Agricultural Science 2025 v1.1

General senior syllabus

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Queensland Government
QCAA Queensland Curriculum & Assessment Authority

For all Queensland schools

Units

Unit 1: Agricultural systems

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

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

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

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

Unit objectives

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

Subject matter

Topic 1: Agricultural enterprises A (4 hours)

Science understanding

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

Science as a human endeavour (SHE)

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

Science inquiry

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

Topic 2: Animal production A (19 hours)

Science understanding

Animal identification, anatomy and physiology

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

Genetics and inheritance of traits (animals/plants)

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

Animal breeding and reproductive technologies

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

Science as a human endeavour (SHE)

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

Science inquiry

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

Topic 3: Plant production A (22 hours)

Science understanding

Agricultural plants

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

Plant anatomy and physiology

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

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

Plant growth and development

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

Plant nutrition

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

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

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

Science as a human endeavour (SHE)

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

Science inquiry

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

Unit 2: Resources

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

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

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

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

Unit objectives

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

Subject matter

Topic 1: Management of renewable resources (12 hours)

Science understanding

Managing ecosystems and renewable resources

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

Use of renewable resources

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

Science as a human endeavour (SHE)

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

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

Science inquiry

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

Topic 2: Physical resource management (18 hours)

Science understanding

Soil properties and classification

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

Climate and weather

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

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

Science as a human endeavour (SHE)

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

Science inquiry

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

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

Science understanding

Enterprise management

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

Developments in agricultural technologies

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

Adopting technologies in agriculture

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

Science as a human endeavour (SHE)

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

Science inquiry

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

Unit 3: Agricultural production

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

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

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

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

Unit objectives

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

Subject matter

Topic 1: Animal production B (26 hours)

Science understanding

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

Animal nutrition

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

Animal growth and development

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

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

Animal health

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

Animal ethics and welfare

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

Science as a human endeavour (SHE)

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

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

Science inquiry

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

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

Topic 2: Plant production B (15 hours)

Science understanding

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

Plant production

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

Plant health

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

Plant reproduction and breeding

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

Science as a human endeavour (SHE)

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

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

Science inquiry

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

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

Topic 3: Agricultural enterprises B (4 hours)

Science understanding

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

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

Science as a human endeavour (SHE)

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

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

Science inquiry

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

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

Unit 4: Agricultural management

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

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

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

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

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

Unit objectives

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

Subject matter

Topic 1: Enterprise management (14 hours)

Science understanding

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

Data for decision-making

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

Decision-making in property management

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

Science as a human endeavour (SHE)

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

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

Science inquiry

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

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

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

Science understanding

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

Environmental factors

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

Financial factors

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

Social factors

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

Science as a human endeavour (SHE)

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

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