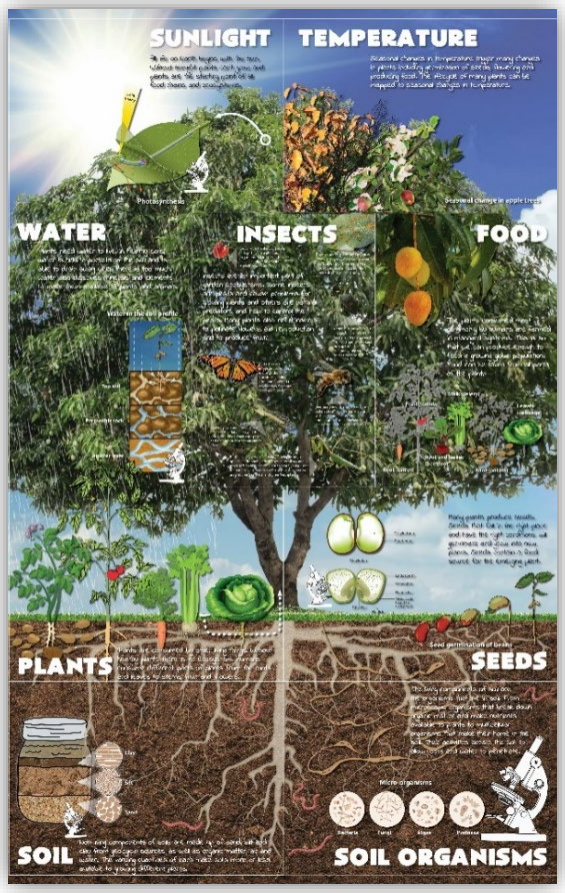
NSW GOVERNMENT | Department of Primary Industries

AGPATCH

GROWING LITERACY



Contents

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INTRODUCTION

This document is designed to help teachers deliver in-class (or in-garden!) learning activities to grow student literacy in food and fibre production, as defined by the Science and Technology outcomes. The work is based around a set of posters. The idea is to work through the learning activities and hang each poster up so that students watch the fruit tree (a mango tree) grow from the ground up, as they learn about different aspects of growing food.

Ideally students will complete the hands-on activities. There are detailed instructions and worksheets for plant trials – suited to older students - at the end of this document. If you are unable to complete the hands-on activities, the workbook activities present content aligned to syllabus outcomes.

Connections are also made to the work of the Department of Primary Industries and the research centres around the state that are helping farmers work towards sustainable food production for future food security needs.

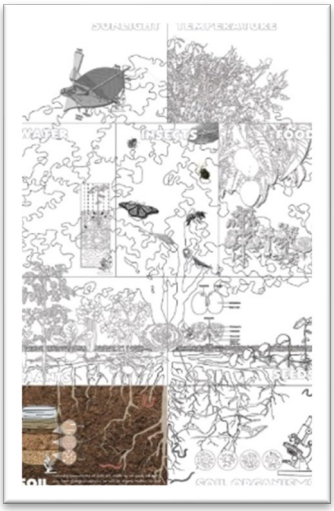
The activities and learning are levelled by Stage. However, you can decide which activities to deliver based on your students' understanding - from getting to know the basics to a more in-depth level of detail. You can pick up the student workbook for your stage and work through the linked activities. However, if students don't understand the basics, it would be more useful for them work through earlier stage activities first. Similarly, if they already understand the information in their stage workbook you can choose to extend their understanding by delivering a 'higher' level (deeper understanding). You can adjust the workbook that you use to meet your needs by swapping or adding pages from other workbooks as needed.

Additionally, you can delete or skip slides from the PowerPoint to reflect the activities you will use and the level of learning your students are ready for.

If you can set up a plant trial and complete it as you are working through the workbook, you will find a page at the end of the workbooks to record student observations.

SOIL

Background



Soils are the foundation of our houses and settlements. They are the basis of agriculture and forestry, and the source of our livelihood. Just as importantly, soils perform vital ecosystem services in filtering and absorbing water, nutrients and pollutants.

The poster for the soil lesson includes a diagram of a jar test. A jar test shows land managers what the relative quantities of sand, silt and clay are in the soil – this tells us about soil texture. The preferred soil for most plants is loam, an almost equal combination of sand, silt and clay.

Student learning

Early-stage 1	What is soil? What does it feel like? What colour is it? What is it for? Many students will be aware that plants grow in the dirt – although not in hydroponic systems. We would like them to know the term *soil* and to understand that soil varies a lot. Introducing this concept early will help them later to understand that some soils are better for agriculture than others and that soil can be degraded if not cared for.
Stage 1	Soils differ in texture and colour. Different plants grow in different soils. Students will consider images of soil from different parts of the state. Some differences are obvious; colour and texture are two physical features that are easy for students to identify. Other differences eg pH (a measure of acidity) and other chemical features, cannot be seen but can have a huge impact on growing food and fibre. The second set of images are from the Tocal Virtual Farm. Each of these images represents a different area of the farm. The differences are more subtle but still have a big impact on the way we farm those areas. Discuss how different soils might impact what we can do on that part of the farm. As a rule, the steeper slope the shallower the soil, and the more protection it needs. On Tocal deeper soils are more likely to be from river flats - areas can be used for grazing livestock and some cropping. Consider the geographical concept of scale here – comparing soils across the state (greater variation) and across the property.
Stage 2	All agriculture begins in the soil. Across Australia we find a range of different soils. Different soils are suitable for different land uses – some are better for agriculture than others. In fact, soil has a huge impact on what we can grow in different parts of the state. The difference in soils is an important issue in growing food and fibre around the world. Some soils are more fertile and better able to handle cultivation for growing crops or grazing livestock.
Stage 3	Soil is made up of living and non-living parts. The non-living parts are determined by the geology of the region. The living parts and parts that come from previously living sources – are influenced strongly by the management of the soil. Both have a big impact on whether you can grow food in the soil, and on agriculture. Performing a jar test on a soil is a way of determining soil components and discovering the geologic origins and history of the soil as well as how much organic matter is present

	in the soil. The information and image of soils in the workbook are from the State of the Environment Australia website (https://soe.environment.gov.au/theme/land/topic/2016/soil-understanding) This page provides great background information about the importance of soils in agriculture as well as the variation of soils across Australia.

Hands on activities

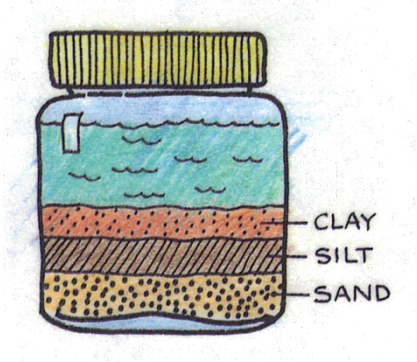
Note: ensure that students wash hands after handling the soil and if you are using potting mix have them handle it outdoors in the fresh air and so they don't inhale the soil dust.

1. Have some soil available for students to see and feel. Ask students to predict answers to questions in workbooks first. Record their answers so they can refer to them when they come to completing the workbooks.
   If they are able to complete soil practical activities, it is advisable that students compare two or more different soils, for example soil from a vegetable garden and compare it to a compacted part of the school yard – students will see and feel the differences. Or you could try comparing potting mix and garden soil.

2. Jar Test instructions

   The relative quantities of different sized components (particles) in soils have an impact on the texture of the soil, affecting its ability to hold water and minerals and its ability to support plant growth.

   In a small jar mix a sample of soil with water, shake the jar and leave in a light location for 24 hours. During this time the sand (large heavier particles) settles first followed by the silt and finally the clay (small particles). If the water stays cloudy, this is because some fine clay particles may never be heavy enough to settle.

   By measuring the depth of the layers comparing that to the overall depth of the settled soils you are able to calculate the percentages of each.

Note: if you would like to cover soils in more detail the Investigate: soils unit of work is available on https://www.dpi.nsw.gov.au/education-and-training/school-resources.

A video about the soil, water and plant testing facilities at Wollongbar is available at https://youtu.be/mrWEahbMkpE .

Vocabulary

Soil/dirt: online definitions indicate that soil scientists refer to soil when it is part of the landscape, in location and dirt as the loose material that sticks to vehicles and clothes.

Sand: a loose granular material that results from the breakdown of rocks, consists of particles smaller than gravel but coarser than silt [link to definition online]

Silt: loose sedimentary (deposited by water, wind or glaciers) material with rock particles usually $^{1}/_{20}$ millimetre or less in diameter [link to definition online]

Clay: an earthy material that is plastic when moist but hard when fired, that is composed mainly of fine particles [link to definition online]

Humus: a brown or black complex variable material resulting from partial decomposition of plant or animal matter and forming the organic portion of soil [link to definition]

https://youtu.be/fQSVn8-Pznw

Soils and the NSW Department of Primary Industries.

Soil research is undertaken by the DPI around the state in a range of soil types for different primary production purposes.

Research occurs across a number of DPI sites including:

Wollongbar Primary Industries Institute (WPII) is a major research centre for NSW Department of Primary Industries, located on the NSW Far North Coast, and comprises four main sites; Wollongbar, Alstonville, Pearces Creek and Duck Creek.

The Institute supports the local community and sustainable, profitable agriculture, horticulture, forestry and fisheries through cutting edge research on soils, pest management, biotechnology, food safety and animal diseases and social sciences, and the provision of soil, water and environmental analyses.

SOIL ORGANISMS

Background

Animals that live in soil include worms, ants and reptiles, amongst others. Microorganisms also play a big part in soil health. Microorganisms may seem too advanced for younger students but the fact that they exist is enough in the younger years and is a good start for many other areas of biology. Talk about the morphology of the term to support literacy development and to extend some students – make the connection to *micro*scopes. You could also use the term 'microbes'.

More information about soil biology is available on https://www.soils4teachers.org/biology-life-soil/.

The poster for this lesson includes some of the organisms that are found in soils.

Student learning

Early-stage 1	Who lives in the soil? Think of some animals that live in soil. Ask students to think about some of the animals that live in soil. Hopefully they are able to think of worms, ants and reptiles, amongst others. The PowerPoint includes some animals that live in soil, including microorganisms.
Stage 1	What lives in the soil? Soil is made up of non-living parts (sand, silt and clay) - formed by the geology of the region, as well as living things including plants, animals, fungi and bacteria. Some of the plants, animals, fungi and bacteria are good (helpful) and some are bad (harmful) to the soil and the things that depend on it. The PowerPoint includes some animals that live in soil.
Stage 2	Is soil a living thing? Why? Some plants and animals are large enough to see and some are tiny and can only be seen with a microscope. Introducing the idea that some living things are microscopic is useful preparation for when students will learn about cells, complexity in living things and single-celled organisms. This also applies to discussing geology, while it may be new to some students at this age, introducing geology will be useful for when they learn about it later in school. It is important at this stage that they understand that soil is the sum of all its parts. The sand, clay and silt from the geology of the region, the organic matter that comes from dead plants, animals and organisms and the living things themselves. With a good balance of all these parts you have a healthy soil. Whether or not it is suitable for growing food is a more complex issue but these components are a good start. So does this mean soil is a living thing or non-living? Check out this video for clarification https://youtu.be/ZcAmpVJgwJI
Stage 3	Why are the living parts of soil important? The living parts of soil – or those from previously living things - are called organic matter.

	Organic matter is an important part of soil health and growing plants. Living animals and microbes in soil break down organic matter (plant and animal matter), which makes nutrients available to plants. They can also aerate the soil allowing air and water to permeate the soil and encourage plant growth. The organic matter in soil tells us about soil health and fertility. If there is a high amount of organic material in soil, there is likely to be a beneficial quantity of living things making nutrients available by breaking down the organic matter. In the jar test most of the organic matter floats on top of the water. Fertile soils are advantageous for growing food. Composting, mulching, resting paddocks from cultivation or timing it to benefit the organic matter, are some of the ways that farmers try to maintain the health of soil organisms. These are things that gardeners can do as well, to help the productivity of their vegetable gardens. If you are uncertain about the place of bacteria, animals and plants and their place in biology, this web site will help. https://byjus.com/biology/difference-between-plant-animal-bacterial-cells/

Hands on activity

Take your students outside to explore the garden. Lift up rocks and branches to see if you can find some bugs living in and around the soil. Dig around in your school garden (if permitted) to search for worms and beetles in the soil. Note that later in the lessons you will also be looking at the insects that play a beneficial role in growing food and fibre. You can do this survey at the same time or focus just on the soil organisms at this stage.

Always keep student safety at the front of your mind. Ask them not to pick up any bugs that you find as they may sting and we also don't want to hurt the animals.

Leave the animals where you found them and discuss the great work that they are doing in the garden. Think of ways we can help to make sure there are plenty of soil organisms in the garden.

Cotton strip trial

A great investigative activity to assess the presence of living things in your soil is to bury strips of cotton fabric in the soil – an old cotton shirt is great. The material you choose must not have any polyester or synthetic fibres or the activity will not work. Leave the top of the strip out so you can retrieve it later. After three or four weeks you will be able to see the effects of the living things as the cotton starts to break down (if moisture is limiting it may take longer). The living things break organic matter down as they consume it and this in turn makes the nutrients available to plants (that are then eaten by animals, who return organic matter to the soil in excrement or when they die).

You can extend this activity by burying synthetic fabrics strips the same size and thickness beside the cotton ones. This will demonstrate the difficulty microorganisms have in breaking down synthetic fabrics. You could also bury them in different parts of the yard to see which areas have more microbial activity eg under trees vs. exposed and trampled areas.

Cover crops are one of the potential ways of looking after soil biology. This video explains the cover crop trial occurring around Cowra in NSW https://youtu.be/RTE6U9vR6Hg.

Vocabulary

Bugs or Beetles: not all insects are bugs, true bugs are from the order Hemiptera and beetles from the order Coleoptera [Link to explanation]

Worms: earthworms are invertebrate herbivores that contribute to soil health by aerating the soil and helping decomposition of organic matter

Organism: a single – simple or complex – living thing [Link to definition online]

Microorganisms: organisms too small to see without a microscope, soils microorganisms include virus, bacteria, fungi and nematodes.

Soil organisms and the NSW Department of Primary Industries

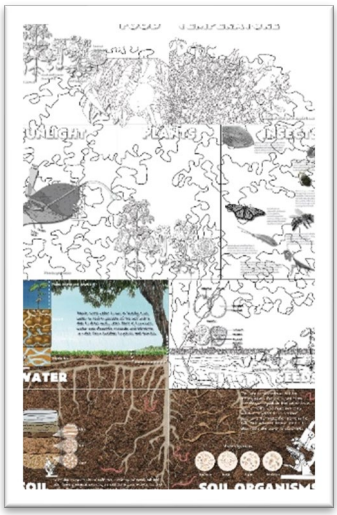
Soil research and development focusses on healthy, productive soils. Soil biology is an important part of healthy soils and so trials on pastures and agricultural production include their impact (positive or negative) on soil biology. Research occurs across a number of DPI sites including:

Wagga Wagga Agricultural Institute (WWAI) is in the sheep-wheat mixed farming region of NSW and on the edge of productive horticultural area. WWAI conducts major programs in Farming Practices and Agronomy; Crop Germplasm Development and Variety Evaluation; Crop Protection; Pastures; Beef Production Animal Nutrition; Weed Science; Entomology; Vine Management; Natural Resource Management; Land Use Planning; Feedlab Testing Services, Cereal Science and Oil Science.

WWAI through industry-driven research, development and regulatory services aims to improve the profitability and competitiveness of mixed farming systems in southern NSW in ways that protect the natural resource base and assist growers adapt to climate change and variability.

WATER

Background



Water is all around us. It is in rivers, oceans and lakes. It comes out of taps and bubblers, even out of the sky. Even when it is not raining there is water in the air!

The reason why water is valuable is the most important message in these lessons. Later in school students will study the water cycle in more detail and the processes that cause water to move through the cycle. The water cycle is a closed system meaning that the water that we have on Earth does not get used up – it changes state – is recycled - and we cannot make any more so, it is worth protecting. Students' understanding of this limitation, will encourage their appreciation of the need to maintain clean, healthy water.

The poster for this activity includes a diagram of water in the soil profile. It's a general diagram: soils hold water differently, and this affects the availability to plants.

Student learning

Early-stage 1	Where does water come from? Water is one of the world's most precious resources, and we can't make any more. Water cycles around the world from rain to the ground and lakes and rivers, through plants, us and our taps and back through the drains and into rivers again. Plants use water in the soil to grow. Where do students think water comes from? Discuss. The idea that water is valuable is the most important message in this lesson.
Stage 1	Why do plants need water? Plants take water up from the soil through their roots. It is used for chemical processes that help plants stay healthy, just like us! Water can enter the soil naturally (eg rain) or artificially (irrigation, watering can, hose). Plants use water for: • Germination – check the grass head with no water • Transpiration – control temp eg breath on to glass • Photosynthesis – converting sunlight into energy eg drinking water • Structure – fill plant cells to make stems strong.
Stage 2	Water is one of the most valuable resources in producing food. Watering plants around your home or school is easy but it is a bit more complex for farmers. Farmers ensure their crops receive enough water at the right time by planning planting and harvest according to the weather and climate patterns in their area. Some farmers also provide water to the plant by irrigation. Hydroponics and glasshouse use is also about ensuring plants grow in in optimal environmental conditions – including control of temperature, light, nutrients and water.
Stage 3	Water is one of the world's most precious resources.

	There is a limited amount of water in the world. We don't want to waste it as we can't make any more! The water cycle demonstrates how this works in the world. The following video makes the process of plants releasing water into the atmosphere visible. This can easily be recreated in the classroom by placing a bag over a plant – it could be an indoor plant and a plastic bag. Just don't leave it on too long! https://youtu.be/J-QAt6UqtSA

Hands on activities

1. To demonstrate water moving through plant leaves and stems place celery or lettuce leaves (Cos lettuce is a good choice for this activity) in a glass of water. Colour the water with food colouring and leave them in a light area for half an hour. Ask students to predict what will happen. As the leaves take up the water, they will change colour. Students will be able to observe the change and can document the process with photos at regular intervals for comparison. This activity will not explain *how* water moves through the plant, but it does make it visual. If you would like students to understand *how* water travels through a plant, they will need an understanding of transpiration.

2. Growing grass heads in the classroom allows students to observe and record growth of a plant from germination. If you have space in a pot or garden, you may also be able to grow them out to a stage where they produce seeds. Instructions for grass heads can be found online including https://www.yates.com.au/ideas-plans/project-guides-articles/all/grow-a-funny-grass-head/
   The grass heads can be used to demonstrate to students the importance of water and sunlight. Make two or four extra grass heads that won't be watered or given sunlight to observe and discus throughout the learning activities. If you are growing grass heads, the head that was not given water should be germinating and growing differently to the others – or not at all! Discuss with students what they think is happening. Ask them to predict what would happen if you add water now. Add the water and observe over the next week.
   If you do this activity there is a page at the end of the workbooks for students to record their observations. If you don't run this activity, leave this page out if you print the workbooks.

Vocabulary

River: a natural water course with water flowing to the sea, a lake or another river

Lake: body of water surrounded by land often with rivers inflow and / or outlet

Ocean/Sea: large expanse of salt water covering ~70% or the Earth

Water cycle: process whereby water circulates between the earth's oceans, atmosphere, and land.

Water and the NSW Department of Primary Industries

The Water Research and Development (R&D) team delivers services that increase water productivity and improve the resilience of water users across NSW agricultural industries.

We do this by applying our hydrology expertise and connecting it with soil science, agronomy and farming systems.

Research occurs across a number of DPI sites including:

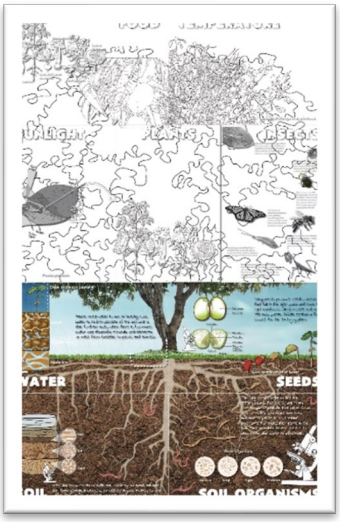
The Tamworth Agricultural Institute (TAI) is the Department's principal research institute for the cropping zone of northern inland NSW. It is a Centre of Excellence for Northern Farming Systems and is dedicated to helping ensure agricultural industries and rural communities remain economically viable and sustainable.

Water management research includes; identifying crop and pasture nutrition issues, strategies for reducing fertiliser losses, extension of soil health, investigating biochar, evaluating soil water balance and productivity.

Narrandera Fisheries Centre (NFC) is a world-class fisheries research and aquaculture facility located adjacent to the Murrumbidgee River in southern inland NSW. Specialist facilities support native fish breeding, conservation, environmental surveys, NSW rivers management and community education.

SEEDS

Background



Seeds are the method of reproduction of flowering plants (Angiosperms) – as well as a great source of nutrition in our diets. Flowering plants represent around 80% of plants on Earth today, and their seeds range in size from less than 1mm (from an orchid (*Aerides odorata)* found in China, south-east Asia and the Philippines) to around 18kg (the Coco de mer or double coconut (*Lodoicea maldivica*) from the Seychelles) – the second largest is the coconut that we are more familiar with.

Seeds form a large part of our diet but you may be surprised by some of the foods we commonly eat, that are actually seeds. An online search for 'seeds that we eat' might surprise you!

The poster for this activity includes a diagram of seed germination and the early stages of plant growth. It also includes a cross section of seeds from the major flowering plant groups, monocotyledons and dicotyledons.

Student learning

Early-stage 1	What are seeds? Seeds develop as part of a flowering plant. If they find the right spot a seed will grow into a new plant. Seeds are also food for people and animals! Can students think of some seeds that you eat? The poster for this activity includes a diagram of a seed germinating and the early stages of plant growth. It is useful for students to think about seeds all around us – growing new plants and providing food – in their understanding of plant growth.
Stage 1	Why do plants have seeds? Seeds are produced by plants as part of the reproductive process. What is reproduction? Think about the word - the base word is production which is making something, so reproduction is making a copy or a similar version. Reproduction in plants occurs by producing seeds that will grow into plants, given the right circumstances. The new plant will have similar traits to the parent plant.
Stage 2	Do all plants have seeds? Seeds are part of the reproductive process. Reproduction is an important concept for students to learn. The different ways that plants reproduce is fascinating and has a huge impact on agriculture and horticulture in that it determines which part of the plants we eat and how reliable the new plant will produce food. Some other ways that plants reproduce include • Budding – new plants grow from a bud or another growth from the parent plant (asexual reproduction). • Vegetative propagation – a portion of the plant produces a new plant structure; this can occur both naturally or artificially (asexual reproduction). • Asexual seed development – Seeds and an embryo are formed without the male and female gametes coming in contact with each other.

	• Fragmentation – fragments of the parent body develop into new plants (asexual reproduction).
Stage 3	How do seeds become plants? Seeds contain everything they need to give a plant a good start. When a plant starts to grow from a seed it is called germination. Seeds will germinate under the right conditions. The ideal conditions for germination depend on what type of seed it is but generally they need a specific temperature, amount of water, oxygen and for continued growth they need healthy soil. In agriculture, farmers need to determine if the right conditions for germination of a particular crop seed have been met to decide if it is time to sow seeds to produce a healthy plant.

Hands on activities

1. Bring some examples of seeds from the supermarket in for students to handle and to research. For example, rice, wheat, peanuts, almonds, chickpeas. Together look at the foods, discuss which part of the plant the seed comes from and what the plant looks like. Research together the plants' appearance and life cycle.

   List of seeds that we eat:

   https://en.wikipedia.org/wiki/List_of_edible_seeds

2. In a plastic bag or another clear container eg used take-away containers or drink bottles cut in half. place cotton wool in the base, the seed on top and add some water. Place the container in a sunny position and ask students to illustrate the setup in their workbooks.

3. Planting a seed on the edge of a see-through container will allow students to observe the germination of a seed.

Vocabulary

Seed: the reproductive part of a flowering plant capable of growing into another plant

Cereal: grass plants grown for the edible components of the grain, also refers to the grain product

Life cycle: the series of changes in an organism / living thing that includes reproduction

Reproduction: the process of copying something or the production of offspring (asexual or sexual).

Seed research and the NSW Department of Primary Industries

Research occurs across a number of DPI sites including:

The Condobolin Agricultural Research and Advisory Station, located in the centre of the NSW cereal cropping belt, continues to make an important contribution to farming systems practice in the Central West. The station has been part of the local community since its founding in 1913. It is a leading dryland research facility with a history of improving efficiency, profitability and viability of agriculture in low rainfall zones.

NSW DPI staff conduct research into cereals, canola, pulses, cropping systems and crop rotations, pastures and new industrial crops. Local farming community cooperation is common in many projects.

SUNLIGHT

Background

While Kindergarten students are probably not ready to understand photosynthesis, they are capable of appreciating that plants need energy and that their energy comes from sunlight. Photosynthesis is a chemical process plants carry out to convert energy from sunlight, carbon dioxide and water into oxygen and sugar (energy for the plant).

This series of lessons help students to develop a deeper understanding of the role of sunlight in growing food. The diagram used in a number of the student workbooks is reproduced below with labels and arrows included.

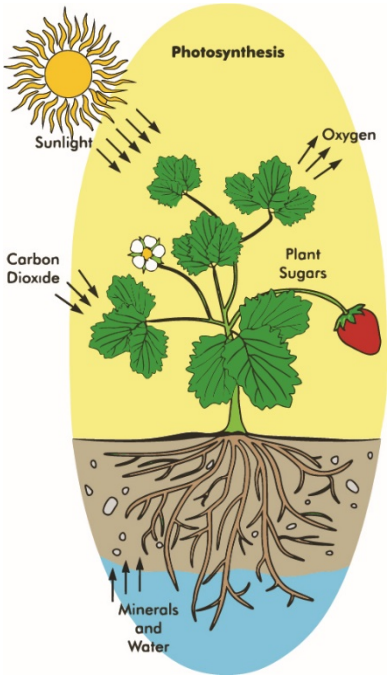
The diagram in the workbook will form a simplified version of the diagrams of photosynthesis that students will learn later in school.

Student learning

Early-stage 1	Why do plants need sunlight? Plants need sunlight to make their own energy. Once a seed germinates and the shoot reaches above the soil, it starts to use sunlight to make energy. This energy allows that plant to continue to grow. Just like we make energy from the food we eat, plants make their energy from sunlight.
Stage 1	Why do plants need sunlight? Plants make their own energy from the sun. Humans need water, oxygen and food to grow. A lot of the energy we consume is from plants, as is the case for many of the animals that that we consume. Plants form the basis of all food chains.
Stage 2	Do plants need sunlight? Plants make energy from the sunlight that they absorb through their leaves. The process is called photosynthesis. Plants also need carbon dioxide and water for photosynthesis. At the same time that they are making energy (in the form of sugar) for the plant to grow they also make oxygen. People need oxygen to survive, so making sure that plants are healthy enough to grow not only provides food and fibre for us, it also means we have plenty of beautiful fresh oxygen to breathe!
Stage 3	Photosynthesis Plants make energy from the sunlight that they absorb through their leaves. The process is called photosynthesis. The water that a plant takes up through its roots is used along with carbon dioxide from the air and minerals from the soil to make energy for the plant to grow. While they are making energy, plants also release oxygen into the air. We need oxygen to survive, so the more healthy plants there are making energy, the more oxygen there is for us! This process is expressed as Carbon dioxide + water -> (in the presence of sunlight) -> glucose (energy) + oxygen

Hands on activities

Ways to observe the process of photosynthesis in the classroom/garden.



1. Place a plastic bag over a limb on a tree outside and tape it up so that there is no gas exchange. After a couple of days, you will see water in the bottom of the bag/condensation (water produced in photosynthesis)
2. Submerge a plant part (eg leaf) in a container of water. After a couple of hours you will see bubbles of oxygen around the edge of the leaf (Oxygen= product from photosynthesis)
3. Observe a Plant in a terrarium - over time, if not opened, the plant will produce its own water, carbon dioxide, oxygen etc with the only external input being sunlight.

Have students observe the plants that have been deprived of light and record the changes observed in student workbooks.

Vocabulary

Germinate: usually refers to plants, includes the process of an organism growing form a seed or a spore. [Link to definition online].

Chemical process: a process that occurs at the atomic or molecular level and effects the structure and composition of the substance [Link to definition online].

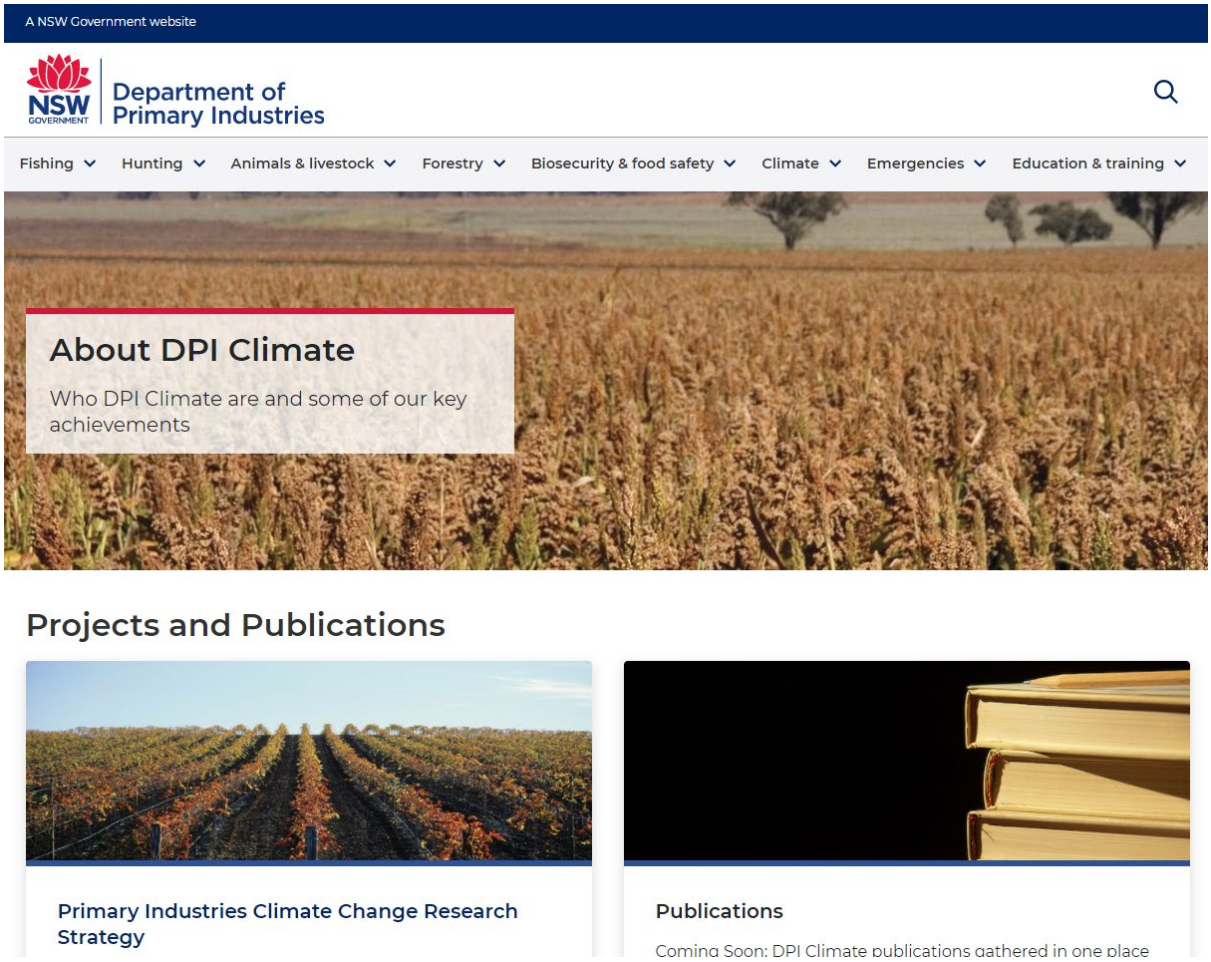
Photosynthesis: biochemical process of converting energy from light into sugars that provide energy for plants to grow [Link to definition online].

Climate research and the NSW Department of Primary Industries

Primary industries in NSW operate in one of the most variable climates in the world. Primary producers already deal with a changing and variable climate through responses to droughts, floods, storms, bushfires, pests and diseases. To ensure the continued growth of NSW primary industries, and safeguard the future of the regional communities, the sector needs to be resilient and adaptable to changes in economic and environmental conditions.

NSW DPI is working to identify through research and innovation:

- energy supply and demand solutions
- carbon market and emission reduction opportunities, and
- climate resilience building programs


A NSW Government website
NSW GOVERNMENT
Department of Primary Industries
Fishing
Hunting
Animals & livestock
Forestry
Biosecurity & food safety
Climate
Emergencies
Education & training
About DPI Climate
Who DPI Climate are and some of our key achievements
Projects and Publications
Primary Industries Climate Change Research Strategy
Publications
Coming Soon: DPI Climate publications gathered in one place

PLANTS

Background

Once students have looked at soil, water, sunlight and seeds, we can bring them together to consider the growing plant. Understanding that plants form the basis of all food chains is important in understanding food production – even if our students don't eat heaps of vegies just yet!

The plants poster includes a diagram of some of the more common food plants.

Student learning

Early-stage 1	Plants grow from the soil We have learnt about healthy soil, water and seeds. When we put them all together, we can grow a plant! The Needs of Plants video on the PowerPoint sums up the last few lessons. The second, The Plant Kingdom, introduces students to the variety of plants. As a class discuss why plants are important. What are some of the ways we use plants? Can you think of some plants that you eat?
Stage 1	Are all plants the same? In this video we learn that plants are living things that create their own energy. https://youtu.be/IYxfz1PSfZ0 The video is quite long for this age group – the main message is in the first 2.30 mins. This shows that plants create their own energy and they fulfil the requirements of the definition of living things. The activity in the workbook helps students understand what makes a plant a plant. It sets them up for learning about which parts of plants we eat and in later stages they will learn the roles of the different parts. There are lots of different types of plants but all share the features of living things. The basic functions of living things include that they are born, they grow, interact, reproduce and they die.
Stage 2	Animals eat plants Plants are essential for life because animals depend on plants for energy. Some animals eat other animals … but the animals they eat probably eat plants! And some animals eat both – like us! Think about these animals, what do they eat? Cows, Birds, Blue tongue lizard / reptiles, Chickens, People, Worms, Bugs In turn animals provide nutrients for plants, either through manure or when their bodies break down and become part of the soil. This is how a food web works. Consider a farm landscape: if the grass can't grow because there is not enough rain eg in a drought, what happens to the sheep that need to eat the grass? What is the role of the farmer when raising livestock? The PowerPoint activity reveals what each animal eats as you tap them. Ask students what they think each of the animals eat before you reveal the answers. As students draw arrows from the plant to the animal that eats them, they will be completing a farm food web. Some students will be able to add detail to the arrow eg the arrow from chicken to humans can include eggs and meat, from organic matter to worm can include the word

	decompose. Note that people are included in the food web diagram as we eat cows and chickens. However, vegetarians may choose not to include this in their food web.
Stage 3	Plants are the basis of all farming operations. Some farms grow plant products, some grow animal products but they all need plants. Even fish farmers feed their livestock aquatic plants or pellets that include plant-based ingredients. Farming systems require that farmers manage the natural environment to produce food and fibre. In some cases that includes building structures that allow farmers to control the weather [image of a greenhouse or hydroponics, chicken sheds]. Even without this infrastructure, farming requires that farmers ensure the needs of plants are met in an open environment. Meeting the needs of plants means farmers can either harvest food or fibre directly from the plant or the animals that rely on the plants have access to fresh, healthy food. [images of cropping, dairy, chickens?] Consider the factors that we have already looked at in this unit. Which of the following considerations might affect which plants a farmer can grow? • Preferred soil types • Who is going to eat it • How much people pay for it in the supermarket • Time to harvest • Weather and climate requirements of the plant • Planting depth • Equipment available An argument can be made for all of the factors listed as considerations when choosing what to plant eg if there is no market for your produce (who is going to eat it) there is no point planting it. However, the factors that are listed here are the ones that determine if a farmer will be able to harvest plant products or feed fodder crops to benefit their animal production. Zerella Fresh provide information about their food crops on their website. They include information about how they ensure their produce reaches their customers in good condition. http://zerellafresh.com.au/produce/onions/

Hands on activities

1. Take students out to the school yard. Take phots of all the different plants they can find. While you are there identify the features of the plants so that students can label the pictures back in the classroom.
2. Growing sprouts shows students how seeds germinate. Lots of different seeds will germinate this way and many will continue to grow to produce fruit (containing seeds). Larger, more robust seeds like broad beans or mung beans are great examples for young children to observe and plant out. To grow the plant out you will also need a pot and some potting mix or a garden bed – or send them home to be planted out there! Keep in mind the plant's growing season and the expected time between planting and fruit production to help decide which seeds to use.
   Use the germinating seeds and sprouts as a stimulus for information reports, introducing the idea of a science journal. The illustrations form an important part of the report.
   As the plants in pots continue to grow use the comparative heights of the plants to reinforce student's understanding of length and the growth of living things.

Vocabulary

Food web: a diagram that shows the relationship between plants and animals in an ecosystem. Arrows point from the plant or animal that is eaten to the one that eats it. [Link]

Decomposer: Plant or animals that breaks down organic matter, making the nutrients available to consumers and recycling organic matter [Link to definition]

Producer: living things in an ecosystem that are able to gain energy from their environment [Link to definition]

Consumer: living thing – usually animals – that rely on consumption of other living things for a source of energy [Link to definition]

Farm system: arrangement of processes designed to produce food [Link to definition]

Hydroponics: system of growing plants without soil, often with nutrient rich water but can also include growing mediums including sand, the temperature, light and humidity are often also controlled in hydroponics systems. [Link to definition]

Greenhouse: structure designed to protect plants and to encourage growth by controlling the growing environment [Link to definition]

Plant research and the NSW Department of Primary Industries

NSW Department of Primary Industries has a broad research capacity in plant health, biosecurity and sustainable production systems. Research includes a wide range of ecosystems from pastures and rangelands, horticulture and broadacre cropping.

Research occurs across a number of DPI sites including:

Cowra Agricultural Research and Advisory Station is located on 390 hectares of red-brown soil in the Central Western Slopes of NSW. Situated 3km from Cowra on the northern town boundary, the research and advisory station is located in undulating arable and grazing country.

Plant breeders throughout Australia have used this reliable rainfall site for over 100 years to undertake the detailed assessment of new selections and conduct on-site national variety trials. Large-scale crop and pasture management demonstrations help extend the latest technology to the local farming community.

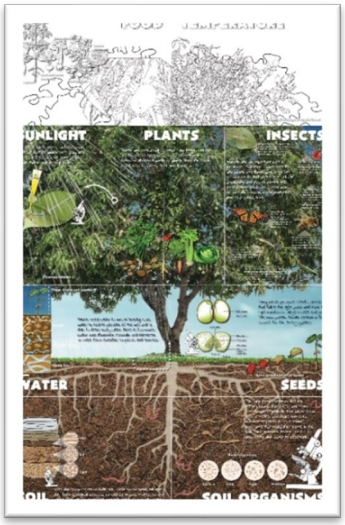
Current plant research includes phosphorus-efficient pastures, legume adaptation through soil management, tropical grasses as fodder, perennial wheat breeding and broadacre crop agronomy trials.

Yanco Agricultural Institute, a NSW DPI Centre of Excellence, strives to provide targeted research, development and education to support the sustainability and profitability of crop production in southern New South Wales. The Institute is located between Leeton and Narrandera in the Murrumbidgee Irrigation Area. Comprising over 813 hectares of dryland farming country and mixed irrigation, the Institute focuses on research on the efficient and sustainable production of crops including rice, cotton, citrus, cereals, canola, soybean and pulses.

INSECTS

Background

Insects are an important part of the garden ecosystem. Many students will already know about the role of pollinators like bees, ants and flies. But is it important for students to understand that all insects have a place, even if some are detrimental to food plants, they have a role elsewhere – we just need to control them in gardens and on farms.



Technically the term insect does not include spiders so we have not included them in this activity. They are certainly something you may find in your garden visit though!

Note the CSIRO guide to identifying bugs in Australia http://anic.ento.csiro.au/insectfamilies/ to help you identify insects that you find in your garden visit.

Student learning

Early-stage 1	Insects in the garden We have looked at who lives in the soil, now let's look at who lives in the garden … above ground! Insects are the largest group of animals in the world. They are very important part of all gardens whether your garden is for flowers or food. Some of the insects you might see in your garden include ants, bees, butterflies, praying mantis, beetles, lady bugs.
Stage 1	Insects, good or bad? What is an insect? Insects are animals that have: • three main body parts, • no internal skeleton – no bones, they have a shell (exoskeleton), • up to three pairs of legs, • one pair of antennae on their head • most have one or two pairs of wings. There are more types of insects in the world than there are in any other group of animals. How many insects can students think of? As for whether we want them in our garden or not, that depends. Some insects sting or bite and that makes some people wary of them. But even the ones that we like to keep our distance from can be really good for the garden. Insects help in the garden by pollinating flowers, breaking down organic matter, keeping the soil aerated and by helping to keep pest insects out of the garden. Good bugs in the garden include: Lacewings, Lady beetles, Ants, Bees, Butterflies, Bugs and beetles that eat pest insects and burrow in the soil.
Stage 2	How insects help or hurt our gardens Insects help in the garden by pollinating flowers, breaking down organic matter, keeping the soil aerated and by helping to keep pest insects out of the garden. The life cycle of different insects means that the role they fulfil in the garden varies.

	For example, insects that lay their eggs underground aerate the soil as they burrow. If their young feed on organic matter in the soil they help to break this down and make the nutrients available to plants. Insects that require pollen and nectar from flowers help to pollinate flowers, without pollination many plants would not produce fruit. Insects that eat other insects help to keep the population of those insects in control.
Stage 3	Encouraging beneficial insects Insects help plants by pollinating flowers, breaking down organic matter, keeping the soil aerated and by helping to keep pest insects out of the garden. The life cycle of different insects means that the role they fulfil in the garden varies. For example, insects that lay their eggs underground aerate the soil as they burrow. If their young feed on organic matter in the soil they help to break this down and make the nutrients available to plants. Insects that require pollen and nectar from flowers help to pollinate flowers. Without pollination many plants would not produce fruit. Insects that eat other insects help to keep the population of those insects in control. A relationship between species that benefits both species is called symbiosis. Relationships between species can also be detrimental to one or both species. In managing gardens and farms, our role is to encourage insects that are beneficial to the food producing aspects of plants. In completing a survey of the school garden students will assess the need to encourage more insects and greater biodiversity in the school landscape. If your school doesn't have a garden, a survey of the plants in the school yard will give them the same experience of field work or you could arrange a trip to a nearby park or green space.

Hands on activities

Take students into a part of the school yard where they will be able to observe insects. See how many different types you can find. Instruct students to find one bug each and to take notice of its features ie Does it have wings? How many legs can they see? What colour is it? Is it bigger than a leaf on a nearby plant or smaller?

Try to identify if they are beneficial or harmful bugs for the garden. Note the CSIRO guide to identifying bugs in Australia http://anic.ento.csiro.au/insectfamilies/ for help in identifying insects.

Support students to plan and complete a survey of your garden. Ensure that they have taken into consideration the need to visit at different times of the day (different species are active at different times of the day), different parts of the plant and garden as well as ensuring that they are not all counting the same insect! Students can also consult the CSIRO guide to identifying bugs in Australia to help identify if they are beneficial or harmful bugs in the garden. http://anic.ento.csiro.au/insectfamilies/

Vocabulary

Insect: any animal of the class Insecta, - small, air-breathing invertebrate with a body divided into three parts (head, thorax, and abdomen), three pairs of legs and usually two pairs of wings. [Link]

Invertebrate: animals that lack a backbone. Insects have a hard outer shell or exoskeleton.

Ecosystem: geographic area where plants, animals, and other organisms, as well as weather and landscapes, work together. [Link]

Features: a distinctive trait of an individual or of a class [Link]

Insect research and the NSW Department of Primary Industries

NSW Department of Primary Industries has a lead role in preventing, responding to, and overseeing the recovery from invasion or spread of plant pests and diseases. NSW DPI works closely with plant industries, other jurisdictions and the general public to put sound biosecurity policies in place, helping to maintain and expand market access for the state's primary producers.

Research occurs across a number of DPI sites including:

NSW DPI Biosecurity Collections hold over half a million preserved scientific specimens. We have two collections: Insect & Mite Collection and Plant Pathology & Mycology Herbarium.

The primary focus has been on agricultural plant pests and diseases, including insects, mites, fungi, bacteria, viruses and nematodes, from NSW dating back to 1890. The Institute also holds plant pest and disease specimens from other Australian regions and overseas, native Australian insect and mite species, native Australian mushrooms and lichens, environmental

pests (termites, ants), and even pests and diseases of insects (mites of bees, or fungi that infect insects). The collections are housed at the Orange Agricultural Institute.

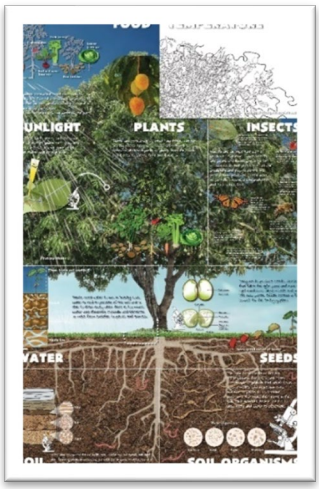
The Elizabeth Macarthur Agricultural Institute (EMAI) is a world renowned, premier biosecurity facility that enhances food and fibre production and helps protect the environment. As part of the Department of Primary Industries, it contributes to the security and prosperity of this sector. The centre collaborates and delivers across broad and diverse portfolios with world recognised research scientists. It aspires to become the laboratory of choice for research and diagnostics for high impact existing and emerging diseases of plants and animals.

The Tocal Agricultural Centre consists of Tocal College, Regional Services and Regulatory programs, Tocal Field Days and Tocal Homestead. Tocal farm staff operate a commercial beef herd, stock horse breeding, dairy and free-range egg production as well as a demonstration sheep flock and bee hives used in training. Research areas include participation in the Southern Multibreed beef research and bees. The National Honey Bee Genetic Improvement Program is a collaboration between beekeeping and horticulture industries, University of Sydney, University of New England and non-profit the Wheen Bee Foundation.

FOOD

Background

The difference between fruits and vegetables is a biological one. The fact that a tomato is a fruit and we generally group it with vegetables is a quirk of our language and societal norms. In these activities we just want students to understand that fruit and vegetables grow on plants and to grow the quantity of food we need, people grow food in places designed for growing food (farms).



If you want to understand the difference between a fruit and a vegetable check these pages. https://www.merriam-webster.com/words-at-play/fruit-vs-vegetable or https://pediaa.com/difference-between-fruit-and-vegetable/.

Student learning

Early-stage 1	We eat plants. A lot of our food comes from plants. All our fruit and vegetables are plants. There are even a lot of plants that we can eat but we don't – Aboriginal people ate very well on Australian native plants for many thousands of years. These foods are still available although they have been replaced by introduced plants in most Australian diets. Fruits and vegetables come from different parts of plants. Label the diagram for stem, leaf, flower, fruit, roots, soil.
Stage 1	Plants grow food. We eat plants every day but which part of the plant do we eat? Sometimes we eat the fruit, sometimes we eat the root of the plant and sometimes we eat the leaves. Have a look at these plants growing, which food do you think do we get from this plant? Sequence the growth of a cabbage.
Stage 2	Farmers manage plant growth and farm processes to provide for the needs of plants and animals that they farm. Harvesting different parts of the plant requires different ways to plant and harvest as well as different ways to get the produce to us! Livestock farmers also manage the growing environment to ensure they have enough healthy fodder (food) for the animals in their care.
Stage 3	There are areas of Australia that are better suited to growing some plants than others. The map in the workbook shows fruit, vegetable and grain growing regions. Some farmers are able to compensate for limiting factors of plant growth. For example, plant growth is limited by weather and climate, water availability, and soil type. Technology helps farmers in areas where growth is limited or variable. Examples include: **Irrigation** – provides water when insufficient natural water is available. It can also be useful in ensuring a constant amount of water is available rather than plants experiencing inconsistent wet and dry extremes. **Hydroponics** – hydroponics is growing plants in a growing medium (usually not soil). Plants are grown in nutrient rich water, sand or gravel. Hydroponics can be part of a greenhouse setup but it can also be an outdoor setup. **Greenhouses / glasshouses** – enable farmers to control all aspects of the growing

	environment from water supply and nutrients to temperature, growing medium (can be soil but not usually), humidity and the amount of light. In some greenhouses plants grow under artificial lights so not even sunlight is a limiting factor. This is a very efficient way to grow food, however greenhouses are expensive to build and maintain and all inputs are sourced by the farmer so represent a large input cost. More information about greenhouse horticulture is available on the NSW DPI website under Protected Cropping https://www.dpi.nsw.gov.au/agriculture/horticulture/greenhouse. **Drones** – enable farmers to monitor plant health, particularly in large paddocks and crops. Cameras have been developed to capture different sections of the light spectrum, the images from these cameras allow farmers to detect problem areas in plants early. For example, a Normalized Difference Vegetation Index (NDVI) scan shows the difference between near-infrared (which vegetation strongly reflects) and red light (which vegetation absorbs). It tells farmers about the vegetation density and can highlight areas that need attention. The farmer can then investigate further to decide what the issue is and apply more or less fertiliser or water to support plant health. NDVI allows a farmer to see a problem before the impact is visible by sight. **Auto-steer tractors**– allow for accurate planting of crops ensuring that there is an even spread of seed and that there are no gaps left in crops. Auto-steer technology uses GPS positioning to operate the tractor, an operator in the tractor to monitor progress, problem solve where necessary and to operate some aspects of the tractor. Fully autonomous tractors are being developed and are used in some areas. Autonomous tractors operate independently (driverless) once programmed for the job that is required. Note the video linked on the ppt includes a number of farm innovations at the following times- plant innovations 0.00 – 04.37, animals 04.37 – 08.51, industry innovations eg genetic modification 08.51-12.00. **Variable rate spreaders** – using the information captured from a drone or other image capturing device farmers can apply the appropriate rate of fertiliser, water or plant nutrient to sections of a crop according to the data captured. This technology allows farmers to apply only what is needed for optimum plant health.

Hands on activities

1. Have a range of fruit and vegetables on hand for students to handle and to taste, some they will know and others may be unfamiliar to them. Ask students to suggest which part of the plant the food is e.g. stem, seed, seedpod, root, leaves. Try to make sure that you have foods from different parts of the plant and some fruits and some vegetables.
   View this video with older students to consider which is a fruit and which is a vegetable. https://youtu.be/a6nKRTG-L4k
2. If you have access to a vegetable garden or fruit trees take students into the garden to give them an opportunity to see the different parts of the plant that we eat. This is a great time to plant some food plants in the garden for students to observe growth and life cycle and to harvest food from.
3. Australian native plant products are available in many supermarkets – some examples include lemon myrtle, macadamias, quandong, native gooseberry, mountain pepper, and the kakadu plum. See what is available in your supermarket and prepare a dish with students. Research the plant, natural growing region,

traditional uses and current production in Australia. It might surprise you to find that some Australian native foods are valued more highly overseas than at home.

4. Plan a native food / bush food garden in your school. You can plan for a range of contexts from vertical gardens and pots, to raised garden beds to an extended in ground garden beds. Information about growing, harvesting and cooking with Australian bush foods is available on http://bushtuckerrecipes.com/at_the_aussie_table/ - note the listing on the right-hand side of the page.

Vocabulary

Fruit: The edible, usually fleshy and sweet-smelling part of a plant that may or may not contain seed(s). [Link to definition].

Vegetable: The edible (part of a) plant (e.g. leaves, roots, flowers) but not including the fruit or seed [Link to definition].

Farm: (NOUN) an area of land, together with the buildings on it, that is used for growing crops or raising animals, usually in order to sell them.

(VERB) If you farm an area of land, you grow crops or keep animals on it.

Fodder: Feed for livestock, especially coarsely chopped hay or straw. [link to definition]

Food research and the NSW Department of Primary Industries

Research in the Department of Primary Industries focuses on quality and quantity improvements in production.

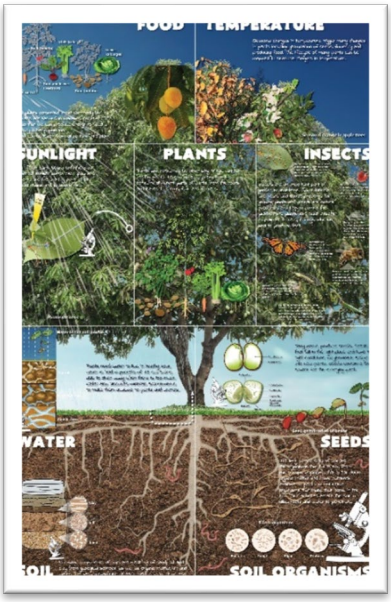
The Dareton Primary Industries Institute is located in the major fruit growing area of the Lower Murray Darling region. The Institute is in the Coomealla irrigation area. About one-third of the site's area has soils suitable for horticulture. Current research includes citrus on fruit sizing, drought tolerance, variety and rootstock selection, persimmons, pistachio, hazelnuts, grapevine propagation and the national germplasm collection of grapevine varieties.

Research is also undertaken on sensory aspects of food to ensure that food produced in NSW meets market preferences. This news release discusses the consumer focus of sensory science https://www.dpi.nsw.gov.au/about-us/media-centre/releases/2018/new-consumer-focus-for-dpi-food-science .

TEMPERATURE

Background

With year-round availability of a lot of fruit and vegetables we can lose touch with growing seasons. Where available, eating local, seasonal foods helps us towards a sustainable future. Naturally occurring appropriate growing conditions require less input from the farmer, lower transport costs and less storage also reduce the cost of food production. Food that is available out of season is either stored, transported – sometimes from overseas – or grown in greenhouses. Greenhouses can be a very efficient environment for growing foods especially annual plants like tomatoes, lettuce or strawberries – including using a lot less water, nonetheless understanding growing seasons means we can consume foods with lower inputs when available. It helps us to be more informed consumers.



Student learning

Early-stage 1	Growing seasons Do you prefer winter or summer? Plants often have a favourite season too! Even with the right soil, water and sunlight there are times that a plant just doesn't grow well. They also need to have the right temperature and that can mean planting it at the right time of the year. We say fruit or vegies are 'in season' when it is the time of the year that they are naturally ripe for harvesting. For example, many apple varieties are in season in winter and watermelons in summer. There are lots of places to help you work out when to plant or harvest fruit and vegies – check out this one from Gardening Australia https://www.abc.net.au/gardening/vegie-guide-zones/9796680 In some places around the world, they can grow fruit and vegies all year because their climate is mild with less variation, others where it is just too hard– think about places that are covered in snow most of the year or deserts. In these place people have to think about what grows there naturally, or they need to modify the growing environment – think greenhouses.
Stage 1	Seasonal and climatic variation in Australia means that there is food being harvested all year around. In NSW alone there is year-round fruit and vegetable harvesting. A lot of harvest information is available on grower and industry websites. The PowerPoint gives links to seasonal produce information on a range of websites – students can record when their favourite fruit and vegetables are harvested – some sites also give growing

	times and planting information. Make a class calendar and map of where and when fresh fruit and vegetables are grown in Australia.
Stage 2	Farmers need to make sure that their crops and trees have enough sunlight, water and the right soil. They also need to make sure that the temperature is just right for the types of plants they are growing. They use weather and climate information for their region to help them decide. We do the same thing when planting a vegie garden or planting a fruit tree. Helpful websites like the Gardening Australia website https://www.abc.net.au/gardening/vegie-guide-zones/9796680 provide guides for when to plant foods and how long they need before food can be harvested.
Stage 3	Seasonal produce Many farms grow plants that fruit or come to maturity at different times of the year so that farmers can manage their workload and have regular income. They may grow several plants on the same area of land but at different times of the year or they could have fruit trees that mature at different times. This way of farming also helps farmers to minimise the impact of disasters like cyclones, floods or fires or changes in weather patterns. Farmers design their farm calendar around the growing seasons of different plants. If they get this wrong, the harvest can be very poor and all the money they have invested in planting a crop or catering to the needs of their plants is wasted.

Hands on / research activities

These websites will help students decide what is growing in their summer and winter garden.

Seasonal Food Guide – NSW
http://static.seasonalfoodguide.com/Seasonal%20Produce%20Guide%20-%20NSW%20-%20Rev%200.pdf

Vegie Zones Guide – Gardening Australia https://www.abc.net.au/gardening/vegie-guide-zones/9796680

The Seed Collection (also includes germination time and days to maturity)
https://www.theseedcollection.com.au/Sowing-Chart

https://www.dpi.nsw.gov.au/agriculture/horticulture/vegetables

https://ausveg.com.au/app/uploads/2018/10/Seasonality-chart.png

Research in the NSW Department of Primary Industries

The Central Coast Primary Industries Centre (CCPIC) is NSW Department of Primary Industries Centre of Excellence for Market Access and Greenhouse Horticulture and has been in the service for over 100 years. The site is collocated with the Ourimbah campus of the University of Newcastle, with a further 78 hectares at Somersby Field station.

Research is guided by the NSW DPI's Strategic Plan (2019-2023) and is focused on four major themes- protected cropping, market access & postharvest, food safety and plant biosecurity.

Current research includes greenhouse and production, market access, horticultural food safety, biosecurity, plant biosecurity research and biometrics.

Vocabulary

Greenhouse: Greenhouse, also called glasshouse, building designed for the protection of tender or out-of-season plants against excessive cold or heat. [Link to definition]

Climate variability: the variations in the climate that last longer than individual weather events [Link to definition]

NSW DPI RESEARCH CENTRES

Research and development is a big part of the role of NSW DPI in supporting stronger primary industries now and into the future. In addition to the research centres highlighted throughout the activities. NSW DPI has research centres at:

Armidale

The Armidale Livestock Industries Centre (ALIC) is focused on improving productivity, profitability and sustainability of livestock industries. ALIC researchers have world-leading expertise in livestock genetics, ruminant nutrition and behaviour, greenhouse gas accounting, livestock methane mitigation, meat quality, animal physiology, animal welfare, and technology development and implementation.

Glen Innes

The Glen Innes Agricultural Research & Advisory Station (GIARAS) is the research and development base for the Northern Tablelands of New South Wales. The Station strives to lead and develop a regional hub for science in collaboration that improves the growth of the grazing industries and the wider community on the Northern Tablelands. Research is conducted in the three broad areas of sheep, beef and pastures.

Grafton

The Grafton Primary Industries Institute (GPII) is unique in NSW by providing operational and research functions for agriculture, biosecurity, fisheries and forestry from the one location. Cattle grazing, cropping, timber and fisheries are presently the mainstay primary industries of the Grafton district and these diverse coastal industries are reflected in the wide range of programs at the Institute. Research areas include northern cropping systems, fisheries, weeds, invasive plants and animals, beef, agricultural land use planning, biosecurity and food safety compliance and forestry.

Ebor and Jindabyne

The NSW DPI operates two breeding and rearing facilities for premier cold water sport fish. The Gaden Trout Hatchery at Jindabyne and the Ebor Dutton Trout Hatchery. Fish are bred from hatchery broodstock and grown out to fry (small fish), when they are released into selected cold water public rivers and lakes of NSW. The key research objective at these centres is to understand the effectiveness of stocking hatchery reared rainbow and brown trout in NSW. This includes investigating the role that time (e.g., season) and size at which fish are stocked has on stocking success.

Narrabri

The Australian Cotton Research Institute (ACRI) research activities have played a key role in the development of cotton in New South Wales and Queensland. Scientists at ACRI are assisting the cotton industry to develop a sustainable future based on productivity and best practice natural resource, disease and pest management. Areas of research include cotton pathology and integrated disease management, insecticide resistance management, cotton agronomy, environmental stewardship, weeds and herbicide resistance, soil and water management and summer pulse agronomy.

Port Stephens

The Port Stephens Fisheries Institute (PSFI) is one of the largest specialised aquaculture research facilities in the country, driving excellence for NSW. Research areas include aquaculture research on oysters, marine fish, and nutrition and diet, aquaculture policy and management, freshwater and marine ecosystems assessment, threats, biodiversity and habitat improvement, fisheries resource assessment, aquatic biosecurity, and aquatic environment protection and management.

Trangie

Trangie Agricultural Research Centre (TARC) provides services to the agricultural and pastoral industries, with special reference to western NSW. As well as rangeland management, the centre is renowned for its research in merino and beef cattle genetics, and the development of conservation farming technology.

Global Ag-Tech Ecosystem (GATE)

The GATE is a DPI initiative to fast-track adoption of agricultural R&D to increase productivity. Australian agriculture competitiveness is based on our ability to increase productivity. The GATE enables greater uptake of ag-tech or digital agriculture as a key pathway for industry growth.

SYLLABUS CONNECTIONS

In completing these activities students are working towards the following outcomes:

- STe-3LW-ST explores the characteristics, needs and uses of living things
- STe-6ES-S identifies how daily and seasonal changes in the environment affect humans and other living things
- ST1-4LW-S describes observable features of living things and their environments
- ST1-5LW-T identifies how plants and animals are used for food and fibre products
- ST2-4LW-S compares features and characteristics of living and non-living things
- ST2-5LW-T describes how agricultural processes are used to grow plants and raise animals for food, clothing and shelter
- ST3-4LW-S examines how the environment affects the growth, survival and adaptation of living things
- ST3-5LW-T explains how food and fibre are produced sustainably in managed environments for health and nutrition

PLANT GROWTH TRIALS

To accompany AgPatch: growing literacy posters for secondary schools

Conducting a series of plant trials while students are completing the AgPatch: growing literacy workbook, enables them to observe the impact that changing growing conditions (the variables in the trials) can have on plant growth – and therefore food production. This hands-on learning will help students apply their learning and give them a better understanding of the challenges faced in food production.

Planning for and setting up the trials also provides a good opportunity for students to understand the role of science and the scientific method in research.

Student workbook pages are included at the end of this document / section.

Fair test

A fair test is one where the results (in this case, the difference in growth rate) are due to changing one aspect of the growing environment (variable). In a fair test, one variable is changed while all other variables remain the same as the control. Any differences can then be attributed to that one changed variable.

For example, if students are to be asked to draw conclusions about the quality of soil for growing plants. The soil is changed but all other variables including sunlight, water or temperature remain the same as the control plant/s. You can then say which soil was better or worse for plant growth.

You must have a control. This will be a plant – or group of plants - that all the other plants will be measured against. More information about fair tests and what you can expect of your students in planning this investigation is in the skills continuum of the NSW Science and Technology syllabus (2017). The plants that vary from the control are called treatments. In this trial you will have a treatment that receives no water, another treatment receives no sunlight and another treatment is planted in a different soil.

Materials

To prepare for the plant trial you will need:

- A set of plants and seeds - divided into groups for the different plant trials.
- Growing medium for seed germination (cotton wool would work but sand also works well).
- Pots or garden beds – these need to be able to be manipulated to ensure you can meet the requirements of a fair test.
- Different soils.

Seed germination trial

This trial assesses the impact of different conditions on seed germination. This is relatively easy to complete using seeds like alfalfa (lucerne), wheat or a sprout mix in cotton wool or a sprout tray. Discuss with students ways that you can ensure that this investigation reflects the rules for a fair test in planning for the plant trials.

Remember, all treatments will be measured against the control group. For each variable you need to have replicates of at least two groups of seeds (to reduce the chance of random events, for example infertile seeds, skewing results). Ideally you would have four to five groups of seeds for each variable plus the control

1. Allocate the same number of seeds to each treatment and the control group.
2. Place all trays in the same growing location.
3. Mark the groups that form the control group and those that will be deprived of sunlight (ensure you block the sunlight in a way that does not change the temperature) and those that will receive no water.
4. Maintain the seeds for the duration of expected germination (usually stated on the seed packet).
5. At the completion of the trial calculate the percentage germination for the individual treatments.
6. Discuss with students the impact of limiting sunlight and water on seed germination.

Plant growth trials

These trials assess the factors that affect plant growth. The easiest way to set this up is to buy seedlings but you can grow your own from seed if you have time. Again, you will need at least two plants for each treatment but ideally five.

The choice of plant depends on your weather and climate, time of the year you are planting and where you will grow them. Check what is in season for your region at the time you plan to run the activity here https://www.aboutthegarden.com.au/seasonal-gardening-australia-vegetable-garden-by-temperate-regional-zone/.

- Set up enough pots (paper-based are fine for this eg jiffy pots) for each of the following treatments:
  - Control
  - No sunlight
  - No water
  - Different soil.
- Discuss with students ways that you can ensure that this investigation reflects the rules for a fair test in planning for the plant trials.
- Maintain the plants for the duration of the trial.
- Measure the growth of each plant at regular intervals during the trial, at least weekly.
- Discuss with students the impact of limiting sunlight and water, and different soils can have on plant growth.

Soil organisms

Assessing soil organism activity using the same soil as the soils used for the plant trials will allow students to comment on the presence of soil organisms in reference to the plants in the trial. If you don't have easy access to the soil from the plant trial you can still complete this activity but it cannot form part of the discussion of plant growth in the trial.

The cotton industry and University of New England run a Soil Your Undies challenge to assess the activity of soil organisms in soils around Australia. The website for this is https://stage.cottoninfo.com.au/soil-your-undies and for those who are interested in participating in the challenge it can be found here https://www.unediscoveryvoyager.org.au/soilyourundies/.

Soil organism activity can also be viewed using cotton strips – the instructions below are also included on page 11 of the student workbook.

Cotton strip trial

This test is only effective for soils in situ.

1) Bury strips of white cotton or calico approximately 5cm wide and 20cm long in the soil, with one end of the strip left above the soil (so it can be found again).
2) Eave the strips in place for about four weeks
3) Remove strips from soil. The decay of the strip is evidence of soil organism activity. If there is no decay there is limited soil organism activity.

Seed germination trial

Introduction

What are we going to investigate?

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We are investigating this because:

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Prediction

What do we think will happen? Explain why.

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Method

What we are going to do: .....

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Fair test

Treatment	We are going to change:	We will keep these the same:	We are going to measure:
Sunlight			
Water			
Temperature			

How are these fair tests?

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Diagram of the set-up (include labels)

Results

What did you observe?

Control: .....

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Less water: .....

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Low sunlight: .....

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Temperature:

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Conclusion

How does this apply to growing plants?

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Plant growth trial

Soil

Consider the different soils you have for the trial. Write a description of the different soils, what differences can you see?

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Record the colour of each of the soils you are using and what that could mean for how the soil performs. Make sure the soil is dry for this.

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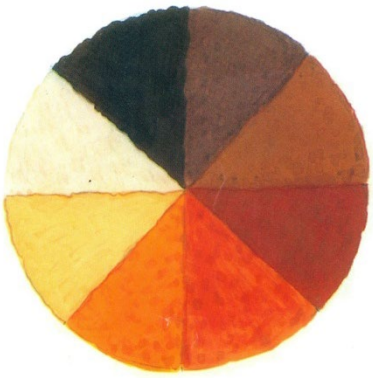

colour

Pale colours generally indicate low fertility. Darker colours usually indicate high levels of organic matter. Red colours indicate the presence of oxidised iron (rust) which means the soil is well drained and well structured. White, pale grey and pale green colours may indicate waterlogging. Mottled soil colours may indicate intermittent waterlogging.

Prediction

Which soil will be better for growing plants for food. Why?

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How will the following impact plant growth?

Not enough water:

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Too much water:

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Not enough sunlight:

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Temperature:

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Method

What we are going to do: .....

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Fair test

Treatment	We are going to change:	We will keep these the same:	We are going to measure:
Sunlight			
Water			
Temperature			

How are these fair tests?

.....

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Diagram of the set-up (include labels)

Record the differences between the seedling(s) that have been receiving sunlight and the ones that haven't. Make measurements and observations to record the effect.

Record your observations and measurements here:

Results

What did you observe?

Control: .....

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Limited water: .....

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Low/no sunlight: .....

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Different soils:

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Which soil grew stronger plants? Is this what you predicted? .....

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Temperature:

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Conclusion

What do these results tell you about growing plants?

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