
partial budget	financial statement that compares the profitability of alternatives
particular	distinguished or different from others or from the ordinary; noteworthy
patents	a government authority or licence conferring a right or title for a set period, especially the sole right to exclude others from making, using or selling an invention
pattern	a repeated occurrence or sequence (ACARA 2015c)
perceptive	having or showing insight and the ability to perceive or understand; discerning (see also 'discriminating')
performance	an assessment technique that requires students to demonstrate a range of cognitive, technical, creative and/or expressive skills and to apply theoretical and conceptual understandings, through the psychomotor domain; it involves student application of identified skills when responding to a task that involves solving a problem, providing a solution or conveying meaning or intent; a performance is developed over an extended and defined period of time
persuasive	capable of changing someone's ideas, opinions or beliefs; appearing worthy of approval or acceptance; (of an argument or statement) communicating reasonably or credibly (see also 'convincing')
perusal time	time allocated in an assessment to reading items and tasks and associated assessment materials; no writing is allowed; students may not make notes and may not commence responding to the assessment in the response space/book
pest	any organism that injures, irritates or damages livestock, livestock products or plant products, and can adversely affect production
pesticide	a substance used for destroying insects or other organisms harmful to cultivated plants or animals; may be inorganic and organic
phenomena	events that are not artificial and can be observed through the senses or can be scientifically described or explained
phenotype	the set of observable characteristics of an individual resulting from the interaction of its genotype with the environment

Term	Explanation
photosynthesis	the process by which green plants and some other organisms use sunlight to synthesise nutrients from carbon dioxide and water
phototropism	the orientation of a plant or other organism in response to light, either towards the source of light (positive phototropism) or away from it (negative phototropism)
physical control	animal, pest and disease control methods where the pest is attacked and/or destroyed, e.g. cultivation and hand removal
planning time	time allocated in an assessment to planning how to respond to items and tasks and associated assessment materials; students may make notes but may not commence responding to the assessment in the response space/book; notes made during planning are not collected, nor are they graded or used as evidence of achievement
plant propagation	the process of creating new plants from a variety of sources: seeds, cuttings, bulbs and other plant parts
polished	flawless or excellent; performed with skilful ease
porosity	a measure of the space between soil particles
post-harvest	the process following crop harvest and preceding sale, including cooling, cleaning, sorting, packing and transport
practical	in science, an activity that produces primary data
precise	definite or exact; definitely or strictly stated, defined or fixed; characterised by definite or exact expression or execution
precision	accuracy; exactness; exact observance of forms in conduct or actions in science, exactness; how close two or more measurements of the same object or phenomena are to each other
predict	give an expected result of an upcoming action or event; suggest what may happen based on available information
prevention, preparedness, response, recovery (PPRR) model	a comprehensive approach used in risk management
primary data	data collected directly by a person or group (ACARA 2015c)
process	in science, to collect and manipulate data to produce meaningful information; operate on a set of data to extract the required information in an appropriate form such as tables or graphs
product	an assessment technique that focuses on the output or result of a process requiring the application of a range of cognitive, physical, technical, creative and/or expressive skills, and theoretical and conceptual understandings; a product is developed over an extended and defined period of time
proficient	well advanced or expert in any art, science or subject; competent, skilled or adept in doing or using something

Term	Explanation
profit-and-loss statements	a financial statement that summarises the revenues, costs and expenses incurred during a specific period of time, usually a financial quarter or year
progeny	a descendant or the descendants of an animal or plant; also known as offspring
progesterone	a hormone that prepares the uterus for a fertilised ovum and maintains pregnancy
project	an assessment technique that focuses on a problem-solving process requiring the application of a range of cognitive, technical and creative skills and theoretical understandings; the response is a coherent work that documents the iterative process undertaken to develop a solution and includes written paragraphs and annotations, diagrams, sketches, drawings, photographs, video, spoken presentations, physical prototypes and/or models; a project is developed over an extended and defined period of time
propose	put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action
prostaglandin	a hormone used to synchronise oestrus in agricultural animals
prove	use a sequence of steps to obtain the required result in a formal way
psychomotor procedures	a domain of knowledge in Marzano's taxonomy, and acted upon by the cognitive, metacognitive and self-systems; these are physical procedures used to negotiate daily life and to engage in complex physical activities; the two categories of psychomotor procedures are skills (foundational procedures and simple combination procedures) and processes (complex combination procedures)
purposeful	having an intended or desired result; having a useful purpose; determined; resolute; full of meaning; significant; intentional
Q	
QCE	Queensland Certificate of Education
qualitative data	information that is not numerical in nature (ACARA 2015c)
quality of evidence	the standard of evidence, as measured against relevant criteria
quantitative data	numerical information (Taylor 1982)
quantity	in science, having magnitude, size, extent, amount or the like
R	
ration	a quantity of foodstuffs given to an animal within a given period of time
rationale	a set of reasons, or logical basis for a course of action or decision
raw data	unprocessed and/or unanalysed data; data that has been collected without any additional processing (Taylor 1982)

Term	Explanation
realise	create or make (e.g. a musical, artistic or dramatic work); actualise; make real or concrete; give reality or substance to
reasonable	endowed with reason; having sound judgment; fair and sensible; based on good sense; average; appropriate, moderate
reasoned	logical and sound; based on logic or good sense; logically thought out and presented with justification; guided by reason; well-grounded; considered
recall	remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind
recognise	identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge
redirect	in science, to redirect an experiment is to modify the methodology to gain further insight into the phenomena observed in the original experiment
referencing conventions	agreed, consistent ways of referencing a source of information
refine	in science, to refine an experiment is to modify the methodology to obtain more accurate or precise data
refined	developed or improved so as to be precise, exact or subtle
reflect on	think about deeply and carefully
regulating services	the benefits obtained from the regulation of ecosystem processes such as climate and natural hazard regulation, water and waste management and pollination and pest control
rehearsed	practised; previously experienced; practised extensively
related	associated with or linked to
relationship	scientific relationships are a connection or association between ideas or between components of systems and structures (ACARA 2015c)
relevance	being related to the matter at hand
relevant	bearing upon or connected with the matter in hand; to the purpose; applicable and pertinent; having a direct bearing on
reliability	in science, the likelihood that another experimenter will obtain the same results (or very similar results) if they perform exactly the same experiment under the same conditions (ACARA 2015c, Taylor 1982)
reliable	constant and dependable or consistent and repeatable
remote sensing	the scanning of the earth by satellite or high-flying aircraft in order to obtain information about it
renewable resource	a resource that can be replaced naturally; examples are oxygen, fresh water, solar energy, timber and biomass and also include wool, paper and leather

Term	Explanation
repetitive	containing or characterised by repetition, especially when unnecessary or tiresome
reporting	providing information that succinctly describes student performance at different junctures throughout a course of study
representation	in science, verbal, physical or mathematical demonstration of understanding of a science concept or concepts; a concept can be represented in a range of ways and using multiple models (ACARA 2015c)
research	to locate, gather, record and analyse information in order to develop understanding (ACARA 2015c)
research ethics	norms of conduct that determine ethical research behaviour; research ethics are governed by principles such as honesty, objectivity, integrity, openness, and respect for intellectual property and include consideration of animal ethics (ACARA 2015c)
research question	a question that directs the scientific inquiry activity; it focuses the research investigation or student experiment, informing the direction of the research, and guiding all stages of inquiry, analysis, interpretation and evaluation
resolve	in the Arts, consolidate and communicate intent through a synthesis of ideas and application of media to express meaning
respiration	a process in living organisms involving the production of energy, typically with the intake of oxygen and the release of carbon dioxide from the oxidation of complex organic substances
risk assessment	evaluations performed to identify, assess and control hazards in a systematic way that is consistent, relevant and applicable to all school activities; requirements for risk assessments related to particular activities will be determined by jurisdictions, schools or teachers as appropriate (ACARA 2015c)
risk-avoidance strategies	the elimination of hazards, activities and exposures that can negatively affect an organisation
routine	often encountered, previously experienced; commonplace; customary and regular; well-practised; performed as part of a regular procedure, rather than for a special reason
rudimentary	relating to rudiments or first principles; elementary; undeveloped; involving or limited to basic principles; relating to an immature, undeveloped or basic form
ruminant	a cud-chewing animal with four stomachs, including a rumen (first stomach) that is inhabited by millions of microbes
runner	also known as a stolon; is a horizontal stem that grows from the base of the plant; the tip of a stolon develops buds that grow into new plants; the lower portion of a stolon develops nodes, which typically form adventitious roots

Term	Explanation
S	
safe	secure; not risky
scientific language	terminology that has specific meaning in a scientific context
scrutinise	to examine closely or critically
seasonal breeding	animal species that successfully mate only during certain times of the year
secondary data	data collected by a person or group other than the person or group using the data (ACARA 2015c)
secure	sure; certain; able to be counted on; self-confident; poised; dependable; confident; assured; not liable to fail
select	choose in preference to another or others; pick out
sensitive	capable of perceiving with a sense or senses; aware of the attitudes, feelings or circumstances of others; having acute mental or emotional sensibility; relating to or connected with the senses or sensation
sequence	place in a continuous or connected series; arrange in a particular order
share farming	method of farming that involves the owner or tenant of agricultural land having a contract with another party where each party takes a share of the profits from the land
show	provide the relevant reasoning to support a response
significant	important; of consequence; expressing a meaning; indicative; includes all that is important; sufficiently great or important to be worthy of attention; noteworthy; having a particular meaning; indicative of something
simple	easy to understand, deal with and use; not complex or complicated; plain; not elaborate or artificial; may concern a single or basic aspect; involving few elements, components or steps
simplistic	characterised by extreme simplification, especially if misleading; oversimplified
simulation	a representation of a process, event or system which imitates a real or idealised situation (ACARA 2015c)
sketch	execute a drawing or painting in simple form, giving essential features but not necessarily with detail or accuracy; represent by means of a diagram or graph; the sketch should give a general idea of the required shape or relationship and should include features
skilful	having technical facility or practical ability; possessing, showing, involving or requiring skill; expert, dexterous; demonstrating the knowledge, ability or training to perform a certain activity or task well; trained, practised or experienced

Term	Explanation
skilled	having or showing the knowledge, ability or training to perform a certain activity or task well; having skill; trained or experienced; showing, involving or requiring skill
soil additives	products added to a soil to improve its physical and/or chemical properties
soil structure	the arrangement of the solid parts of the soil and of the pore space located between them
soil texture	percentage of the sand, silt and clay particles in a soil
sole trader	a person trading as the individual legally responsible for all aspects of the business
solve	find an answer to, explanation for, or means of dealing with (e.g. a problem); work out the answer or solution to (e.g. a mathematical problem); obtain the answer/s using algebraic, numerical and/or graphical methods
sophisticated	of intellectual complexity; reflecting a high degree of skill, intelligence, etc.; employing advanced or refined methods or concepts; highly developed or complicated
source	any piece of scientific literature or text from which scientific evidence is drawn
southern Oscillation Index	SOI; a measure of changes in air pressure at sea level that describes the cyclic warming and cooling of the Eastern and Central Pacific Ocean (Hubble, Huxley & Imlay-Gillespie 2011)
species	division of a genus, a group of living things that can interbreed
specific	clearly defined or identified; precise and clear in making statements or issuing instructions; having a special application or reference; explicit, or definite; peculiar or proper to something, as qualities, characteristics, effects, etc.
sporadic	happening now and again or at intervals; irregular or occasional; appearing in scattered or isolated instances
statement	a communication or declaration setting forth facts, particulars; an expression
straightforward	without difficulty; uncomplicated; direct; easy to do or understand
structure	*verb* give a pattern, organisation or arrangement to; construct or arrange according to a plan; *noun* in languages, arrangement of words into larger units, e.g. phrases, clauses, sentences, paragraphs and whole texts, in line with cultural, intercultural and textual conventions; in Agricultural Science, an arrangement or organisation of parts to form a cell, tissue, organ, system or living thing
structured	organised or arranged so as to produce a desired result

Term	Explanation
subject	a branch or area of knowledge or learning defined by a syllabus; school subjects are usually based in a discipline or field of study (see also 'course')
subject matter	the subject-specific body of information, mental procedures and psychomotor procedures that are necessary for students' learning and engagement within that subject
substantial	of ample or considerable amount, quantity, size, etc.; of real worth or value; firmly or solidly established; of real significance; reliable; important, worthwhile
substantiated	established by proof or competent evidence
subtle	fine or delicate in meaning or intent; making use of indirect methods; not straightforward or obvious
successful	achieving or having achieved success; accomplishing a desired aim or result
succession planning	refers to the orderly transfer of management, responsibility, ownership and control, over time to other family members
succinct	expressed in few words; concise; terse; characterised by conciseness or brevity; brief and clear
sufficient	enough or adequate for the purpose
suitable	appropriate; fitting; conforming or agreeing in nature, condition, or action
summarise	give a brief statement of a general theme or major point/s; present ideas and information in fewer words and in sequence
summative assessment	assessment whose major purpose is to indicate student achievement; summative assessments contribute towards a student's subject result
superficial	concerned with or comprehending only what is on the surface or obvious; shallow; not profound, thorough, deep or complete; existing or occurring at or on the surface; cursory; lacking depth of character or understanding; apparent and sometimes trivial
superovulation	the induction of multiple ovulations in animals
supported	corroborated; given greater credibility by providing evidence
sustainable use	of natural resources, the process to minimise the waste of inputs in a system which ensures that the system has the potential to continue without negative impacts on environmental, financial and social factors
sustained	carried on continuously, without interruption, or without any diminishing of intensity or extent
syllabus	a document that prescribes the curriculum for a course of study

Term	Explanation
syllabus objectives	outline what the school is required to teach and what students have the opportunity to learn; described in terms of actions that operate on the subject matter; the overarching objectives for a course of study (see also 'unit objectives', 'assessment objectives')
symbolise	represent or identify by a symbol or symbols
synthesise	combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding
system	a group of interacting objects, materials or processes that form an integrated whole; systems can be open or closed (ACARA 2015c); in agricultural science, an assemblage of components that are united by some form of interaction and interdependence and that operate within a prescribed boundary to achieve a specified agricultural objective on behalf of the beneficiaries of the system (McConnell & Dillon 1997)
systematic	done or acting according to a fixed plan or system; methodical; organised and logical; having, showing, or involving a system, method, or plan; characterised by system or method; methodical; arranged in, or comprising an ordered system
T	
test	take measures to check the quality, performance or reliability of something
testosterone	a steroid hormone that stimulates development of male secondary sexual characteristics, produced mainly in the testes, but also in the ovaries and adrenal cortex
theory	in science, a set of concepts, claims and/or laws that can be used to explain and predict a wide range of related observed or observable phenomena; theories are typically founded on clearly identified assumptions, are testable, produce reproducible results and have explanatory power (ACARA 2015c)
thigmotropism	the turning or bending of a plant or other organism in response to a touch stimulus
thorough	carried out through, or applied to the whole of something; carried out completely and carefully; including all that is required; complete with attention to every detail; not superficial or partial; performed or written with care and completeness; taking pains to do something carefully and completely
thoughtful	occupied with, or given to thought; contemplative; meditative; reflective; characterised by or manifesting thought
tillage	the mechanical modification of soil to undertake a change in the use of the soil
tissue culture	a collection of techniques used to maintain or grow plant cells, tissues or organs under sterile conditions on a nutrient culture medium of known composition for the purposes of reproduction

Term	Explanation
topic	a division of, or sub-section within a unit; all topics/sub-topics within a unit are interrelated
trace element	a nutrient needed in trace amounts; usually fewer than 1 to 10 parts per million (also can be referred to as micronutrient)
transpiration	the process where water in the soil is absorbed into the plant root, moves up the stem of the plant and is then released as water vapour through pores in the leaves
trend	general direction in which something is changing (ACARA 2015c)
tropism	the response of an organism by an external stimulus that causes the organism to respond in a particular manner
U	
uncertainty	range of values for a measurement result, taking account of the likely values that could be attributed to the measurement result given the measurement equipment, procedure and environment (ACARA 2015c); indicators of uncertainty may include percentage, and/or absolute measurement uncertainty, confidence intervals, inferential statistics, statistical measure of spread, e.g. range, standard deviation
unclear	not clear or distinct; not easy to understand; obscure
understand	perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication
understanding	perception of what is meant by something
uneven	unequal; not properly corresponding or agreeing; irregular; varying; not uniform; not equally balanced
unfamiliar	not previously encountered; situations or materials that have not been the focus of prior learning experiences or activities
unit	a defined amount of subject matter delivered in a specific context or with a particular focus; it includes unit objectives particular to the unit, subject matter and assessment direction
unit objectives	drawn from the syllabus objectives and contextualised for the subject matter and requirements of a particular unit; they are assessed at least once in the unit (see also 'syllabus objectives', 'assessment objectives')
unmanned aerial vehicles (UAV)	an aircraft piloted by remote control or on-board computers; can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems; can be alternatively referred to as a remotely piloted aircraft
unrelated	having no relationship; unconnected
urbanisation	the occurrence of an increasing proportion of people living in towns and cities; resulting from people moving from rural areas (countryside) to urban areas (towns and cities)

Term	Explanation
use	operate or put into effect; apply knowledge or rules to put theory into practice
V	
vague	not definite in statement or meaning; not explicit or precise; not definitely fixed, determined or known; of uncertain, indefinite or unclear character or meaning; not clear in thought or understanding; couched in general or indefinite terms; not definitely or precisely expressed; deficient in details or particulars; thinking or communicating in an unfocused or imprecise way
valid	sound, just or well-founded; authoritative; having a sound basis in logic or fact (of an argument or point); reasonable or cogent; able to be supported; legitimate and defensible; applicable
validity	in science, the extent to which tests measure what was intended; the extent to which data, inferences and actions produced from tests and other processes are accurate (ACARA 2015c)
variable	*adjective* apt or liable to vary or change; changeable; inconsistent; (readily) susceptible or capable of variation; fluctuating, uncertain; *noun* in mathematics, a symbol, or the quantity it signifies, that may represent any one of a given set of number and other objects in science, a factor that can be changed, kept the same or measured in an investigation, e.g. time, distance, light, temperature
variety	a number or range of things of different kinds, or the same general class, that are distinct in character or quality; (of sources) a number of different modes or references; in agriculture science, a type of organism, especially a cultivated plant
visual representation	in science, an image that shows relationships within scientific evidence
W	
water harvesting	a form of water conservation where runoff is collected for production purposes
water holding capacity	the total amount of water a soil can hold at field capacity
water quality	refers to the chemical, physical, biological and radiological characteristics of water; a measure of the condition of water relative to the requirements of one or more biotic species and/or to any human need or purpose
weather	the daily conditions of the atmosphere in terms of temperature, atmospheric pressure, wind and moisture
wide	of great range or scope; embracing a great number or variety of subjects, cases, etc.; of full extent

Term	Explanation
with expression	in words, art, music or movement, conveying or indicating feeling, spirit, character, etc.; a way of expressing or representing something; vivid, effective or persuasive communication

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8 Version history

Version	Date of change	Update
1.1	December 2017	Editorial changes.
		Syllabus objective 2: Amendment to explanatory paragraph
		IA1: Data test • Minor amendments to Assessment objectives 2,3 & 4 • Percentage of marks modified – objective 3 — 40% changed to 30% – objective 4 — 30% changed to 40% • Condition amendment (Length) — 400 words changed to 'up to 500 words'
		IA2: Student experiment • Minor amendment to Assessment objective 5
		IA3: Research investigation • Minor amendment to Assessment objective 5
		Amendments to ISMGs to reflect modifications to objectives
		Glossary update
1.2	June 2018	Editorial changes
		IA1: Data test • Minor amendments to Assessment objective 2 • Minor amendments to description and conditions • Addition of information about cognition and nature of response for each objective
		IA2: Student experiment • Minor editorial changes to ISMG
		IA3: Research investigation • Minor editorial changes to ISMG
		EA: Examination • Minor amendments to Assessment objectives 3 and 4 • Minor amendments to description and conditions
		Glossary update
1.3	July 2022	Amendments to Unit 1 and Unit 2 Assessment guidance

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