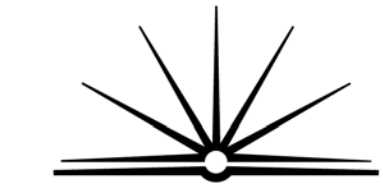

Agriculture
Stage 6

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Contents

Introduction

This support document is designed to assist teachers to implement the Agriculture Stage 6 syllabus. It provides some examples of programming and assessment models for the three Electives: Agri-food, Fibre and Fuel Technologies, Climate Challenge and Farming for the 21st Century.

Each elective is designed to be delivered in approximately 6 weeks. There is a common Research Methodology and Presentation of Research section in each elective.

Each of these electives includes content that focuses on current and emerging issues. Some resources currently used by teachers may require updating to ensure they are relevant to planned teaching, learning and assessment activities.

Information specific to the units of work

Elective 3 – Farming for the 21st Century
Technologies studied in this elective must be current, that is, they should have been developed within the last 10 years.

Research methodology and presentation of research
All three electives contain a common section in which students analyse and critique a published research article relevant to the elective studied. This article can be sourced from publications such as scientific journals, industry research and/or farmer organisation reports.

The article should be a report on research and contain details of methodology and results.

Unit length and sample teaching program
A suggested unit length has been provided, however, teachers may elect to alter this. In some cases, certain aspects of a unit may be integrated or combined.

Suggested references
Each unit of work has a suggested list of references. There may be other resources available to schools that are appropriate and relevant.

Assessment

The sample assessment schedule illustrates one way in which an assessment program can be constructed.

Sample scope and sequence for elective: Climate Challenge

Agriculture HSC Course				
	Term 4	**Term 1**	**Term 2**	**Term 3**
Plant/ Animal Production 16 weeks	• Physical and chemical characteristics of local soil • Factors impacting on soil, nutrient and water degradation • Sustainable resource management	• Growing and managing a crop through the production cycle • How environmental factors impact on plant production	• Experimental research in plant or animal production • Ethical issues • Animal welfare legislation and production systems	• Monogastric and ruminant animal nutrition; lamb growth and development • Sheep reproduction and genetics • Animal disease
Farm Product Study 10 weeks	• Review a farm case study to explore the farm as a business	• New agricultural technologies and their impact upon farm production and marketing • Beef processing and marketing beyond the farm gate		
Elective 6 weeks			**Climate Challenge** Begin towards the end of Term 2. • Predicting agricultural production using historical data and climate zones • Collecting, calculating and predicting climate and weather patterns • Climatic regions • Plant and animal production techniques and managing the effects of climate variability	**Climate Challenge** Continue Term 3. • The impact of climate change on agricultural production • Water storage and production in the local area • Management of the effects of climate variability and agricultural production
Outcomes	H1.1, H2.1, H2.2, H3.4, H5.1	H1.1, H3.1, H3.2, H3.3, H3.4	H1.1, H2.1, H2.2, H3.4, H4.1, H5.1	H3.4, H4.1, H5.1

Note: due to the seasonal constraints affecting agriculture, the sequence of study may need to be re-ordered.

Sample HSC assessment grid for Agriculture

This sample assessment grid illustrates one way in which an assessment program can be constructed to meet the Board's requirements that three to five tasks are sufficient for a two unit course. It shows that a variety of tasks can be used and that, overall, the weighting requirements for each of the assessment components are met.

HSC assessment grids may be constructed in many other ways that involve different types of tasks, timing of tasks and weightings given to each task.

Schools may use this assessment grid without modification, or change it to suit their particular needs, being mindful that the weightings for each of the assessment components in the HSC course are mandatory.

Component	**Task 1**	**Task 2**	**Task 3**	**Task 4**	**Weighting**
	Plant/Animal Production Oral presentation	Farm Product Study Practical test	Elective Research task	Trial HSC Written examination	
	Term 4, Week 8	Term 1, Week 6	Term 2, Week 8	Term 3, Week 4	
	H1.1, H2.1, H2.2	H3.1, H3.2, H3.3, H3.4	H3.4, H4.1, H5.1	H1.1, H2.1, H2.2, H3.4, H5.1	
Knowledge and understanding of: • the physical, chemical, biological, social, historical and economic factors that interact in agricultural production systems • the impact of innovation, ethics and current issues on Australian agricultural systems	10		10	20	40
• Knowledge, understanding and skills required to manage agricultural production systems in a socially and environmentally responsible manner • Knowledge of, and skills in, decision-making and the evaluation of technology and management techniques used in sustainable agricultural production and marketing	5	20		15	40
Skills in effective research, experimentation and communication	5		15		20
Marks	**20**	**20**	**25**	**35**	**100**

Agriculture Stage 6
HSC course programmed unit of work

Elective 1: Agri-food, Fibre and Fuel Technologies **Time: 6 weeks**

Introduction
This elective examines the role of biotechnology in the production of food, fibre, and fuel in agricultural systems. This elective includes a study of the technology and process of biotechnology at the gene level; and the problems and benefits of genetic engineering and gene technology.

Outcomes
A student:
H3.4 evaluates the management of the processes in agricultural systems
H4.1 justifies and applies appropriate experimental techniques, technologies, research methods and data presentation and analysis in relation to agricultural problems and situations
H5.1 evaluates the impact of innovation, ethics and current issues on Australian agricultural systems

Suggested references

1. Australian Centre for Plant Functional Genomics Pty Ltd http://www.acpfg.com.au/index.php?id=1
2. Agrifood Awareness Australia http://www.afaa.com.au/default.asp
3. Australian Government Rural Industries Research and Development Corporation http://www.rirdc.gov.au/
4. Rural Industries Research and Development Corporation, *Future Biofuels for Australia,* RIRDC Publication No 08/117 June 2008
5. Food and Drink Federation http://www.fdf.org.uk/
6. Australian Food and Grocery Council Fact Sheet – Gene Technology http://www.afgc.org.au/
7. Office of the Gene Technology Regulator http://www.ogtr.gov.au/
8. Food Standards Australia New Zealand http://www.foodstandards.gov.au/
9. Australian Broadcasting Corporation - "Gene Wars- the race to own our food"- http://www.abc.net.au/news/events/gene-wars/
10. Department of Agriculture, Fisheries and Forestry http://www.daff.gov.au/animal-plant-health/pests-diseases-weeds/biosecurity
11. Department of Agriculture, Fisheries and Forestry -Bureau of Rural Sciences "Plant Gene Technology: Improving the Productivity of Australian Agriculture" http://www.daff.gov.au/brs
12. Biofuels Association of Australia http://www.biofuelsassociation.com.au/
13. Maize Association of Australia www.maizeaustralia.com.au
14. CSIRO http://www.csiro.au/
15. CSIRO – Plant Genetic Engineering http://www.csiro.au/science/Biotechnology.html and http://www.csiro.au/resources/pf44.html
16. International Centre for Genetic Engineering and Biotechnology http://www.icgeb.org/home.html
17. Biotechnology Australia http://www.biotechnology.gov.au/
18. Gene Ethics http://www.geneethics.org/
19. Fuel ethanol – Manildra Group http://www.manildra.com.au/ Sucrogen BioEthanol http://www.sucrogenbioethanol.com/
20. Scirus, scientific research tool http://www.scirus.com/

21. AGRIS information system for the agricultural sciences and technology http://agris.fao.org/
22. AGRICOLA, catalogue of agricultural literature http://agricola.nal.usda.gov/
23. HSC on Line http://www.hsc.csu.edu.au/
24. TaLe www.tale.edu.au/
25. *Safety Assessment of Genetically Modified Foods,* Food Standards GM Foods http://www.foodstandards.gov.au/_srcfiles/GM%20Foods_text_pp_final.pdf
26. Green Power newsletter http://www.greenpower.gov.au/admin/file/content13/c6/suncoast_macadamia.pdf
27. Report by the Agriculture and Food Policy Reference Group "Creating Our Future - Agriculture and food policy for the next generation"
28. Pahl, G, 2009 *Biodiesel-Growing a New Energy Economy*, Chelsea Green Publishing Company
29. New Internationalist Magazine August 1997 'Bordering on the Misleadingly Simple "Guide to Genetics"'
30. Engdahl, W, 2007 *Seeds of Destruction. The Hidden Agenda of Genetic Manipulation*. Global Research, Centre for Research on Globalisation
31. Grace, E, (2005) *Biotechnology Unzipped. Promises and Realities.* Henry (Joseph) Press

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
Innovation, ethics and current issues • the term 'biotechnology', a term used to cover the use of living things in industry, technology, medicine or agriculture	• define DNA, gene, genetically modified organism (GMO), gene markers, genetic engineering and protein synthesis	Biotechnology is a broad term for a group of technologies based on the application of biological processes. It describes a range of processes and techniques especially at the molecular level. Teacher explains the meaning of the following terms, and gives examples where possible: – DNA – genetically modified organism – gene markers, eg for marbling in beef – genetic engineering – protein synthesis. Students use models to make a DNA molecule.	H5.1	2	
	• describe the implications of biotechnology in the agri-foods, fibre and fuel industries	Students: • define the term biotechnology with respect to agriculture • describe at least one plant food product which results from the use of biotechnology, eg genetically modified canola, soybean, cotton or potato • describe at least one animal food product which results from the use of biotechnology, eg transgenic sheep, pigs, dairy cows (bovine growth hormone) • describe at least one fibre product which results from the use of biotechnology, eg transgenic cotton • debate ethical issues. Suggested topic 'Transgenic species will feed the world' • describe (at least) one fuel product which results from the use of biotechnology • construct a table to compare and contrast the implications (both positive and negative) from the production and use of products derived from	H5.1	14–16 1–2 1–2 2 3–4	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
		biotechnology including plant, animal, fibre and fuel products			
• ethical concerns and controversy surrounding the use of biotechnology in agricultural production	• outline the importance of food safety and labelling of GMOs	Teacher outlines the reasons why food safety and labelling are important issues in relation to genetically modified foods. Students collect a range of packaged food products manufactured in different countries and identify the genetically manipulated organism information provided on the label, eg soya bean products.	H5.1	5–8 and 31	
	• discuss issues relating to food production using GMO	In groups, students list and explain issues relating to the use of genetically manipulated organisms in food production such as patenting, cross pollination, cost, public perception, animal cross breeding, animal welfare and the escape of genetically modified organisms to the wider environment.	H5.1	8–10 You Tube Biotechnology in agriculture.	
	• examine regulations that surround development and use of GMOs and biotechnology	Teacher explains the process for approval to grow a genetically modified crop. Students outline the regulations that have been put in place for the use of a genetically modified crop. They also make a link between these regulations and the issues relating to food production using genetically modified organisms.			

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	• explain the role of biosecurity	Students define the term biosecurity, with reference to Australian agriculture, and outline the role of the food divisions within the Biosecurity Services Group in the NSW Department of Primary Industries, Fisheries and Forestry (DAFF) such as: – exotic disease control – manage the risk of disease outbreak – development of mitigation – oversee food import protocols – storage and stock piling of vaccines. Teacher leads a discussion about why biosecurity is important to Australia and the world.	H3.4 H5.1	11	
	• evaluate biofuel production with respect to world food demands and sustainable and efficient use of carbon	Students: • investigate different forms of biofuel production around the world, eg methane biogas • identify conflict issues between biofuel production and world food demands • evaluate biofuel production and world food demands with sustainable and efficient use of carbon, for two forms of biofuel, eg ethanol, biogas, corn, sugarcane • create a staged Wiki page for a debate over several weeks of research. Teacher uses smart board for summation • compare and contrast potential sustainability of biofuel vs fossil fuels • research uses for crude oil.		4, 12–13	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
• current areas of development in biotechnology	• describe current developments in biotechnology , including biofuels, biopesticides, rumen modification, gene markers, vaccine production, embryo and sperm testing and embryo splitting • discuss a current biotechnology development	Student presentation • students research, summarise and present a brief class talk and paper (to be compiled in booklet form for class at end of presentations) on current world and Australian developments in one of the following areas: – biofuels – biopesticides – rumen modification – gene markers (beef, cattle, sheep) – vaccine production – embryo and sperm testing – embryo splitting. • should include: – a description of the technology – an explanation of its potential use – an outline of the advantages and disadvantages – an outline of the method and cost of production – an assessment of the feasibility of the biotechnology – an evaluation of the marketability of the biotechnology – an explanation of the ease of use – an outline of the practical applications for the biotechnology. Examples and references should be cited.	H5.1	10–13	
Managing processes in agricultural systems • the benefits and problems of biotechnology and genetic engineering in agricultural industries	• analyse the conflict between increased production and ethical concerns in biotechnology innovation	Teacher explains the areas for conflict such as: – consumer choice – increased production of biofuels in third-world countries and decrease of food production – use of hybrid seed in third-world countries and the resulting dependence on international seed companies for seed supplies	H3.4	17–19	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
		– increase in chemical use in crop production for crop pest and disease control – shrinking of gene pools in crop seeds – increase in human allergies in the population – product development by multinational companies. Students prepare an essay to analyse the conflict between increased production and ethical concerns in biotechnology innovation.			
• a wide range of potential applications of gene technology and biotechnology in agriculture	• investigate uses of biotechnology in agriculture such as genetic modification of crops to incorporate resistance to pests and diseases, herbicide tolerance, slow the ripening of fruit or alter the timing and duration of flower production	In class and with teacher assistance, students examine one example where each of the following are used: – genetic modification of crops to incorporate resistance to pests and disease, eg transgenic cotton, grapevine biotechnology – herbicide tolerance, eg Monsanto seeds, Roundup Ready soybean system – terminator gene sterile male fruit flies and sheep blow flies – slowing the ripening of fruit using hormone treatment. Students select one of the following and write a fact sheet and/or make a PowerPoint presentation and/or promotional brochure for: – altering the timing and duration of flower production in the nursery industry using light regimes, eg for Mother's Day chrysanthemums, poinsettia, tulips – chemical thinning of stone fruit.	H5.1	20–22	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
• biofuel production	• describe ways biofuel is produced from grain, sugar, vegetable oils, algae and green waste/straw	Students research the production of one biofuel listed and present a summary of their findings to the class: – grain – sugar – vegetable oils – algae – green waste/straw – sugar cane waste – waste vegetable oil from the chip industry. Students produce a sample of biofuel, eg ethanol from sugar or methane from fermentation of manure.	H4.1 H5.1	23–24	
	• identify and describe industries or activities that consume biofuel products	Students identify and describe at least two industries that consume biofuel products, eg piggeries using their own waste to produce methane as a fuel source or macadamia nut husks used to create energy.	H4.1 H5.1	23–24 33	
Research methodology and presentation of research					
• research into technological developments	• analyse a research study of the development and/or implementation of ONE agricultural biotechnology in terms of: – design of the study – methodology of the study – collection of data for the study – presentation of data – analysis of the data – conclusions and recommendations	Students select an appropriate research study on the development and/or implementation of one agricultural biotechnology. They: – comment on aims of the research study and the hypothesis to be tested – analyse the role of control, treatment, randomisation, replication and standardisation – discuss the effectiveness of the methodology – design validity, appropriateness, ethics and suitability of the statistical analysis – discuss alternative methods available for conducting research – analyse data collection, eg timeframe, breadth of information, use of second-hand data, accuracy of collection, qualitative and quantitative methods	H4.1	25–30	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
		– discuss data presentation – analyse appropriateness of the presentation – evaluate alternative forms of presentation, depending on the audience – evaluate the validity of the conclusion and recommendations made and whether they reflect the aim – analyse the need for further research and the relevance of this research to the broader community.			
	• explain the need for research into the development of agricultural technologies	Teacher explains the importance of research for agriculture, eg improving yield, quality, disease resistance. Students identify and comment on the focus and role of organisations involved in the research such as government organisations, universities, private companies and Meat and Livestock Australia.	H3.4	21	

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Elective 2: Climate Challenge **Time: 6 weeks**

Introduction

Australia has one of the most variable climates in the world. This presents particular challenges and opportunities for agricultural production. Recent research indicates that atmospheric changes could cause even more variation to climate in the future. This elective examines the variability of climate and some possible causes; the way farmers can manage their farms; and adaptation strategies to mitigate risk and maximise profitability and sustainability.

Outcomes

A student:

H3.4 evaluates the management of the processes in agricultural systems

H4.1 justifies and applies appropriate experimental techniques, technologies, research methods and data presentation and analysis in relation to agricultural problems and situations

H5.1 evaluates the impact of innovation, ethics and current issues on Australian agricultural systems

Suggested references

1. Bureau of Meteorology
   Climate glossary http://reg.bom.gov.au/climate/glossary/elnino.shtml
   Climate zones based upon temperature and humidity http://www.bom.gov.au/climate/environ/travel/tmp_zones.jpg
   Southern Oscillation Index (SOI) http://reg.bom.gov.au/climate/glossary/soi.shtml
   El Niño and La Niña: Southern Oscillation Index http://www.bom.gov.au/watl/enso/
2. Department of Sustainability, Environment, Water, Population and Communities, Climate classification
   http://www.environment.gov.au/soe/2001/publications/theme-reports/atmosphere/introduction-4.html
3. Australian National Resources Atlas, national land use map http://www.anra.gov.au/topics/agriculture/images/ag_report/section_1/figure1_2.gif
4. Screen NSW, winter crop sowing dates http://www.screen.nsw.gov.au/data/page/34/NSW_Crops.pdf
5. *The Age* article 'Ice Cores Reveal Climate Change' http://www.theage.com.au/news/national/ice-cores-reveal-climate-change/2007/01/26/1169594482202.html by Liz Minchin
6. 'Ice-core evidence of abrupt climate changes', proceedings of the National Academy of Sciences (USA) http://www.pnas.org/content/97/4/1331.full
7. Ausgrain, domestic wheat and coarse grain production http://www.ausgrain.com.au/Back%20Issues/177ybgrn08/30_Wheat.pdf
8. Human activity and greenhouse gases http://www.koshland-science-museum.org/exhibitgcc/causes03.jsp
9. National Geographic http://environment.nationalgeographic.com/environment/global-warming/gw-overview-interactive.html
10. Australian Broadcasting Corporation Landline http://www.abc.net.au/landline/ 'The Carbon Farmers' http://www.abc.net.au/science/features/soilcarbon/
11. CSIRO
    http://www.clw.csiro.au/issues/water/
    http://www.clw.csiro.au/education/

http://www.clw.csiro.au/issues/landuse/
12. Department of Agriculture and Fisheries http://www.daff.gov.au/climatechange/australias-farming-future/climate-change-and-productivity-research
13. Food Climate Research Network, 'Intensive versus extensive livestock systems and greenhouse gas emissions' http://www.fcrn.org.uk/fcrnPublications/publications/PDFs/FCRN_int_vs_ext_livestock.pdf
14. Department of Primary Industries http://www.dpi.nsw.gov.au/research/topics/climate-change
15. *Farming Ahead*, Kondinan Group http://www.kondinin.com.au/

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
Innovation, ethics and current issues • Australia's variable climate	• examine, using secondary sources, the climates of the local area and of a contrasting region in Australia • calculate mean and standard deviation of rainfall and maximum and minimum temperature over the past 30 years for the local area and for a contrasting region in Australia • analyse data to determine the frequency of wet, normal and dry years, hot, normal and cool years for the local area and for a contrasting region in Australia • compare the variability of climate in different geographical regions in Australia	Students collect climate information from the last 30 years about their local area and another contrasting area, eg Sydney and the central west; NSW or Sydney and south western WA. The information should include the following climate information: – rainfall – maximum/minimum temperature including evaporation rates, frost days, wind speed and direction, humidity. Students: • calculate mean and standard deviation • construct graphs and annotate the graphs with information about: – hot or cold years – dry or wet years – drought or flood events – 'normal' years – cool years. • describe the climate characteristics of their area and a contrasting area in Australia • identify the cold and hot, and wet and dry months and examine different climatic regions • examine a map of agricultural distribution and compare the agricultural production of different areas, eg areas suitable for wheat and barley production • compare similar production enterprises in contrasting areas, eg sowing time of wheat, time of lambing, harvest and sale of produce	H5.1 H4.1 H5.1	1 2–3 4 5	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	• explain the implications of climate variability for agricultural production	• predict climate events, eg rainfall, temperature, weather patterns, 10 years into the future	H5.1	6–8	
	• extrapolate from climate variability data to determine the effects of climate change on production	• predict how and explain why the local area may change agriculture production because of climate variability, eg type of production (wool products to sheep meat), timing of operations (sowing time, lambing time to avoid frosts)			
	• investigate research evidence in relation to long-term climate variation such as ice cores and tree growth rings	• examine slices of timber from trees to see variation in growth from year to year (eg fire, wood, logs) • investigate tree growth rings and research the evidence in relation to long-term climate variation	H4.1		
• causes of climate variability	• outline the effects sea surface temperature and the Southern Oscillation Index (SOI) have on climate in Australia	Students: • define the Southern Oscillation Index (SOI) • present the effects of sea surface temperatures and SOI on the climate • state the current SOI and describe the trend over the last 6 months • discuss in groups and predict the implications of climate change in your local area	H5.1	12–13	
	• describe the processes causing the climate events of La Niña and El Niño. • analyse the variations in crop yields in Australia with changes in SOI	• define La Niña and El Niño • prepare diagrams to show La Niña and El Niño events • list when La Niña and El Niño events have occurred in the past • describe grain yields over the long term and compare with SOI data		11 and 14	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
• changes in climate that may be attributed to human activity	• identify carbon dioxide, methane and nitrous oxide as the three main greenhouse gases • identify the sources of greenhouse gas emissions • recognise the effect of greenhouse gases on atmospheric temperature and climate change	Students investigate the causes and effects of greenhouse gases including: • carbon dioxide (CO_2), methane (CH_4) nitrous oxide (N_2O) and halocarbons • the major source of greenhouse gases – industrial – agricultural – domestic • prepare a pie chart to represent sources of greenhouse gases. Students define the term 'greenhouse effect'. They describe the impact on global temperatures and on climate change and produce and annotate diagrams.	H5.1 H3.4	15	
Managing processes in agricultural systems • managing resources	• identify methods which can be used in agricultural systems to reduce the concentration of greenhouse gases in the atmosphere • describe methods farmers can use to reduce methane emissions from ruminant livestock • outline methods used to sequester carbon in agricultural soils • explain the contribution	Students: • suggest ways sectors of society may reduce their production of greenhouse gases, eg industrial coal burning, agricultural methane, domestic solar energy • describe the potential of the major greenhouse gases to increase global warming • investigate genetic selection of livestock with low methane emissions, testing of varied feed sources and grazing techniques, for their ability to reduce methane in ruminants Students: • define carbon sequestration and describe how agricultural soils may play a role in capturing and storing carbon • understand how ruminants produce CO_2 and CH_4 and estimate the annual production of CO_2 and CH_4 by one cow. Students relate this to Australian cattle population and greenhouse gas production • compare intensive and extensive ruminants and the	H4.1 H3.4 H5.1	17 18 18	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	of nitrogen fertiliser and intensive ruminant production to greenhouse gas production	greenhouse gases produced • outline the effect of nitrogen fertilizers on plant growth and describe the losses of nitrogen from soils by denitrifying bacteria and outline which gases are released into the atmosphere • Extension: review the current Australian position on an approach to managing greenhouse gas production, eg carbon trading scheme		18	
	• explain how vegetation changes and land clearing can affect local climate	• describe the effect of land clearing and vegetation change on climate, eg monocultures, wind-breaks • investigate, gather and analyse information from their local area about the temperature in different locations – bushland, built environments, cleared land	H3.4		
	• describe methods used to store and trade water resources • analyse issues related to water storage and trading such as river flows, aquifer depletion and enterprise change	• compare the methods available for farmers to store water on farms and individual farmer storage with the methods available for communities to store water • review and describe the water storage facilities in your local area, eg dam, river, aquifer • discuss locally available water trading systems • discuss issues related to water use in Australia, eg water trading regulation, environmental flows, quality of drinking water • conduct a debate on the topic 'Farmers should pay more for irrigation water'		9	
• management techniques available to the farmer to minimise risk and maximise opportunities from climate variability	• evaluate a range of management options available to the farmer to manage climate variability in plant and/or animal production such as:	• use a collaborative learning strategy such as wiki, debate, published booklet, typewith.me to gather information about and evaluate a range of strategies farmers may use to cope with climate variability in:		18	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	plant production – plant breeding – improved irrigation practices – timing of planting – soil moisture conservation – extended fallows – retaining residues – moisture monitoring – crop density and/or animal production – grazing strategies – stocking rates – shelter or shade areas – fodder conservation – new varieties/ breeds – enterprise changes – financial analysis such – as gross margins	plant production such as: – plant breeding – drought tolerant wheat – improved irrigation practices, eg microjet/drip vs overhead/flood irrigation – timing of planting – soil moisture conservation, eg mulches, stubble retention – extended fallows – retaining residues – moisture monitoring, eg use of moisture probes – crop density, eg altering up and down according to season and/or animal production such as: – grazing strategies, eg cell grazing – stocking rates – reduction of shelter or shade areas – tree planting/effect on water intake – fodder conservation including silage/hay/grain – new varieties/breeds including fat tail sheep/Dorper, Boer goats – enterprise changes, eg native animals and plants – financial analysis such as gross margins, whole farm and enterprise change.	H4.1		
Research methodology and presentation of research • research into climate variability	• analyse a research study of climate variability or management strategies related to climate variability in terms of:	Students select an appropriate research study on climate variability or management strategies related to climate variability. They: – comment on aims of the research study and the hypothesis to be tested – analyse the role of control, treatment, randomisation,	H3.4		

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	– design of the study – methodology of the study – collection of data for the study – presentation of data – analysis of the data – conclusions and recommendations	replication and standardisation – discuss the effectiveness of the methodology – design validity, appropriateness, ethics and suitability of the statistical analysis – discuss alternative methods available for conducting research – analyse data collection, eg timeframe, breadth of information, use of second-hand data, accuracy of collection, qualitative and quantitative methods – discuss data presentation – analyse appropriateness of the presentation – evaluate alternative forms of presentation, depending on the audience – evaluate the validity of the conclusion and recommendations made and whether they reflect the aim – analyse the need for further research and the relevance of this research to the broader community.			
	• explain the need for research in climate variability or management strategies for climate variability	Students explain why research is important, eg the effect of changes in temperature, and analyse the effectiveness of different management strategies. They identify and comment on the role of the organisation involved in the research such as the CSIRO, government, university, private companies and Meat and Livestock Australia.			

Agriculture Stage 6
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Elective 3: Farming for the 21st century **Time: 6 weeks**

Introduction

The continued success of Australian agriculture in the global economy relies on the adoption of new technologies and continual innovation at all levels within the industry. This elective examines existing and developing technologies and the role they play in the development of agriculture in Australia.

Outcomes

A student:

H3.4 evaluates the management of the processes in agricultural systems

H4.1 justifies and applies appropriate experimental techniques, technologies, research methods and data presentation and analysis in relation to agricultural problems and situations

H5.1 evaluates the impact of innovation, ethics and current issues on Australian agricultural systems

Suggested references

1. Animal welfare www.schools.nsw.edu.au/animalsinschools
2. IP Australia, Plant Breeders Rights http://www.ipaustralia.gov.au/pbr/index.shtml
3. CSIRO, Gene Technology and Farming http://www.csiro.au/science/Gene-Tech-Farming.html
4. Meat and Livestock Australia (MLA) newsletter http://www.mla.com.au/Publications-tools-and-events/eNewsletters
5. TaLe website http://www.tale.edu.au/tale/live/teachers/secondary/
6. *Farming Ahead*, Kondinan Group http://www.kondinin.com.au/
7. Farm Industry News http://farmindustrynews.com/
8. Australian Government Department of Agriculture, Fisheries and Forestry http://www.daff.gov.au/
9. NSW Department of Primary Industries http://www.dpi.nsw.gov.au/agriculture
10. Victorian Department of Primary Industries http://new.dpi.vic.gov.au/
11. The Agricultural Marketing Resource Center http://www.agmrc.org/
12. HSC Online http://www.hsc.csu.edu.au/agriculture/
13. Spatial Information Exchange https://six.maps.nsw.gov.au/wps/portal/
14. Australian Government Bureau of Meteorology www.bom.gov.au
15. The Official Global GPS Cache Hunt site www.geocaching.com
16. You Tube http://www.youtube.com/
17. ABC Landline http://www.abc.net.au/landline/
18. National Livestock Identification System https://www.nlis.mla.com.au/
19. Future Dairy http://www.futuredairy.com.au
20. Larkin PJ, *Genes at work: Biotechnology*, CSIRO Publication

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
Innovation, ethics and current issues					
• issues relating to research and development	• discuss issues related to the research and development of technologies, including funding sources, patents, plant breeding rights, animal welfare, legislation and contracts	Teacher and students identify sources of funding available to the research community and discuss the possible ethical issues associated with the source of funding and the link to the type of research conducted Students: • review legislation for plant breeding rights and patents • identify potential issues for plant breeding rights and patents, eg genetically modified plants • identify potential issues for the ownership of intellectual property, eg genes at work • discuss the impact of animal welfare legislation and the type of research that can be conducted on animals, eg guidelines for animals in schools • identify activities that can be conducted by students in schools and those that may need further approval	H 5.1	1 and 2 3 1	
• developments in agricultural technologies	• evaluate a range of new technological developments that may assist agricultural industries including: – satellite technologies, eg global imaging systems and global positioning systems – computer technologies, eg climate/weather forecasting, laser technologies and computer recording keeping systems – biotechnologies, eg	• research a range of computer technologies currently available for use in agriculture, for example: – computer record-keeping systems – electronic identification systems, eg National Livestock Identification System (NLIS) – marketing systems, eg AuctionsPlus Livestock website – weather forecasting and monitoring, eg Bureau of Meteorology – use the Spatial Information Exchange website data to observe the local area and show how multi-speed images can identify vegetation types – research low satellite imaging technology and how it can be used in agriculture – use a global positioning system (GPS) receiver, eg mobile phone, to mark points in school yard and then track from one point to another	H3.4 H5.1	8–10, 14–19	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	genetically modified organisms – electronic identification systems, eg NLIS – robotics, eg milking, shearing and machinery	– research how GPS systems can be used in agriculture – use a meteorology website to investigate weather forecasting – students develop their own weather forecast using a synoptic map and satellite images – research how computer technology can be used in weather forecasting – as a class, log on to the school's NGIS account to observe how livestock movements can be monitored. • investigate the use of laser technology in levelling and seedbed land preparation • investigate the role of satellite imaging and global positioning systems used in cultivation tracking, tree clearing, fertiliser use • define the term genetically modified and outline the process of gene transfer • research and identify a range of genetically modified plants currently available in agriculture, eg transgenic cotton, soybean, canola • suggest possible impacts of these genetically modified technologies on food and fibre production • discuss a range of issues identified surrounding the use of a particular technology, eg cost, labelling, consumer choice, ethics, gene transfer, genetic integrity, smartgene • research the extent to which robotics are being used in agriculture. Observe/visit a facility that uses this technology, eg future dairy or undertake a 'virtual tour' via Landline.		21	

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
Innovation, ethics and current issues • marketing of technology developments	• evaluate methods that companies may use tomarket new technological developments	Students list reasons that support the adoption of new technologies in Australia, eg subsidies, competitive edge. Students research methods available for marketing new technologies, eg field days, rural newspapers and magazines, industry-based newsletters, web sites, direct marketing, local TV and radio, for example: • compare and contrast at least two marketing strategies • identify impediments to the rapid uptake of new technology in agriculture, eg level of exposure, cost, availability of transport, education and training, conservatism, changing markets	H4.1	12	
Managing processes in agricultural systems • reasons for adopting technologies	• explain the reasons for adopting technologies in agriculture	Students identify examples of recent technologies that have been adopted, eg GM crops, satellite navigation, post-harvest storage. Class discusses reasons for adopting technologies such as GM crops – profit, disease resistance, weed control, marketability, product quality.	H3.4 H5.1	8–10	
• adopting a technological development.	• for ONE recent technological development – explain the reason for the development of the technology – outline the historical development of the technology – describe in detail the	Students summarise the benefits of adopting these technologies such as GM crops, eg increased production, disease resistance, efficient weed control, quality, marketability. Class presentation – research, summarise and present to the class a brief paper, on one recent technological development in agriculture. Examples and references should be citied. Topics may include:			

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
	technology development – evaluate the impact of the technological development in terms of economic, environmental, social, legal and managerial factors	– ultrasound scanners – NSIS reader in cattle – GM crops – herbicide tolerant OR pest resistant – semen or embryo sexing – marker genes in livestock – GPS or precision agriculture – fertiliser application OR herbicide spraying OR monitoring of yield – robotic shearing – robotic dairy – remote sensing to monitor vegetation conservation – remote sensing and estimation of crop yields – laser land lending. Students explain the reasons for this technology including: – a farmer need identified – or a new technology Students prepare an outline of the historical development of the technology and construct a timeline of the development and implementation. They describe the technology including: • what it looks like, how it is operated and what skills are needed • the advantages and disadvantages of the technology • an evaluation of the impact of the technology in terms of economic, environmental, social, legal and management factors. Other activities may include: • explaining the use of technology in measuring fat depth, eye muscle area • identifying the commercial advantage of the technology • making a timeline for development and			

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
		implementation • explaining how the technology works and its potential use in an agricultural industry • evaluating the potential impact of the technology upon an industry you have studied such as economic, environmental, social, legal, managerial factors • examining issues surrounding: – the cost of implementing the technology to the producer – the perceived benefits to the producer – changes in management practices as a result of the technology – user skills and training – access to and supply of the technology • identifying the issues of cost, training, accessibility of the technology • conducting a case study of a particular technology to examine issues surrounding: – accessibility to the technology – cost of equipment and training – ease of operation, eg reading NLIS tags vs using a reader – contrast accuracy, eg visual appraisal vs kill sheet information – changes to management operations and practices – health benefits and/or social benefits – other issues, eg legal, long-term benefits to the industry, meeting market requirements. • identifying a range of beneficial aspects of adopting a particular technology, eg yield, achieving marketing requirements, reduction in input, identifying issues that may lead to the slow adoption of new technology such as cost of implementation and training			

Students learn about	Students learn to	Strategies and Activities	Outcome	Reference	Registration
Research methodology and presentation of research • research into technological developments	• analyse a research study of the development and/or implementation of ONE recent agricultural technology in terms of: – design of the study – methodology of the study – collection of data for the study – presentation of data – analysis of the data – conclusions and recommendations	Students select an appropriate research study on the development and/or implementation of one recent agricultural technology. They: – comment on aims of the research study and the hypothesis to be tested – analyse the role of control, treatment, randomisation, replication and standardisation – discuss the effectiveness of the methodology – design validity, appropriateness, ethics and suitability of the statistical analysis – discuss alternative methods available for conducting research – analyse data collection, eg timeframe, breadth of information, use of second-hand data, accuracy of collection, qualitative and quantitative methods – discuss data presentation – analyse appropriateness of the presentation – evaluate alternative forms of presentation, depending on the audience – evaluate the validity of the conclusion and recommendations made and whether they reflect the aim – analyse the need for further research and the relevance of this research to the broader community.	H4.1	13	
• the need for research	• explain the need for research in the development of agriculture technologies	Students identify and comment on the focus and role of organisations involved in research such as the CSIRO, government, universities, private companies and Meat and Livestock Australia.	H3.4		