Agricultural Systems

2021 Subject Outline | Stage 2

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Introduction

Subject description

Agriculture is a 10-credit subject or a 20-credit subject at Stage 1. Agricultural Production and Agricultural Systems are 20-credit subjects at Stage 2.

Improved agricultural productivity will be vital in the coming decades to help meet the global challenge of feeding the world’s increasing population. Farmers need the knowledge and skills to manage agricultural production, businesses, and marketing at the local level, while scientists seek to develop new strategies and technologies to help farmers manage our resources for sustainable food and fibre production.

Agriculture encompasses the primary industries and includes enterprises such as livestock (for fibre, meat, milk, and egg production), broadacre cropping, horticulture, viticulture, forestry, and aquaculture. Through the study of agriculture, students develop and apply their knowledge and understanding of concepts from science, technology, economics, and marketing. Work health, safety, and ethical principles underpin all aspects of this subject.

Students consider the changes in agricultural practices over time. They analyse different methods of agricultural production in relation to benefits, risks, and opportunities. They deepen their understanding of sustainable management of the physical and biological environments and of how agriculture impacts on their lives, their communities, and the environment.

Students develop skills in critical thinking that inspire them to explore strategies and possible solutions to address major challenges now and in the future related to the global food supply. They explore and understand agricultural science as a human endeavour, and are encouraged to pursue future pathways, including in agriculture, horticulture, land management, agricultural business practice, natural resource management, veterinary science, food and marine sciences, biosecurity, and quarantine.

Capabilities

The capabilities connect student learning within and across subjects in a range of contexts. They include essential knowledge and skills that enable people to act in effective and successful ways.

The SACE identifies seven capabilities. They are:

* literacy
* numeracy
* information and communication technology (ICT) capability
* critical and creative thinking
* personal and social capability
* ethical understanding
* intercultural understanding.

Literacy

In this subject students extend and apply their literacy capability by, for example:

* interpreting the work of scientists across disciplines, using agricultural knowledge
* critically analysing and evaluating primary and secondary data
* extracting agricultural information presented in a variety of modes
* using a range of communication formats to express ideas logically and fluently, incorporating the terminology and conventions of the study of agriculture
* synthesising evidence-based arguments
* communicating appropriately for specific purposes and audiences.

Numeracy

In this subject students extend and apply their numeracy capability by, for example:

* solving problems using calculations and critical thinking skills
* measuring with appropriate instruments
* recording, collating, representing, and analysing primary data
* accessing and interpreting secondary data
* identifying and interpreting trends and relationships
* calculating and predicting values by manipulating data and using appropriate scientific conventions.

Information and communication technology (ICT) capability

In this subject students extend and apply their ICT capability by, for example:

* locating and accessing information
* collecting, analysing, and representing data electronically
* modelling concepts and relationships
* using technologies to create new ways of thinking about agriculture
* communicating agricultural ideas, practices, processes, and information
* understanding the impact of ICT on the development of agriculture and its application in society
* evaluating the application of ICT to advance understanding and investigations in agriculture.

Critical and creative thinking

In this subject students extend and apply critical and creative thinking by, for example:

* analysing and interpreting problems and solutions from different perspectives
* deconstructing a problem to determine the most appropriate method for investigation
* constructing, reviewing, and revising hypotheses to design investigations
* interpreting and evaluating data and procedures to develop conclusions and make recommendations
* analysing interpretations and claims, for validity, reliability, and usefulness
* devising imaginative solutions and making reasonable predictions
* envisaging consequences and speculating on possible outcomes
* recognising the significance of creative thinking on the development of agricultural knowledge and applications.

Personal and social capability

In this subject students extend and apply their personal and social capability by, for example:

* understanding the importance of agricultural knowledge on health and well-being, personally, in local communities, and globally
* making decisions and taking initiative while working independently and collaboratively
* planning effectively, managing time, following procedures effectively, and working safely
* sharing and discussing ideas about agricultural issues, developments, and innovations while respecting the perspectives of others
* recognising the role of their own beliefs and attitudes in gauging the impact of agriculture on society
* seeking, valuing, and acting on feedback.

Ethical understanding

In this subject students extend and apply their ethical understanding by, for example:

* considering the implications of their investigations on organisms and the environment
* making ethical decisions based on an understanding of agricultural principles and the impact of agricultural activities
* understanding and applying safety and ethical considerations in the treatment of animals
* using data and reporting the outcomes of investigations accurately and fairly
* acknowledging the need to plan for the future and to protect and sustain the biosphere
* recognising the importance of their responsible participation in social, political, economic, and legal decision-making.

Intercultural understanding

In this subject students extend and apply their intercultural understanding by, for example:

* recognising that agricultural science is a global endeavour with significant contributions from diverse cultures
* respecting and engaging with different cultural views and customs and exploring their interaction with agricultural research and practices
* being open-minded and receptive to change in the light of scientific thinking based on new information
* understanding that the progress of agriculture and the nature of agricultural practices influence and are influenced by cultural factors.

Aboriginal and Torres Strait Islander knowledge, cultures, and perspectives

In partnership with Aboriginal and Torres Strait Islander communities, and schools and school sectors, the SACE Board of South Australia supports the development of high-quality learning and assessment design that respects the diverse knowledge, cultures, and perspectives of Indigenous Australians.

The SACE Board encourages teachers to include Aboriginal and Torres Strait Islander knowledge and perspectives in the design, delivery, and assessment of teaching and learning programs by:

* providing opportunities in SACE subjects for students to learn about Aboriginal and Torres Strait Islander histories, cultures, and contemporary experiences
* recognising and respecting the significant contribution of Aboriginal and Torres Strait Islander peoples to Australian society
* drawing students’ attention to the value of Aboriginal and Torres Strait Islander knowledge and perspectives from the past and the present
* promoting the use of culturally appropriate protocols when engaging with and learning from Aboriginal and Torres Strait Islander peoples and communities.

Health and safety

The handling of live animals, pathogens, and a range of chemicals and equipment requires appropriate health, safety, and welfare procedures.

It is the responsibility of the school to ensure that duty of care is exercised in relation to the health and safety of all students and that school practices meet the requirements of the Work Health and Safety Act 2012, in addition to relevant state, territory, or national health and safety guidelines. Information about these procedures is available from the school sectors.

The following safety practices must be observed in all laboratory work:

* Use equipment only under the direction and supervision of a teacher or other qualified person.
* Follow safety procedures when preparing or manipulating apparatus.
* Use appropriate safety gear when preparing or manipulating apparatus.

Any teaching activities that involve the care and use of, or interaction with, animals must comply with the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes, 8th edition, in addition to relevant national, state, or territory guidelines.

Keeping live animals in an educational setting requires permission from the relevant animal ethics committee. Permission to dissect animals must be obtained in writing from these committees.

For Department of Education and Child Development schools, information can be obtained from the DECD Intranet Animal Ethics webpage (<https://myintranet.learnlink.sa.edu.au/educating/extra-curricular-activities/animal-ethics>).

The Non Government Schools Animal Ethics Committee is a collaboration between Catholic Education South Australia and the Association of Independent Schools of South Australia ([www.ais.sa.edu.au/home/general-information/animal-ethics](http://www.ais.sa.edu.au/home/general-information/animal-ethics)).

Learning scope and requirements

Learning requirements

The learning requirements summarise the knowledge, skills, and understanding that students are expected to develop and demonstrate through their learning in Stage 2 Agricultural Systems.

In this subject, students are expected to:

1. apply science inquiry skills to deconstruct a problem and design and conduct agricultural investigations, using appropriate procedures and safe, ethical working practices

2. obtain, record, represent, analyse, and interpret the results of agricultural investigations

3. evaluate procedures and results and analyse evidence to formulate and justify conclusions

4. develop and apply knowledge and understanding of agricultural concepts, skills, and practices in new and familiar contexts

5. explore and understand agricultural science as a human endeavour

6. communicate knowledge and understanding of agriculture, using appropriate terms, conventions, and representations.

Content

Stage 2 Agricultural Systems is a 20-credit subject.

Stage 2 Agricultural Systems focuses on the scientific principles that underpin agricultural systems. Students develop an understanding of the relevant agricultural concepts that inform ways in which animal and plant production, and soil and water resources are managed. Students explore aspects of agriculture that are important locally, nationally, and/or globally.

The topics in Stage 2 Agricultural Systems provide the framework for developing integrated programs of learning through which students extend their skills, knowledge, and understanding of the three strands of science in the context of agricultural principles and practices.

The three strands of science to be integrated throughout student learning are:

* science inquiry skills
* science as a human endeavour
* science understanding.

The topics for Stage 2 Agricultural Systems are:

* Topic 1: Animal systems
* Topic 2: Plant systems
* Topic 3: Soil and water systems.

Students study all three topics. The topics can be sequenced and structured to suit individual groups of students.

The following pages describe in more detail:

* science inquiry skills
* science as a human endeavour
* the topics for science understanding.

The descriptions of the science inquiry skills and the topics are structured in two columns: the left-hand column sets out the science inquiry skills or science understanding and the right-hand column sets out possible contexts.

Together with science as a human endeavour, the science inquiry skills and science understanding form the basis of teaching, learning, and assessment in this subject.

The possible contexts are suggestions for potential approaches, and are neither comprehensive nor exclusive. Teachers may select from these and are encouraged to consider other approaches according to local needs and interests.

Within the topic descriptions, the following symbols are used in the possible contexts to show how a strand of science can be integrated:

|  |  |
| --- | --- |
|  | indicates a possible teaching and learning strategy for science understanding |
|  | indicates a possible science inquiry activity |
|  | indicates a possible focus on science as a human endeavour. |

 Science Inquiry Skills

In Stage 2 Agricultural Systems, investigation is an integral part of the learning and understanding of concepts, using scientific methods to test ideas and develop new knowledge.

Practical agricultural investigations must involve a range of individual and collaborative activities during which students extend the science enquiry skills described in the table that follows.

Practical activities may take a range of forms, such as developing or using models and simulations that enable students to develop a better understanding of particular agricultural concepts. The activities include field and laboratory studies during which students develop investigable questions and/or testable hypotheses, and select and use equipment appropriately to collect data. The data may be observations, measurements, or other information obtained during the investigation. Students represent and analyse the data they have collected; evaluate procedures, and describe the limitations of the data and procedures; consider explanations for their observations; and present and justify conclusions appropriate to the initial question or hypothesis.

It is recommended that a minimum of 16–20 hours of class time involves practical activities.

Science inquiry skills are fundamental to students investigating the social, ethical, and environmental impacts and influences of the development of scientific understanding and the applications, possibilities, and limitations of science. These skills enable students to critically consider the evidence they obtain so that they can present and justify conclusions.

| Science Inquiry Skills | Possible contexts |
| --- | --- |
| Scientific methods enable systematic investigation to obtain measurable evidence.   * Deconstruct a problem to determine and justify the most appropriate method for investigation. * Design investigations, including: * a proposal, hypothesis, or inquiry question * types of variables * dependent * independent * factors held constant (how and why they are controlled) * factors that may not be able to be controlled (and why not) * materials required * the method to be followed * the type and amount of data to be collected * identification of ethical and safety considerations. | Develop inquiry skills by, for example:   * designing investigations that require investigable questions and imaginative solutions (with or without implementation) * critiquing proposed investigations * using the conclusion of one investigation to propose subsequent experiments * changing an independent variable in a given procedure and adapting the method * researching, developing, and trialling a method * improving an existing procedure * identifying options for measuring the dependent variable * researching hazards related to the use and disposal of chemical and/or biological materials * developing safety audits * identifying relevant ethical and/or legal considerations in different contexts. |
| Obtaining meaningful data depends on conducting investigations using appropriate procedures and safe, ethical working practices.   * Conduct investigations, including: * selection and safe use of appropriate materials, apparatus, and equipment * collection of appropriate primary and/or secondary data (numerical, visual, descriptive) * individual and collaborative work. | Develop inquiry skills by, for example:   * identifying equipment, materials, or instruments fit for purpose * practising techniques and safe use of apparatus or equipment * comparing resolution of different measuring tools * distinguishing between, and using, primary and secondary data. |
| Results of investigations are represented in a well-organised way to allow them to be interpreted.   * Represent results of investigations in appropriate ways, including: * use of appropriate SI units, symbols * construction of appropriately labelled tables * drawing of graphs, including lines or curves of best fit as appropriate * use of significant figures. | Develop inquiry skills by, for example:   * practising constructing tables to tabulate data, including column and row labels with units * identifying the appropriate representations to graph different data sets * selecting appropriate axes and scales to graph data, e.g. see:   <http://www.contentextra.com/lifesciences/unit3/unit3home.aspx>   * clarifying understanding of significant figures using, for example:   <http://www.math-aids.com/Significant_Figures/>   * comparing data from different sources to describe as quantitative or qualitative. |
| Scientific information can be presented using different types of symbols and illustrations.   * Select, use, and interpret appropriate representations, including: * mathematical relationships, such as ratios * diagrams * equations   to explain concepts, solve problems, and make predictions. | Develop inquiry skills by, for example:   * drawing and labelling diagrams * recording images * writing and using formulae and chemical equations * constructing flow diagrams. |
| Analysis of the results of investigations allows them to be interpreted in a meaningful way.   * Analyse data, including: * identification and discussion of trends, patterns, and relationships * interpolation or extrapolation where appropriate. | Develop inquiry skills by, for example:   * analysing data sets to identify trends and patterns * determining relationships between independent and dependent variables * using graphs from different sources (e.g. CSIRO or the Australian Bureau of Statistics (ABS)) to predict values other than plotted points * calculating mean values and rates of reaction, where appropriate. |
| Critical evaluation of procedures and data can determine the meaningfulness of the results.   * Identify sources of uncertainty, including: * random and systematic errors * uncontrolled factors. * Evaluate reliability, accuracy, and validity of results, by discussing factors including: * sample size * precision * resolution of equipment * random error * systematic error * factors that cannot be controlled. | Develop inquiry skills by, for example:   * discussing how the repeating of an investigation with different materials/equipment may detect a systematic error * using an example of an investigation report to develop report-writing skills.   Useful website:  <http://www.biologyjunction.com/sample%20ap%20lab%20reports.htm> |
| Conclusions can be formulated that relate to the hypothesis or inquiry question.   * Select and use evidence and scientific understanding to make and justify conclusions. * Recognise the limitations of conclusions. * Recognise that the results of some investigations may not lead to definitive conclusions. | Develop inquiry skills by, for example:   * evaluating procedures and data sets provided by the teacher to determine and hence comment on the limitations of possible conclusions * using data sets to discuss the limitations of the data in relation to the range of possible conclusions that could be made. |
| Effective scientific communication is clear and concise.   * Communicate to specific audiences and for specific purposes using: * appropriate language * terminology * conventions. | Develop inquiry skills by, for example:   * reviewing scientific articles or presentations to recognise conventions * developing skills in referencing and/or footnoting * distinguishing between reference lists and bibliographies * practising communication in written, oral, and multimodal formats (e.g. presenting a podcast or writing a blog). |

 Science as a Human Endeavour

The science as a human endeavour strand highlights the development of science as a way of knowing and doing, and explores the purpose, use, and influence of science in society.

By exploring agricultural science as a human endeavour, students develop and apply their understanding of the complex ways in which science interacts with society, and investigate the dynamic nature of agricultural science. They explore how agricultural scientists develop new understanding and insights, and produce innovative solutions to everyday and complex problems and challenges in local, national, and global contexts. In this way, students are encouraged to think scientifically and make connections between the work of others and their own learning. This enables them to explore their own solutions to current and future problems and challenges.

Students understand that the development of science concepts, models, and theories is a dynamic process that involves analysis of evidence and sometimes produces ambiguity and uncertainty. They consider how and why science concepts, models, and theories are continually reviewed and reassessed as new evidence is obtained and as emerging technologies enable new avenues of investigation. They understand that scientific advancement involves a diverse range of individual scientists and teams of scientists working within an increasingly global community of practice.

Students explore how scientific progress and discoveries are influenced and shaped by a wide range of social, economic, ethical, and cultural factors. They investigate ways in which the application of science may provide great benefits to individuals, the community, and the environment, but may also pose risks and have unexpected outcomes. They understand how decision-making about socio-scientific issues often involves consideration of multiple lines of evidence and a range of needs and values. As critical thinkers, they appreciate science as an ever-evolving body of knowledge that frequently informs public debate, but is not always able to provide definitive answers.

The key concepts of science as a human endeavour underpin the contexts, approaches, and activities in this subject, and must be integrated into all teaching and learning programs.

The key concepts of science as a human endeavour, with elaborations that are neither comprehensive nor exclusive, in the study of Agricultural Systems are:

Communication and Collaboration

* Agricultural science is a global enterprise that relies on clear communication, international conventions, and review and verification of results.
* Collaboration between scientists, governments, and other agencies is often required in scientific research and enterprise.

Development

* Development of complex scientific models and/or theories often requires a wide range of evidence from many sources and across disciplines.
* New technologies improve the efficiency of scientific procedures and data collection and analysis. This can reveal new evidence that may modify or replace models, theories, and processes.

Influence

* Advances in scientific understanding in one field can influence and be influenced by other areas of science, technology, engineering, and mathematics.
* The acceptance and use of scientific knowledge can be influenced by social, economic, cultural, and ethical considerations.

Application and Limitation

* Scientific knowledge, understanding, and inquiry can enable scientists to develop solutions, make discoveries, design action for sustainability, evaluate economic, social, cultural, and environmental impacts, offer valid explanations, and make reliable predictions.
* The use of scientific knowledge may have beneficial or unexpected consequences; this requires monitoring, assessment and evaluation of risk, and provides opportunities for innovation.
* Science informs public debate and is in turn influenced by public debate; at times, there may be complex, unanticipated variables or insufficient data that may limit possible conclusions.

Topic 1: Animal systems

Students investigate ways in which knowledge of the anatomy and physiology of agricultural animals maximises production, informs the choice of optimal feeding systems, and maintains healthy farm animals. They explore how the processes of mechanical and chemical digestion affect nutrient uptake. Students analyse and compare the components of feed and the role of the components in animal nutrition, to enable decision-making about efficient and cost-effective feeding systems.

Students explore the science of reproductive processes to maximise the outcomes and returns of breeding programs. They investigate systematic approaches to pest and disease management in agricultural animal production, taking into account the microorganisms and invertebrates that affect agricultural animals, and analyse best-practice strategies.

Throughout their study of this topic, students maintain a key focus on animal health and welfare.

| Science Understanding | Possible contexts |  |
| --- | --- | --- |
| Animal nutrition  Knowledge of the anatomy and physiology of agricultural animals is essential for maintaining healthy farm animals.   * Explore the structure and function of the major components of the digestive systems of ruminant and non-ruminant animals. * Investigate the processes of mechanical and chemical digestion and nutrient uptake. * Analyse the components of feed, including carbohydrates, proteins, fats, vitamins, minerals, and water, and their roles in animal nutrition. * Investigate the manipulation of nutrition to influence growth rates and productivity in intensive and extensive systems. * Explain the management of feeding practices and their impact on animal health and welfare. | Investigate the digestive systems of farm animals such as sheep, cattle, pigs, and poultry.  Compare different monogastric digestive systems.  Compare different ruminant digestive systems.  Investigate intensive livestock systems and extensive livestock systems.  Investigate issues associated with inadequate or poorly managed nutrition, such as acidosis, bloat, and deficiencies. |  |
| Examine components and feed values of feed types, including pastures, grains, and roughages.  Carry out feeding trials to measure growth rates.  Measure and graphically represent stages of animal growth. |  |
| Compare the economic and ethical issues associated with intensive livestock systems, such as feedlotting, sow stalls, and caged hens, with alternative systems. |  |
| Animal reproduction and breeding  Knowledge of animal reproductive systems and emerging reproductive technologies is required to produce robust stock.   * Explain the structure and function of components of the reproductive systems of animals in agricultural production. * Discuss the reproductive stages in agricultural animals. * Explore the role of reproductive hormones, including those used in artificial insemination and embryo-transfer programs. * Investigate selective breeding programs, including the use of estimated breeding values (EBVs) and breeding technologies. * Explore the role of genetics and how it is applied in the inheritance of characteristics in agricultural animals. * Investigate the selection of livestock to match climate and environmental constraints. | Discuss the applications of reproductive technology in different commercial settings.  Explain the stages of oestrus, ovulation, copulation, fertilisation, gestation, parturition, and lactation.  Understand the role of follicle-stimulating hormone, luteinising hormone, oestrogen, progesterone, prolactin, oxytocin, and testosterone.  Compare reproduction in different livestock types (e.g. sheep, cattle, pigs, and poultry).  Discuss which characteristics are targeted during selection of sires and dams in different livestock systems.  Examine stud sale data to identify the characteristics most valued by industry. |  |
| Run mock bull or ram auctions using EBVs and buyer scenarios.  Interview a stud breeder about dam and sire selection. |  |
| Debate the ethical issues surrounding genetic modification of farm animals. |  |
| Animal health  Pest and disease management strategies are an essential part of agricultural animal production.   * Investigate the importance of microorganisms and invertebrates in the management of agricultural animals. * Investigate best-practice strategies in integrated management plans for microorganisms and invertebrates that affect agricultural animals. * Analyse how quarantine and biosecurity strategies are used to control the spread of pests and diseases. | Investigate the role of ruminant microbes.  Investigate methods to reduce methane production by ruminants.  Investigate the effects of microbial diseases, such as ovine Johne’s disease, enterotoxaemia, and leptospirosis, on livestock.  Research invertebrate pests of agricultural animals, such as sheep blowflies, lice, tapeworms, and liver flukes.  Investigate quarantine procedures used to control the spread of pests and diseases, at the farm level through to international controls.  Compare and link pest and disease management strategies, including chemical, biological, legislative, physical, and mechanical methods.  Investigate the documents and database transactions required for livestock sales and movements.  Interview a pig farmer about quarantine measures in their business.  Discuss resistance-management strategies for parasites.  Debate the impact of relaxing quarantine restrictions on livestock movement.  Discuss the consequences for Australian agricultural markets of an outbreak of a disease such as mad cow disease. |  |
| Using appropriate PPE (personal protective equipment) and SOPs (standard operating procedures), conduct faecal egg counts pre- and post‑drenching, and analyse the effectiveness of the drenching program. |  |
| Investigate why a national approach to the management of Johne’s disease, managed by Animal Health Australia, has been agreed to by key stakeholders including Australian livestock industries, government, and the veterinary profession. |  |

Topic 2: Plant systems

Students investigate ways in which knowledge of the anatomy and physiology of agricultural plants maximises effective plant production. They examine intensive and extensive plant production systems, and explore how farmers modify and/or manage environmental factors to maximise the productivity of agricultural plants.

Students investigate how innovative scientific techniques have improved plant breeding for more successful plant production. They consider the ethical issues associated with plant production in agriculture.

Students explore ways in which farmers and researchers can contribute more efficiently to international collaboration on global problems.

| Science Understanding | Possible contexts |  |
| --- | --- | --- |
| Plant growth and nutrition  Knowledge of the anatomy and physiology of agricultural plants is essential for effective plant production.   * Compare monocotyledonous and dicotyledonous agricultural plants. * Explore the function of external and internal plant structures. * Investigate how the differences between monocotyledonous and dicotyledonous agricultural plants and weeds affect their management. * Explain the processes of photosynthesis, respiration, transpiration, water transport, and nutrient uptake; and the transfer, translocation, and storage of plant products. * Explore how environmental factors, such as temperature, humidity, carbon dioxide concentration, and light (intensity and wavelength), can affect photosynthesis, respiration, and transpiration. * Investigate intensive and extensive plant production systems. * Investigate how farmers modify environmental factors to maximise productivity of agricultural plants. * Analyse how macronutrients and micronutrients affect agricultural plant growth. * Explore the ethical issues associated with plant production in agriculture. * Investigate how farmers match their plant enterprises to environmental and climate conditions. * Explain the importance of plant hormones on plant growth. * Investigate how plant hormones are used by farmers to influence plant productivity. | Explain, in terms of the structural characteristics of plants, why the use of both monocotyledonous and dicotyledonous crops can be advantageous in a broadacre cropping system.  Investigate the type of herbicide that farmers use to remove dicotyledonous weeds that grow amongst crops.  Investigate the influence of the lateral roots of vines in determining row spacing and row crops that can be grown.  Investigate the proportion of monocotyledonous crops (such as grasses) and dicotyledonous crops (such as legumes) in pastures that provides balanced nutrition for grazing animals.  Research the effects of nutrients, such as nitrogen, phosphorus, potassium, sulfur, calcium, zinc, and boron, on plant growth.  Compare different cropping methods such as organic, biodynamic, and conventional.  Research the role of auxins, abscisic acid, gibberellins, ethylene, and cytokinins in plant production.  Discuss the environmental impact of issues such as marginal cropping. |  |
| Investigate the growth of agricultural plants using different growing media.  Conduct fertiliser trials to explore macronutrient and micronutrient deficiencies.  Conduct a legume trial assessing the root nodulation of different crop types, or within different crop rotations.  Using a hydroponics kit, investigate, for example, the response of different wheat varieties to high levels of boron. |  |
| Investigate the advantages of fertiliser use and potential issues caused by nutrient run-off.  Debate the impact of different cropping methods on the environment and associated ethical concerns such as food miles:  <http://www.sbs.com.au/shows/foodinvestigators/listings/detail/i/1/article/2941/Food-Miles> |  |
| Plant breeding and propagation  Innovative scientific techniques have improved plant breeding for more successful plant production.   * Compare sexual and asexual reproduction in agricultural plant production. * Explore the role of genetics and how it is applied in the inheritance of characteristics in agricultural plants. * Investigate the role of tissue culture and cloning in plant propagation and breeding. * Assess how breeding techniques can be used to improve plant production in agriculture. | Research different propagation techniques.  Compare the effectiveness and efficiency of traditional plant breeding techniques with genetic engineering.  Research the advances in crop characteristics that plant breeding has contributed (e.g. yield, disease resistance, pest control). |  |
| Design an investigation using different propagation techniques to test a hypothesis about the quality of the plants produced. |  |
| Debate the risks and benefits of using genetic engineering technology in advancing plant breeding.  Discuss the issues around South Australia’s moratorium on genetically engineered crops. |  |
| Plant health  The management of pests and diseases is vital to plant health.   * Investigate the importance of microorganisms and invertebrates in the management of agricultural plants. * Investigate best-practice strategies in integrated management plans for weeds, microorganisms, and invertebrates that affect agricultural plants. * Analyse how quarantine and biosecurity strategies are used to control the spread of pests and diseases. | Research microbial diseases of plants, such as stem rust and black leg.  Research invertebrate pests of agricultural crops, such as redlegged earth mite and heliothis.  Investigate quarantine procedures used to control the spread of pests and diseases, at the farm level through to international controls.  Compare the benefits and risks of pest, disease, or weed management strategies, including chemical, biological, legislative, physical, and mechanical methods.  Discuss the consequences for Australian agriculture of an outbreak of a disease such as a new strain of stem rust like Ug99.  Investigate the effects of herbicide drift and herbicide resistance. |  |
| Investigate pest populations in glasshouses by setting insect traps and analysing the density and diversity of species detected. |  |
| Investigate how the use of chemicals for weed control introduced the problem of resistant strains and hence initiated the development of innovative strategies for weed control.  Investigate an example of international collaboration that has produced effective strategies to control a pest or disease. |  |

Topic 3: Soil and water systems

Students investigate the fundamental role of soil and water in agricultural systems. They explore the interconnections between agriculture and the management and sustainability of natural resources.

Students consider how agricultural scientists perform a key role in monitoring and giving expert advice on environmental issues that affect soil and water resources. Students investigate issues relating to quality soil and water resources that have an impact on agricultural systems.

Students explore innovations in technology that enable more efficient data collection and analysis, enabling modification of, and improvements to, the use of soil and water systems.

| Science Understanding | Possible contexts |  |
| --- | --- | --- |
| Water quality and soil quality affect the productivity of agricultural enterprises.   * Explain why soil texture and soil structure are important for plant growth. * Investigate how the physical, chemical, and biological properties of soils impact on their productivity. * Explain how a change in pH affects nutrient availability and soil fertility. * Investigate how the breakdown of organic matter affects soil fertility. * Analyse how tillage systems can affect soil structure. * Explain how interactions in the soil biota affect soil fertility. * Explain how soil additives modify soil properties. * Investigate factors that result in soil degradation, and methods used to rehabilitate affected soil. * Analyse the impact of soil type on enterprise selection and potential. * Explore current techniques used to measure levels of soil water. * Analyse the impact that water quality and availability have on enterprise selection. * Evaluate the management of agricultural water resources. * Investigate industry best practice for waste-water management from both animal and plant production systems. * Investigate the relationship between agricultural practices and the health of natural water systems. | Research how the productivity of different soils is affected by the properties of porosity, water infiltration and percolation, and nutrient- and water-holding capacity.  Landline: <http://www.abc.net.au/landline/>  Research living organisms that have a positive impact on soil productivity.  Livestock Biosecurity Network:  <http://www.lbn.org.au/>  Examine soil horizons and explain how their depth and physical properties can affect plant growth.  Explore how the cation exchange capacity of a soil is related to the textural types and composition of the soil.  Compare the effects of soil additives, both positive (e.g. pH and structure modifiers like lime, sulfur, gypsum, clay, and organic residues) and negative (e.g. fertiliser overuse).  Research salinity, sodicity, acidification, non-wetting soils, and how to rehabilitate affected areas.  Debate the impact of water restrictions on South Australian agriculture.  Research the impact of water quality on aquaculture production systems. |  |
| Create a soil profile.  Analyse a local soil profile.  Analyse soil samples to determine components, using mechanical analysis.  Use the CSIRO soil texture triangle to determine textural classes.  Design an investigation to compare soil characteristics, such as texture, structure, dispersion, non-wetting characteristics, pH, organic matter, sodicity, compaction, and salinity, of soil samples from different locations.  Analyse the data from a soil-moisture probe and use it to make recommendations for in-season fertiliser application  Monitor water quality in an aquaculture system, and determine the causes of fluctuations and appropriate management strategies. |  |
| Discuss how soil-monitoring technology can improve the efficiency of data collection to assist irrigation scheduling and fertiliser application.  Investigate how the use of technology to reduce water wastage in irrigation and livestock systems can improve the sustainability of water resources.  Investigate the contributions of scientific data and public opinion to the debate about suggestions for water use outlined in the Murray–Darling Basin Management Plan. |  |

Assessment scope and requirements

All Stage 2 subjects have a school assessment component and an external assessment component.

Evidence of learning

The following assessment types enable students to demonstrate their learning in Stage 2 Agricultural Systems:

School assessment (70%)

* Assessment Type 1: Agricultural Reports (30%)
* Assessment Type 2: Applications (40%)

External assessment (30%)

* Assessment Type 3: Experimental Investigation (30%).

Students provide evidence of their learning through seven assessments, including the external assessment component. Students complete:

* three agricultural reports:
* two with a practical focus, including one with individual student design
* one with a focus on science as a human endeavour
* three applications tasks
* one experimental investigation.

At least one agricultural report or applications task should involve collaborative work.

Assessment design criteria

The assessment design criteria are based on the learning requirements and are used by:

* teachers to clarify for the student what they need to learn
* teachers and assessors to design opportunities for the student to provide evidence of their learning at the highest possible level of achievement.

The assessment design criteria consist of specific features that:

* students should demonstrate in their learning
* teachers and assessors look for as evidence that students have met the learning requirements.

For this subject, the assessment design criteria are:

* investigation, analysis, and evaluation
* knowledge and application.

The specific features of these criteria are described below.

The set of assessments, as a whole, must give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

Investigation, Analysis, and Evaluation

The specific features are as follows:

IAE1 Deconstruction of a problem and design of an agricultural investigation.

IAE2 Obtaining, recording, and representation of data, using appropriate conventions and formats.

IAE3 Analysis and interpretation of data and other evidence to formulate and justify conclusions.

IAE4 Evaluation of procedures and their effect on data.

Knowledge and Application

The specific features are as follows:

KA1 Demonstration of knowledge and understanding of agricultural concepts and practices.

KA2 Application of agricultural concepts, skills, and practices in new and familiar contexts.

KA3 Exploration and understanding of the interaction between agricultural science and society.

KA4 Communication of knowledge and understanding of agricultural concepts and information, using appropriate terms, conventions, and representations.

School assessment

Assessment Type 1: Agricultural Reports (30%)

Students complete three agricultural reports. Two reports have a practical focus, and one report has a focus on science as a human endeavour in an agricultural context.

Students investigate aspects of agriculture through practical discovery and data analysis, and/or by selecting, analysing, and interpreting information.

Practical Reports

As students design and safely carry out agricultural investigations, they demonstrate their science inquiry skills by:

* deconstructing a problem to determine the most appropriate method for the investigation
* formulating investigable questions and hypotheses
* selecting and using appropriate equipment, apparatus, and techniques
* identifying variables
* collecting, representing, analysing, and interpreting data
* evaluating procedures and considering their impact on results
* drawing conclusions and/or making recommendations
* communicating knowledge and understanding of agriculture.

As a set, practical investigations should enable students to:

* work both individually or collaboratively
* investigate a question or hypothesis for which the outcome is uncertain.
* investigate a question or hypothesis linked to one of the topics in Stage 2 Agricultural Systems
* individually deconstruct a problem to design their own method and justify their plan of action.

For each investigation, students present an individual report.

Evidence of deconstruction (where applicable) should outline the deconstruction process, the method designed as most appropriate, and a justification of the plan of action, to a maximum of 4 sides of an A4 page. This evidence must be attached to the practical report.

Suggested formats for this evidence include flow charts, concept maps, tables, or notes.

In order to manage the implementation of an investigation efficiently, students could individually design investigations and then conduct one of these as a group, or design hypothetical investigations at the end of a practical activity.

A practical report must include:

* introduction with relevant agricultural concepts, and either a hypothesis and variables, or an investigable question
* materials/apparatus
* the method that was implemented
* identification and management of safety and/or ethical risks
* results, including table(s) and/or graph(s)
* analysis of results, including identifying trends and linking results to concepts
* evaluation of procedures and their effect on data, and identifying sources of uncertainty
* conclusion and/or recommendations, with justification.

The report should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

Only the following sections of the report are included in the word count:

* introduction
* analysis of results
* evaluation of procedures
* conclusion and/or recommendations, with justification.

Suggested formats for presentation of a practical investigation report include:

* a written report
* an oral presentation
* a multimodal product.

Science as a Human Endeavour Report

Students investigate a contemporary example of how agricultural science interacts with society. This may focus on one or more of the key concepts of science as a human endeavour described on pages 11 and 12, and may draw on a context suggested in the topics or relate to a new context.

Students select and explore a recent discovery, innovation, issue, or advance linked to one of the topics in Stage 2 Agricultural Systems. They analyse and synthesise information from different sources to explain the science relevant to the focus of their investigation, show its connections to science as a human endeavour in an agricultural context, and develop a conclusion.

Possible starting points for the investigation could include, for example:

* the announcement of a discovery in the field of agricultural science
* an expert’s point of view on a controversial innovation
* a TED talk based on an agricultural science development
* an article from an agricultural publication (e.g. *Stock Journal*)
* public concern about an agricultural issue that has environmental, social, economic, or political implications
* changes in government funding for agriculture-related purposes, e.g. for scientific research into biotechnology, soil conservation, hormone use in food production, biosecurity, water management, the greenhouse effect, pest and disease control, monitoring changes in global temperature
* innovative directions in research.

Based on their investigation, students prepare a report that must include use of appropriate terminology and:

* an introduction to identify the focus of the investigation and the key concept(s) of science as a human endeavour that it links to
* relevant agricultural science concepts or background
* an explanation of how the focus of the investigation illustrates the interaction between agricultural science and society, including a discussion of the potential impact of the focus of the investigation, e.g. potential of new development, effect on quality of life, environmental implications, economic impact, intrinsic interest
* a conclusion
* citations and referencing.

The report should be a maximum of 1500 words if written, or a maximum of 10 minutes for an oral presentation, or the equivalent in multimodal form.

This report could take the form of, for example:

* an article
* a letter to the editor
* a talk.

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:

* investigation, analysis, and evaluation
* knowledge and application.

Assessment Type 2: Applications (40%)

Students undertake three applications tasks, with at least one under the direct supervision of the teacher. The supervised setting should be appropriate to the task. Each supervised task should be a maximum of 90 minutes of class time, excluding reading time.

Applications tasks allow students to provide evidence of their learning in tasks that may:

* be applied, analytical, and/or interpretative
* pose problems in new and familiar contexts
* involve individual or collaborative assessments, depending on task design.

An applications task may involve, for example:

* deconstructing and analysing a problem
* creating possible solutions
* considering different scenarios in which to apply knowledge and understanding
* graphing, tabulating, and/or analysing data
* evaluating procedures and identifying their limitations
* formulating and justifying conclusions.
* representing information diagrammatically or graphically
* using agricultural terms, conventions, and notations.

As a set, applications tasks should be designed to enable students to apply their science inquiry skills, demonstrate knowledge and understanding of key agricultural concepts and practices, and explain connections with science as a human endeavour. Problems and scenarios should be set in a relevant context, which may be practical, social, or environmental.

Applications tasks may include:

* developing simulations
* a practical skills assessment
* graphical skills
* a multimodal product
* a data-interpretation exercise
* an oral presentation
* an extended response and/or short-answer questions
* a response to agricultural science in the media.

For this assessment type, students provide evidence of their learning in relation to the following assessment design criteria:

* investigation, analysis, and evaluation
* knowledge and application.

External assessment

Assessment Type 3: Experimental Investigation (30%)

Students individually undertake one experimental investigation. They develop their investigation in negotiation with the teacher and conduct it based on a specific aspect of animal or plant production systems. Students design a proposal. They develop their own hypothesis, then design and undertake the investigation, and analyse, evaluate, and report on their findings.

The investigation involves the collection of primary and secondary data. Students may work collaboratively to gather data, but each student must produce an individual investigation report.

One draft of the proposal should be submitted for teacher feedback and approval. Students may modify their plan in response to teacher feedback before they undertake their investigation.

Students submit their modified proposal with their report for assessment.

Proposal

The proposal must include:

* an introduction to identify the purpose and relevant background
* a hypothesis
* independent and dependent variables, and the type of data that will be collected
* materials/apparatus
* method, with justification for the design
* identification of, and a management plan for, safety and/or ethical risks.

Report

The completed experimental investigation should be presented as a report, using clearly expressed ideas and appropriate agricultural terminology, and include:

* appropriate presentation of data, e.g. summary tables, graphs, photographs, or other illustrations
* analysis of the findings
* evaluation of the design, including recommendations for improvements
* a conclusion, which includes the relevance of findings to ethical, economic, environmental, and/or political impacts on agricultural systems
* references.

The combined word count for the proposal and the report should be a maximum of 2000 words, if written, or the equivalent in multimodal form.

The following specific features of the assessment design criteria for this subject are assessed in the experimental investigation:

* investigation, analysis, and evaluation — IAE1, IAE2, IAE3, and IAE4
* knowledge and application — KA1 and KA4.

Performance standards

The performance standards describe five levels of achievement, A to E.

Each level of achievement describes the knowledge, skills, and understanding that teachers and assessors refer to in deciding how well students have demonstrated their learning on the basis of the evidence provided.

During the teaching and learning program the teacher gives students feedback on their learning, with reference to the performance standards.

At the student’s completion of study of each school assessment type, the teacher makes a decision about the quality of the student’s learning by:

* referring to the performance standards
* assigning a grade between A+ and E for the assessment type.

The student’s school assessment and external assessment are combined for a final result, which is reported as a grade between A+ and E.

Performance Standards for Stage 2 Agricultural Systems

| - | Investigation, Analysis and Evaluation | Knowledge and Application |
| --- | --- | --- |
| A | Critically deconstructs a problem and designs a logical, coherent, and detailed agricultural investigation.  Obtains, records, and represents data, using appropriate conventions and formats accurately and highly effectively.  Systematically analyses and interprets data and evidence to formulate logical conclusions with detailed justification.  Critically and logically evaluates procedures and their effect on data. | Demonstrates deep and broad knowledge and understanding of a range of agricultural concepts and practices.  Applies agricultural concepts, skills, and practices highly effectively in new and familiar contexts.  Critically explores and understands in depth the interaction between agricultural science and society.  Communicates knowledge and understanding of agriculture coherently, with highly effective use of appropriate terms, conventions, and representations. |
| B | Logically deconstructs a problem and designs a well-considered and clear agricultural investigation.  Obtains, records, and represents data, using appropriate conventions and formats mostly accurately and effectively.  Logically analyses and interprets data and evidence to formulate suitable conclusions with reasonable justification.  Logically evaluates procedures and their effect on data. | Demonstrates some depth and breadth of knowledge and understanding of a range of agricultural concepts and practices.  Applies agricultural concepts, skills, and practices mostly effectively in new and familiar contexts.  Logically explores and understands in some depth the interaction between agricultural science and society.  Communicates knowledge and understanding of agriculture mostly coherently, with effective use of appropriate terms, conventions, and representations. |
| C | Deconstructs a problem and designs a considered and generally clear agricultural investigation.  Obtains, records, and represents data, using generally appropriate conventions and formats, with some errors but generally accurately and effectively.  Undertakes some analysis and interpretation of data and evidence to formulate generally appropriate conclusions with some justification.  Evaluates procedures and some of their effect on data. | Demonstrates knowledge and understanding of a general range of agricultural concepts and practices.  Applies agricultural concepts, skills, and practices generally effectively in new or familiar contexts.  Explores and understands aspects of the interaction between agricultural science and society.  Communicates knowledge and understanding of agriculture generally effectively, using some appropriate terms, conventions, and representations. |
| D | Prepares a basic deconstruction of a problem and an outline of an agricultural investigation.  Obtains, records, and represents data, using conventions and formats inconsistently with occasional accuracy and effectiveness.  Describes data and undertakes some basic interpretation to formulate a basic conclusion.  Attempts to evaluate procedures or suggest an effect on data. | Demonstrates some basic knowledge and partial understanding of agricultural concepts and practices.  Applies basic agricultural concepts, skills, and practices in familiar contexts.  Partially explores and recognises aspects of the interaction between agricultural science and society.  Communicates basic information about agriculture, using some appropriate terms, conventions, and/or representations. |
| E | Attempts a simple deconstruction of a problem and a procedure for an agricultural investigation.  Attempts to record and represent some data with limited accuracy or effectiveness.  Attempts to describe results and/or interpret data to formulate a basic conclusion.  Acknowledges that procedures affect data. | Demonstrates some limited recognition and awareness of agricultural concepts and practices.  Attempts to apply one or more basic agricultural concepts, skills, and/or practices in familiar contexts.  Attempts to explore and identify an aspect of the interaction between agricultural science and society.  Attempts to communicate information about agriculture. |

Assessment integrity

The SACE Assuring Assessment Integrity Policy outlines the principles and processes that teachers and assessors follow to assure the integrity of student assessments. This policy is available on the SACE website ([www.sace.sa.edu.au](file:///C:\Users\Ekwomr01\Objective\edrms.saceboard.sa.gov.au-8008-ekwomr01\Objects\www.sace.sa.edu.au)) as part of the SACE Policy Framework.

The SACE Board uses a range of quality assurance processes so that the grades awarded for student achievement, in both the school assessment and the external assessment, are applied consistently and fairly against the performance standards for a subject, and are comparable across all schools.

Information and guidelines on quality assurance in assessment at Stage 2 are available on the SACE website ([www.sace.sa.edu.au](file:///C:\Users\Ekwomr01\Objective\edrms.saceboard.sa.gov.au-8008-ekwomr01\Objects\www.sace.sa.edu.au)).

Support materials

Subject-specific advice

Online support materials are provided for each subject and updated regularly on the SACE website ([www.sace.sa.edu.au](file:///C:\Users\Ekwomr01\Objective\edrms.saceboard.sa.gov.au-8008-ekwomr01\Objects\www.sace.sa.edu.au)). Examples of support materials are sample learning and assessment plans, annotated assessment tasks, annotated student responses, and recommended resource materials.

Advice on ethical study and research

Advice for students and teachers on ethical study and research practices is available in the guidelines on the ethical conduct of research in the SACE on the SACE website ([www.sace.sa.edu.au](file:///C:\Users\Ekwomr01\Objective\edrms.saceboard.sa.gov.au-8008-ekwomr01\Objects\www.sace.sa.edu.au)).