From PADDOCK to PLATE

Science

Year 7 | Stage 4

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Curriculum focus

The resources in the Science Teacher Manual help teachers and students explore how different ecosystems within agriculture coexist, their related food webs and the impact of external influences. Students explore the Virtual Video Excursion/s for one or more industries and use this information to put themselves in the shoes of a botanist, explore food biology and discover how agriculture waste can turn into renewable energy by building knowledge in physics and chemistry.

How to use this Teacher Manual

The Science Teacher Manual consists of lesson plans and supplementary activities about several agricultural industries in Australia. There are facts about Australian agriculture for your use on page 4, 6, 11, 16, 21 and 27.

First, start with the Springboard virtual video excursions on page 5.

Then, move on to the products or industries within this manual that match your learning aims or interests.

Themes and topics:

- Animal welfare
- Biodiversity
- Communications
- Community
- Drought & natural disasters
- Economics
- Employment
- Environment
- Ethics
- Food miles
- Food security
- Food waste & recycling
- Innovation
- Marketing
- Nutrition
- Pests & diseases
- Profitability
- Seasonality
- Soil & pasture management
- Sustainability
- Technology
- Traceability
- Waste management
- Water security

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Australian Curriculum Links

All Industries | Year 7 | Stage 4

Cross-curriculum priorities

Aboriginal and Torres Strait Islander histories and cultures

Asia and Australia's Engagement with Asia

Sustainability

Lesson 1 Orchard Food Webs	ACSSU112	Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions
Lesson 1 Orchard Food Webs	ACSIS131	Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method
Lesson 1 Orchard Food Webs	ACSIS125	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed
Lesson 2 Plant Science Professionals	ACSSU111	There are differences within and between groups of organisms; classification helps organise this diversity
Lesson 2 Plant Science Professionals	ACSHE223	Science knowledge can develop through collaboration and connecting ideas across the disciplines of science
Lesson 2 Plant Science Professionals	ACSHE120	Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations
Lesson 2 Plant Science Professionals	ACSHE121	Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management
Lesson 3 Seasons and Fruit	ACSSU115	Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon
Lesson 3 Seasons and Fruit	ACSIS124	Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge
Lesson 4 Poultry Poo Power	ACSSU116	Some of Earth's resources are renewable, but others are non-renewable
Lesson 4 Poultry Poo Power	ACSHE223	Science knowledge can develop through collaboration and connecting ideas across the disciplines of science
Lesson 4 Poultry Poo Power	ACSHE120	Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations
Lesson 4 Poultry Poo Power	ACSHE121	Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management
Lesson 5 Fishing for Future Food Webs	ACSSU112	Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions

Australian Curriculum Links

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Lesson 5 **Fishing for Future Food Webs**	ACSIS131	Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method
Lesson 5 **Fishing for Future Food Webs**	ACSIS125	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed

Facts about the Australian agricultural industry

- The gross value of Australian agriculture increased by $3.7 billion from 2014–15, to $58.1 billion in 2015–16.
  SOURCE: ABARES, Agricultural Commodities – June Quarter 2017.
- TIn Australia, individuals spent on average $4739 for food in 2015–16. This includes eating out and non-alcoholic beverages. This amount has risen by 16% during the past six years.
  SOURCE: ABS, Household Expenditure Survey, Australia: Summary of Results, 2015–16, Catalogue No.6530.0.
- Food imports, particularly for processed food, accounted for only 15 per cent of household food consumption in Australia in 2015–16.
  SOURCE: Hogan, Linsday. (2017) *Food demand in Australia: Trends and food security issues*. ABARES research report 17.7, Canberra.
- Out of the $58.1 billion worth of food and fibre Australian farmers produced in 2015–16, 77 per cent ($44.8 billion) was exported.
  SOURCE: ABARES, Agricultural Commodities – June Quarter 2017
- More than 99% of Australia's agricultural businesses are wholly Australian owned, owning 88% (or 343.3 million hectares) of Australia's agricultural land. Wholly Australian owned businesses also control 87% of Australia's agricultural water entitlements (or 13.3 million megalitres).
  SOURCE: ABS, Agricultural Land and Water Ownership, 2015–16, Catalogue No. 7127.0. 2017
- As of May 2017, 304,200 people were employed in the Australian farm sector — accounting for about 3% of the national workforce.
  SOURCE: Australian Bureau of Statistics, *Labour Force, Australia, Detailed, Quarterly, May 2017 Catalogue No. 6291.0.55.003.*
- Across the supply chain agriculture powers 1.6 million jobs.
  SOURCE: Australia's Farm Dependent Economy: *Analysis of the role of Agriculture in the Australian Economy.*
- 216,100 males and 88,100 females are employed in the Australian farm sector
  SOURCE: Australian Bureau of Statistics, *Labour Force, Australia, Detailed, Quarterly, May 2017 Catalogue No. 6291.0.55.003.*
- Agricultural businesses occupy and manage 48% of Australia's landmass, as such, they are at the frontline in delivering environmental outcomes on behalf of the broader community.
  SOURCE: Australian Bureau of Statistics, *Land Management and Farming in Australia, 2015–2016, Catalogue No. 4627.0.*
- At 30 June 2016 there were 371 million hectares of agricultural land in Australia, a 1.4% increase on the previous year.
  SOURCE: Australian Bureau of Statistics, *Land Management and Farming in Australia, 2015–2016, Catalogue No. 4627.0.*
- Australian primary industries have led the nation in reducing greenhouse gas emissions intensity — a massive 63% reduction between 1996–2016.
  SOURCE: Australian Bureau of Statistics, *Australian Environmental-Economic Accounts, 2017, Catalogue No. 4655*
- Australian water consumption decreased in 2014–15 by 7% from 2013–14. The largest decrease in water consumption was in the agriculture industry.
  SOURCE: Australian Bureau of Statistics, *Water Accounts, 2014, Catalogue No. 4655.*
- Agricultural businesses spend a significant amount on managing pest animals and weeds. An average of $19,620 was spent per agricultural business on undertaking pest animal and weed management activities.
  SOURCE: Stenekes, N, Kancans, R and Binks, B, 2017, Pest animal and Weed Management Survey: National landholder survey results, ABARES research report 17.5, May. CC BY 4.0.
- Australian farmers are among the most self-sufficient in the world, with government support for Australian farms representing just 1% of farming income. By comparison, in Norway it is 62%, Korea 49%, China 21%, European Union 19% and United States 9%.
  SOURCE: OECD (2017), Agricultural Policy Monitoring and Evaluation 2017, OECD Publishing, Paris.

Virtual video excursions

Let's get started

All Industries | Year 7 | Stage 4

If this is your first time teaching with the From Paddock to Plate Schools Program, welcome! When planning your lessons, you may first like to read the Welcome Guide on our website.

www.frompaddocktoplate.com.au/school-programs/

Assessing prior knowledge

Kick off by understanding the level of knowledge your students have of farming in Australia. This will determine your structure of delivery.

- ASK the students to describe and list what they know about farming in Australia.
- EXPLORE the facts about Australian agriculture (page 4).
- BRAINSTORM and gather ideas, questions and information from the class and use this as a platform to begin this unit. What information do students want to confirm, check, debate or explore?
- DISCUSS any questions that arise.

Now is the time to choose and watch a selection of the **From Paddock to Plate Virtual Excursions.**

You can find them all on the From Paddock to Plate website. Log in and choose your year level, subject or industry of interest:

www.frompaddocktoplate.com.au

Ask students to reflect on what they already know about this industry and what the video showed them that was new, or that changed their thinking.

ALMONDS

Ask students first to reflect on the *From Paddock to Plate* **Almonds Virtual Video Excursion**:

- How do almonds grow?
- What does an orchard look like?
- What can they say about the paddock to plate journey of almonds and almond products?
- What did they learn that they hadn't considered before?
- What would they like to know more about the almonds industry in Australia?

Facts and Vocabulary - Almonds

Facts about the Australian almond industry

- Australian growers produce approximately 10% of the total volume of almonds grown in the world.
- Orchard area planted to almonds increased by 15.8% or 4,904 hectares in 2016 to now total 35,886 hectares
- The number of almond trees now planted in orchards totals more than 10 million.
- Two million virus tested buds were delivered by the ABA to nurseries for grafting to produce healthy trees
- 2016 production of 82,333 tonnes was slightly less than the 2015 harvested crop
- Australia produced 7.7% of the global crop to remain the world's second largest producer behind the USA that grew 80% of world production
- Almonds were 62% of Australia's total tree nut crop that includes macadamias, walnuts, pistachios, hazelnuts and chestnuts (measured as inshell tonnage)
- 97% of almond orchards are efficiently irrigated using drip systems managed by soil moisture monitoring technology
- Annual per capita consumption of almonds in Australia is increasing strongly and exceeded one kilogram for the first time in 2016/17
- Australia ranks 6th in per capita consumption globally
- Domestic sales tonnage increased by 9.9%
- 46.7% of Australian households purchased almonds in the year ending February 2017
- Almond demand by manufacturers was boosted with 274 new products reaching supermarket shelves in 2016
- Australian almonds were exported to 46 countries
- Almond exports earned the nation $464 million
- For every one tonne of almonds sold in Australia, 2.7 tonnes were sold overseas
- India was the single largest destination for exports
- Europe as a region consumed 43.2% of Australia's almond exports with sales of $200.3 million
- East Asia is an emerging market for Australian almonds taking 13.8% of total exports

SOURCE: ABS, Household Expenditure Survey, Australia: Summary of Results, 2015–16, Catalogue No.6530.0.

Useful words and phrases

- Activated almonds
- Almond meal
- Almond milk
- Australian Stock Exchange
- Bacteria
- Belly dumper
- Biomass
- Blanch
- Conveyor belt
- Deciduous
- Drupe
- Export
- Fertigation
- Foliage
- Geographic diversity
- Hi vis clothing
- Hulling process
- Husk
- Irrigation
- Kernel
- Laser sorter
- Microorganisms
- Non-pollinator
- Pasteurisation
- Pollination
- Prune
- Quality assurance
- Renewable energy
- Salmonella
- Self-pollinator
- Shelling
- Stock feed
- Stock pad
- Stockpile
- Weighbridge

Lesson 1

Orchard Food Webs

Almonds	Year 7	Stage 4

ACSSU112

Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions

ACSIS125

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed

ACSIS131

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method

Themes

Biodiversity | Food chains | Food webs | Sustainability

Imagining the landscape

Review what students remember of the natural environment they saw in the Almonds Virtual Excursion.

"A non-pollinator comes out with a flower, but it actually needs something else to pollinate it like a bee. So that's what we do around August each year in Victoria, we put millions of bees out. They take pollen from the pollinated almond and transfers it to the non-pollinated almond and each flower turns into a nut. Each of these trees turns about 10,000 nuts per tree."

(2:00 – 2:24)

"The key to making sure that insects don't get into these nuts, is to keep the canopy clean, making sure that the trees have all the nuts taken off them each year and not old nuts sitting from the previous year, and making sure that the bed floor underneath the trees is kept clean."

(4:11 – 4:28)

Make a class word cloud as they describe the almond farm and orchards. What did they see? (e.g. grass, shade, blossom, fruit, water, hills, bare earth). Focus on natural elements.

DISCUSS: What animals, insects and birds are likely to be attracted to the almond farm? Make a class list (e.g. birds, moths, bees, butterflies, etc.)

Producers and predators

Students work in pairs to suggest a predator or predators that will be attracted to the orchard for each of the animals, insects and birds on the list, for example:

- Birds=feral cats
- Birds=foxes
- Mice=birds of prey
- Beetles=lizards

If necessary, remind them to consider micro-organisms and insects in the soil, such as earthworms and beetles eating decaying leaf litter. RESEARCH may be required if the rural environment is unfamiliar to students.

Add vegetation and pull together several examples of these pairings into a food chain with more than two links, such as:

- grass seed – mouse – snake – kookaburra.

Show students that a **food chain** is a linear relationship of organisms and explain that a **food web** is a much more complex interconnected system of multiple food chains in an ecosystem.

Recommended source material:

> 'Each food chain is a possible pathway that energy and nutrients can follow through the ecosystem. For example, grass produces its own food from sunlight. A rabbit eats the grass. A fox eats the rabbit. When the fox dies, bacteria break down its body, returning it to the soil where it provides nutrients for plants like grass. Of course, many different animals eat grass, and rabbits can eat other plants besides grass. Foxes, in turn, can eat many types of animals and plants. Each of these living things can be a part of multiple food chains. All of the interconnected and overlapping food chains in an ecosystem make up a food web.'
>
> – National Geographic

> 'In a grassland ecosystem, a grasshopper might eat grass, a producer. The grasshopper might get eaten by a rat, which in turn is consumed by a snake. Finally, a hawk—an apex predator—swoops down and snatches up the snake.'
>
> – National Geographic

Teacher resource:

- Enchanted Learning – Food Chains and Food Webs: https://www.enchantedlearning.com/subjects/foodchain/

Constructing food webs

Students use their deductions and research to CONSTRUCT and PRESENT their understandings about the food web that exists within an almond farm. They INTERPRET their food webs to show the relationships between organisms in this environment.

Students CLASSIFY organisms in this environment according to their position in the food chain.

Almond farms and food webs

Students INVESTIGATE the effect of agriculture (including growing almonds) on local ecosystems and food webs within these ecosystems.

Students examine one or more of these sustainable techniques in growing almonds that limit an orchard's negative effect on the local food web (and may provide positive effects such as added organic matter increasing soil life):

- Establishing an orchard on land that had been cleared previously, particularly if it was degraded land of some sort, such as an environment with hard surfaces or vacant land.
- Building up the soil with organic matter.
- Recycling materials for compost.
- Recycling grey water to use on the orchard.
- Mulching and planting to potentially reduce water runoff (compared with grass or hard surfaces).
- Increasing the uptake of CO_2 by planting plants (plants take in CO_2 from the surrounding air and give off O_2 as part of the process of photosynthesis).
- Providing habitat and food for pollinators (if suitable species are planted).
- The use of companion planting techniques and the manipulation of natural plant products to avoid the use of artificial pesticides (artificial pesticides could potentially harm native species and enter the food chain).
- Being sure to avoid using invasive plants that would have an effect on local ecosystems.

CAREERS

Careers | Year 7 | Stage 4

Ask students first to reflect on the *From Paddock to Plate* **Careers Virtual Video Excursion**:

- What are some of the varieties of grains they saw in the video?
- What different careers do people have in the grains industry?
- Are there careers they had not heard of before? What were they?
- Are there any careers they would like to explore in more detail?

Facts and Vocabulary - Careers

Facts about careers in the Australian agricultural industry

- About 50% of all jobs in the agriculture industry are in capital cities. These jobs include environmental management, research, development, agribusiness and education.

  SOURCE: St Joseph's College Geelong, *Weekly Career News*, 19 June 2018

- The demand for agricultural science graduates grew strongly over the past 5 years and around 6000 job openings will be available by 2020.

  SOURCE: St Joseph's College Geelong, *Weekly Career News*, 19 June 2018

- Experts are needed in the areas of sustainable farming practices, land management, land conservation, climate change practices, food security, agricultural research and policymaking.

  SOURCE: St Joseph's College Geelong, *Weekly Career News*, 19 June 2018

- 'Here are the top 10 most in-demand and highest-paying agriculture careers:

  10. Agricultural Operations Manager: Not to be confused with farm managers, agricultural operations managers are typically in charge of maintaining processes in huge agribusinesses such as grain manufacturing and mills.

  9. Animal Geneticist: Nope. Animal geneticists aren't responsible for creating the Indominus Rex (a writer did that!), but they are responsible for discovering what makes animals weak and what keeps them strong.

  8. Food Scientist: If you've ever wondered who's responsible for creating the nutritional information printed on the back of your pack of chips, well, you've guessed it: it's food scientists.

  7. Agricultural Engineer: If you're fascinated with the film Transformers, and you enjoy the idea of machines helping humans, then you might want to be to be an agricultural engineer.

  6. Agronomy Sales Manager: One of the main drivers of the agricultural industry is agronomy sales managers. These professionals are responsible for training the team that will travel to different places to educate farmers on how to care for their land and crops properly.

  5. Bioinformatics Scientist: Plant and animal life is widely diverse, which is why gathering and updating information on all of them is incredibly difficult – and that's where bioinformatics scientists come in.

  4. Environmental Engineer: There would be nothing to harvest if the conditions for planting and growing are poor; that's why the work of environmental engineers is so important to agriculture.

  3. Biochemist: Biochemists study and analyse different living organisms to look for new ways to improve human lives. In the field of agriculture, their work primarily involves developing new crops that are more resistant against natural elements like drought, storms or even insect infestations.

  2. Agricultural Economist: To work as an agricultural economist, you must be prepared to wear different hats. Not only do they work as researchers and market analysts, but they're also business advisors, consultants and land appraisers.

  1. Agricultural Lawyer: Agricultural lawyers are responsible for mitigating disputes on land while making sure that all government regulations are adhered to.

  SOURCE: CareerAddict, *Top 10 Highest-Paying Careers in Agriculture*, by Michi Ancheta, 27 September 2018

Useful words and phrases

- Aptitude
- Attitude
- Body language
- Budget
- Career
- Career clusters
- Communication
- Consumers
- Coworkers
- Decision-making process
- Discriminate
- Economy
- Employee
- Employer
- Ethics
- Entrenpreneur
- Free enterprise
- Full-time
- Goods
- Income
- Interest inventory
- Income tax
- Interests
- Job market
- Job
- Learning styles
- Lifestyles
- Minimum wage
- Overtime
- Part-time
- Personality
- Producers
- Salary
- Skill
- Supervisor
- Time management
- Values
- Wages
- Workers' compensation
- Work place

Lesson 2

Plant Science Professionals

Careers	Year 7	Stage 4

ACSSU111

There are differences within and between groups of organisms; classification helps organise this diversity

ACSHE223

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science

ACSHE120

Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations

ACSHE121

Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management

Themes

Classification | Biology | Technology

Getting started

DISCUSS biological classifications and ASK: Why might people want to classify plants into groups?

BRAINSTORM ideas from the class, such as providing a basis for international communication, allowing botanists to categorise plants by similar growth characteristics and preferred conditions, and enabling botanists to easily classify and therefore make assumptions about new species as they are discovered.

Plant classification

DISCUSS the fact that new species are being discovered and classified all the time, and that botanists refine, improve on and sometimes shift the names of groups of plants on the classification.

Barley (in the video, the grain that Georgia eats in her muesli) has the following classification:

- Kingdom – Plantae (Plants)
- Subkingdom - Tracheobionta (Vascular plants)
- Superdivision - Spermatophyta (Seed plants)
- Division - Magnoliophyta (Flowering plants)
- Class - Liliopsida (Monocotyledons)
- Subclass: Commelinidae
- Order - Cyperales
- Family – Poaceae (Grass Family)
- Genus - ***Hordeum***

Students DISCOVER the meanings of the classifications above, by researching the history of plant classification. Resources below will assist.

EXPLAIN why structure is a useful characteristic in classifying organisms, for example monocot vs dicot growth (single seed leaf vs double seed leaf growth).

Lesson 2: Plant Science Professionals (continued)

Provide each student with the name of a fruit or vegetable (including grains), such as:

- Rice
- Corn
- Oats
- Pumpkin
- Potato
- Celery
- Teff
- Carrot
- Tomato
- Eggplant
- Durian
- Apple
- Amaranth
- Quinoa
- Mustard
- Broccoli
- Cabbage
- Coriander
- Fennel
- Parsnip
- Grape
- Wheat
- Mango
- Banana
- Breadfruit
- Mint
- Watermelon

Students find out the taxonomy (botanical classification) for their plant.

Give the class 3 minutes for students to compare their plant to others and find at least one other member of their family group (for example, brassicaceae, apiaceae, poeaceae).

In these groups, students list some of the specific features common to the family (for example, apiaceae such as carrot, coriander and fennel all produce flowers of the same shape).

Careers in botany

Students explore one or more careers in the botanical sciences, producing a short video about their career of choice or a 'Day in the Life' write-up.

Careers to explore include (but are not limited to):

- Aquatic biologist (Marine or Freshwater)
- Biotechnologist
- Botanist
- Conservation ecologist
- Ecologist
- Farm manager / Farmer
- Geneticist (plants)
- Horticulturalist
- Laboratory technician
- Microbiologist
- Plant anatomist
- Plant biologist
- Plant research scientist
- Propagation scientist
- Wildlife Biologist

Grass for lunch?

Students research the top ten (or seven) staple foods of the world. What does the world's population survive on? How many of these top staple foods are members of the grass family (poaeaceae)?

Students create a statement about how important botany as a science is, to feeding the world. How do the botanical sciences relate to ecosystems and biodiversity as well as to food production systems?

Lesson 2: Plant Science Professionals (continued)

Teacher resources:

- Royal Botanic Gardens Sydney – Plant names and classification: https://www.rbgsyd.nsw.gov.au/science/plants/plant-information/plant-names-classification
- Seed Site – Plant families: http://theseedsite.co.uk/families.html
- The Wild Classroom - Online Botany Guide: http://www.thewildclassroom.com/biodiversity/floweringplants/Intro.htm
- USDA Careers - Botanist (Plant biologist): https://www.agriculture.purdue.edu/usda/careers/botanist.html
- University of Melbourne – Careers In Science, Botanist: https://science.unimelb.edu.au/students/careers-in-science/where-can-a-bsc-take-me/life-sciences/botanist
- University of California – What is a Botanist: https://www.ccber.ucsb.edu/research/katherine-esau-digital-archive-esaus-career-plant-anatomist/career-botany

CHERRIES

Cherries | Year 7 | Stage 4

Ask students first to reflect on the *From Paddock to Plate* **Cherries Virtual Video Excursion**:

- How do cherries grow?
- What does a cherry orchard look like? What other fruit trees do cherry trees resemble? (Are they related?)
- What can they say about the paddock to plate journey of Australian cherries?
- What did they learn that they hadn't considered before?
- What would they like to know more about the fruit growing / orcharding industry in Australia?

Facts and Vocabulary - Cherries

Facts about the Australian cherry industry

- Cherries are a small, plump stone fruit and a member of the Rosacea (rose) family that also includes almonds, peaches, apricots and plums.
- The top four cherry producing countries (Turkey, USA, Iran and Italy) account for approximately 50% of the world's cherry production.
- Australia is a relatively small cherry producer by world standards, only producing approximately 0.5% of the world's total cherry production.
- Currently up to 15,000 tonnes of Australian cherries are produced every year with 30% exported. This number is expected to rise to 20,000 tonnes and 50% exported by 2020.
- The Australian industry is spread over six states with around 2,845 hectares under production and 485 grower enterprises currently operating.
- New South Wales and Victoria are the two largest producers of cherries. Tasmania has had a rapid expansion in plantings and is currently the third highest producer. It has a strong export focus, enhanced by its relative pest and disease freedom. South Australia is the fourth largest producer with a significant proportion of its production sold interstate and a small percentage also exported. Both Western Australia and Queensland are relatively small producers primarily focusing on their domestic markets.
- Australian cherries are available from mid/late October to late February, depending on the state and seasonal calendar due to climatic variation, varieties and growing season.
- There are two main cherry species:
- Sweet cherries (Prunus avium L.) are often sold as just generic fresh cherries.
- Sour cherries (Prunus cerasus L.) are mostly used in processed products such as freezing, canning and juices or typically preserved and used in cooking or for making cherry brandy.
- Today there are over 50 varieties grown and many more are being developed in Australia.
- Sour cherries are more commonly grown in Europe but some plantations exist in Victoria South Australia and Tasmania.
- The most well known sour cherry is the Morello.
- A study published in the American Journal of Clinical Nutrition found that sour cherries ranked 14 in the top 50 foods for highest antioxidant content per serve – and are among well-known 'superfoods' such as red wine, berries and dark chocolate.

SOURCE: Cherry Growers Australia Inc.

Useful words and phrases

- Bird damage
- Blossom
- Certified organic
- Cherry season
- Cherry variety
- Commercially available
- Cool store
- Cross compatibility
- Cultivar
- Domestic market
- Earwigs
- Export
- Fertigation
- Fertiliser
- Flowering
- Frost
- Fruit maturity
- Fruit set
- Grading equipment
- Gross value
- Growing season climatic conditions
- Global cherry production
- Hail netting
- Hand picked
- Harvest
- Irrigation
- Microclimate
- Morello
- Orchardists
- Packing shed
- Pollenisers
- Providence
- Pruning
- Rootstock
- Seasonality
- Shelf life
- Sour cherries
- Sweet cherries
- Sweetheart
- Thinning
- Topography
- Tree vigour
- Verticillium wilt fungus

Lesson 3

Seasons and Fruit

Cherries	Year 7	Stage 4

ACSSU115

Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon

ACSIS124

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge

Themes

Seasons | Climate | Weather | Food security

Climate change

Changing seasons

DISCUSS the changing seasons – when does summer usually start? What is winter like in our area?

EXPLAIN why different hemispheres of the Earth experience different seasons at the same time. DEFINE the terms, season, climate and weather.

Recommended source material:

'In June, when the Northern Hemisphere is tilted toward the sun, the sun's rays hit it for a greater part of the day than in winter. This means it gets more hours of daylight. In December, when the Northern Hemisphere is tilted away from the sun, with fewer hours of daylight. Seasons have an enormous influence on vegetation and plant growth. Winter typically has cold weather, little daylight, and limited plant growth. In spring, plants sprout, tree leaves unfurl, and flowers blossom. Summer is the warmest time of the year and has the most daylight, so plants grow quickly. In autumn, temperatures drop, and many trees lose their leaves.'

— National Geographic

'One of the most common and persistent scientific misconceptions is that Earth's seasons are caused by Earth's distance from the sun. A closely related and perhaps more common misconception is that the equator is warmer than the poles because the equator is significantly closer to the sun than are the poles (i.e. the equator "bulges out" toward the sun).'

– *Seasons and Why the Equator is Warmer than the Poles* by Ann Bykerk-Kauffman, Department Of Geological and Environmental Sciences, California State University

Cherry seasons

EXPLORE information in the Cherries Virtual Excursion about the ways that cherry growing is affected by seasons. What is the cycle of the seasons in a cherry orchard?

DISCUSS and RECORD what students have perceived of this from the video. They could plot the evidence on a seasonal wheel (a circle with the seasons marked on it), or a simple calendar of months with the seasons roughly marked in.

"Cherries are grown Australia-wide. Mostly in the southern half of Australia."

(2:10 – 2:15)

"We have cherries that blossom in October and start fruiting in November so the cycle of cherries is quite short. Some other stone fruits are similar, but we also have cherries that grow over quite a long period of time."

(2:50 – 3:08)

"The early cherries are harvested in November and the late cherries are harvested in as late as February, so there's quite a range of cherries and there are thousands of varieties of cherries."

(3:09 – 3:20)

Cherry dependencies

DISCUSS: What would happen to the cherry industry if the seasonal pattern in Southern Australia changed?

In the video, we hear that the season for ripe cherries is very short.

DETERMINE how the seasons and seasonal changes impact cherry production.

For example:

- Unpredictable rainfall patterns
- Extreme temperatures – heatwaves and frosts
- Drought and flooding
- Unusual humidity
- Incidents of pests and diseases

"A cherry starts as a flower, as we all know, then it sets into a piece of fruit. Depending on the weather, as in rain or lots of sunshine, we get a good fruit set or an ordinary fruit set."

(2:16 – 2:30)

Lesson 3: Seasons and Fruit (continued)

"A flower turns into a piece of fruit by pollination. Lots of bees, lots of sunshine and good healthy weather. A bit of help from us with some fertilisers and it will set and each flower could produce six, seven or eight pieces of fruit."

(2:31 – 2:50)

Students RESEARCH what happens if a cherry blossom (flower) is exposed to:

- frost;
- high winds; and/or
- high humidity (moisture/damp).

They explain to a partner how this might affect the crop.

READ the source material below together.

DISCUSS and come up with a class statement about how the seasons are linked to food security. Students DEFINE the term "seasonal eating". What does this mean to you and why might it be related?

Recommended source material:

'In California, cherry trees grow well in locations with long, warm summer days and cool nights. During the growing season, excessively high temperatures can cause rapid growth and fruit deterioration during the current season (Crisosto et al., 2003) and high rates of fruit doubling and spurs (small side fruit formed on the normal fruit) the following growing season (Bethell 1988). In late winter, normal bloom and bud break require temperatures no lower than 20°F (Bethell 1988) because cherry is highly susceptible to frost damage (Lang 2001). However, adequate chilling is required to break dormancy. If the required chill hours have not been reached rest-breaking agents can be used to help offset the deficiency (Glozer 2010). Once adequate winter chilling (with or without rest-breaking agents) has been experienced, moderately warm spring temperatures without excessive heat (more than about 75°F), cold (prolonged temperatures below the mid-50's °F), or frost is needed for even bloom development and good overlap of pollinizer varieties to set a viable crop.'

– The Fruit & Nut Research and Information Center, University of California

'Food is one of society's key sensitivities to climate. A year of not enough or too much rainfall, a hot spell or cold snap at the wrong time, or extremes, like flooding and storms, can have a significant effect on local crop yields and livestock production. While modern farming technologies and techniques have helped to reduce this vulnerability and boost production, the impact of recent droughts in the USA, China and Russia on global cereal production highlight a glaring potential future vulnerability.'

– *How will climate change affect food production?* by Grantham Research Institute and Duncan Clark, The Guardian, 19 September 2012: www.theguardian.com/environment/2012/sep/19/climate-change-affect-food-production

EGGS

Ask students first to reflect on the *From Paddock to Plate* **Eggs Virtual Video Excursion**:

- How often do chickens lay an egg?
- What sort of environment do farmers build to keep their chickens happy and healthy?
- What can they say about the paddock to plate journey of Australian eggs?
- What did they learn that they hadn't considered before?
- What would they like to know more about the egg farming industry in Australia?

Facts and Vocabulary - Eggs

Facts about the Australian egg industry

- Australians consume an average of 213 eggs per person per year.

  SOURCE: Agrifutures Australia
- With the ability to manage larger flocks and the advent of mechanisation, the number of egg farms in Australia has decreased since the late 1970s from 3,200 in 1979 to 337 today.

  SOURCE: Agrifutures Australia
- There are 19 millions hens in farms across the country.

  SOURCE: Egg Farmers of Australia
- Approximately 15 million eggs are produced daily to meet domestic consumption.

  SOURCE: Egg Farmers of Australia
- The egg industry contributes 1.6 billion dollars to the Australian economy.

  SOURCE: Egg Farmers of Australia
- About half of all eggs are bought by consumers in supermarkets and grocery stores, the rest go to food manufacturers, restaurants, cafes and other food outlets.

  SOURCE: Egg Farmers of Australia
- The 12 (dozen) packs of eggs are most popular, with 83% of all grocery eggs sold in this pack size at 79% value.

  SOURCE: Australian Egg Corporation Limited (AECL)
- Hens are kept in two main types of production systems; cage and cage-free, which includes barn and free range systems. Many producers run more than one type of production system and in some cases more than one production system is operated on the same farm. These farms vary in size from less than 1,000 hens to over 500,000 hens. Farms with flocks of 20,000 - 60,000 are most common.

  SOURCE: NSW Department of Primary Industries
- Approximately 55% of hens are kept in cage production systems with the remaining in cage-free systems.

  SOURCE: NSW Department of Primary Industries
- Most aspects of egg farm operations are the same across all production systems – ie shed design, bird genetics, nutrition, routine husbandry, and egg collection and handling.

  SOURCE: NSW Department of Primary Industries
- The most common egg production system world-wide is cage, with approximately 80% of all eggs produced in this way.

  SOURCE: NSW Department of Primary Industries

Useful words and phrases

- Air cell
- Albumen
- Artificial insemination
- Avian
- Barn laid
- Battery cages
- Beak-trimming
- Best practice
- Biosecurity
- Blastoderm
- Blastodisc
- Bloom
- Breed
- Brooding
- Buffer distances
- By-product
- Calcium
- Candling
- Chicks
- Closed flock
- Clutch
- Coop
- Embryo
- Feed hopper
- Flock
- Free range
- Hatchery
- Hen welfare
- Layer
- Manure
- Omega-3 fatty acids
- Omnivorous
- Organic
- Pathogen pressure
- Poultry
- Pullet
- Roost
- Scotophase
- Scratch feed
- Shell membrane
- Stocking density
- UV steriliser
- Yolk

Lesson 4

Poultry Poo Power

Eggs	Year 7	Stage 4

ACSSU116

Some of Earth's resources are renewable, but others are non-renewable

ACSHE223

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science

ACSHE120

Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations

ACSHE121

Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management

Themes

Energy	Environment	Renewable energy	Greenhouse gas emissions
Innovation	Technology	Waste management	

Classifying resources

In groups, students CONSIDER and DISCUSS what is meant by the term 'renewable' when used in relation to the Earth's resources, such as:

- Solar energy
- Wind power
- Water
- Geothermal energy
- Biomass

Examples include:

- Solar-powered electric fencing
- Windmills used for a wide variety of purposes including pumping water, grinding meal into flour, generating electricity and aerating ponds

Manure for the future

ASK: Is chicken manure a renewable or non-renewable resources? Why?

Students EXPLORE how chicken manure is being turned into renewable energy.

They PRESENT their findings to the class. The resources and case study below will be of use.

Case study

In December 2014, Darling Downs Fresh Eggs became the first Australian egg producer to power its business using renewable energy generated from poultry manure. An anaerobic digester converts the chicken manure to biogas, and a generator converts the biogas to electricity. Located about 40 kilometres southeast of Toowoomba in Queensland, Darling Downs Fresh Eggs produces about 6 million dozen eggs a year, supplying both domestic and international markets. The family-owned business began as a free-range farm about 40 years ago but since 2000 its focus has been caged hens. The operation includes rearing hens from 1-day old; grading, packaging and distributing the eggs; and milling stock feed onsite.

Lesson 4: Poultry Poo Power (continued)

LISTEN to Geoff Sondergeld, CEO of Darling Downs Fresh Eggs, as he explains what drove the family to generate their own energy, such as wanting to be in a position to feed future generations and look after the environment.

- Biomass Producer (video, duration 1:02): https://youtu.be/kC6K3eQae8U

Recommended source material:

A waste problem

The 130 tonnes of chicken manure produced every week by the 390,000 hens, is a resource that is now powering the farm. It was once an issue for the business.

"We used to stockpile the manure and sell it to neighbouring farmers who spread it on their cultivation", says CEO Geoff Sondergeld. "But we didn't get much for it and the family is conscious of its environment footprint, so we decided to look for alternatives."

Wastewater from the grading floor also has to be disposed of. The grading floor is where the eggs are sorted by size, inspected for cracks, washed, stamped and packed into boxes. This wastewater was previously fed into temporary evaporation ponds along with the reject water from the onsite filtration plant. The filtration plant uses reverse osmosis to filter the local bore water to provide drinking water for the chickens, which drink up to 60,000 litres a day. One third of the bore water—up to 24,000 litres a day—is rejected and this water is high in salt. Other organic waste includes broken eggs and hens that are no longer laying. All of this waste is now being used to generate electricity.

Rising electricity costs

While waste was becoming a concern, even more worrying was the rising cost of electricity, especially as the family wanted to expand the business.

Egg production is power-intensive. The 100-metre-long sheds where the chickens are housed are kept at a constant temperature during winter and summer. And the day-old chicks need to be kept at a constant 36 degrees until they are 5 or 6 weeks old. The business consumes almost a megawatt of electricity which costs many hundreds of thousands of dollars a year.

Generating electricity from poultry manure – why anaerobic digestion?

In 2011, Chris did a lot of research on the technologies that could potentially convert chicken manure to gas. At the time, plenty of Australian piggeries were using anaerobic digestion to convert their effluent to biogas, but no one in...'

Recommended source material (continued):

'...the poultry business was doing it, he says. Anaerobic digestion uses microorganisms to decompose the biomass, producing gas comprising mostly methane and carbon dioxide. The gas is captured and converted to electricity. "There are other technologies out there, but they're 10 times the cost and 10 times as complex", says Chris. "We needed something that we could put on the farm and that we could all understand it to a reasonable extent; something simple to use that produces the same quantity of gas."

Benefits to the business

The anaerobic digester, which is where the manure is converted to gas, was commissioned in mid–2014 and the first of the gas was converted to electricity in December 2014. The obvious benefit to the business is lower electricity costs. "We'll save in excess of a quarter of a million dollars in year one", says Geoff. "And there's a whole host of other operating benefits."

The business now has a clear management plan for all waste produced on site. All of the liquids and solids produced are being reused in some capacity. With no manure stockpile, there is minimal odour on site, says Geoff, which is good for staff, for the local community and for the environment.

Funding

Funding the project was a challenge, says Geoff, given the risk associated with being the first in Australia to convert poultry manure to gas. Several parties fund the capital cost of $2.86 million:

- Clean Energy Finance Corporation (CEFC) finance of $950,000 (originally through Low Carbon Australia, now integrated into the CEFC)
- National Australia Bank finance for nearly half the project cost
- A federal government grant of $333,823 through the Clean Technology Food and Foundries Investment Program
- The balance of capital cost is funded by Darling Downs Fresh Eggs.

Cost savings

- Total project cost: $2.86 million
- Projected cost savings on electricity and LPG in year one: more than $250,000
- Expected payback period (when the total project benefits are considered): 5–7 years.

Lesson 4: Poultry Poo Power (continued)

Recommended source material (continued):

How the system works

"It's a simple process", says Chris. "You mix the manure with water to make a slurry. You put the slurry into the digester where it sits for up to 30 days and is mixed regularly. It produces methane. The methane is captured and pumped into an engine, which is basically a gas-driven generator, and it produces power."

WATCH the process of creating electricity from chicken manure through anaerobic digestion.

- Creating electricity from chicken manure (video, duration 0:46): https://youtu.be/-_00dvgyZe4

Monitoring and maintenance

Once the generator is fully commissioned, Chris will be able to use his mobile phone to log in and see how much power they're producing, and be able to start and stop processes in the same way he does today with the controls for the chicken sheds, the egg collection, the manure conveyor, the grading floor and the feed mill.

If there's a water failure, a power failure, a feed failure, a rise in temperature or a drop in temperature, an alarm is triggered and a text message is sent to six people.

Geoff's advice to other poultry farmers embarking on a similar journey

- Keep a good attitude and be patient, though this may be a challenge.
- Explore all options and be open with everyone.
- Don't be afraid to ask for help or solicit other people's views — it's not an exact science.

FISH

Ask students first to reflect on the *From Paddock to Plate* **Fish Virtual Video Excursion**:

- What does a typical day on a fishing boat look like?
- What can they say about the paddock to plate journey of Australian fish?
- What did they learn that they hadn't considered before?
- What would they like to know more about the fishing industry in Australia?

Facts and Vocabulary - Fish

Facts about the Australian fish industry

- Australia's wild capture fisheries and aquaculture industries contribute almost $3 billion a year to Australia's economy.

  SOURCE: Australian Government, Department of Agriculture and Water Resources December 2017

- More than 14,000 people are directly employed by the commercial fishing and aquaculture sectors and many of these jobs are based in regional areas.

  SOURCE: Australian Government, Department of Agriculture and Water Resources December 2017

- Australia's Exclusive Economic Zone extends 200 nautical miles from the coast and is the world's third-largest fishing zone (8.1 million square kilometres).

  SOURCE: Australian Government, Department of Agriculture and Water Resources December 2017

- Around 300 boats operate in Commonwealth fisheries.

  SOURCE: Australian Government, Department of Agriculture and Water Resources December 2017

- More than 3.5 million Australians are recreational fishers.

  SOURCE: Australian Government, Department of Agriculture and Water Resources December 2017

- On average, Australians eat 140 serves of seafood every year.

  SOURCE: Australian Government, Department of Agriculture and Water Resources December 2017

- The volume of fishery and aquaculture production increased by 4 per cent between 2006–07 and 2016–17. During this period, the pattern of production changed significantly, shifting from the production of wild-catch stocks toward production of aquaculture products.

  SOURCE: Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

- Asia remains a major export destination for Australian fishery and aquaculture products. However, the pattern of Australian fishery and aquaculture exports has shifted towards the south-eastern China and Vietnam region. The major export product is rock lobster.

  SOURCE: Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

- Australia's apparent consumption of seafood increased, on average, at an annual rate of 0.8 per cent between 2006–07 and 2016–17, increasing 9 per cent overall in this period. Owing to faster population growth, apparent per person consumption of seafood declined over the same period, from 15 kilograms per person on an edible equivalent basis in 2006–07 to 13.9 kilograms per person in 2016–17.

  SOURCE: Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

Useful words and phrases

- Acoustic survey
- Algal bloom
- Artisan fishing
- Anadromous
- Antarctic convergence
- Aquaculture
- Beam trawling
- Benthos
- Biotoxins
- Bottom trawling
- Bycatch
- Casting
- Catadromous
- Cephalopods
- Cetacean
- Crustaceans
- Dredging
- Ectothermic
- Elasmobranch
- Endemic
- Estuary
- Farmed fisheries
- Fecundity
- Founder effect
- Gametes
- Ghost nets
- Habitat
- Hatchery
- Individual transferable quota (ITQ)
- Invertebrates
- Mariculture
- Marine mammal
- Meristics
- Migration
- Oceanodromous
- Plankton
- Shoaling
- Spawning
- Sustainable fishing
- Tag and release
- Threatened species
- Vertebrates
- Wild fisheries

Lesson 5

Fishing for Future Food Webs

Fish	Year 7	Stage 4

ACSSU112

Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions

ACSIS125

Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed

ACSIS131

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method

Themes

Productivity | Human impact | Food security | Pest management
Biodiversity | Food webs

After watching the *From Paddock to Plate* **Fish Virtual Video Excursion**, students CONSTRUCT, INTERPRET and PRESENT the food web that exists in the Indian Ocean where Jim catches his sardines.

They create a poster to show the relationships between organisms in this environment. Don't forget to include the sardines!

To start, students need to research and CLASSIFY organisms in this environment according to their position in the food chain.

Prompt students to write their reports in such a way that they RECOGNISE the role of microorganisms within food chains and food webs.

They INVESTIGATE the effect of agriculture on local habitats including the introduction of specific fish and add this to their poster or present their findings orally.

Resources below will assist.

Recommended source material:

'Forage fish are key. They feed on algae and plankton — which derive their energy from the sun — and are then consumed by larger fish, birds, and marine mammals. In other words, these little dynamos undergird the entire marine ecosystem, converting the boundless resource that is solar energy into edible protein. Alas, because Western populations have traditionally had little appetite for these oily outcasts, the market has had to find other uses for them: namely as fodder for the stuff we do like to eat, such as cows, pigs, chickens, and farmed salmon and other large fish. Today, no less than 90 percent of the worldwide catch of forage fish gets processed into fishmeal and oil used for growing fish, pigs, and chickens. (The oil — which is high in omega-3 fatty acids and has been proven to benefit heart health and brain development and function — also goes, increasingly, into nutritional supplements and infant formula.)'

– *Don't hold the sardines* by Jocelyn C. Zuckerman, OnEarth magazine, 6 July 2013

Lesson 5: Fishing for Future Food Webs (continued)

Recommended source material (continued):

'Almost every year, a fascinating sardine phenomenon known worldwide as "The Greatest Shoal on Earth" occurs off the eastern coast of South Africa. From May to July, scuba divers, researchers, and nature enthusiasts flock to South Africa to see what many call the most spectacular marine event on the planet: a sardine run. Not only do millions of sardines gather during this time, but thousands of ocean predators such as whales, dolphins, sea birds, and sharks also congregate to feed on the little fish. It is a rare chance to watch ocean food chains in action.'

– A Prairie Food Chain by A. D. Tarbox

WATCH this trailer for the vivid documentary Wild Ocean, capturing one of nature's greatest migration spectacles. 'Plunge into an underwater feeding frenzy amidst the dolphins, sharks, whales, gannets, seals and billions of fish.' – www.youtube.com/watch?v=Mzcfiz73JKE

'The first carp introduced to waters of the Murray–Darling Basin were a bright orange strain of Asian koi carp. These fish were released into irrigation canals in the Murrumbidgee Irrigation Area in southern–central NSW sometime during the 1940s or 1950s, where they established a self– sustaining population, but did not disperse widely and had limited ecological impact (Lake 1967). It was not until the introduction of a second strain, imported from Europe and raised on a fish farm at Boolarra, Victoria (Shearer and Mulley 1978), that the species became a 'pest'. Carp are now present in all Australian states except the Northern Territory and their range continues to increase (Brumley, 1996). Within NSW, carp are distributed across most of the Murray–Darling Basin, occurring in 85% of the state's inland waterways (Graham et al. 2005). The impacts of carp are estimated to cost ~$15.8 million dollars annually (McLeod 2004), $2 million of which is spent on carp management, $2 million on research and $11.8 million on remediation of environmental impacts. However, it is still unclear if carp invasion represents a symptom or a cause of degraded aquatic systems. Increased incidence of blue–green algae blooms, declining native fish populations, increased turbidity in major rivers, damage to stream banks and loss of aquatic vegetation have all been attributed to carp populations (Lachner et al. 1970; Crivelli 1983; Hume et al. 1983; Fletcher et al. 1985; Page and Burr 1991; Wilcox and Hornbach 1991; Breukelaret et al. 1994; Faragher and Harris 1994; Gehrke and Harris 1994; Hindmarsh 1994; Roberts and Ebner 1997; Koehn et al. 2000; Schiller and Harris 2001; Williams et al.. 2001), backed by differing levels of credible scientific evidence. In most cases, the specific impacts of carp are complex and difficult to isolate from other inter–related anthropogenic changes to ecosystems (Hume et al. 1983).'

– *NSW Department of Primary Industries – Fisheries Research Report Series: 14, The distribution, spread, ecological impacts and potential control of carp in the upper Murray River* by Dean Gilligan and Thomas Rayner, Department of the Environment and Water Resources & NSW Department of Primary Industries