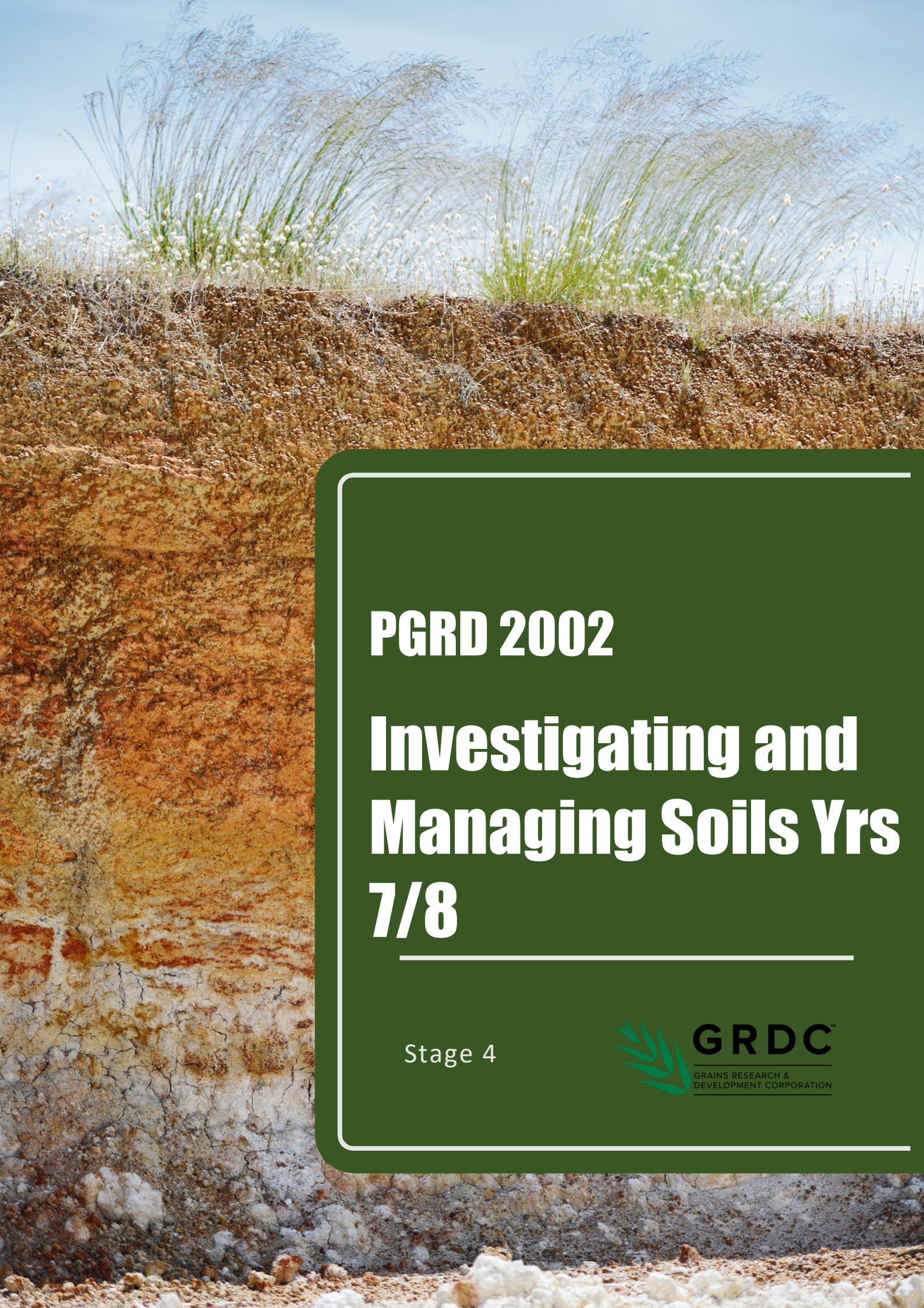


PGRD 2002

Investigating and Managing Soils Yrs 7/8

Stage 4

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

Unit Instructions for Students

INVESTIGATING SOILS

YEARS 7/8

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

The growth and survival of living things are affected by physical conditions of their environment (ACSSU094)

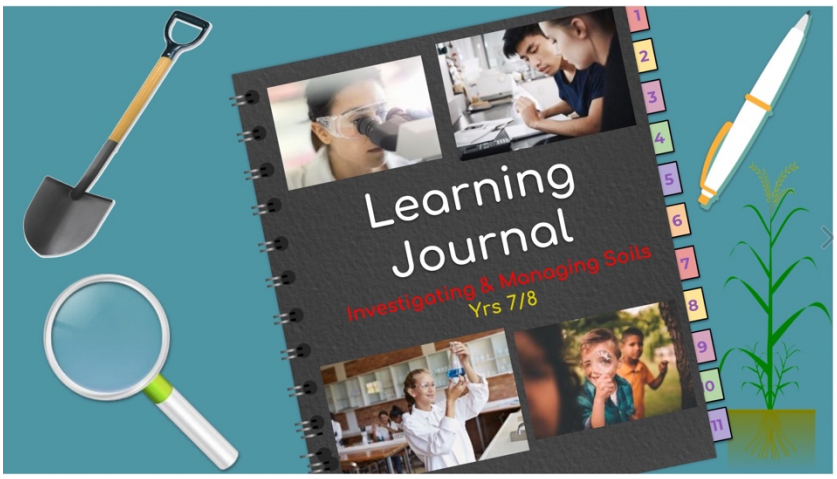
This online course has a number of individual activities or tasks that you MUST complete and submit to your teacher. These tasks form an important part of your final grade.

NOTE: *You should contact your teacher to confirm how they want you to submit your work.*

In each lesson, students will be asked to reflect on and record their learning in the learning journal, which they can submit to their teacher at the end of the course as evidence of understanding and progress. Click on the following link to access the learning journal:

Save Learning Journal to Your Computer:

- PowerPoint: LearningJournal-InvestigatingManagingSoils.pptx



The learning journal can be used in the following ways. Students may choose to:

- Save the PowerPoint document in the Google Drive. The document can be opened and edited at any time in Google Slides. Changes will be saved automatically. At the completion of the online course, students can email their teacher with a link to their learning journal as evidence of work completed.

- Save the PowerPoint document on the computer. The document can be opened, edited and saved at any time. At the completion of the online course, students can email their teacher with the PowerPoint document attached as evidence of work completed.
- Open the PowerPoint document, download and print the pages. Record learning with hand-written responses. At the completion of the online course, students can submit the hard copy of their work to their teacher as evidence of work completed.

To complete this unit, you need to complete all of the lessons, videos and tasks.

NOTE: A certificate is issued as soon as you complete all lessons within your course! You will need to make sure to click **Complete & Continue on every lesson to reach 100% completion.** After that, you can simply click **Get Your Certificate** to download it as a PDF.

Enjoy learning all about soils!

Instructions for Teachers

The table below outlines the content and structure of the course, with links to the Australian Curriculum.

Students will need access to the Internet to follow links so that they can answer the questions in each of the lessons. They should record their answers in a document for marking. Marking could be completed as a class group to encourage discussion about the results.

Lesson	Learning Content	Australian Curriculum links
1	Visually Investigate Soil	ACSHE136 ACTDEK032
2	Soil Texture	ACSHE136 ACTDEK032
3	Soil Chemistry	ACSHE136 ACTDEK032
4	Soil pH	ACSHE136 ACTDEK032
5	Testing Soil pH	ACSHE136 ACTDEK032
6	Improving Soil Nutrients With Fertiliser	ACSHE136 ACTDEK032
7	Precision Agriculture	ACSHE136 ACTDEK032

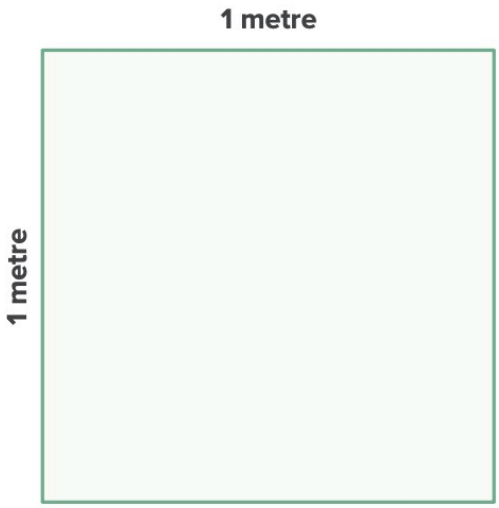
Living Soils - Activities Overview

In this section, you are going to complete a set of tasks on a square metre of ground where you can dig up the soil.

If you're at school, divide into groups consisting of two to five students. Each group should choose a different area and soil type from within the school to investigate (e.g., the sand pit, vegetable garden, school oval, under trees).

If you're working at home, pick an area of your own choosing.

Using a ruler, map out a one metre by one metre quadrant. This is your study site. If you're allowed, you can use pegs with string running between them to show the boundaries of your area. You could also mark the corners with paint dots or another method of your choosing. Just make sure you can clearly see your square.



There are six activities you can do with soil from this site:

1. Visually investigate soil texture
2. Classify the soil texture
3. Learn about soil chemistry
4. Determine the pH
5. Improving soil nutrients with fertiliser
6. How does precision agriculture help build better soils?

Each of these activities is explained in detail as you move forward.

Visually Investigate Soil Texture

Lesson 1

Soil is made of three main particle sizes – sand, silt, and clay. The texture of the soil depends on the amount (ratio) of each of these particles it contains.

 Sand is the largest particle; these particles are 0.05-2 mm in diameter.	 Silt is the mid-size particle; the diameter of these are 0.05-0.002 mm.	 Clay is the smallest of the soil particles. The diameter of clay is less than 0.002 mm.

Soils are put into texture classes by the way they feel and respond when you handle them.

- Sand feels gritty and the grains do not stick together when squeezed.
- Silt feels velvety or like flour when dry and forms a “ribbon” when wet.
- Dry clay feels smooth; clods are very hard and difficult to crush by hand. Wet clay feels sticky or smooth.

Activity

Equipment

- 3 ice cream containers or small buckets
- Clean white pieces of A4/A3 paper
- Spade
- Magnifying glass &/or dissection microscope
- Notebook
- Pencil
- Computer / Tablet

Experiment

- Collect three different samples of soil from around your home/school. Try under a tree, a bare patch and perhaps a garden. Remove any loose leaves or other material from the soil surface before collecting your samples.
- Take a photo of each collection point.

- Put one handful of soil on your sample mat (i.e., your white piece of paper).
- Spread the soil thin so that you can observe it closely.
- Use the magnifying glass to look at the sample of soil. Record your observations in a notebook.
- Now place a sample of soil under a microscope (if you have access to one). Draw what you see.
- Repeat with each soil sample.
- Fill in what you recorded in your notebook.
- Open your learning journal & record your answers. Include your photos.
- Save the file.

Hand lens	Hand lens	Hand lens
Microscope	Microscope	Microscope

HINT:

When you are looking at your soil consider their different properties. Properties are characteristics or attributes that describe matter. The properties you should consider are:

- Texture: This considers the composition of the soil. Is it made up of mainly sand, a silt, clay, or organic matter? The composition determines the look and feel of the soil.

- Living organisms: What can you see in the soil which might be living?

- Colour: What colour is it? (Fun Fact! Geologists officially recognise over 170 different soil colours).

Usually (but not always), the darker a soil, the more nutrient rich it is. The darker colour indicates an increase in decomposed organic matter (humus).

Classify Soil Texture

Now that you have taken an initial look at your soil, it's time to classify it. Use the "Field Texture of Soils" table below and the soil texture triangle to classify your three soil samples.

1. Take a handful of your soil and wet it (add the same amount as you would to make a scone dough).

2. Work through the steps outlined in Table A and B.

3. Using the soil texture triangle (Table C below), work out where your soil fits. This enables you to define your soil type.

4. Open your journal and record what each sample came out as.

SAMPLE 1: Texture =
SAMPLE 2: Texture =
SAMPLE 3: Texture =

5. Save your results into your portfolio.

A. Field Texture of Soils table

Field Texture of Soils

STEP 1: Take a handful of soil and wet it (add as much water as you would when making a bread or scone dough).	**Length of Ribbon**	**Texture Grade**	**Approx. Clay Content**
STEP 2: Try rolling the soil into a ball... What happens now gives you a clue to the soil texture (i.e. what % of clay, silt, sand and organic matter)			
• Ball is smooth and feels like plastic. When handled feels like rigid plasticine and can be moulded into rod without cracking.	>75mm Firm resistance when made into ribbon	**Heavy Clay**	>50%
• Ball is smooth and feels like plastic. When handled feels like plasticine and can be moulded into rod without cracking.	>75 mm Moderate resistance when made into ribbon	**Medium Clay**	45 – 55%
• Ball feels like plastic. Smooth to touch	Approximately 75 mm Moderately hard to mould into ribbon	**Light medium clay**	40 – 45%
• Ball feels like plastic. Smooth to touch	50 – 75mm Can be a little hard to mould into ribbon.	**Light Clay**	
• Ball feels like plastic. Small to medium grains of sand can be seen and felt in clayey texture when made into a ribbon.	50 – 75mm	**Sandy clay**	35 – 40%
• Holds together well, feels smooth. When moulded into ribbon feels plastic and often silky to touch.	40 – 50mm	**Silty, Clay Loam**	
• Hold together well, feels plastic like. Medium size grains of sand can be seen	40 – 50 mm	**Clay Loam, Sandy**	30 – 35%
• Hold together well, feels plastic like. When made into ribbon feels smooth.	40-50 mm	**Clay Loam**	<30%
• Holds together strongly, sandy to touch, medium grains of sand	25 – 40 mm	**Sandy Clay Loam**	
• Holds together, when made into a ribbon feels smooth to silky	Approximately 25mm	**Silty Loam**	
• Holds together well and feels spongy. When made into ribbon feels smooth. Does not feel very sandy. Sometimes feels greasy if has a lot of organic matter (e.g. broken down leaves).	Approximately 25mm	**Loam**	25%
• Holds together but sandy, medium sized grains of sand and can be seen easily	Small ribbon of approximately 5 – 25mm	**Sandy Loam**	10 – 20%
• Holds together slightly, sticky when wet, lots of sand grains stick to fingers, clay stains hands	Small ribbon 5 – 15mm	**Clayey sand**	5 – 10%
• Holds together slightly	Small ribbon of approximately 5mm	**Loamy Sand**	
• Ball easily breaks down, cannot be moulded, singular grains of sand stick to fingers	Cannot be made into ribbon	**Sand**	< 5%

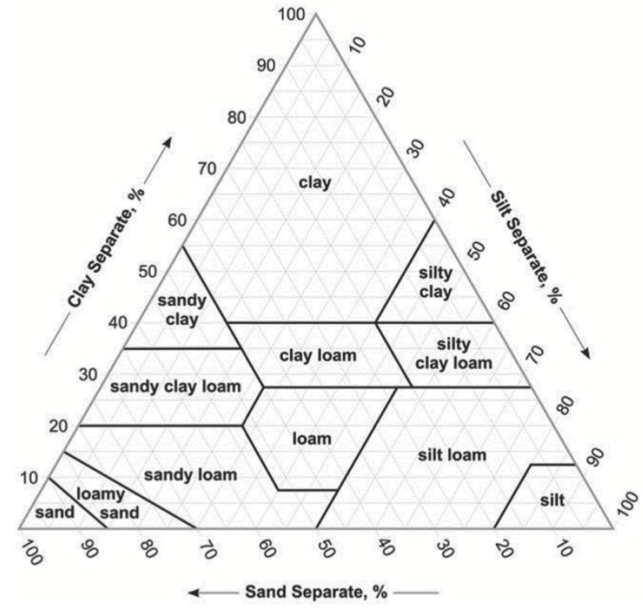
Source: SoilQuality.org.au & Dr Katharine Brow

B. This diagram explains how you can better understand what type of soil you have by how it reacts when you mould it in your hands.

Soil texture	Description	Shape	Constraints
Sand	The soil stays loose and separated and can only be accumulated in the form of a pyramid.	A	• low water-holding capacity; seedlings can wilt because of a rapidly drying soil surface • low nutrient retention; excessive leaching of nutrients (particularly nitrate, potassium and sulphate) • acidity • extremely low phosphorus fixation • low organic matter content.
Sandy loam	The soil contains enough silt and clay to become sticky and can be shaped into a fragile ball.	B	
Silty loam	Similar to the sandy loam, but the soil can be shaped by rolling it into a small, short cylinder. Soil has a 'silky' feel.	C	• hard-setting/surface sealing if texture is fine sandy loam or silty loam • prone to compaction.
Loam	Can be rolled into a 15 cm long (approx.) cylinder that breaks when bent.	D	
Clay loam	Similar to loam, although the cylinder can be bent into a 'U' shape (without forcing it) and does not break.	E	
Fine clay	The soil cylinder can be shaped into a circle, but shows some cracks.	F	• excessive/prolonged wetness • prone to compaction.
Heavy clay	The soil cylinder can be shaped into a circle without showing any cracks.	G	

[2] Alternatively, you could include texture as a test in your next laboratory soil analysis.
[3] Adapted from EUROCONSULT (1989).

C. The Soil Texture Triangle



Source: USDA http://www.nrcs.usda.gov/

Soil Chemistry

Plants require nutrients which are essential for successful growth and optimum yields. Without their presence, the consequences can range from stunted growth, leaf discolouration and loss of fruiting bodies, all of which lead to reduced crop yields.

Three of the most important plant nutrients are nitrogen, phosphorus, and potassium. Because plants need them in large quantities, they are called macronutrients.

Some nutrients are only required in very small amounts, known as micronutrients. Nonetheless, if these are missing in the soil, plants will suffer. Some examples include copper, iron, and zinc.

Plants mainly take up nutrients in their mineral or inorganic forms. So organic fertilisers must be decomposed before they become available to plants. Most large-scale farmers apply man-made inorganic fertilisers which are more concentrated and rapidly available to plants.

1. Open your journal.

2. Using **Google**, answer the following questions & record your answers.

- Search for "common fertilisers" and research their ingredients. Make a list of five fertilisers and their top five ingredients. Do they have anything in common that you can deduce?
- Search for "plant macro nutrients" and "plant micro nutrients". Make a table to list 10 of these plant macro and micro nutrients. Describe what each one does to help the plant grow.
- What symptoms would you see in plants if there was a nitrogen deficiency? Can you find a simple experiment to test this? Copy the instructions into your document.

3. Save your answers to your learning journal.

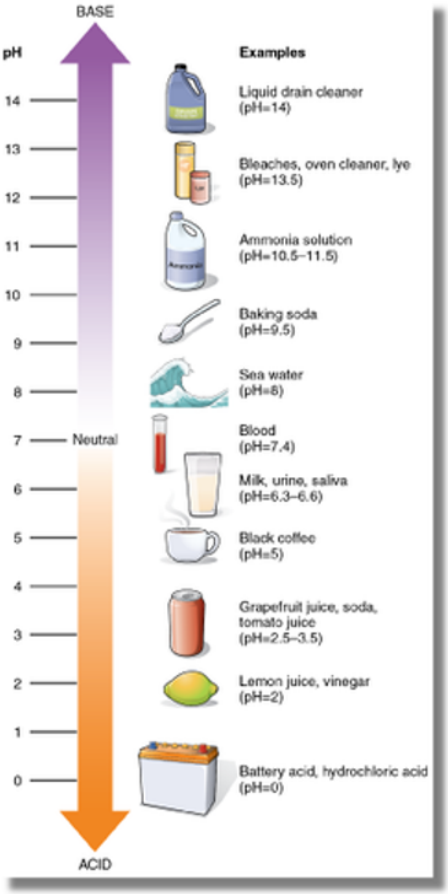
Soil pH

Soil chemistry is another set of soil characteristics which have an important impact on plant growth. Specifically, the pH of a soil (a measure of acidity or alkalinity) can influence a plant's health by affecting root growth and its ability to absorb nutrients.

The pH of a soil can also affect cereal crop growth and productivity. Many areas throughout Australia's wheat belt have varying soils, so knowing its pH is important for a management plan to be developed.

Some points about soil pH:

- Soil pH is a measure of the concentration of hydrogen ions (acid) dissolved in the soil water. The pH scale ranges from 0 to 14 (see image below)
- Most plants prefer a neutral soil with pH between 6 and 8. Soils with pH above 8 are basic or alkaline. Soils with pH below 6 are acidic.
- Plants can be sensitive to soil pH – acidic or alkaline soils need to be carefully managed to improve plant growth and development.
- In most agricultural systems, the removal of alkaline plant and animal products results in the accumulation of acidity in the soil. Therefore, most agricultural soils become more acidic overtime.
- Lime can be added to acidic soils to help neutralise the acidity.



Testing Soil pH

It is possible to test the pH of a soil using a soil pH test kit. In the activity below, determine the soil pH of the three soils.

MATERIALS

- 3 soil samples taken from same places as your earlier samples
- Manutec pH test kit (available at garden stores for about $15) or similar.
- 3 250 ml beakers or clear plastic cups
- Marker pen
- 3 clean plastic dessert spoons
- Waste cup
- Notebook / pen
- Journal / computer / tablet
- Paper towels

PROCEDURE

Gear up! Perhaps you can wear lab coats and safety glasses. Try a dust mask if needed.

If you're in a classroom, work in teams of two to collect three different soils from your local environment. Collect samples in a clean container. Ensure each container is labelled with the date and location of the sample. It is good practice to have a map and mark your sample collection points on a map. You will also need a control; in this case it is ok to use distilled water which should be neutral.

1. Prepare the soil.

- Label three beakers/cups as “A”, “B” and "C".
- Using a spoon, place a level spoon of soil A into beaker A. To avoid cross-contamination of the soils, leave this spoon in the beaker.
- Using a new spoon, place a level scoop of soil B into beaker B. Leave the spoon in the beaker.
- Using a new spoon, place a level scoop of soil C into beaker C. Leave the spoon in the beaker.
- Using your fingers, remove all of the organic matter that you can from the soil (roots, bark, leaves etc).

2. When you have finished cleaning your soil proceed with measuring the pH of each of the samples. Watch this video to see how: Soil pH Testing

3. Measuring the pH of your samples.

- Watch the video above.
- Carefully complete the pH test on each sample beaker - A, B and C.
- Note the pH reading by comparing the colour card to your test samples.
- If the reading is stable, simply record the pH value for each in your notebook.

4. Clean up your experiment equipment and dispose of your samples safely.

5. Process your data

- Open your notes ready to transfer to your computer / tablet.
- Open your journal.
- Using the results you wrote in your notepad, record your answers to the following questions.

Are the soils acidic, basic, or neutral?

a. SOIL 1: pH a/b/n
b. SOIL 2: pH a/b/n
c. SOIL 3: pH a/b/n

- Take a photo of your 3 test strips to include in your journal.
- Save your journal.

EXTENSION ACTIVITY

Research how farmers adjust the pH of soils. Design an experiment to test the effectiveness of their methods.

Improving Soil Nutrients With Fertiliser

The amount of nutrients in agricultural soils declines over time unless the nutrients removed by plants and animals are replaced using fertilisers. Grain growers and other farmers must continually test their soil to ensure sustainable high-quality grain production. Paddock records, including grain yield and protein levels, fertiliser tests areas, crop monitoring, and soil and plant tissue tests all assist in monitoring nutrient uptake and achieving better crop results.

Although rotations with crop and pasture legumes play an important role in maintaining and improving soil nitrogen, fertilisers remain the major source of nutrients to replace nutrients removed in farm products. Fertiliser programs must add a balance of the required nutrients to help grow the best crop.

The amount of grain produced in a crop may be limited by the nutrients supply from the soil. Poor crop growth is often linked to a deficiency in a range of nutrients.

Fertilisers are a major expense for most farmers, so they need to manage their inputs carefully to optimise yields and costs.

How Do We Work Out How Much Fertiliser?

As you will see in the scenario below, there's a surprising amount of maths involved in using fertilisers on a farm. You can work in teams or individually for this next activity. You'll need to show your working and how you came up with your answers.

1. A farm is growing several paddocks of wheat with a total area of 601 hectares. According to soil and plants tests, the wheat needs 30kg of urea per hectare to ensure it has adequate nitrogen levels. What is the total weight of urea needed for all the wheat paddocks?

2.If urea comes in 1,000 kg bags, how many bags will the farmer need to fertilise all the wheat?

3. To add urea to the crop, it needs to be applied from an aircraft. If the aircraft can carry up to 3.5 tonnes of fertiliser in each flight, how many flights will it take to fertilise the crop? Remember 1 tonne = 1000 kg.

4. The farm has been unable to purchase urea, and instead plans to apply 40L per hectare of the liquid fertiliser urea ammonium nitrate to their wheat using a boomspray. If urea ammonium nitrate comes in 1000L containers, how many containers will they need to order?

5. Urea ammonium nitrate needs to be diluted with water before being applied. If the ratio of the mix is 40L of fertiliser plus 20L of water, how many litres of water will the farm need to spray their wheat crops?

Make sure you include your answers and working in your journal for marking.

What is Precision Agriculture?

Traditionally, farmers managed each paddock as one uniform unit with blanket applications of seed, fertiliser, herbicides and other inputs. But soils can be highly variable, with areas of poor, average and good growth within a paddock.

Farmers are embracing science and technology to make their farm management more precise, by closely monitoring weather, soil, and crops and using this information to vary their inputs at different sites within a paddock. This is known as precision agriculture using variable rate technology.

In these variable situations, the amounts of fertilisers and other inputs need to be varied in different parts of the paddocks to maximise crop growth and yield and economic returns.

Variable Rate Technologies

Variable Rate Technologies are based on the principle that not all fields are uniform and therefore crops & soils should not be managed uniformly. VR tech allow inputs such as fertiliser, lime, irrigation and pesticides to be applied at different rates across a field and are increasingly being used in vegetable production.

Watch: https://youtu.be/rBGeEa-4ZFM

Drones & GPS Technology

Farmers are increasing their use of information technology such as GPS systems and a wide range of sensors, robotics, drones, autonomous vehicles and internet connected software to get better results from their farm operations.

Watch the following two videos to get a better understanding of precision agriculture.

Soil Mapping

Monash University engineers are working with Australian farmers to help them improve irrigation practices by using autonomous drone technology.

Watch: https://www.youtube.com/watch?v=3H24zXrYa0s

Weed Management

Weeds cost grain growers an estimated $3.3 billion every year in control costs and lost revenue. Precision agriculture enables the use of non-chemical alternatives in paddocks without disturbing the soil too much. The Weed Chipper is fitted with sensors that detect weeds and trigger individual tynes to rapidly chip out the weeds.

Watch: https://youtu.be/PvfXT4nEgFA

Activity

1. Using the Internet, find images of precision farming in action.

2. Using your computer or a sheet of paper, create a poster displaying images of over 20 different applications of precision farming.

3. Label each image and add a sentence explaining what is happening.

4. Add the final montage to your journal as a photo or file.

Checklist of Activities

This online course has a number of individual activities or tasks that you MUST complete and submit to your teacher. Here is a list of tasks to tick off against your portfolio to ensure you've included everything:

Living Soils Activities

- Visually Investigate Soil
- Soil Texture.
- Soil Chemistry
- Soil pH
- Testing Soil pH
- Improving Soil Nutrients With Fertiliser
- Precision Agriculture

NOTE: *You should contact your teacher to confirm how they want you to submit your work.*

You will need to use the file: LearningJournal-InvestigatingManagingSoils.pptx that includes all of your assessment files. Make sure that you include *all text, drawings, tables, brainstorms, farm model photos*, *etc* that are asked for in the tasks. Once you have completed all of the activities, you will need to upload this **one (1) file** to your teacher for marking.

It is your choice what software you will use to build your learning journal. We recommend:

- Microsoft PowerPoint

Other tools you could use to present your portfolio include:

- Keynote
- Pages
- Google Slides

To complete this unit, you need to complete all of the lessons, videos and tasks.