AN EDUCATIONAL UNIT FOR YEAR 7

Water in the world

YEAR 7

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Contents

Introduction

Australian farmers own, manage and care for 61 per cent of Australia's land mass. The environment and the natural climate and, in particular, the water supply, have determined the farming activities that can be undertaken in different places. Today, planning, technology and management techniques are used by 94 per cent of farmers to make greater and better use of the wide range of environments. Our farmers provide 93 per cent of the food needs of the Australian population and earn 12 per cent of the Australian Gross National Product from exports and value-added products.

Data source: http://www.nff.org.au/farm-facts.html

Aim

The aim of this resource is to provide teachers with an inquiry-based teaching approach that focusses on those characteristics of Australia's water supply that influence the pattern of agriculture and considers water's economic value in farming.

Australian Curriculum content descriptions

Geography

Strand: Geographical knowledge and understanding

The classification of environmental resources and the forms that water takes as a resource. ACHGK037

The ways that flows of water connect places as it moves through the environment and the way this affects places. ACHGK038

The nature of water scarcity and ways of overcoming it, including studies drawn from Australia and West Asia and/or North Africa. ACHGK040

The economic, cultural, spiritual and aesthetic value of water for people, including Aboriginal and Torres Strait Islander Peoples and peoples of the Asia region. ACHGK041

Strand: Geographical inquiry and skills

Collect, select and record relevant geographical data and information using ethical protocols from appropriate primary and secondary sources. ACHGS048

Evaluate sources for their reliability and usefulness and represent data in a range of appropriate forms, for example, climate graphs, compound column graphs, population pyramids, tables, field sketches and annotated diagrams, with and without the use of digital and spatial technologies. ACHGS049

Analyse geographical data and other information using qualitative and quantitative methods, and digital and spatial technologies as appropriate, to identify and propose explanations for spatial distributions, patterns and trends and infer relationships. ACHGS051

Inquiry sequence

1. How can environmental resources be classified? ACHGK037
2. How is water used in farming? ACHGK038
3. How does Australian agriculture overcome water scarcity? ACHGK040
4. What is the economic value of water in cotton/rice farming ACHGK041
5. Where is agriculture significant to Indigenous Australians? ACHGK041

Suggested time: 24–28 lessons

Resources required

- Internet access
- Website: http://www.primezone.edu.au/school-resources/all-school-resources.html
- Access to Google Earth
- Tracing paper

How can environmental resources be classified?

Activity 1: What is a resource?

Resources abound in our life. Some resources occur naturally in our environment and others are made by people. Something becomes a resource when it is able to be used by people to help them fulfill a need.

Natural resources are things that occur in the environment and help us to live. We need water to survive, sunshine for growth and energy, soil for food, minerals for metals and fossil fuels for transport and energy.

Resources can be classified into renewable, non-renewable and continuous resources. Renewable resources are those resources that can be replaced in a short time. Non-renewable resources cannot be replaced in a short time. Continuous resources are those resources that are ongoing and always in supply.

Time

4–5 lessons

Geographical concepts

Place, space, environment, change, sustainability

Aim

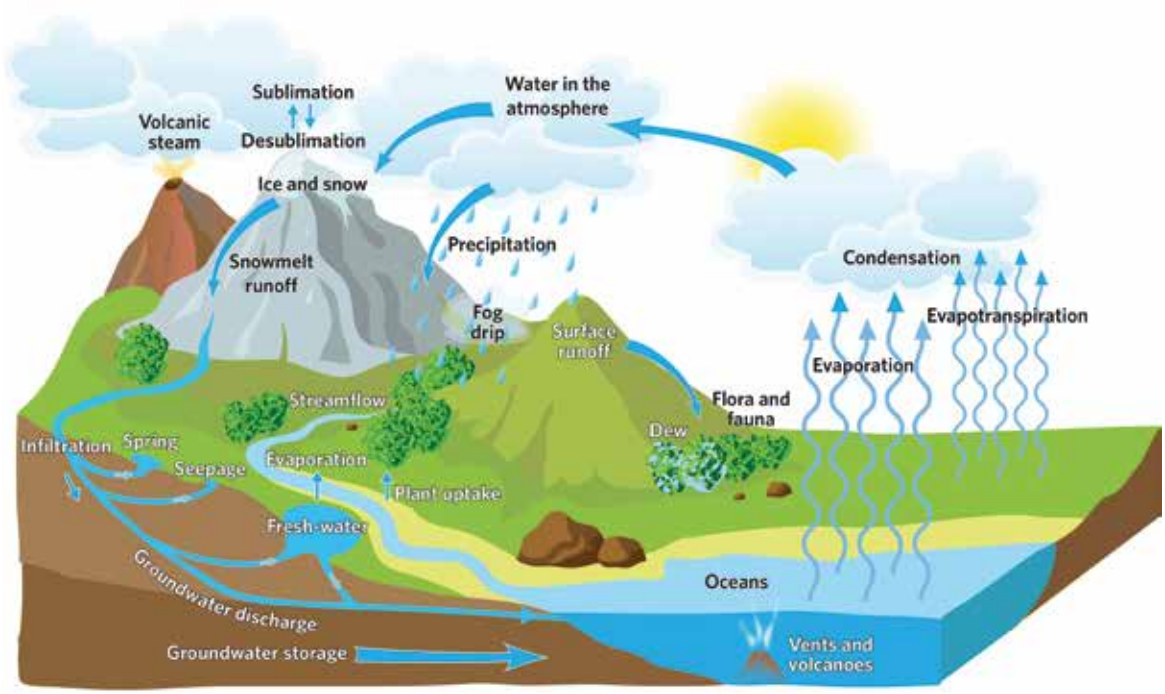
To consider and recognise resources that are used in daily life.

Worksheet 1: What is a resource?

This worksheet asks students to match a series of images with images of resources. It can be done by either printing the page and having students cut out the images below the table and glue them into the appropriate part in the table or by students using the "cut and paste" tools on the computer to put the images in the appropriate part of the table. To complete the activity, students have to state whether the resource is "renewable", "non-renewable" or "continuous", according to the definitions in the text.

Activity 2: Water as a resource

Water is a vital resource; it is a continuous resource. Water circulates through the water cycle. The following diagram shows this continuous movement of water.



Source: Cosmos: Water our most precious resource p3; plus additional labels

Farmers are very reliant on the rain arriving on their farms each year. Farmers are often concerned about water, especially when the "normal" pattern of rain does not occur. Too little rain means grasses don't grow, animals are poorly nourished, crop yields are reduced and the viability of the farm can be at risk if farm income is affected. In the worst cases, drought lasts for years. On the other hand, too much water can flood environments, drown crops and animals and, again, impact the farm viability. Farmers can be the most resourceful people, coping with change and the environment.

Use this video to introduce the class to the various types of farming in Australia and some of the issues that farmers face: http://www.youtube.com/watch?v=OSLNi8in2iU (5:23 minutes)

Worksheet 2: Resources on a farm

Computer access is required to complete this worksheet. Students use the site http://virtualfarm.mla.com.au to explore information about farms in Gippsland, Victoria, Yeoval in New South Wales and in the Kimberley, Western Australia. It is an extensive site but students are advised about which sections to focus their attention. Also included is a plan for a dairy farm and students are asked to add details relating to water resources. Finally, by utilising additional sections of http://virtualfarm.mla.com.au, students complete a concept map of the inputs and outputs that make a farm work.

You may like to start the concept map as a whole class activity to make sure all students understand what is required. Students could complete this in small groups. Compare different concept maps when they are complete.

Activity 3: Underground water

It is not always possible to see all the resources available to us. Minerals are generally found underground. Deep oceans are home to fish stocks and oil. Our atmosphere provides the oxygen we need to breathe and absorbs the carbon dioxide that we produce. Wetlands are often thought of as wastelands, yet are so vital to the variety of flora and fauna in our environment. Hidden water reaches the surface from underground at a few places or is pumped to the surface.

The main way to bring groundwater to the surface is to sink a bore. A drilling device is brought to the site and takes out cores of soil until the aquifer is reached. When water is discovered, a windmill is built at the site to provide the energy to bring the water to the surface. At the surface, water is either stored in dams or drinking troughs for animals to use. Technology has also developed windmills that are driven by solar power.

Current research is exploring the use of helicopters to take water samples in remote areas to learn more about the groundwater supplies.

Worksheet 3: Where are the hidden water resources?

Worksheet 3 looks at the extraction of groundwater in Australia and the growing knowledge that we have about it that is changing the ways it is used. This worksheet requires students to read and interpret diagrams and text from articles.

Stop the class after "What is groundwater" and discuss the answers. Students can then continue with the subsequent activities at their own pace.

Extension activity:
What resources help make a gourmet breakfast?

This extension activity explores student understanding of resources by having students plan a gourmet breakfast and concept mapping the resources that helped produce the contents of the breakfast – *Worksheet 4: From paddock to plate*.

How is water used in farming?

Activity 1: Looking at farming from above

Technology plays an important role in modern farming. Farmers use a variety of technologies to communicate, to learn, to plan, to manage and to organise farming activities. Google Earth allows us to look at different landscapes and different types of farming across Australia and the world, and to see if available water resources play a role in the type of farming taking place. Farms can be described as extensive (having large areas of land) or intensive (having small areas of land, usually in high rainfall, coastal areas or using irrigation) – each type is influenced by water as well as soils.

Time

6–7 lessons

Geographical concepts

Place, space, environment, scale, change, sustainability

Aim

To look at the way water is used in different farming practices at a variety of scales.

Worksheet 5: A view of farming from above

Google Earth is used for this activity. If students are not familiar with Google Earth it may be necessary to give a few brief instructions on moving around the screen. By using Google Earth students are able to get "a birds-eye view" of farming regions. Students will be able to see different landscapes and waterways and gain a sense of farm sizes for a variety of farm types.

Worksheet 5: Answer sheet

Red print indicates the spaces that students had to complete by using Google Earth.

Latitude and longitude	Place	Landscape description of the general area, including elevation	Farming activity	Scale of farming – small scale/ large scale – use measurements	Water for farming is provided by a source
15°46'26.98"S 128°44'21.20"E	Kununurra, WA	Flat area along a river with some dry hills nearby at 50 metres above sea level	Cotton	35 kilometres along the River Ord – small scale	Lake Argyle and the Ord River for irrigation
34°32'08.96"S 146°24'25.32"E	Leeton, NSW	The land is predominantly flat at 136 metres above sea level	Rice	Large scale	Irrigation from the Murrumbidgee River
34°41'32.69"S 135°58'38.54"E	Port Lincoln, SA	–3 metres (in the ocean)	Fishing	Small scale	Ocean
37°04'29.15"S 149°48'41.88"E	West of Eden, NSW	Hilly, forested area 216 metres above sea level	Forestry	Large scale	Rainfall
37°37'33.76"S 143°23'28.52"E	North of Skipton, Vic	Flat land 386 metres above sea level; trees as windbreaks obvious	Sheep	Large scale	Rainfall and some dams
18°56'53.63"S 135°11'36.30"E	Brunette Downs Station, NT	Flat area with red soils and clumps of trees; 225 metres above sea level	Cattle	Large scale, remote, has its own airstrip	A few small dams near homestead; groundwater for animals

Activity 2: A study of water use in livestock farming

Some livestock farms are located in remote areas where the farms are extensive (large areas of land), sometimes over one million hectares, and where the income per hectare and the input of labour are both low. Other livestock farms are intensive with small acreage, higher incomes per hectare and a higher input of labour per hectare. Seven case studies of livestock farms across Australia are provided for students to explore.

Worksheet 6: How can livestock be farmed sustainably?

Internet access is required to complete Worksheet 6 as a group activity.
Divide the class into groups. Each group is to read or listen to a farmer's story http://www.target100.com.au/Farmer-stories/ (select from the many stories on this site) and gather information on the following:

- farm name
- farm activity
- extensive or intensive farming
- use of water
- specific farming practices
- farming philosophy
- pests
- product sales.

When the groups have gathered their information, they are to prepare an interview about the farm studied. One member of the group should be the interviewee and other members of the group can take on the role of workers, grandparents, children or hired help living on the farm. Students can then either record their presentations or perform for the class. Stress the importance of presenting the geographical information on livestock, their raising, including the elements involved, and markets.

Activity 3: Farmers looking to the future

Worksheet 6 shows how farmers need to continually monitor their farm's input and outputs and, at times, redirect the farming activities taking place. Often this is market driven. At other times it is about the best use of the available land and water resources. Improved farming techniques and a better understanding of the land have resulted in changes taking place in established farming industries. Changing how water is used can result in better products and improve the farm environment.

a. Using water wisely

The first European settlers established the cotton industry in Australia as well as bringing livestock and grains to grow. Since then the success of cotton industry has fluctuated with the markets, with the availability of water and with the ability to control pests. Today cotton farmers are more knowledgeable than ever about the requirements of land and water for their product to grow.
View: http://www.youtube.com/watch?v=QRwCRGopwHE (1:56 minutes)

Worksheet 7: Using water sustainably in the cotton industry

Internet access is required for this worksheet. The history of the cotton industry is provided on a timeline for Worksheet 7 and students are asked to graph the significant moments. If necessary, revise how to draw a line graph with students. A diamond-ranking exercise challenges students to understand the importance of water to the cotton industry.

b. Diversifying crops

Read this article http://www.theage.com.au/victoria/corn-the-new-golden-crop-on-boort-farms-20130213-2edk2.html showing changing farming practices on a farm at Boort, Victoria. Here the farmer is moving from another grain crop to the highly productive, yet expensive to establish, cropping of corn. Either provide Internet access for the class or print off the article, and have students use this information to create a flow diagram to show the progression from a corn seed arriving on a farm in Boort to a lollipop being produced in Japan.

Extension activity: Predicting the future of farming

Begin this Extension Activity by showing students "The work of farmers", http://www.youtube.com/watch?v=_pb2fCoPmjw (3:52 minutes). This clip provides a range of challenging thoughts on the future of farming.

Then go to the following LandLearn sites that provide ready access to the brainstorming approach of a futures wheel based on a drier climate. Half of the class could complete this scenario, while the other half of the class could consider the impacts of a wetter climate.

http://www.landlearn.net.au/newsletter/2007term4/page3.htm

http://www.landlearn.net.au/newsletter/2007term4/page4.htm

How is water scarcity overcome in Australian agriculture?

Time

6–7 lessons

Geographical concepts

Place, interconnection, environment, scale, change, sustainability

Aim

To look at the reliability levels of Australian rainfall and the need to support agriculture with best practice management of available water resources.

My Country

Verse 2

I love a sunburnt country,
A land of sweeping plains,
Of ragged mountain ranges,
Of droughts and flooding rains.
I love her far horizons,
I love her jewel-sea,
Her beauty and her terror -
The wide brown land for me!

Verse 4

Core of my heart, my country!
Her pitiless blue sky,
When sick at heart, around us,
We see the cattle die -
But then the grey clouds gather,
And we can bless again
The drumming of an army,
The steady, soaking rain.

Dorothea Mackellar

http://www.dorotheamackellar.com.au/archive/mycountry.htm

Rain in Australia is always a major topic of conversation. Will it rain today? Will it rain all day or just for a short time? How much rainfall will be recorded? How many days will there be without rain? What will the season bring in the way of rain?

Activity 1: Rainfall and land use

The Bureau of Meteorology (www.bom.gov.au) records data at numerous places across Australia. Average (mean) annual rainfall is one way of considering the rainfall of a place. However, an average figure indicates that some years will have more rainfall and some years will have less rainfall and some years will have the average rainfall. These figures indicate the annual rainfall at one place and across Australia is very variable. In Australia, these total rainfall figures in a given area can vary from year to year. The annual rainfall variability can be mapped. These are vital statistics for a farmer, but further knowledge can be gained when the interconnection between temperatures and rainfall are calculated in the average annual evaporation rate for a place. These figures or maps tell farmers about the effectiveness of the rainfall for their farming activities.

Worksheet 8: Rainfall and land use in Australia

Worksheet 8 asks students to construct overlay maps from maps provided on the sheet so that the students come to understand the variability and effectiveness of rainfall. Students are also required to construct a climatic graph to understand the "wet" season.

Worksheet 8: Rainfall and land use in Australia – Cloze answer sheet

In the following passage, the correct words are in bold.

Australia's rainfall distribution is very <**varied**>. Farming along the east coast of Australia experiences relatively <high> levels of average annual rainfall. Most of the farming in this region is <g**razing on modified pastures**>. West of the Great Dividing Range, the average annual rainfall <**decreases**> to <**below 500 millimetres**> and the land use changes to <**dryland cropping**>. In the areas of central Australia, where the annual rainfall is at it <**lowest**>, the land use is either <**minimal**> or <**grazing on native vegetation**>. Grazing on native vegetation takes up the <**largest**> proportion of Australia's land mass. Although there is <**over 1200 millimetres**> average annual rainfall across northern Australia, the fact that it comes in one season, "the wet" does not encourage <**intensive**> agriculture. The south-west corner of Australia is an exception as it has a <**higher**> average annual rainfall with <**1200 millimetres**> and the farming zones are more varied. Tasmania, with its high average annual rainfall on the <**west**> coast, utilises this in the forests as an area of <**nature conservation**>. Across many parts of Australia, irrigation plays an important role in sustaining agriculture.

Activity 2: Farming with rainfall variability

Farmers are known for their adaptability. Initially farmers simply had larger farms in areas with greater variability and less effective rainfall, such as on the outback stations of central Australia. Across Australia, farmers have learnt to overcome the scarcity of water by retaining water on properties as dam water, by encouraging governments to construct large water storages for downstream use in irrigation, and by tapping into the groundwater. Farming knowledge has now moved to ways in which water consumption can be reduced. Researchers have developed new breeds of crops, animals and grasses that require less water, yet provide high yields.

Worksheet 9: Waterproofing Australia for agriculture

Five techniques to waterproof farms in Australia are considered in Worksheet 9. Students explore research that has proved to be beneficial to farmers in coping with rainfall variability.

Extension activity: A rap to rain

In 1907, Dorothea Mackellar wrote My Country which refers to the rainfall and its impact on farming life in Australia. Even in the 21st century, one of the key issues for farmers continues to be the unpredictable nature of rainfall and how to overcome its variability. Encourage students individually or in groups to become a song writer/s and create a rap to rain. When it is complete, students should perform their rap and upload it to a class Blog or Wiki to share with others.

How is water used in rice farming?

Time

6 lessons

Geographical concepts

Place, environment, scale, interconnection, change, sustainability

Aim

To look at the importance of water in rice growing in two places and the costs/benefits that can make or break rice farming.

Two places that illustrate the economic value of water are the Murrumbidgee Irrigation Area, near Leeton, New South Wales and the Mekong Delta in Vietnam. Both of these regions value water and the rice yields that are produced from the land. In the Murrumbidgee Irrigation Area , Sodosol soils and water allocations regulate the growing of rice for export (85 per cent is exported). In the Mekong Delta the mighty flows of the Mekong River from its source in Tibet, through China, Cambodia and Laos and into Vietnam, have enriched the soils and provided food for the people; they in turn acknowledge the water in their cultural rituals.

Activity 1: Rice farming and the economic value of water

The two case studies in Worksheet 10 show very different approaches to water use and management. The Murrumbidgee Irrigation Area uses technology and knowledge to produce the greatest yield per hectare and the greatest yield per Megalitre of water used in the world. In Vietnam, tradition and long-standing practices feed the people and allow Vietnam to be the second largest producer of export rice, after Australia.

Worksheet 10: What is the value of water in rice farming?

When students have completed Worksheet 10 hold a class discussion about the similarities and differences of growing rice in Australia and Vietnam.

Activity 2: Putting a price on water

For some agricultural practices it is possible to calculate the economic costs of sustainable water usage. For other agricultural practices, the volume of water used comes as an economic cost and often an environmental cost.

Worksheet 11: Putting a price on water

Internet access is required for this activity. Worksheet 11 shows how one farmer juggled his farming practices to cope with a lengthy drought and a reduced water allocation. It also shows the different proportions of irrigated water used by various agricultural practices by asking students to construct a pie graph. Finally, it shows how a farmer "balances his books" and decides whether to introduce technology with the aim of learning more about his livestock, their use of water and how he can make his property more sustainable.

Extension activity

Organise a class debate on the topic "Water is more important to the Vietnamese farmers of the Mekong Delta than it is to the Australian rice growers". View "The Mighty Mekong River" http://www.youtube.com/watch?v=3Yu8nst95ug (8:57 minutes) as support material. Encourage student discussion of not only economic aspects, but historic, cultural, environmental and political aspects.

Where is agriculture significant to Indigenous Australians?

Indigenous Australians have always been involved in agriculture (see Year 5 unit). Traditional stories show the spiritual connection to the land and water. Read to the students the stories of the Rainbow Serpent or those to do with water and/or fish at http://australianstamp.com/coin-web/feature/history/abdream.htm Today, many Indigenous Australians are training to take on the management of outback cattle stations on their traditional lands. Others are developing their skills in the fishing industry. Indigenous Australians have a long cultural history and respect for the water – both freshwater and oceans.

Time

2–3 lessons

Geographical concepts

Place, space, environment, scale, interconnection, change, sustainability

Aim

To look at the understanding of water and its importance to Indigenous Australians in the past and into the future.

Activity 1: Indigenous fish farming

In five locations around the coast of Australia, complex negotiations have taken place between traditional owners about the spaces that are now considered for fish-farming activities. These are generally aquaculture projects where research has gone hand-in-hand with Indigenous knowledge and brought an increased level of training and understanding of farming practices to the communities in these areas. Worksheet 12, presented as a game, considers five case studies from around Australia to show the way in which water has been utilised to increase employment and finances for communities.

Worksheet 12: Let's go fishing

This card game can be built by the students or the teacher can make the packs of cards to distribute to the students. Each group should be five students in size since there are five case studies. Students are to share each case study in their group and then complete a series of questions which focus on the key geographical concepts – place, space, environment, interconnection, scale, change and sustainability. Included here is a summary table for teachers to see how the ideas on the cards fit together.

Once the students have completed the game, gather the groups as a class and ask students to read each of the case studies.

Use atlases to locate each of the places mentioned in each case study. Students could label these places on a blank map of Australia.

Worksheet 12: Let's go fishing – cards in a summary table

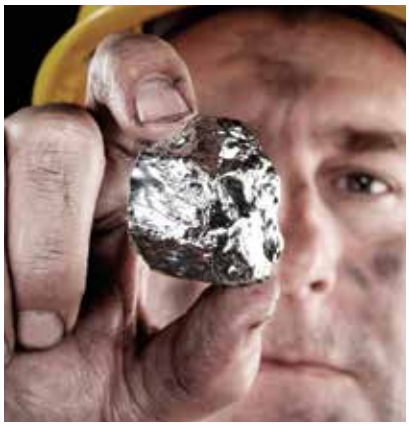
Case Study	Fishery type	Water type	Season/Market	Expected Value	Community role	Issues
Kulaluk, near Darwin, Northern Territory	Mud crab aquaculture (3 hectares).	Freshwater – dams had been established for a previous prawn farm.	Mud crabs to be harvested at 350 grams; Australian domestic market, especially Darwin.	$200 000–300 000.	Education and training; employment; building community capacity.	Reliant on rain.
Port Lincoln, South Australia	Blue mussel aquaculture.	Seawater area in Boston Bay – leased from the government.	All year requiring ocean currents and wave action to provide nutrients; Australian domestic market. This species has high growth rate and low mortality rates.	70 000 tonnes worth $210 000.	Mussel shells are found in the ancient Indigenous middens. Local industry knowledge and existing Indigenous expertise. Fully Indigenous owned.	Too much rain changes nutrient balance and reduces salinity of ocean; waters must be pristine so not near any urban developments; risk of algal blooms.
One Arm Point, north of Broome, Western Australia	Trochus hatchery.	Seawater for breeding in tanks.	Meat (1750 kilograms) is eaten locally; 70 000 shells used in jewellery and exported.	Exported shells go to Italy for buttons.	Bardi Jaawi people are the only community allowed to collect the shell. Other local ventures include an industry cleaning shells, tourism, aquarium products.	Remote site.
Coolgaree Bay, Palm Island, Queensland	Sea sponge farm.	Seawater within the borders of the Great Barrier Reef Marine Park.	All year – pieces are cut from a sponge and then recut to smaller pieces and each piece becomes another sponge. Used in the cosmetic industry.	500 000 sponges per year worth $4.3 million a year – at least half will be exported.	Fully staffed and owned by the people of Palm Island.	A suitable product for a remote location, requiring no refrigeration and so reducing transport costs.
Pandanus Park, West Kimberley, Western Australia	Freshwater prawns (Cherabin) and barramundi.	Freshwater for pond farming.	All year round and sold mostly to locals or frozen for Broome and Derby.	$223 000 per year.	Cherabin are a traditional food for Indigenous people of the area. Community very interested in other benefits to be gained.	Reliant on wet season to provide sufficient water.

Worksheets

Worksheet 1: What is a resource?

Natural resources are things that occur in the environment and help us to live. We need water to survive, sunshine for growth and energy, soil for food, minerals for metals and fossil fuels for transport and energy. Resources can be classified.

Column 1 shows a range of resources. To complete Column 2, either cut out the pictures and paste them in the appropriate place or drag / cut and paste on your computer file into the relevant box. In Column 3, state if the resource is renewable, non-renewable or continuous.

Natural Resources	People's needs	Is the resource: Renewable (R) Non-Renewable (NR) Continuous (C)?
		
		
		

Cut the following photos and paste them into the appropriate box in the table.









Worksheet 2: Resources on a farm

Aim: Farmers are very reliant upon the rain arriving on their farms each year. Farmers are often concerned about water, especially when the "normal" pattern of rain does not occur. Rain, though, is only one of the resources or inputs required by a farmer for successful production. Keep this in mind as you work through this worksheet and use your ideas when producing a concept map of the inputs and outputs of a farm.

1. Go to http://virtualfarm.mla.com.au and complete the following about the importance of water as a resource on each farm.

Malabar farm, Gippsland, Victoria

Look at the "About Malabar" video and fact sheet.

a. Describe the rainfall at this location in Gippsland and the benefits the farmer gains from the rain.

b. Soils are of low quality as the Malabar farm is close to the sea. Why is it important that the farmer keeps up a nutrient supply to the soil?

c. What is the farmer producing on this farm for a market that is changing over time?

Iona farm, Yeoval, New South Wales

Look at the "About Iona" and "Climate" video and fact sheet.

a. Describe the activities that take place on this farm.

b. The farmer describes the weather as a challenge. How is it a challenge from year to year?

c. How has the rain pattern changed over time?

d. How do changing rainfall amounts affect the production and income of the farm?

Kalyeeda Station, the Kimberley, Western Australia

Look at the "About Kalyeeda" and "Climate variability" video and fact sheet.

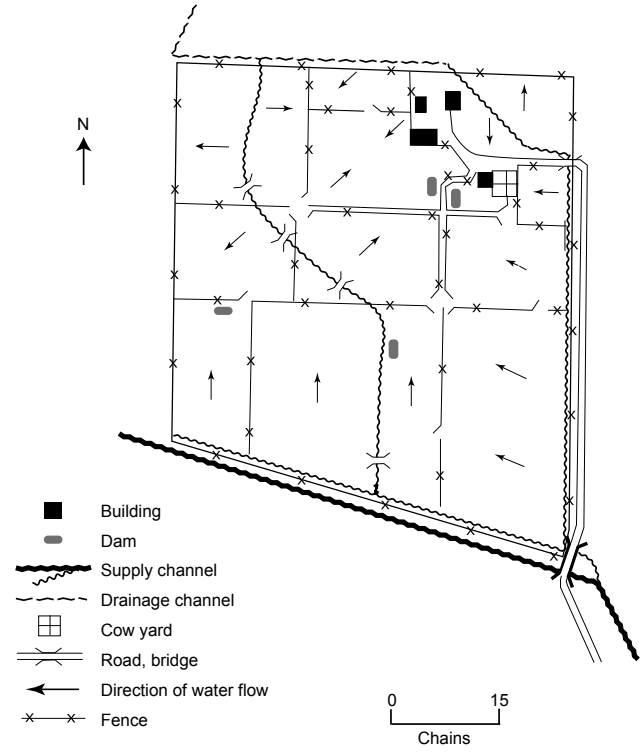
a. The farmer says it is "a harsh environment". What does he mean by this?

b. In this region there are only two seasons – "the wet" and "the dry". Describe the differences between the wet season and the dry season.

c. Every year is different. What impacts can a poor wet season have on farming?

2. Study the following layout of a typical irrigated dairy farm.

Figure 1: A plan of an irrigated dairy farm



Note: This is an old map! One chain = ~20 metres. Source: A Regional Geography of Victoria, K.J. Collins and D.D. Harris, published by Whitcombe and Tombs, Melbourne, 1967, p.52.

Use the legend below to show your understanding of the water cycle on the irrigation farm.

Legend

a. Use a pale blue colour to show areas of the farm that are irrigated.

b. Add a windmill to the plan to indicate use of groundwater.

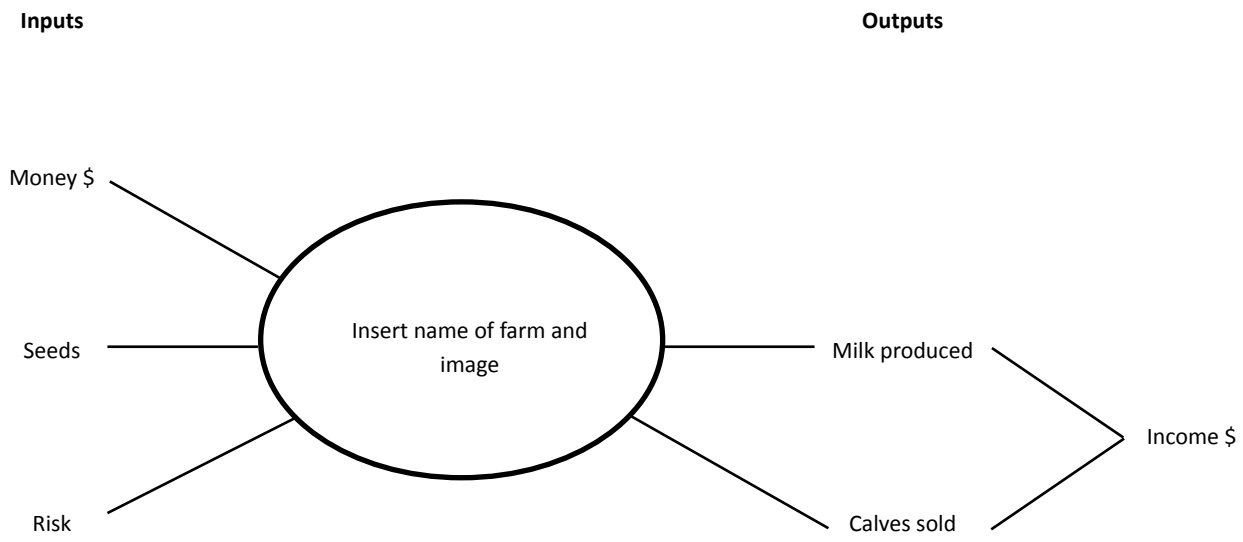
c. Use a dark blue colour to show blue water on the farm.

d. Use black arrows to show the potential resource of water above the farm in the atmosphere.

e. Create a symbol to show reuse of water as manure sludge is sprayed on the land from a tractor with a tank on a trailer.

f. Use hatched lines to indicate which paddock on the farm the farmer has set aside for the growth of grass for silage, a green feed used in winter, and the full utilisation of the soil moisture.

3. Choose one of the farms on http://virtualfarm.mla.com.au and undertake further research from the other Fact Files available to complete an input (resources that go into making a farm operate) and output (resources that leave the farm) diagram for the farm. Use the template below for your answer. Some examples have been completed for you.

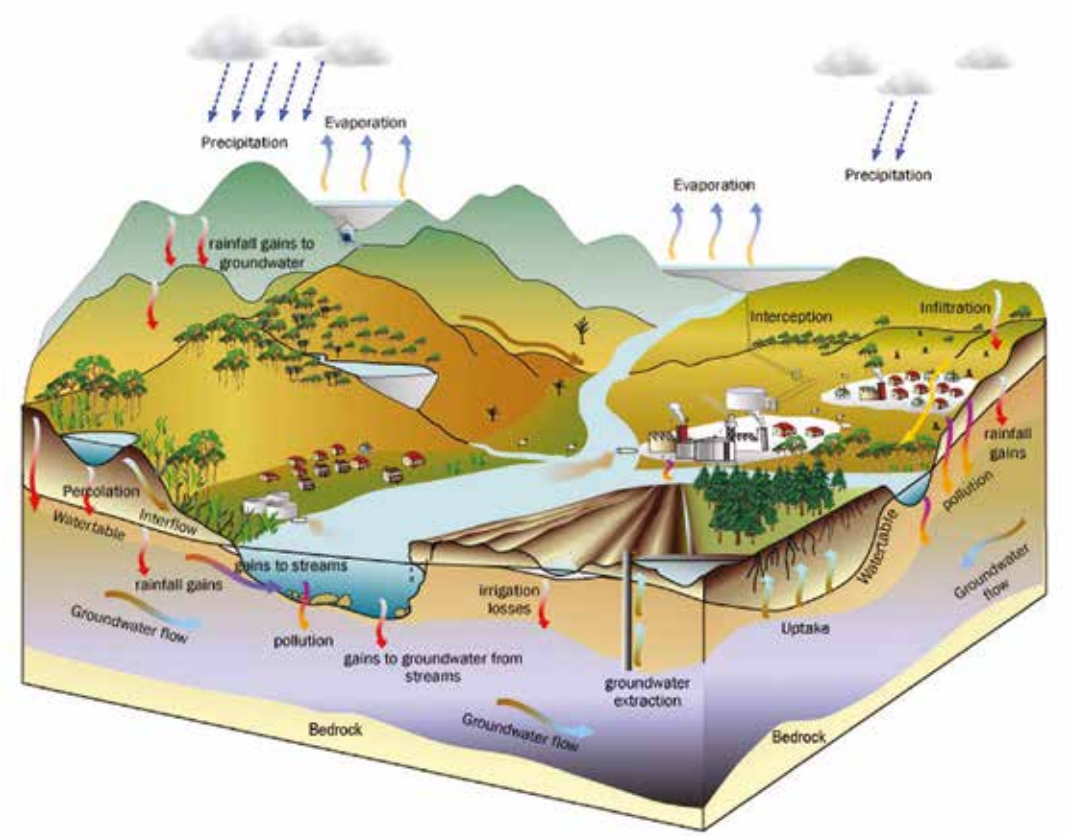


Worksheet 3: Where are the hidden water resources?

Aim: to learn about groundwater and its importance in agriculture.

Can you believe that beneath your feet there are hidden pools of water? When it rains, the water not only flows across the surface of the land, as we see in the flooded street gutters, the spreading water on roadsides and more rapidly flowing rivers, but the water also seeps into the soil. Not all of this water is used by plants, as it goes deeper and deeper underground. Levels of solid rock act as barriers to further downward movement and the water begins to flow like an underground stream. This water resource is very important to farmers across Australia.

What is groundwater?



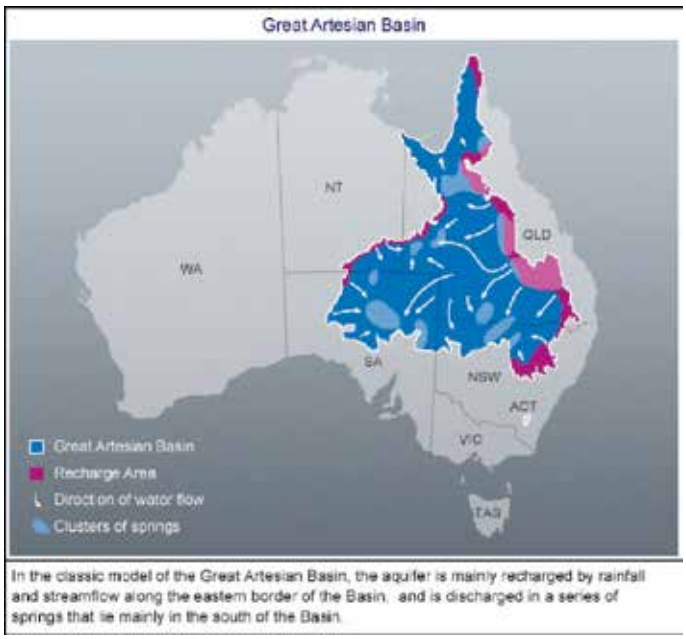
Source: http://soer.justice.tas.gov.au/2009/image/299/ilw/id299-o-groundwaterillustratio-l.jpg

a. Match the terms in the diagram of groundwater to the following definitions:

..... a level under the land surface which is fully saturated below	(water table)
..... water seeps into the soil from irrigation	(irrigation losses)
..... a level under the land surface where water flows like in a stream	(groundwater flow)
..... plants with deep root systems use the water in the water table	(uptake)
..... groundwater is pumped to the surface	(groundwater extraction)
..... water passes through the soil under a dam	(percolation)
..... other materials pass with the water through the soil and into the groundwater	(pollution)
..... solid rock layer where water can flow along	(bedrock)
..... precipitation plays an important role in this process.	(rainfall gains)

b. Write your own definition of groundwater.

Australia's groundwater



In the classic model of the Great Artesian Basin, the aquifer is mainly recharged by rainfall and streamflow along the eastern border of the Basin, and is discharged in a series of springs that lie mainly in the south of the Basin.

Source: http://www.abc.net.au/science/articles/2012/04/04/3470245.htm

Credit: ABC Science

a. What is meant by a "recharge area"?

b. What is the dominant flow direction of the groundwater? Why?

c. A spring brings groundwater to the surface naturally. Where does the water go from there?

d. Why is groundwater important to the farming activities taking place in the region?

"Banking" water

Read this article which shows the research that has been undertaken about recharging the aquifers: http://beefcentral.com/p/news/article/2468

a. What is meant by "banking" water in the aquifer?

b. Why is there space in the aquifers to store water when rains are plentiful?

c. What does Mr Ross mean by "We need to start thinking of surface water and groundwater as a single resource – and managing them together, in an integrated way over time."

d. Mr Ross suggests that water banking can be done at a local scale and at a national scale. How is it possible that water banking can provide benefits across large areas of Australia?

e. What is seen as a very good reason for putting water underground?

f. "Waterproofing" of cities could also be achieved. Give an example of what could happen in Australia.

g. List the types of water that can be "banked".

h. Why are new management policies required?

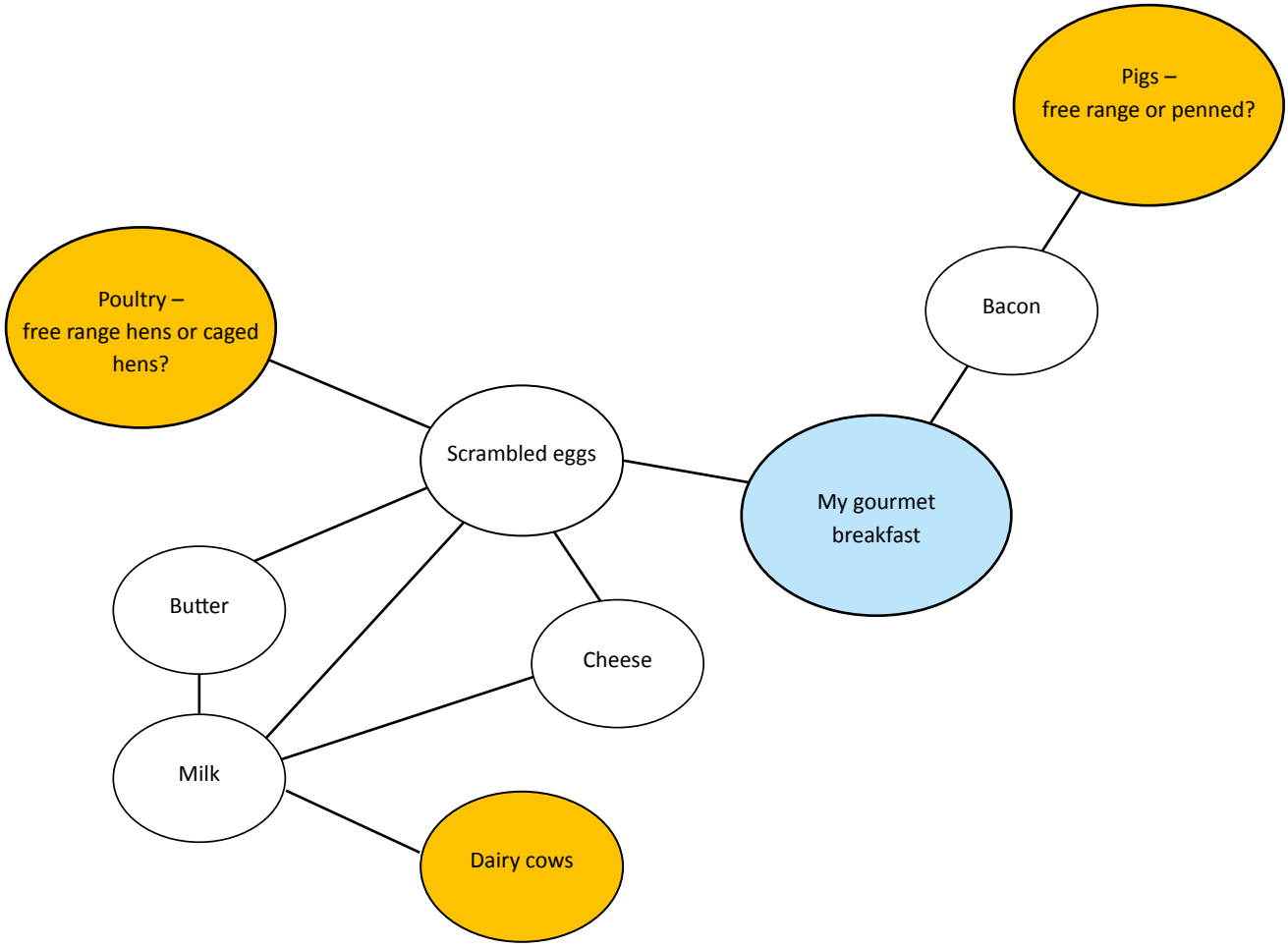
Worksheet 4: From paddock to plate

Aim: To investigate how the ingredients of a gourmet breakfast can be traced back to various resources.

Many farms products are processed before reaching our plate. But it is a good idea to think about the resources that provide us with the components of our meals.

a. Use the space below to create a concept diagram of the ingredients (resources) used to make a gourmet breakfast. Many of the products will have been processed, so you need to follow these products back to their resource base. Colour the resource in each instance (yellow is used here). An example has been started here.

   Alternatively, use a paper plate to draw your gourmet breakfast on. The plates for the class can then be used as a fantastic wall display.



b. Share your completed gourmet breakfast diagram with other members of the class and notice three similarities and three differences. Discuss as a class if everyone sees resources in the same way.

Worksheet 5: A view of farming from above

Google Earth can provide an aerial view of a range of farming areas. To complete this activity you will need to access the Internet and use Google Earth to find these farming places and zoom in/around each area to see the detail of the farming environment. Don't forget to use the Tools to assist with your answer, for example, the Ruler will give distances between places.

a. Complete the gaps in the following table:

Latitude and longitude	Place	Landscape description of the general area, including elevation	Farming activity	Scale of farming – small scale/ large scale – use measurements	Water for farming is provided by a source
	Kununurra, WA	Flat area along a river with some dry hills nearby at 50 metres above sea level	Cotton	35 kilometres along the River Ord – small scale	
34°32'08.96"S 146°24'25.32"E	Leeton, NSW		Rice		
34°41'32.69"S 135°58'38.54"E		-3 metres (in the ocean)	Fishing		
37°04'29.15"S 149°48'41.88"E			Forestry		
37°37'33.76"S 143°23'28.52"E			Sheep		
18°56'53.63"S 135°11'36.30"E			Cattle		

b. Look at the table you have completed.

(i) What types of land uses appear in outback Australia?

(ii) What types of land uses appear in the east of Australia?

(iii) Which farmers rely on the rain?

(iv) Which farmers seek another source other than the rain for their water supply? Why?

(v) How can you explain that some forms of farming are small scale and others are large scale?

(vi) Is farming land the same across Australia? Explain your answer.

Worksheet 6: How can livestock be farmed sustainably?

Aim: To use this website to investigate meat and livestock farming.

Target 100 is a program designed to deliver 100 new ideas on livestock farming practices that help to make the industry more sustainable. It has set a date of 2020 by which to have made significant changes to the way farmers operate.
http://www.target100.com.au/Farmer-stories/

Your teacher will divide the class into groups. Each group is to read or listen to a farmer's story as instructed by the teacher.

Step 1: Read or listen to the story given to your group.

Step 2: Gather information on the following:

- farm name
- farm activity
- extensive or intensive farming
- use of water
- specific farming practices
- farming philosophy
- pests
- product sales.

You might write the notes in separate paragraphs or you could construct a table to summarise your ideas.

Step 3: Use these ideas to prepare an interview about the farm studied. One member of the group should be the interviewee and other members of the group can take on the role of workers, grandparents, children or hired help living on the farm.

Step 4: Record the presentations or perform for the class. Make sure the group is presenting the geographical information on livestock, their raising, including the elements involved, and markets.

Step 5: Consider the different types of farms from the other groups. Are all farms the same? What are some of the similarities? The differences? How is water used and supplied in each farm?

Worksheet 7: Using water sustainably in the cotton industry

Aim: To investigate how water can be used sustainably in the cotton industry.

Cotton has been grown in Australia for many years. At times it has been hugely successful; at other times it has struggled to survive. Highly dependent upon water to maximise growth, cotton has to be regularly irrigated and a major source of water supply is required (for example, Lake Argyle on the Ord River in the Northern Territory). Experts have frequently looked at the cotton industry and noted the volume of water required. Today the industry uses modern technology and other initiatives to be a successful farming practice.

1. a. Go to this site: http://cottonaustralia.com.au/cotton-library/fact-sheets/cotton-fact-file-australian-cotton-history1 It provides a timeline of Australia's cotton industry. From the data provided construct a line graph to show the changing levels of production over time. Put the dates on the horizontal (x) axis and the number of cotton bales on the vertical (y) axis. Join up the points with a smooth, hand-drawn curve.

   b. Onto this line graph, identify and label any reasons that are given for any peaks and troughs on the graph.

   c. The cotton industry has battled to have sufficient water for its crops. What developments, since the 1950s, in water supply conditions have allowed the industry to flourish?

   d. Cotton farmers have taken on greater initiatives to "waterproof" their industry. Visit http://cottonaustralia.com.au/cotton-library/fact-sheets/cotton-fact-file-practical-approaches-to-water-use

2. Read through this list of initiatives that cotton farmers have undertaken. You may have to do some research or ask the teacher to clarify some of these ideas.

3. Rank in order from 1 (being the most important) to 9 using the Diamond Ranking below, the initiatives that you believe would have made the most impact on waterproofing the industry.

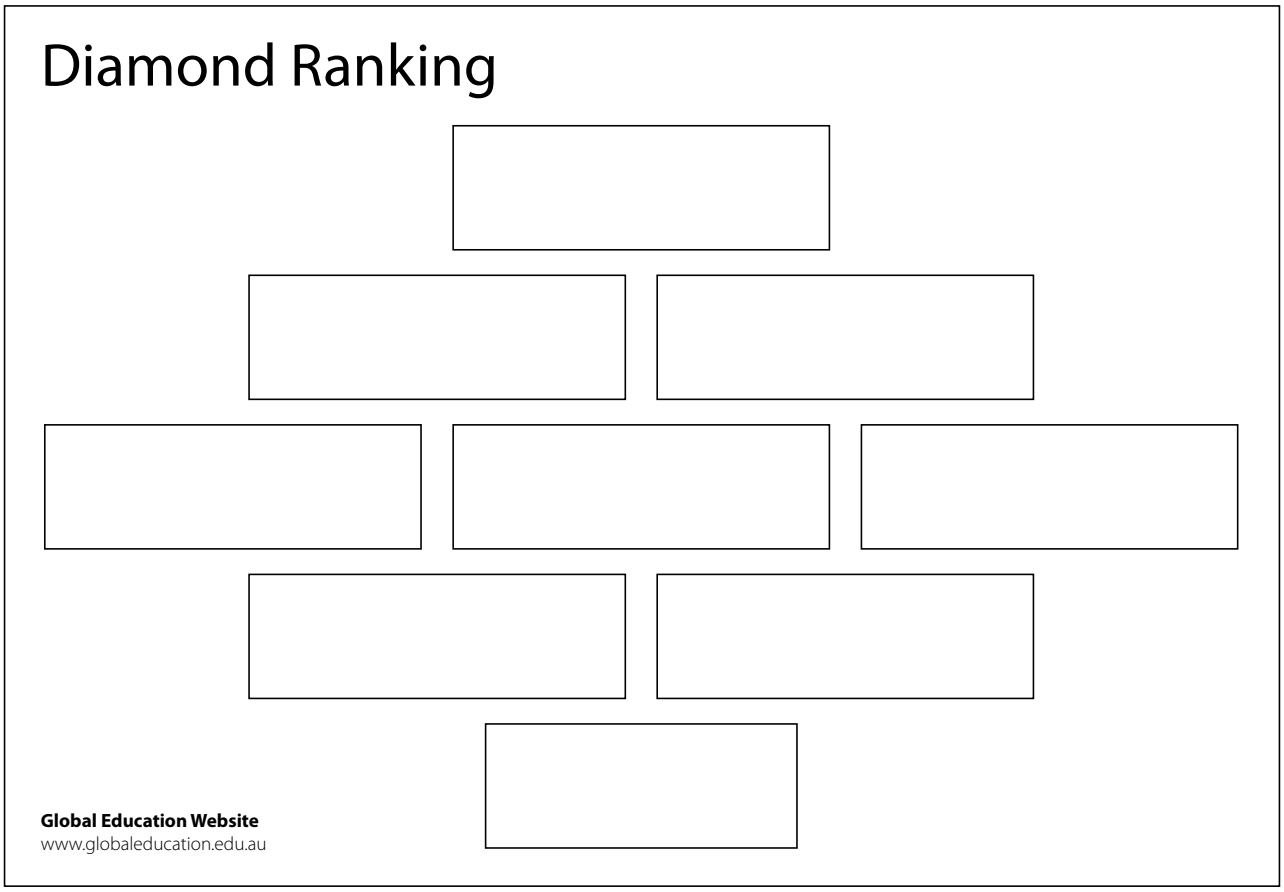
4. Be prepared to debate your list with a classmate and together come up with a further combined 1–9 Diamond Ranking.

5. Join with another pair and make a decision between the four of you as to what this 1–9 listing looks like and present this diamond ranking to the class. A wall display is a good way for everyone to be able to see each other's work.

6. Does your ranking match that of another group? Why or why not?

Diamond Ranking Template

Source: http://www.globaleducation.edu.au/verve/_resources/diamond_ranking-1.pdf



Worksheet 8: Rainfall and land use in Australia

Aim: To create an overlay map showing land use and rainfall in Australia.

Rain in Australia is always a major topic of conversation. Will it rain today? Will it rain all day or just for a short time? How much rainfall will be recorded? How many days will there be without rain? What will the season bring in the way of rain? What does this all mean for the farmer? A farmer's knowledge of climate must consider average annual rainfall statistics and consider the effectiveness of any rain according to rainfall variability and evaporation rates. In some parts of Australia there are only two seasons – "the wet" and "the dry" – and the farmer must cope with long periods of no rainfall.

1. a. Use the maps in figures 1 and 2 to create an overlay map of land uses and average annual rainfall in Australia.

An overlay map is where two or more maps of the same area can be viewed at the same time so that comparisons and interconnections can be identified.

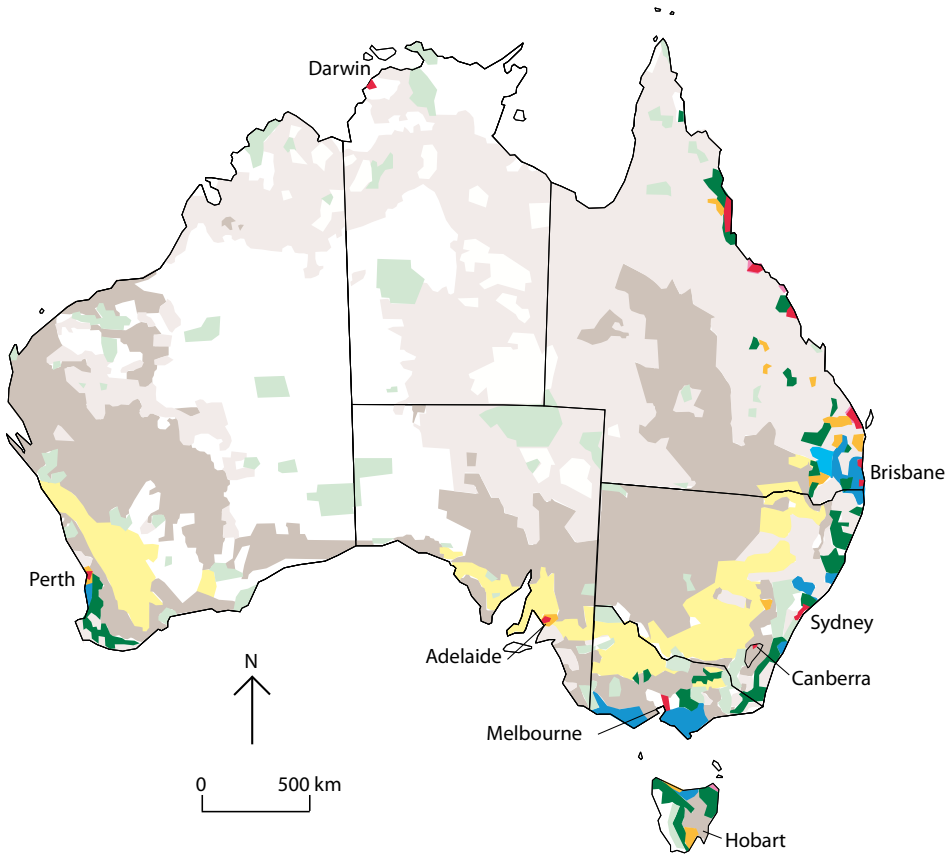
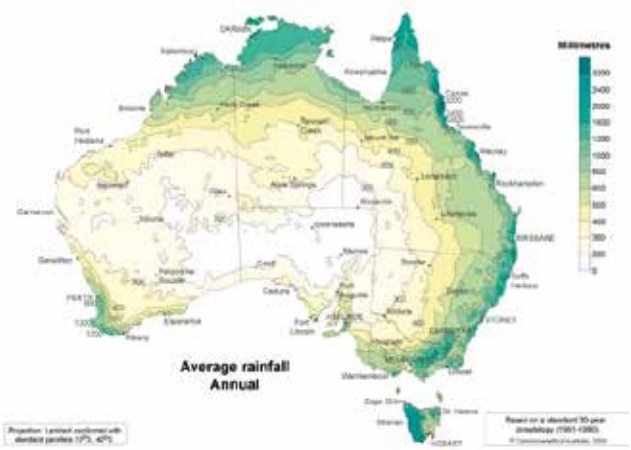


Figure 1: Australian land use



Source: Bureau of Meteorology:
http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp

Step 1: Begin by using tracing paper to make a copy of the average annual rainfall map of Australia. Make sure that any colours you use are light so that you can see through the tracing.

Step 2: Print a copy of the land use map of Australia. This will save you from having to do a second tracing.

Step 3: Using sticky tape, tape together the tracing and the map along one edge only of the tracing paper. Make sure that the maps are aligned perfectly before you tape.

Step 4: Look through the tracing paper and look at the relationship between average annual rainfall in Australia and the different farming activities.

Step 5: Complete this passage using this word list:

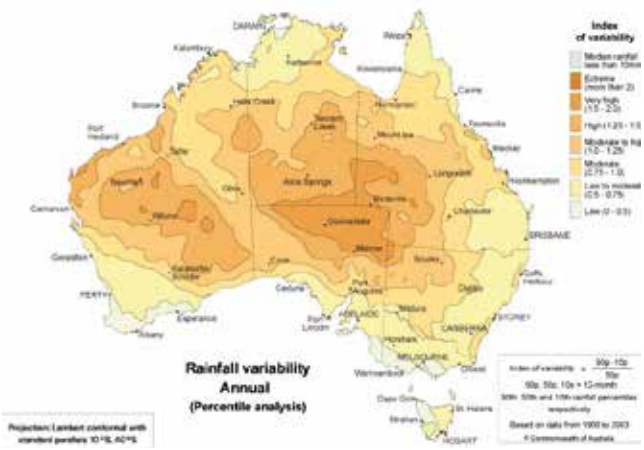
dryland cropping high varied 1200 millimetres decreases grazing on native pasture Below 500 millimetres higher west nature conservation lowest largest intensive over 1200 millimetres grazing on modified pastures minimal

Australia's rainfall distribution is very _____. Farming along the east coast of Australia experiences relatively _____ levels of average annual rainfall. Most of the farming in this region is _____. West of the Great Dividing Range, the average annual rainfall _____ to _____ and the land use changes to _____. In the areas of central Australia, where the annual rainfall is at its _____, the land use is either _____ or _____. Grazing on native vegetation takes up the _____ proportion of Australia's land mass. Although there is _____ average annual rainfall across northern Australia, the fact that it comes in one season, "the wet" does not encourage _____ agriculture. The south-west corner of Australia is an exception as it has a _____ average annual rainfall with _____ and the farming zones are more varied. Tasmania, with its high average annual rainfall on the _____ coast, utilises this in the forests as an area of _____. Across many parts of Australia, irrigation plays an important role in sustaining agriculture.

2. Rainfall effectiveness

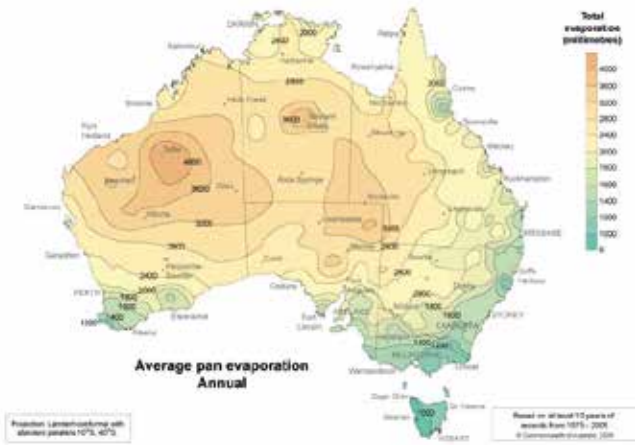
   Use these maps of Australia's average annual rainfall variability and the map of average annual evaporation, and create another overlay map. Use annual rainfall variability as the base map and trace the map of average annual evaporation to tape onto the base.

Figure 2: Annual rainfall variability



Source: Bureau of Meteorology:
http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall-variability/index.jsp

Figure 3: Average evaporation



Source: Bureau of Meteorology:
http://www.bom.gov.au/jsp/ncc/climate_averages/evaporation/index.jsp

a. Which area of Australia has the most variable rainfall?
b. Which area of Australia has the least variable rainfall?
c. Which area of Australia has the highest evaporation rate?
d. Which area of Australia has the lowest evaporation rate?
e. Which area of Australia would have the most effective climate for farming activities?
f. Which area of Australia would have the least effective climate for farming activities?
g. Think of four things that farmers could do to cope with the rainfall variability and the evaporation rates?

Worksheet 9: What is the impact of floods on agricultural land?

3. What does "the wet" mean?

Kununurra, Western Australia: 15° 47'S 128° 45'E

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature													
Mean maximum temperature	35.0	34.0	35.5	35.2	32.7	30.1	30.5	32.0	36.5	33.5	38.9	37.1	34.9
Mean minimum temperature	26.1	24.8	24.2	21.9	18.5	15.7	15.2	15.9	20.0	23.5	25.2	25.4	21.3
Rainfall													
Mean rainfall (mm)	103.6	210.6	154.7	30.4	7.0	3.6	1.6	0.1	3.0	23.6	60.8	135.9	840.2

Using this table of statistics for Kununurra, create a climatic graph of mean maximum temperatures and mean rainfall per month. Then answer the following questions:

a. In how many months of the year does Kununurra receive a mean monthly rainfall over 100 mm?

b. Which months of the year receive a mean rainfall of less than 10 mm?

c. Which months of the year could be seen as "bridging" months with mean rainfall between 10 mm and 70 mm?

d. How would you describe the mean maximum temperatures for Kununurra throughout the year?

e. When is the wet season and when is the dry season?

f. Are these climatic conditions different from your place?
Use www.bom.gov.au to get local detailed information.

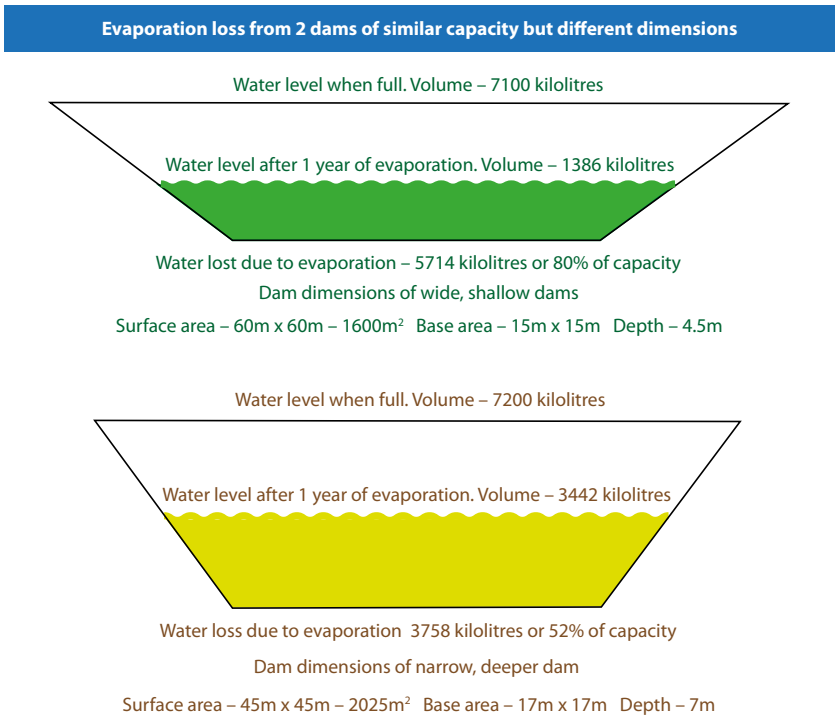
g. How do climatic statistics like these make farming difficult in the region? Think rainfall variability and evaporation.

With Australia's agriculture vulnerable to climate change, farmers have had to take steps to ensure water is available for grasses, crops and animals, as well as for people. Farmers have learnt a lot over time about how to manage their land to make the best use of available water.

Aim: To investigate different methods that farmers are using to ensure water availability on their farms.

1. Dam shape

Look at this figure of two shapes for building a dam. Explain why farmers should be constructing dams that are deeper rather than wider?



Source and permission: Ninti One

2. Plastic-lined irrigation channels and dams

Study this image of a water channel that has been lined with plastic. Create a sketch of this photo to show the channel and the purpose of the plastic lining.

Label the following:

water in the channel

plastic

evaporation

reduced green water

irrigated land

Credit: John Baker, Department of the Environment'

3. Laser grading

Irrigation land is levelled, or slightly shaped, by grading the surface according to laser beam readings across the paddock, as show in this diagram.

Source: *http://www.knowledgebank.irri.org/rkb/benefits-of-laser-leveling.html*

a. For each of the following statements decide whether it is a cost to the farmer or a benefit to have his land laser graded for irrigation. Before each dot point put a "C" for a cost and a "B" for a benefit.
   - levelling occurs every 8–10 years
   - 20–25 per cent of water used in irrigation is saved
   - tractor and laser beam equipment are expensive
   - nutrients are not washed away
   - precise slopes drain all excess water away
   - skilled operator of tractor/beam technology comes at a price
   - weeds are decreased by up to 40 percent
   - 10–15 per cent of the farmer's time freed up for other farming tasks
   - water is spread evenly
   - crop germination, growth and yield is even across the paddock
   - less seeds, fertiliser and fuel for irrigation pumps is used
   - unusually shaped paddocks cause difficulties
   - yields are higher and consistent.

b. Using the statements in (a), write a paragraph explaining the role of laser grading in irrigated agriculture.

4. New breeds of crops/grasses

In the past 10 years, Australian rice farmers have improved water use efficiency by 60 per cent – growing more rice with much less water. Australian growers use 50 per cent less water to grow one kilo of rice than the world average. Australian rice production can be "switched on or off" depending upon water availability.

Read this fact file about rice growing in Australia http://www.rga.org.au/f.ashx/overview.pdf Overview of the Australian rice industry.

a. What is meant by "switched on or off"?

b. List three ways in which rice farms in Australia are unique.

c. How does research benefit the rice industry?

5. Using telemetry

Go to http://www.abc.net.au/landline/content/2006/s2308100.htm and watch the video (on the right of the screen) rather than read the text about Remote Control. In your own words, describe how technology is changing farming on remote cattle stations in Australia, such as Napperby Station in the Northern Territory.

Examples of telemetry systems used to remotely monitor water points

Sources: Adrian James and Patrick Francis

Source and permission: Ninti One

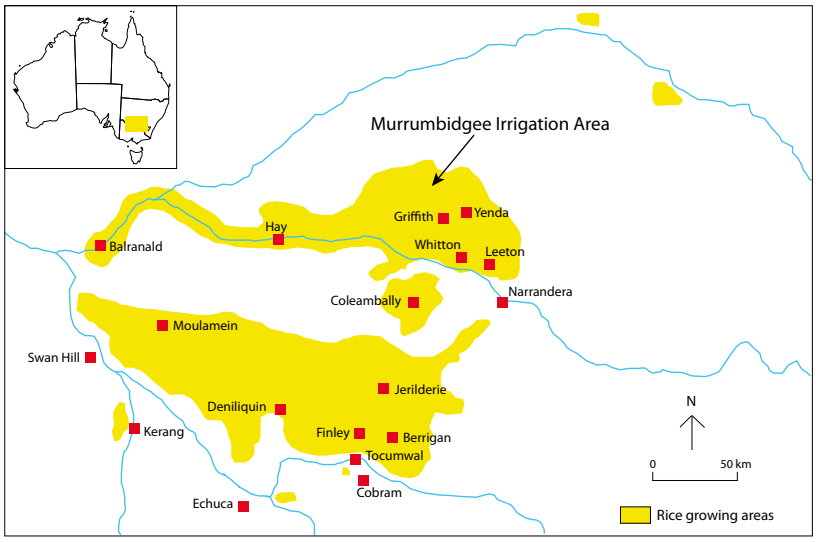
Worksheet 10: What is the value of water in rice farming?

Aim: To compare rice growing in Australia and Vietnam.

Rice growing has a long history as a staple food of the people of Asia. Australia has established a rice growing industry predominantly to export the crop and bring economic return to the country. In Vietnam, rice growing initially fed the people in each community. Today Vietnam also exports rice as well as feeding its people. Modern techniques and technology have increased the crop output from each farm.

1. Read the following case studies on the Murrumbidgee Irrigation Area in New South Wales and in the area of An Giang, in the Mekong Delta, south-west Vietnam. Then use the table that follows the case studies to compare rice growing in two different places of the world.

Case study 1: The Murrumbidgee Irrigation Area



The Murrumbidgee Irrigation Area (MIA) sits along the Murrumbidgee River, a major tributary of the Murray River. In the early 1900s, farmers poured water from the river onto the land and proved that irrigation increased the capability of the area from being a sheep and cattle region to include fruit and grain farming, such as rice. The MIA, with its network of channels, was established in 1912 and, in the 1950s, the Ricegrowers Cooperative Ltd was formed to advance the knowledge and skills within the rice industry and to assist in the global sales of rice.

In 2013, 100 000 hectares of land sat under water at least 15 centimetres deep for the length of the growing season (October–March), only being drained of the water a month before harvesting. The rice industry is strictly regulated and so only 30 per cent of areas approved for rice growing can be used at one time, and only one third of any farm can be growing rice in a season. Sodosol soils, found across the MIA, mean that water use can be maximised. These soils set hard when dry and this dry layer prevents the irrigated water from seeping through the soil layers when the rice fields are flooded. When the rice is harvested, the soil moisture is taken up by the planting of a different grain crop, such as wheat, or the land is used for pasture. The amount of water required for rice growing is minimised; efficiency levels see Australian rice production as the most water-efficient and most productive in the world.

There is a lot of technology used in farming to prepare the land – laser grading to ensure control of the water, the use of aircraft and guidance equipment to sow the seeds, the development of varieties of rice suited to the high summer temperatures and lack of humidity, and the controlled use of fertiliser and pesticides. These

advancements have seen Australian rice farmers gain a nine tonne per hectare harvest while other global farmers average four tonne per hectare. Australian rice farmers produce a farm gate value of $350 million. Since 85 per cent of the crop is exported – with the addition of value-added products – $800 million comes into the Australian economy. In the last 10 years, rice farmers have improved water use efficiency by 30 per cent while increasing production per hectare by 60 per cent.

Case study 2: The Mekong Delta, Vietnam

Phan Dinh Duc leans against yellow sacks of freshly harvested rice. It's a warm spring evening in Vietnam's Mekong Delta, and Duc, a local farmer, is waiting for traders to arrive by truck to purchase his rice and sell it for him. Beyond him lies a vast checkerboard of rice paddies, each filled with water and bordered by a network of canals and roughly three-metre-high earthen dikes. They enable year-round rice cultivation in an area where, a half-century ago, vast floodplains typically lay fallow (rested) for half the year and farmers planted one annual rice crop that grew according to the seasonal floods.

Here in the southern province of An Giang, a stronghold of Vietnam's booming rice industry, yields have increased fourfold in the last 40 years. The late 1960s saw the development of high-yielding rice varieties and the construction of so-called "August dikes," which extended the end of the rice-growing season from June to August and enabled farmers to plant a second annual crop. "High dikes" were built in late 1990s-early 2000s to keep the annual Mekong River flood off the rice paddies and allowed farmers like Duc to plant a third crop on the same acreage. Within a generation, Vietnam has gone from a poor country where the government rationed rice and other staples, to a lower middle-income one that is now among the world's top rice producers. The rise of triple-cropped rice across An Giang has increased annual yields from 2 or 3 tons per hectare in the 1970s to 22 tons per hectare today. The Mekong Delta's rice farmers don't see substantial economic benefits from the extra crop; their rice is of low quality, currently selling to traders for as little as 16 cents per kilogram, and any extra income is usually offset by the need to buy more pesticides and fertilisers – even though their efficiency is reduced after a shift from double- to triple-cropping.

The government's longstanding "rice first" policy has encouraged steady intensification of rice production. Today, Vietnam produces more than enough rice to feed its 90 million people.

Courtesy of the U.S. Department of Agriculture, Foreign Agricultural Service, International Production Assessment Division (IPAD), Washington, DC.

Courtesy of the U.S. Department of Agriculture, Foreign Agricultural Service, International Production Assessment Division (IPAD), Washington, DC.

Rice farming	Murrumbidgee Irrigation Area (MIA), Australia	Mekong Delta, Vietnam
Source of water		
Type of water used		
Use of the seasons		
Scale of rice growing		
Yields from rice crops		
Changes over time		
Effectiveness of land use		
Marketing of rice		
Value to the country		
Control of the industry		

Worksheet 11: Putting a price on water

Aim: To look at the value of water in agriculture; to draw a pie graph showing water use in specific crops

Water can be a difficult resource on which to put a price. Rainfall contributes to the production of many crops and assists in the growth of livestock. Irrigated water, though, requires a network of channels and source regions, whether major rivers or man-made water storages. Infrastructure and associated costs must be considered when deciding which crop to grow. Livestock farming can be made more sustainable by using technology, such as that used on Napperby Station in the Northern Territory (Worksheet 9).

1. Read this report by Adam Barclay, 2010, and answer the questions following the article.

Reporting the impact of an eight-year drought on rice production is a strange caper, I thought, as the wheels of a four-wheel motorbike covered me head to toe with mud. I was sitting behind Rob Houghton, a farmer from just outside Leeton, New South Wales, who was driving me through the pouring rain to his soybean field. When I met Mr Houghton, I expected him to take me to his rice field. The problem is, he's not growing any this year. Mr Houghton wasn't allocated enough water this season to ensure a good rice crop. The alternative was soybeans, which, although not as profitable don't need as much water.

"There have been only two years since my father started growing rice here in 1942 that we haven't grown rice, and they've been in the last five years – this year and two years ago," says Mr Houghton.

Mr Houghton farms 520 hectares in the Riverina region of south-west New South Wales, which includes the Murray Valley, Murrumbidgee, and Coleambally irrigation areas. Overall, the region is home to around 1500 rice-farming families.

Before the drought began in 2002, Mr Houghton grew a rice crop of 100–150 hectares each summer (planting in October–November and harvesting in March–April). His farm yielded about 10 tonnes per hectare. Since the rains failed, that area for rice has fallen to an average of around 30 hectares per year, excluding the seasons in which he grew no rice at all.

"The summer crop is where we really make our money," says Mr Houghton. "In drought times, though, we've really ramped up our winter crop program because your water goes so much further."

The long-term lack of rain has not only reduced the amount of water available to farmers, but it has also increased water requirements when rice is grown. In better times, Mr Houghton needed 13 million litres (megalitres) of water per hectare per season to grow rice. In the 2008–09 season, with water tables sinking lower and lower after almost a decade of drought, the figure was 22 megalitres.

"We just need a good wet winter to sort that out," says Mr Houghton. "It's only a short-term impact, but you can't grow rice economically using 22 megalitres per hectare and, environmentally, it's not a sound move either."

Source: ECOS (www.ecosmagazine.com) http://www.ecosmagazine.com/?paper=EC154p22 "Change a constant for Australian rice growers."

a. What impact did the extensive drought have on Mr Houghton's rice farming?

b. Why was an insufficient water allocation a major problem for Mr Houghton?

c. How did Mr Houghton adapt his farming practices to continue to economically provide for his family?

d. Why were the water tables getting lower and lower?

e. What natural event were all the rice growers waiting on?

2. Which agricultural practices use the most irrigated water?

Use this table of data to construct a pie graph of net water use per irrigated crop type.

Agricultural practice	Gigalitres of water	Percentage of net water use per irrigated crop
Cotton	1841	12
Fruit	704	5
Grapes	649	4
Livestock, pasture, grains and other agriculture	8795	56
Rice	1643	11
Sugar	1236	8
Vegetables	635	4

Source: http://www.savewater.com.au/index.php?sectionid=124

Step 1: Use only the percentage column and reorganise the agricultural practice column from largest to smallest according to the percentage.

Step 2: To draw the percentages onto the graph you have first to convert each percentage to the number of degrees of a circle. To do that you will need to use a calculator and taking the percentage figure multiply it by 360° (the degrees of a circle). Your answer is now ready to plot onto the graph. Complete the calculation for all agricultural practices.

Step 3: To construct a pie graph, use a mathematic compass to draw a large circle.

Step 4: From the central point draw a line vertically to the 12 o'clock position.

Step 5: Begin with the agricultural practice with the largest percentage. Using a protractor and the degrees calculated, mark off the required segment to the right of the vertical line. Continue until each agricultural practice is graphed.

Step 6: Label this area outside the circle with the name of the agricultural practice and the percentage figure.

Step 7: Continue with each of the agricultural practices until the circle is filled.

Step 8: Give your pie graph a title and underneath provide the source of the information.

Step 9: You may choose to colour each segment of the pie graph.

3. Answer the following questions using the pie graph you have drawn:

a. Which agricultural practice uses the most irrigated water?

b. Which agricultural practices use the least irrigated water?

c. The use of irrigated water for cotton (12 per cent) and rice (11 per cent) causes controversy. Can you suggest why this might be the case?

d. Why are people not concerned by the use of irrigated water for livestock, pasture, grains and other agriculture?

4. Read the costs and benefits of introducing telemetry to Station Z as set out by the station manager below. Make a list of the costs involved in using telemetry and the benefits of using telemetry. Decide whether these costs and benefits are to the workers (put a "W" beside a cost or benefit), to Station Z management ("Z") and to the environment ("E"). Write a paragraph to assess whether you believe a telemetry system should be installed or not.

Example of cost and benefits of a telemetry system

Station Z has 15 water points.
Distance driven each bore run: 480 kilometres
Average bore runs per year: 130 (average 2.5 per week)
Average bore run time: 8 hours
Vehicle running costs: $2.50 per kilometre (fuel, tyres, maintenance, depreciation, etc.)
Annual cost of bore runs is:
(Bore run distance) X (Number of bore runs) X (cost per kilometre)
480 x 130 x 2.5 = $156 000

Station Z wants to invest in telemetry to reduce costs.

1 x Base station and software	$ 1 500
15 x Telemetry units with water level sensors	$30 000
3 x Remote start/stop units for diesel pumps	$ 3 500
1 x Repeater unit to get signal over hills	$ 2 000
Total cost `	$37 000

Manager thinks this will result in one less bore run each week.
52 fewer runs each year will save:
480 x 52 x 2.5 = $62 400 each year.

The investment will pay for itself after (37 000/ 62 400 = 0.59) 0.59 years, or seven months.

It will also save eight hours of labour each week, totalling (8 x 52 = 416) 416 hours of labour each year.

The manager thinks the telemetry investment will last at least 10 years, so the investment should save Station Z at least (10 x 62 400 – 37 000) $585 000.

Bore run vehicle produces 330 grams of CO^2 per kilometre.
Saving (52 x 480 = 24 960) 24 960 kilometres each year will save (24 960 x 0.33 = 8236) 8236 kilograms of carbon dioxide emissions each year.

Source: Ninti One

Worksheet 12: Let's go fishing – cards in a summary table

The following table is a summary of five case studies showing examples of Indigenous Australian involvement in the fishing industry. Each coloured square appears in the cards that students have used to play "fish". Students in the card game gather all the cards of one colour (one case study) and build up an idea of what is happening at each location. The student worksheet asks them to report about their case study to the group and then for each student to answer a series of questions.

Case Study	Fishery type	Water type	Season/Market
Kulaluk, near Darwin, Northern Territory	Mud crab aquaculture (3 hectares).	Freshwater – dams had been established for a previous prawn farm.	Mud crabs to be harvested at 350 grams; Australian domestic market, especially Darwin.
Port Lincoln, South Australia	Blue mussel aquaculture.	Seawater area in Boston Bay – leased from the government.	All year requiring ocean currents and wave action to provide nutrients; Australian domestic market. This species has high growth rate and low mortality rates.
One Arm Point, north of Broome, Western Australia	Trochus hatchery.	Seawater for breeding in tanks.	Meat (1750 kilograms) is eaten locally; 70 000 shells used in jewellery and exported.
Coolgaree Bay, Palm Island, Queensland	Sea sponge farm.	Seawater within the borders of the Great Barrier Reef Marine Park.	All year – pieces are cut from a sponge and then recut to smaller pieces and each piece becomes another sponge. Used in the cosmetic industry.
Pandanus Park, West Kimberley, Western Australia	Freshwater prawns (Cherabin) and barramundi.	Freshwater for pond farming.	All year round and sold mostly to locals or frozen for Broome and Derby.

Expected Value	Community role	Issues
$200 000–300 000.	Education and training; employment; building community capacity.	Reliant on rain.
70 000 tonnes worth $210 000.	Mussel shells are found in the ancient Indigenous middens. Local industry knowledge and existing Indigenous expertise. Fully Indigenous owned.	Too much rain changes nutrient balance and reduces salinity of ocean; waters must be pristine so not near any urban developments; risk of algal blooms.
Exported shells go to Italy for buttons.	Bardi Jaawi people are the only community allowed to collect the shell. Other local ventures include an industry cleaning shells, tourism, aquarium products.	Remote site.
500 000 sponges per year worth $4.3 million a year – at least half will be exported.	Fully staffed and owned by the people of Palm Island.	A suitable product for a remote location, requiring no refrigeration and so reducing transport costs.
$223 000 per year.	Cherabin are a traditional food for Indigenous people of the area. Community very interested in other benefits to be gained.	Reliant on wet season to provide sufficient water.

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