Curriculum focus

The resources in the Technologies Teacher Manual help teachers and students explore the ethical, sustainable, social and profitable qualities of old and new technologies used in agriculture. Students explore the Virtual Video Excursion/s for one or more industries and use this information to understand the importance of food labelling and marketing in a world where technology is the foundation of consumer awareness.

How to use this Teacher Manual

The Technologies 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 3, 5, 13, 19 and 26.

First, start with the Springboard virtual video excursions on page 4.

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
### Australian Curriculum Links

#### Cross-curriculum priorities
- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia’s Engagement with Asia
- Sustainability

<table>
<thead>
<tr>
<th>Lesson 1</th>
<th>Technology, Past and Present</th>
<th>ACTDEK040</th>
<th>Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson 1</td>
<td>Technology, Past and Present</td>
<td>ACTDEK041</td>
<td>Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>Beef Burps</td>
<td>ACTDEK040</td>
<td>Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>Beef Burps</td>
<td>ACTDEK041</td>
<td>Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>Beef Burps</td>
<td>ACTDEK044</td>
<td>Investigate and make judgments on the ethical and sustainable production and marketing of food and fibre</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>Ethics, Efficiency, Energy and Price</td>
<td>ACTDEK040</td>
<td>Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>Ethics, Efficiency, Energy and Price</td>
<td>ACTDEK044</td>
<td>Investigate and make judgments on the ethical and sustainable production and marketing of food and fibre</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>Ethics, Efficiency, Energy and Price</td>
<td>ACTDEK047</td>
<td>Investigate and make judgments, within a range of technologies specialisations, on how technologies can be combined to create designed solutions</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>Ethics, Efficiency, Energy and Price</td>
<td>ACTDEP048</td>
<td>Critique needs or opportunities to develop design briefs and investigate and select an increasingly sophisticated range of materials, systems, components, tools and equipment to develop design ideas</td>
</tr>
<tr>
<td>Lesson 4</td>
<td>Technology Solutions in Aquaculture</td>
<td>ACTDEK040</td>
<td>Critically analyse factors, including social, ethical and sustainability considerations, that impact on designed solutions for global preferred futures and the complex design and production processes involved</td>
</tr>
<tr>
<td>Lesson 4</td>
<td>Technology Solutions in Aquaculture</td>
<td>ACTDEK041</td>
<td>Explain how products, services and environments evolve with consideration of preferred futures and the impact of emerging technologies on design decisions</td>
</tr>
<tr>
<td>Lesson 4</td>
<td>Technology Solutions in Aquaculture</td>
<td>ACTDEK044</td>
<td>Investigate and make judgments on the ethical and sustainable production and marketing of food and fibre</td>
</tr>
</tbody>
</table>
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.

- In 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.

- Food imports, particularly for processed food, accounted for only 15 per cent of household food consumption in Australia in 2015–16.

- 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.

- 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).

- As of May 2017, 304,200 people were employed in the Australian farm sector — accounting for about 3% of the national workforce.

- Across the supply chain agriculture powers 1.6 million jobs.

- 216,100 males and 88,100 females are employed in the Australian farm sector.

- 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.

- At 30 June 2016 there were 371 million hectares of agricultural land in Australia, a 1.4% increase on the previous year.

- Australian primary industries have led the nation in reducing greenhouse gas emissions intensity — a massive 63% reduction between 1996–2016.

- Australian water consumption decreased in 2014–15 by 7% from 2013–14. The largest decrease in water consumption was in the agriculture industry.

- 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.

- 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%.
Virtual video excursions
Let’s get started

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 3).
- 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 resources are important to an almond farm?
• 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

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

Technology, Past and Present

Themes

<table>
<thead>
<tr>
<th>Society</th>
<th>Ethics</th>
<th>Innovation</th>
<th>Renewable energy</th>
<th>Design</th>
<th>History</th>
<th>Skills</th>
<th>Technology</th>
</tr>
</thead>
</table>

Getting started

After having watched the *From Paddock to Plate Almonds Virtual Video Excursion* students can undertake this lesson.

Talking technology

Watch the video again and collect a list of all forms of technology students see in the video. Remind them that technology does not just refer to machinery and digital technologies – it can also refer to a process, a practice (such as grafting) and ways of designing and managing an environment such as an orchard. Ask them to imagine de-husking all these almonds by hand!

Collect a class list of moments in the video relating to all forms of technology.

With the class, discuss designed solutions in the almond industry. Here are a few examples for you – students may add to this list or propose other suggestions:

- The tradition of harvesting almonds by lying nets on the ground and tapping the branches so that the nuts fall into the nets.
- A biomass energy plant that uses almond waste product to produce renewable energy such as steam and electricity.
- The way the entry into the almond processing plant is designed to eliminate contamination, through the use of wash basins, hairnets and slippers placed conveniently for workers.
- Land management and orchard designs that reduce fire risk.
- Solutions to increase pollination, such as by locating mobile bee hives in the orchard.
- Design and management tactics to reduce pollution from vehicles on the farm.
Further examples include:

- Automated fruit farms
- Cloud computing
- Drone technology
- Espaliering and trellising trees
- Frost management
- Grafting
- Greenhouses
- Hybridisation
- Hydroponics
- Irrigation
- Permaculture
- Plant breeding
- RFID and traceability systems
- Robots
- Soil sensors
- Water management

**Development of design**

Discuss how technology can be provoked by needs, such as efficiency and reliability. Explore together how designed solutions are developed within a context and how several factors influence design and professional designers and technologists, including:

- access to skills;
- expertise;
- knowledge; and
- time.

EXPLAIN how the life cycle of a product can influence decision-making related to design and technologies, for example rethinking products to allow for recycling and re-use of components, and selecting materials for a product that have lower carbon footprints.

**Technology research**

Students choose one form of technology (new or old) that interests them. They RESEARCH their chosen technology and produce a description of the key technique/s and equipment, the problem it seeks to solve, what practices or technologies it replaces, the benefits of the technology and any limitations or issues it may give rise to. Resources below may assist.

**Class discussion**

After presenting their technology, its benefits and limitations, as a class, students CRITIQUE the system of almond mass production taking into account ethics and sustainability considerations.

"In terms of these trees, these trees are approximately 12 years old. The trees themselves, will start producing nuts after about two years, but really become productive at about seven years of age and stay productive for about another 10 years. Once they start getting too old, they start producing less nuts and so at certain points in time, like after about 20 years, we'll actually pull the trees out and put young ones back in."

(4:08 – 4:35)
“This is the most exciting time of the year. About February, March in Australia each year, the trees behind me are ready to drop their fruit. Naturally the nuts will drop on the ground and then what we can do is try and accelerate that process by shaking them.”
(5:15 – 5:28)

“So we take specially designed machine that grabs the trunk of the tree and shakes it for up to three seconds and all the nuts fall onto the ground. Once the nut has been sitting on the ground for three days, we get these huge sweeping machines that have big blowers. The blowers push all the almonds into a small pile and they sit there for another two days and then a huge truck turns up and we load them into a semi trailer and that semi trailer is then driven to our processing plant.” then what we can do is try and accelerate that process by shaking them.”
(5:30 – 5:56)

“Once it gets to the processing plant, each truck goes through a weigh bridge. At the weigh bridge we look at how much does it weigh, what is the moisture of the nuts, what farm did it come from, what variety is it, what size are they. All that information is entered into a computer and then we can trace all of our product from the farm all the way to the finished product.”
(5:57 – 6:16)

Recommended source material:

‘When entrepreneurs in Asia Pacific think of what tech company to start, they are most often drawn to high tech fields, such as ride-hailing, fin-tech, and many other sectors that are suffixed with “tech”. Entrepreneurs, in short, want to disrupt traditional, consumer-facing industries with the latest innovations. While creating new solutions for consumers is important, there are many less visible industries in the region that are also ripe for innovation. One such example is agriculture. We seldom think of how the food on our table gets there, much less how it was farmed, harvested, and delivered, but agriculture is also experiencing a seismic shift through tech-enablement. The so-called agri-tech is growing in Asia Pacific both among startups dedicated to the space as well as horizontal companies that target the sector in some way. It’s important to highlight the companies and founders working in agri-tech, as a means of encouraging other talented entrepreneurs in Asia Pacific to consider doing the same. With a global food shortage threatening the region in as little as 10 years, agri-tech may be one of the few fields where entrepreneurs can create as much social impact as they do business revenue. Food security and sustainable agriculture are among the sustainable development goals of the UN for 2030...’
Lesson 1: Technology, Past and Present (continued)

Recommended source material (continued):

‘... Here are four tech companies from Asia Pacific that can give you an idea of how entrepreneurs can innovate in agriculture.

**Agrostar (India):** Most farmers across the region have not had a formal education in agriculture, relying instead on knowledge from the community. Agrostar aims to fill in this gap. The company has created a mobile app that provides farmers with best practices related to farming, customized to whatever particular crops they grow. This kind of market education helps farmers in India improve their yields, and in turn, their income.

**i-Grow (Indonesia):** Since many people will not be inherently interested in supporting farmers no matter how much education they receive, i-Grow approaches them from another angle: money. Through the i-Grow app, individuals can invest in the crops of individual farmers, solving a pain point for two sides of the marketplace. Individual investors, who want to diversify their investments, can get a return of 9 to 13 per cent in as little as six months. Farmers, for their part, gain the capital they need to grow their farming operations and business.

**Pundi X (Singapore):** In partnership with Indonesian company HARA, Pundi X will deploy its blockchain-based point-of-sale systems to unbanked farmers across the world, beginning with an initial deployment in Indonesia. The Pundi XPOS will extend financial inclusion to the unbanked farmers, who can use it to accept transactions in cryptocurrency as well as process other incentives.

**Farm Citizens App (the Philippines):** Founded by Jo Soliman, a serial entrepreneur and also a trader who famously lowered prices of rice beneath market rates to make it more accessible to Filipinos, Farm Citizens is an end-to-end solution for farmers in the Philippines that includes the ability to register their products and sell directly to consumers. One of the more innovative features is the ability for farmers to take a photo of diseased crops, upload it to the app, and have experts respond within 24 hours on how to address the blight. It's a new category: on-demand crop assistance.

— Four Agri-Tech Innovations in Asia Pacific that are Changing the Game for Agriculture by Gracy Fernandez, Entrepreneur, 19 November 2018: [https://www.entrepreneur.com/article/323463](https://www.entrepreneur.com/article/323463)
Lesson 1: Technology, Past and Present (continued)

Recommended source material (continued):

‘During the 1600s several techniques were used to protect horticultural crops against the cold. These included glass lanterns, bell jars, cold frames and hot beds covered with glass. In the seventeenth century, low portable wooden frames covered with an oiled translucent paper were used to warm the plant environment much as plastic row covers do today. In Japan, straw mats were used in combination with oil paper to protect crops from the severe natural environment. Greenhouses in France and England during the same century were heated by manure and covered with glass panes. The first glass house built in the 1700’s, used glass on one side only as a sloping roof. Later in the century, glass was used on both sides. The glasshouse was used for fruit crops such as melons, grapes, peaches and strawberries and only rarely for vegetable production. The developers of this new technology kept market profitability in mind: they produced crops which appealed to the wealthy and privileged, the only people who could afford the luxury of fresh fruit produced out of season in greenhouses. The development of hydroponics has not been rapid. In the U.S., interest began to develop in the possible use of complete nutrient solutions about 1925. Greenhouse soils had to be replaced at frequent intervals or be maintained from year to year by adding large quantities of commercial fertilizers. As a result of these difficulties, research workers in certain U.S. agricultural experiment stations turned to nutrient solution culture methods as a means of replacing the natural soil system with either an aerated nutrient solution or an artificial soil composed of chemically inert aggregates moistened with nutrient solutions.’

– College of Agriculture and Life Sciences, The University of Arizona

‘A team of scientists at Clemson University’s Coastal Research and Education Center has unveiled a robotic system that grafts disease-resistant roots to robust plant tops. “Grafting has been done all over the world for about 60 years, but when done by hand, it’s very slow and labor intensive,” said vegetable expert Richard Hassell. “The robot does it much faster than a human can do it. This reduces labor costs while at the same time enhancing healthy robust growth because the same clean cut is made every time.”


‘[Mr Rogers’s] farm is wired up like a lab rat. Or, to be more accurate, it is wirelessly up. Moisture sensors planted throughout the nut groves keep track of what is going on in the soil. They send their results to a computer in the cloud (the network of servers that does an increasing amount of the world’s heavy-duty computing) to be crunched. The results are passed back to the farm’s irrigation system—a grid of drip tapes (hoses with holes punched in them) that are filled by pumps. The system resembles the hydroponics used to grow vegetables in greenhouses...’
Lesson 1: Technology, Past and Present (continued)

Recommended source material (continued):

‘...Every half-hour a carefully calibrated pulse of water based on the cloud’s calculations, and mixed with an appropriate dose of fertiliser if scheduled, is pushed through the tapes, delivering a precise sprinkling to each tree. The pulses alternate between one side of the tree trunk and the other, which experience has shown encourages water uptake. Before this system was in place, Mr Rogers would have irrigated his farm about once a week. With the new little-but-often technique, he uses 20% less water than he used to. That both saves money and brings kudos, for California has suffered a four-year-long drought and there is social and political, as well as financial, pressure to conserve water. Mr Rogers’s farm, and similar ones that grow other high-value but thirsty crops like pistachios, walnuts and grapes, are at the leading edge of this type of precision agriculture, known as “smart farming”.


‘In a shed near Toowoomba, researchers at the University of Southern Queensland are developing the tools and techniques they think will dominate farming practice by 2025.

- Mechatronic engineer Dr Cheryl McCarthy is researching the use of drones to automatically detect hot spots in crops, and will soon be one of the few people in Australia licensed to operate unmanned aerial vehicles commercially.

- Agricultural engineer and biosecurity expert Paul Kamel traps moths in a device that allows him to photograph them under a microscope and upload the image, to help spot incursions early.

- Crown rot is a disease caused by fungus, which survives in the stubble of its host plant, limits water movement from the soil and causes browning of the stem. It can be a major headache for the grains industry, causing significant yield losses, particularly in wheat crops. Plant pathologist Dr Cassy Percy is investigating better ways of using phenotyping to learn more about resistance to the disease.

- Food expert Lindsay Brown has been investigating the potential of recycling food waste. He has begun clinical trials to look at how the waste products of foods such as wine can be utilised, and made into functional foods which could improve health. “For example, when we make red wine most of the stuff gets thrown out [and] gets used as compost,” Mr Brown said.

- Precision agriculture expert Troy Jensen has been developing technology which can measure and quantify the spatial capacity of farms in terms of things like fertiliser use. However, to do so requires advanced technology such as auto-steer tractors, which Mr Jensen said already existed. But farm equipment could be even more advanced in the future. “The idea behind fully autonomous, driverless tractors is a possibility,” Mr Jensen said.

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

- What does a cattle farm look like?
- What can they say about the paddock to plate journey of beef?
- What are three technologies students saw in the video?
- What did they learn that they hadn’t considered before?
- What would they like to know more about the beef industry in Australia?

## Facts and Vocabulary - Beef

### Facts about the Australian beef industry

- In total, Australian beef cattle farmers produce 2.5 million tonnes of beef and veal each year.
  
  **SOURCE:** ABARE, *Australian Commodity Statistics, 2016.*

- The beef industry accounts for 55% of all farms with agricultural activity.
  

- The gross value of Australian cattle and calf production (including live cattle exports) in 2015–16 was $12.7 billion.
  

- Australians eat an average 26kg of beef per person, per year. Remarkably, this has remained relatively constant for the past 15 years.
  

- In 2015–16, Australians spent $8.5 billion on beef. In terms of volume, beef is the third most popular fresh meat consumed through the food service industry after chicken and seafood.
  

- Australians remain the second-largest consumers of meat per capita, and the sixth-largest consumers of beef in the world, averaging 26 kg per person in 2016.
  

- Australia exported 962,983 tonnes of beef in 2016–17, worth $8.5 billion. The major export markets for beef are Japan (29%), the United States (21.7%) and Korea (16.8%).
  

- Australian live cattle exports are worth $1.2 billion in 2016–17 – predominantly exported to Indonesia (58.7%), Vietnam (17.7%) and China (8.2%).
  

- Australia produces 3% of the world’s beef, and was the third largest beef exporter during 2016–17.
  
Useful words and phrases

- Abattoir
- Arbitrage
- Australian Certified Organic
- Barley
- Bear market
- Boning room
- Bovine
- Bovine spongiform encephalopathy (also known as ‘mad cow disease’)
- Bull
- Bull market
- Butcher
- By-product
- Carcase weight
- Chorizo
- Dressed weight
- Eastern Young Cattle Indicator (EYCI)
- Export market
- Fat score
- Feedlot
- Grain-fed
- Grass-fed
- Heifer
- Holistic
- Livestock agent
- Marbling
- Meat Standards Australia
- Muscle score
- National Livestock Identification System
- Omega-3
- Organic
- Pastrami
- Premium
- Restocker
- Rotational grazing
- Rump steak
- Sold to the trade
- Steer
- Stocking density
- Store sale
- Trade buyers
- Vealer
- Yearling
- Wagyu
Lesson 2
Beef Burps

Themes
Ethics | Biofuels | Breeding | Renewable energy

Careers

Getting started
After having watched the From Paddock to Plate Beef Virtual Video Excursion students can undertake this lesson.

Ask students to tell you what it would be like to be on a cattle farm with all those cattle. Ask them to tell you what they would see, hear, taste, touch, smell and feel amongst the cattle. Focus on smell. What are cows famous for?

If someone doesn’t mention burps or farts, lucky you! Introduce them to the fact that cows produce methane from their digestive processes. Read the following source material about methane emissions and cattle:

Recommended source material:

“Ruminant livestock are the single biggest source of methane emissions in Australia and the largest source of emissions from agriculture (71%). Large quantities of enteric methane are produced during fermentation in the rumen and released by burping or breathing. Methane is a highly concentrated form of energy; its emission represents a significant loss of energy from dairy production systems, energy that could be used in milk production. The energy lost from one dairy cow in a year represents enough methane to power a six-cylinder LPG car for over 1000km.”


Did you know?
A new chemical food additive has been developed that reduces methane emissions in cattle by 30%.

– Proceedings of the National Academy of Sciences
Lesson 2: Beef Burps (continued)

The methane issue

As a class, make a list of the issues and questions that relate to ethics – not just of animal handling, but also of land and resource use.

For example: Is it right to raise livestock that pollute the air with methane? If we do raise such livestock, is it our responsibility to use all technologies and practices at our disposal to reduce their methane emissions as much as possible?

Students INVESTIGATE and DEBATE the ethical and sustainable production and marketing of food and fibre.

Provide time and resources for students to research and rate selected emerging production technologies and methods, giving each a score for their positive (or negative) contribution to ethics, productivity, profitability, sustainability and renewable energy production.

Examples from the list in the previous lesson can be used, or new examples can be studied and their impact judged. Two examples are provided below to get the class started.

Mini Case Study – Methane and fuel

Students might explore the following as one of the technologies and methods.

Researchers are looking for ways to reduce the release of methane (CH₄) emissions from cattle in the atmosphere, by using the methane to produce biofuel. Is this a win-win outcome, producing more beef, while also reducing greenhouse emissions?

Recommended source material:

‘The methane gas that cows produce by belching and farting can be redirected into biofuels, a pilot program in Argentina demonstrated, Fast Company reported recently. Last fall, Argentina’s National Institute of Agricultural Technology (INTA) announced it was testing a method of capturing the average 80 gallons (300 liters) of methane a cow produced before it ever left the its intestinal tract. The agency also devised a way to compress that gas into biofuel by using a low-tech method that it hopes will work well in rural, outlying areas of the country. INTA spokesman Pablo Sorondo told Fast Company the resulting methane could be used to power a farm or, through a collective, provide electricity to an entire town in remote areas of Argentina as an alternative for cooking, lighting and even driving their cars.’


Students EXPLAIN their argument and how they have given this approach a score for positive (or negative) contributions to ethics, efficiency, profitability, sustainability and renewable energy production.
Lesson 2: Beef Burps (continued)

Mini Case Study – Ban the belch

In another approach, researchers are looking for ways to reduce the methane emissions at the source – the digestive tract of the cow. Their approach is to find out what chemical and biological processes inside the cow produce the methane that is the problem. They seek to understand if the production of methane is related to modern feeding regimes or breeds of cattle. They hope to intervene in ways that will reduce the amount of methane cows produce.

Recommended source material:

‘In a new study, researchers added the chemical 3-nitrooxypropanol, also known as 3NOP (an anti-burp compound), to the corn-and-alfalfa-based feed of 84 milk-producing Holsteins and monitored their methane production for 12 weeks—the largest and longest such trial of its type in lactating cows, the scientists say. For cows whose feed included 3NOP, methane emissions dropped, on average, by 30%, the researchers reported online yesterday in the Proceedings of the National Academy of Sciences.’


‘Methanogens (microbes that produce methane) are a small proportion of the total rumen microbial population. Reducing the numbers of methanogens in the rumen can reduce methane production, apparently without detriment to the digestion process.’


Students EXPLAIN their argument and how they have given this approach a score for positive (or negative) contributions to ethics, efficiency, profitability, sustainability and animal husbandry.

Beyond burps

In pairs, students THINK about how digital technologies could be used to enhance food production systems. What technologies and opportunities have they heard of or could they propose?

As a class, BRAINSTORM your ideas and then select the top three concepts agreed on by everyone.

Divide the class into three groups. Give one idea to each group to develop further into a proposal. Guide them to consider the ethics, efficiency, profitability, sustainability and similar considerations related to their proposal.
Lesson 2: Beef Burps (continued)

Examples:

- Global positioning system (GPS) for managing animals and sowing pasture or food crops more efficiently and effectively.
- Automated animal feeding or milking systems.
- Smart technologies that increase the efficiency of energy, water and nutrients: conservation agriculture, site-specific nutrient management, low-cost drip irrigation and other water-saving irrigation technologies.
- Harvest and postharvest technologies that save labour, reduce grain losses and improve product quality: combine harvest, drying and storage.
- Technologies that take advantage of cheap information and connectivity or cloud computing (mobile/smart phones, internet, social media, videos, remote sensing, soil and weather data, etc.) to provide digital agriculture solutions for farmers (access to information, knowledge, inputs and markets).
- New business models for smallholder farming: test, promote, and support new farming enterprises and integrated value chains that link farmers to the market.

If time permits, students could swap groups and undertake an exercise of rating or scoring each others’ proposals for positive (or negative) contributions to ethics, efficiency, profitability, sustainability and renewable energy production.
Ask students first to reflect on the From Paddock to Plate Cherries Virtual Video Excursion:

- How do cherries grow?
- What role does technology play in cherry growing, processing and packing?
- 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
- Hall 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

Ethics, Efficiency, Energy and Price

Themes
Ethics  Food security  Energy efficiency  Resource management
Careers

Sustainable fruit

Ask students to choose one of the case studies below (or you may include additional case studies from your own region) to explore further.

Students will explore and debate the ethical and sustainable considerations involved in growing and marketing fruit in Australia.

Case studies are chosen to show businesses that see the benefit in carefully refining their processes (how people do what they do, and how the farm or production facility is designed for efficiency) to save energy, benefiting the environment and increasing productivity at the same time.

Case Study One – Shizuoka, Japan

‘Not much about Makoto Koike’s adult life suggests that he would be a farmer. Trained as an engineer, he spent most of his career in a busy urban section of Aichi Prefecture, Japan, near the headquarters of the Toyota Motor Corporation, writing software to control cars. Koike’s longtime hobby is tinkering with electronic kits and machines; he is not naturally an outdoorsy type. Yet, in 2014, at the age of thirty-three, he left his job and city life to move to his parents’ cucumber farm, in the greener prefecture of Shizuoka. “I thought I was getting old,” Koike told me. “I wanted to be close to my home and my family.”

The Koikes have been growing cucumbers in Kosai, a town wedged between the Pacific Ocean and the brackish Lake Hamana, for nearly fifty years. Their crop, which fills three small greenhouses, grows year-round. Koike’s father, Harumi, plants the seeds; Koike oversees their cultivation; and his mother, Masako, sorts the harvest. This last job is particularly important in Japan, which is famously discerning about its produce...’
Recommended source material (continued):

‘...Nice strawberries can fetch several dollars apiece in some markets, and a sublime cubic watermelon can go for hundreds. Vegetables hold a less privileged place than fruits, but supermarkets rarely stock produce that is at all irregular in shape or size. The Koikes send their better cucumbers, the ones that are straight and uniform in thickness, to wholesalers. The not-so-perfect ones go to local stands, where they are sold at half price. (“They taste the same,” Koike said.) Masako judges the vegetables one by one, separating them into bins. Though she devotes only half a second to each cucumber, the task takes up most of her work time; on some days, she goes through around four thousand of them. The laborious process of categorizing the cucumbers had remained essentially the same for decades, until last spring, when Koike began developing a new approach. It was inspired, in part, by articles he read about AlphaGo, the first computer program ever to beat a human master of the game of Go. Developed by Google DeepMind, the program relied on deep learning, a method for making computations by arranging basic processing units into complex, layered networks, rather like the way that billions of neurons work together to produce the incomparable (for now) intelligence of the human brain. In the past several years, deep learning has proved exceptionally useful for finding patterns in big piles of data; it has been incorporated into Facebook’s facial-recognition algorithms, Amazon Alexa’s language processing, and autonomous cars’ navigation systems. In AlphaGo’s case, the program was fed thirty million images of positions from real games, which it used to help determine which kinds of moves work best. Koike hoped that a similar strategy might help him sort his family’s cucumbers.’


Case Study Two – Newton Brothers

At Newton Brothers pack house and cold storage in Manjimup, WA, approximately 70% of the business’s total electricity is used for cold storage.

The facility produces and packs around 7,680 tonnes of apples, pears and stone fruit annually. It has two cold store facilities with 27 individual cold storage rooms. From May 2012 to April 2013, the business consumed over 1.2 million kWh of electricity at a cost of just over $350,000 (excluding GST) for the year.

‘Newton Brothers operates a HCFC-based refrigeration system from a fixed head pressure set-point (at condensing temperatures between 35°C and 40°C), and the condenser fans are cycled to maintain this set-point...’
Lesson 3: Ethics, Efficiency, Energy and Price (continued)

Recommended source material (continued):

‘...A reduction in head pressure is possible during low load periods, and in cold ambient conditions the opportunity exists to reduce compressor power use. Resetting the condenser fan cycling pressure switch settings means the condenser fans will activate more frequently, but the overall refrigeration system will operate more efficiently.’


Case Study Three – Cunich Orchard

The E.F. Cunich & Co. (Cunich) Orchard in Young, NSW, produces around 220 tonnes of cherries and stone fruit per annum. It is a small enterprise compared to other facilities.

It is comprised of a pack house and two cold store rooms that consumed just under 79,500 kWh of electricity between June 2012 and July 2013. Electricity usage by the pack house and cold store rooms represent 85% of the orchard’s total usage, costing around $21,500 (excluding GST) for the year.

‘Installing a new automated sliding door for cool store Room A using an electric, automated tracking system will enable the door to be opened and closed on demand using either:

- radio control (remote control clicker),
- motion detection,
- photo eyes; or
- induction loop activators.

The opportunity will ensure the working room door remains closed when access to the room by staff is not required and will reduce cold air losses and associated refrigeration electricity usage and costs. In addition, staff will be able to access the room without the need to disembark from forklifts, reducing the time and effort taken to move fruit in and out of the working room.’


Case Study Four – Caernarvon Orchard

Caernarvon Orchard in Orange, NSW (which features on the Paddock to Plate app) produces and packs approximately 4,500 tonnes of apples and 800 tonnes of cherries per annum and is regarded as a medium sized orchard. Lighting accounts for approximately 5% of their annual electricity use and costs about $3,400 per year.
Lesson 3: Ethics, Efficiency, Energy and Price (continued)

‘Throughout the pack house, lighting requirements and configurations differ according to the activities of each area, height of the ceilings and the availability of natural sunlight. All of the lighting is manually controlled, requiring the staff to turn lights on and off as they enter or exit a work area. In total, the pack house uses 28 T8 fluorescent tubes and 16 High Bay (Metal Halide) lighting fixtures, all with magnetic ballasts. The lights operate for 45 hours per week for 46 weeks of the year, resulting in about 15,500 kWh of electricity consumption per year. Electricity and cost savings can be made at Caernarvon Orchards by replacing both the existing T8 fluorescent tubes and the High Bay (Metal Halide) lighting fixtures with more efficient bulbs. By implementing lighting efficiency opportunities, Caernarvon could reduce the electricity it consumes for lighting by about 68% and save over $2,300 (excluding GST) annually. The orchard’s total electricity consumption could reduce by 4% annually.’


Going digital

As a class, DISCUSS about how digital technologies could be used to enhance food production systems. BRAINSTORM ideas with the whole class and select the top three concepts agreed on by everyone. Divide the class into groups. Give one idea to each group to develop into a prototype.

Examples include (but are not limited to) digital technologies that include an If This, Then That function (e.g. if this sensor detects less than 10% moisture in the soil, then that water source is turned on):

• Global positioning system (GPS) for tracking vehicles and positioning them accurately.
• Sensors and smart technologies such as soil moisture sensors and automated flow adjusters for irrigation and other water-saving technologies and methods.
• Smart technologies to detect light levels in production facilities.
• Automated mechanical components linked to motion sensors activating doors, air vents, shade or sun panels and conveyor belts.
• Automatic weighing machines, plus weight-activated sensors for sorting, portioning and packing fruit.
• Economic price watch software checking for the optimum moment to pick, pack and sell fruit for the best price.

Students DEFINE an intensive production system and an extensive production system, then FIND an example of each (they could use the Paddock to Plate app to help with this).
Lesson 3: Ethics, Efficiency, Energy and Price (continued)

Students COMPARE the environmental impacts and contribution to food and fibre production of each of these types of production systems. Remind them to consider the interdependence of plants and animals in food and fibre production.

Return from investment

"Everyone has a little love affair with cherries. Everyone loves cherries and it's quite surprising when you give someone a kilo of cherries in a lovely little pack like that, they think they're winning in lotto almost you know. So it's really nice and we get a lot of pleasure out of it."

(7:58 – 8:13)

To finish the lesson, bring students back to the purpose behind businesses making adjustments to save energy, time, and money. For many business owners, the costs involved in the technology are pitched against the potential higher yield and better price for their fruit.

DISCUSS as a class that the effect of product processing and advertising on demand and price. If time permits, pairs or groups, students ANALYSE and DRAW the marketing chain of several Australian-grown fruits and find out the price difference between top-quality and low-grade fruit.

Recommended source material:

‘The farmer’s interest is focused on getting the best return from his produce, which usually equates to maximum price for unlimited quantities. Manufacturers want least cost, best quality produce from the farmer so that he can sell it at competitive, but profitable, prices. Traders and retailers want high quality and reliable supplies from the manufacturer or farmer, at the most competitive prices. Consumers are interested in obtaining high quality products at low prices. Clearly, there are conflicting interests here.’

— Food and Agriculture Organization of the United Nations (FAO)
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 4
Technology Solutions in Aquaculture

Themes
Resource management | Digital technologies | Innovation | Careers

Fishing for information

“We used to bale the fish out with a big scoop net in the old days. This might be an old boat, but it's full of modern technology. Now we pump on the boat and pump off the boat, so we've got it easier than we used to have it.”
(3:30 – 3:44)

Students COMPARE the impact of past and present designed solutions in the fishing and aquaculture industry. Collect a list of examples showing how the industry has changed – in 20 years – in 50 years – in 100 years. What examples can students find of changing and revised/updated technologies?

“We spot a school of fish on a sonar. A sonar is an instrument like a radar that can find the fish forward. I can see the fish 250 metres in front of me.”
(1:52 – 2:04)

For example:

- Modern sonar technology helps to find fish in the ocean. Fish finding sonar units send and receive signals many times per second. They determine the presence of fish primarily by detecting the air in their swim bladders. The air conserved in the swim bladder changes the sound path and reflects energy back. The fish finder detects this reflected energy and converts it into fish images on the screen.

- Turtle Excluder Devices (TEDs) are now incorporated into net designs used in tropical prawn trawl fisheries. TEDs allow prawns to enter a net, but prevent large marine animals like turtles from being captured. The device has proven to be highly successful in many fisheries around the world.

- Mobile communication and smartphone data reporting can alert aquaculture farmers to environmental changes in the water and/or detect potentially devastating diseases in the fish stock.
Lesson 4: Technology Solutions in Aquaculture (continued)

Teacher resources:
- Furuno – All about fish finders: https://www.furuno.com/special/en/fishfinder/

Design decisions

As a class, ANALYSE the factors that influence design and professional designers and technologists.

For example:
- time;
- access to skills;
- knowledge; and
- expertise.

EXPLAIN how the life cycle of a product can the direction design and technologies innovations take, for example reworking established technologies such as nets to catch prawns, to eliminate a problem that is increasingly important (protecting turtle populations). DISCUSS how changing values and considerations affect which design solutions are developed.

Working in pairs or groups, students look at each of the five types of technology opportunities in the fishing industry (listed below). They discuss and develop a list of many options under each of these five categories.

Five Ways Technology Can Help Sustainable Fishing

1. Tracking and monitoring
2. Reporting illegal and unregulated fishing activities
3. Registering your catch
4. Identifying fish at market and educating consumers about species and sustainability
5. Long-term population mapping

Groups present their findings. As a class, CRITIQUE the system of fish mass production taking into account ethics and sustainability considerations and discuss the potential for technology to ease some of these concerns.
Using what they have learned in the previous lesson, students work in their groups to prepare a timeline to demonstrate the evolvement of innovation and design in the fishing and aquaculture industry in Australia. For example, how have larger trends in technology innovation (such as networked sensors and actuators) affected the specific needs of the aquaculture industry?

Watch the video again to EXPLORE the ways commercial enterprises such as the Fremantle Sardine Company respond to challenges such as seasonality, as well as to opportunities for technological change to solve a problem (such as their concern about their carbon footprint).

“The species we are catching are a warm water fish, which come down with the warm water current. The other species are just a little further out to sea, but I don't need to go that far. So, global warming really hasn't got rid of the fish stocks, it's just moved them.”

(4:56 – 5:14)

“I'm a big fan of sustainability. Catching the fish that you are going to eat. Using it from your environment. Not necessarily from your front door like I am here, but from your region. To keep the fishing industry sustainable, I think it's a matter of management.”

(8:08 – 8:26)

As a class, DISCUSS and EXPLAIN the consequences of social, ethical, welfare and sustainability decisions for products, services and environments. For example, training employees to use the fish scaling equipment (5:58) and the sardine-filleting machine (5:43).

In their groups, students PREDICT the impact of emerging technologies in the fishing and aquaculture sector.
Lesson 5: Trends in Technology (continued)

Design assignment

In order to RECOGNISE some of the main problems in the fishing and aquaculture industry, students work in their groups to DESIGN a technology that they believe will assist this industry to overcome one of these problems.

For example:

- Breeding
- Carbon footprint
- Diseases
- Drought
- Food miles
- Illegal fishing
- Seafood imports
- Seafood mislabeling
- Seafood prices
- Seasonality
- Sustainability
- Water security
- Workforce safety and availability

"Australia has got very strict restrictions on our fisheries, on all the types of fisheries. So, Australia is very sustainable. With us, we've got a quota and we can catch what we want in the quota, but I don't need all the quota because I only need small schools every day for consistency to keep the fresh market going."
(4:01 – 4:22)

"My zone is huge. I'm only fishing within two or three kilometres of my waters and I've got thousands of miles of it. So super sustainable. I've got a lot of water out there to catch sardines."
(4:25 – 4:39)

"If I got two tonne a day, that's plenty, but I'm happy with one tonne. Sometimes we catch three, but no more than that. That's enough."
(4:40 – 4:47)
Lesson 5: Trends in Technology (continued)

“For air freight, we chill the product down quickly and then put it in foam eskys with gel packs and that’s what goes on the plane.”
(7:00 – 7:15)

“These days there are a lot of chemicals in foods and I prefer natural foods. We should support our farming industry and our fishing industry instead of buying all of these imported foods. I know we haven’t got enough sometimes, but we should always choose Australian first.”
(7:36 – 7:58)