

# THE IMPORTANCE OF SOIL FOR GROWING GREAT GRAIN

EXPLORING SOIL MAPPING AND SOIL MANAGEMENT FOR HEALTHY  
FARMING SYSTEMS



**GRDC**

GRAINS RESEARCH  
& DEVELOPMENT  
CORPORATION

A TEACHING UNIT  
FOR YEAR 9 & 10  
GEOGRAPHY STUDENTS



# About the GRDC

## The GRDC

The Grains Research and Development Corporation is a statutory authority established to plan and invest in research, development and extension (RD&E) for the Australian grains industry.

Its primary objective is to drive the discovery, development and delivery of world-class innovation to enhance the productivity, profitability and sustainability of Australian grain growers and benefit the industry and the wider community.

Its primary business activity is the allocation and management of investment in grains RD&E.

## GRDC Vision

A profitable and sustainable Australian grains industry, valued by the wider community.

## GRDC Mission

Create value by driving the discovery, development and delivery of world-class innovation in the Australian grains industry.

## GRDC Values

- We are committed and passionate about the Australian grains industry.
- We value creativity and innovation.
- We build strong relationships and partnerships based on mutual trust and respect.
- We act ethically and with integrity.
- We are transparent and accountable to our stakeholders.

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# 1.0 Teaching the science of grains



The Grains Research and Development Corporation has invested in the development of a suite of user-friendly grain education resources and initiatives for students, teachers and families.

These resources have been developed with teacher and researcher input and have been designed following a comprehensive survey of more than 340 teachers throughout Australia.

In each of our curriculum-linked resources, we have worked to incorporate a range of lesson plans which explore the latest science, technology, engineering, mathematics, nutrition, research and innovation in the Australian agricultural industry. You can use these resources as a unit or select components to complement your teaching plan.

Using an investigation and inquiry based approach students will touch, try, taste and even smell the science of the Australian grains industry. It provides an ideal and relevant teaching context to engage students in food production.

Specifically, resources are available to address the food and fibre curriculum descriptors in geography, science, home economics and agriculture.

We hope you have fun teaching with these resources. Please contact us for more information.

Kind regards

**The GRDC Education Team**



# 2.0 Learning outcomes and curriculum links

## About the importance of soil for growing great grain

Below the earth's surface lies the problems and solutions to growing great grain in Australia. The soil health and quality is imperative to the success of every crop and the soil has many roles - storing nutrients, filtering and holding water, regulating the climate through carbon storage and housing two-thirds of the Earth's species. Australia faces a big challenge in soil quality due to numerous factors such as drought and salinity and varying profiles across regions. We need to know as much as possible about the soils to assist in our management of and applications onto the land.

Our farmers, researchers and scientists are working hard to understand the geological structures of the land which influence the soil characteristics, the chemical, physical and biological properties of soil and best management practices to improve and maintain its health. The Grains Research and Development Corporation is supporting research and development which ensures good soils and growing good food. The health of a crop is a useful indicator of the soil's health.

## Overview

Using exploration of the environment and ICT, this resource engages students in researching soils, geological data and the importance of soil health and monitoring to Australian crop production. Students are asked to use methodologies such as soil profiling and mapping, which are representative of those used within the grains industry. Students will assess past and present soil data and conduct a comparative study to strengthen their understanding of numeracy in farming. Practicals emulate in-field tests for soil, with inquiry and reporting skills utilised.

## Curriculum focus

Students should be able to

- Engage in systems thinking by looking at the interactions between the environment and use of the land for economic factors.
- Recognise the challenges of producing food in Australia, particularly those relating to soil.
- Examine patterns of change over time in the way land has been used.
- Through inquiry based learning, investigate the geography of the local environment.
- Examine findings and present to other students for comparison.

## Australian curriculum content descriptions

### Geography

#### Geographical knowledge and understanding

##### Year 9

##### Biomes and food security

Challenges to food production, including land and water degradation, shortage of fresh water, competing land uses, and climate change for Australia and other areas of the world (ACHGK063).

Environmental, economic and technological factors that influence crop yields in Australia and across the world (ACHGK062).

##### Year 10

##### Environmental change and management

The application of human-environment systems thinking to understand the causes and likely consequences of the environmental change being investigated (ACHGK073).

#### Geographical inquiry skills

##### Year 9 and 10

##### Observing, questioning, planning

Develop geographically significant questions and plan an inquiry that identifies and applies appropriate geographical methodologies and concepts (ACHGS063) (ACHGS072).

##### Communicating

Present findings, arguments and explanations in a range of appropriate communication forms selected for their effectiveness and to suit audience and purpose, using relevant geographical terminology and digital technologies as appropriate (ACHGS070) (ACHGS079).

##### Reflecting and responding

Reflect on and evaluate the findings of the inquiry to propose individual and collective action in response to a contemporary geographical challenge, taking account of environmental, economic and social considerations; and explain the predicted outcomes and consequences of their proposal (ACHGS071) (ACHGS080).

# 3.0 Teaching unit content and overview

This resource contains a range of curriculum-linked lesson plans which teachers can cut, paste, and utilise as they see fit. Our team work to develop resources which are interactive, fun and fit into your busy teaching schedule. The below table summarises the wide modes of engagement strategies including activity supported insights, exploring critical and lateral thinking and inquiry. You can use some of these lesson plans or all. Whatever you do, we hope you have fun teaching your students about the role of soils and their management in growing great grains.

<b>PAGE</b> <b>8</b>	<b>4.0 Introduction</b> Toil with soils	Before reading through the insight, ask the students to list some of the important roles of soil, e.g. production of biomass and maintaining biodiversity. Provide historical imprint of the past land formation and processes. Storage and filtering of water. Cycling nutrients. Storing carbon.
	<b>Watch</b>	As an additional introduction to soils, view this segment from ABC Landline which looks at soil in Australia and the challenges faced by farmers. 'Soil Secrets', ABC Landline, Prue Adams, November 2012 <a href="http://www.abc.net.au/landline/content/2012/s3630158.htm">http://www.abc.net.au/landline/content/2012/s3630158.htm</a>
	<b>Article</b>	This article provides a great introduction to soils for students: 'The Secret Life of Soils', E-Science Magazine, Issue 15 Oct 2015 <a href="http://escience.realviewdigital.com/?iid=129651#folio=24">http://escience.realviewdigital.com/?iid=129651#folio=24</a>
<b>PAGE</b> <b>9</b>	<b>Career scope</b>	The article's author and soil scientist Associate Professor Tim Cavagnaro is profiled.
<b>PAGE</b> <b>10</b>	<b>5.0 Insight</b> Soils of Australia & Horizon and Soil Type Overview	Engage students in thinking about the diversity of soil and land use in Australia. Students are also provided with information about horizons and soil classifications which will assist them in the tasks which follow.  <i>*In this context the word fibre relates to the production of commodities such as wool and cotton.</i>
<b>PAGE</b> <b>13</b>	<b>6.0 Activity</b> Grains of soil	Ongoing research and investigation helps us to better understand human-environment systems thinking. Use this activity as a colour worksheet and/or project the two maps for students to assess.  Further information: James Prescott was an agricultural chemist whose studies took him from England to Germany and Egypt before arriving in Adelaide in 1924. At the Waite campus of the University of Adelaide, Prescott held the position of Professor of Agricultural Chemistry and also Foundation Chief of the Council for Scientific and Industrial Research (CSIRO) division of soils. After researching salinity and water-logging in the Murray and Murrumbidgee river area, Prescott identified a need for an assessment of the continent to effectively plan the use of Australian resources.  Discover more about Prescott here <a href="http://www.csiropedia.csiro.au/display/CSIROPedia/Prescott%2C+James+Arthur">http://www.csiropedia.csiro.au/display/CSIROPedia/Prescott%2C+James+Arthur</a>  ASRIS – Australian Soil Resource Information System. More maps at <a href="http://www.asris.csiro.au">www.asris.csiro.au</a>
<b>PAGE</b> <b>16</b>	<b>7.0 Activity</b> Getting the dirt on soil	Read through the introduction and show Video 'Soil and landscape grid of Australia' <a href="http://www.clw.csiro.au/aclep/soilandlandscapegrid/About-Video.html">http://www.clw.csiro.au/aclep/soilandlandscapegrid/About-Video.html</a>  Students are to complete the Soil Grid Report Card task using the website <a href="http://www.clw.csiro.au">www.clw.csiro.au</a> . This is to be completed individually or in pairs with students assigned the same or different areas to investigate. This activity could also promote oral communication skills by asking students to present their report card to the class and comparatively discuss the best areas for this farmer to grow grain.

PAGE 18	<b>8.0 Practical</b> Practical investigations	<p>These practicals can be used individually or as a set to create a report.</p> <p><i>*Note: If students will complete all the practicals, they will need to be able to calculate the size of a plot, e.g. if soil sample comes from the school oval they will need to calculate its approximate total area to complete the report.</i></p> <p><i>If an oval shape, use ellipse calculation <math>Area = \pi * A * B</math></i></p> <p><i>'A' being from the centre of the oval to the longest point and 'B' being from the centre of the oval to the shortest point.</i></p> <p>GPS: Emulate geographical surveying by discussing with students the importance and benefit of using GPS to record sample locations. Smartphones have the ability to show GPS coordinates if the location services are switched on. There are also websites that can be accessed. <a href="http://www.gps-coordinates.net/">http://www.gps-coordinates.net/</a></p>
	<b>Extension</b>	<p>If you have an area at school which you would like students to use for the following exercises, smartphones or devices can be used to plot a map of the specific area along with geotagged notated photographs. Students will need to ensure location services on their device are active.</p> <p>Apps which use satellites to track movement and plot on a map are great for this exercise as it emulates what can be practised by a consultant or by machinery in a grain paddock. Example apps include MyTracks or Strava.</p> <p>Students can walk out their plot and track their path using the app. They can also take photos of areas of interest and geotag them by adding GPS coordinates to the photo information or photo tag. Encourage students to take notes on points of interest and if used in partnership with any of the practicals within this resource, where they took their samples from. This is a basic activity which could allow for a homework task or flipped classroom scenario. <i>An example can be found Appendix A.</i></p>
PAGE 19	<b>8.1 'Soil texture'</b>	Students will need to be provided with or supply their own sample of soil. For the texture practical, ask students to collect a sample from the topsoil and from a below horizon.
PAGE 22	<b>8.2 'Soil profile'</b>	<p>Students can repeat the experiment for each sample of soil from each horizon.</p> <p>Soil scientists recommend assessing soil texture with bare hands however gloves should be offered to students for precautionary measures and/or hand hygiene practices implemented. Ensure that students add enough water to their soil.</p> <p><i>*Safety: Sample should not come from an area which is at risk of contamination.</i></p>
PAGE 24	<b>8.3 Acid or base</b>	<p>Discuss with students their understanding of the pH scale ensuring they recognise acids and bases. Students are to read through the introduction and discuss as a class, followed by students comparing the maps 'Soil acidification in Australia' and 'Australian wheat belt'. Kits and probes for testing soil pH may be available in the school science department or can be bought from local hardware shops and are simple to use.</p> <p>More information: Australian Government, Department of Environment, State of Environment Reporting, 2011 <a href="http://www.environment.gov.au/science/soe/2011-report/5-land/1-introduction/1-1-soil#s1-1">http://www.environment.gov.au/science/soe/2011-report/5-land/1-introduction/1-1-soil#s1-1</a></p> <p>This report provides further information on soil acidification in Australia including graphs. To illustrate the need and use of lime on the land in Australia, show students the graphs representing lime levels scales for different states. These have been increasing over time and the current rate of lime application is only about half of what is needed to successfully manage acidification.</p>
PAGE 28	<b>8.4 Report</b> Advise the farmer what to grow	Students are to collate the information they have gathered from their completed practical tasks and generate a report for the farmer. Think about including information gained from the activities to bring the unit together.

# 4.0 Toil with Soils

Soils have many important roles: they produce food, filter rain water, regulate the climate by absorbing carbon and are home to two-thirds of all species that live on earth. Without soils, we could not survive!

We need as much information about soils as we can to make informed decisions about how the land is used. A soil scientist plays an important role in providing information on the geological structure of the land, chemical properties, physical properties and biological properties of the soil. Soil scientists collect information out in the field, are good at working with maps, make decisions about the best way to use the land and are able to communicate information about soils to farmers and other land users.

In Australia, the Grains Research and Development Corporation has developed a resource to assist the grains industry in understanding and managing soil challenges. The 'Soil Biology Initiative' looks at various perspectives of soil quality including biology, chemistry and physics. It provides growers with information about their region so that they can compare local data to their paddocks and also provides expert opinions on management practices.

## Physical

Structure  
Compaction  
Available Water  
Texture

## Biological

Carbon  
Amount of  
Microbes  
Nitrogen  
Disease

## Chemical

pH  
Organic matter  
which microbes  
eat for energy

## Watch

View this segment from ABC Landline which looks at soil in Australia and the challenges faced by farmers. Answer the following questions.

**'Soil Secrets', ABC Landline, Prue Adams, November 2012**  
<http://www.abc.net.au/landline/content/2012/s3630158.htm>

- 1 How many microorganisms are in a shovel of soil?
- 2 How much do we know about the microorganisms in the soil?
- 3 Name some of the groups these microbes belong to?
- 4 What is The Earth Microbiome Project setting out to discover?
- 5 List the ways in which the data being collected could be beneficial to grain growers?
- 6 What strategies are farmers adopting to maintain the soil structure?



# Career Scope

## SOIL SCIENTIST

### Associate Prof Tim Cavagnaro

#### Pathway

As a high school student I was fascinated by biology and geology. I wanted to study science but in a real-world context that matters. I therefore decided to study agricultural science. During my studies I became interested in soil microbes and the role they play in sustaining life on the planet.

#### Tasks

I have worked on work on issues ranging from food security in the developing world through to environmental sustainability, water quality and revegetation. This involves working in the field, often in exotic and challenging conditions, as well as working in highly advanced analytical laboratories.



#### Grains

I have been working with the grains industry to improve the growth and nutrition of crops. This has included work on using waste materials as a source of potential fertiliser. I have also provided advice on the role of soil microbes in cropping systems.

#### Advice

Many of the great challenges we face today, like climate change, achieving food security, sustainability have their answers below ground. To meet these challenges, we need the best scientists to work together on these issues. Soil scientists need to lead the way on these issues.

#### Skills

The ability to work across different fields of science including chemistry, biology, geology, microbiology & ecology.

#### Highlights

I get paid to explore the most complex & fascinating environment on the planet - the soil! I also get to visit many parts of the world & work with a great diversity of very smart people.

#### Challenges

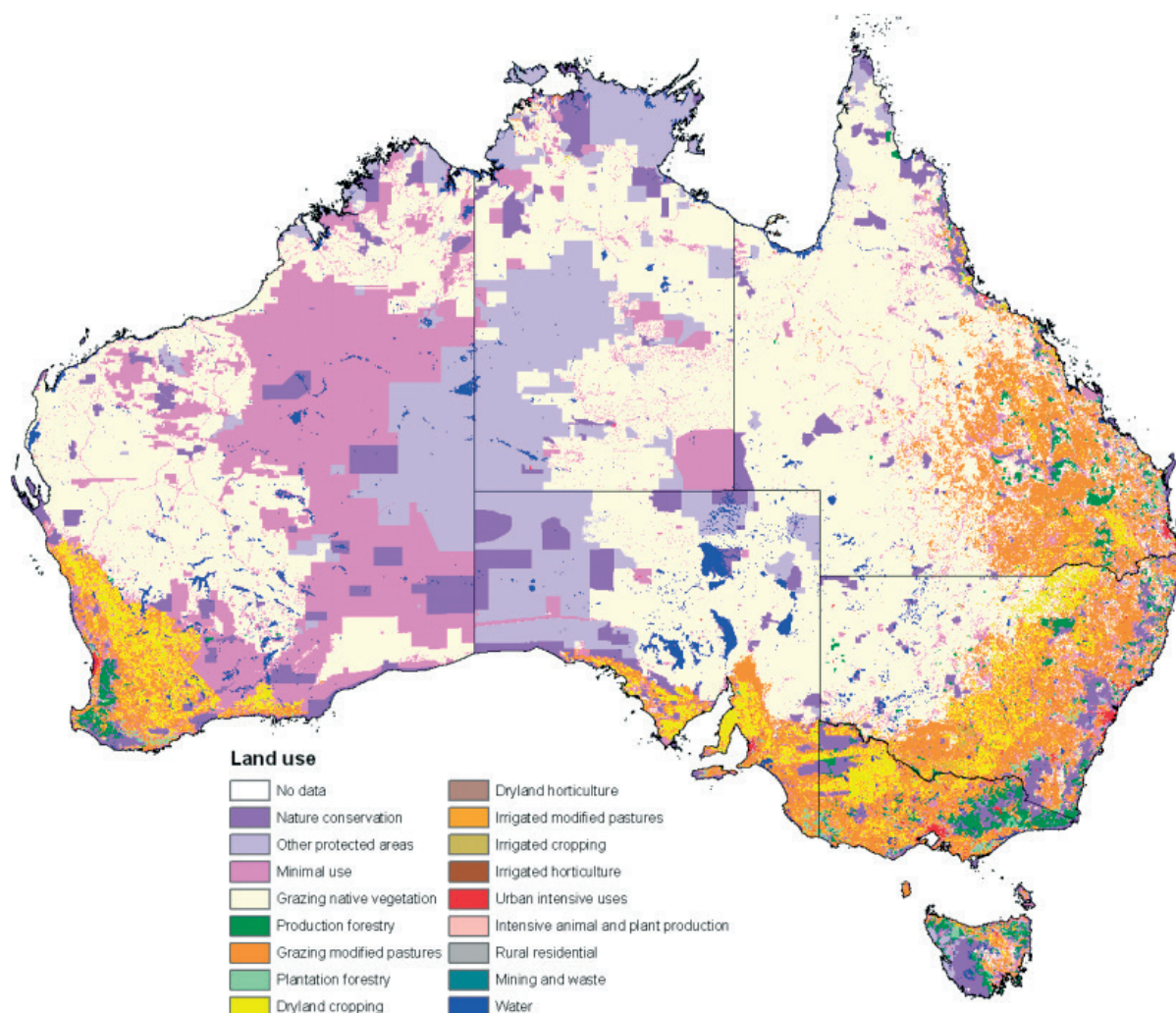
Soils contain the most diverse terrestrial communities on the planet. The vast majority of soil organisms remain undiscovered. So a great challenge for me, which I find exciting, is working out who the organisms in the soil are & what they do.

# 5.0 INSIGHT

## Soils of Australia

Australia is a big place and there is a lot about the environment here that we are still trying to learn. In fact, the surface of the mainland and the islands of Australia cover approximately 7.7 million square kilometres. That is a lot of area to understand!

About 50 per cent of this land area is used for producing food and fibre. There are many factors which limit the use of more land to grow more food and fibre, including urbanisation, drought, lack of infrastructure and poor soils. By understanding as much as we can about the land, we can overcome some of the challenges of growing food, we can plant smarter and we can farm in a more sustainable way.



Source: Australian Government, Department of Agriculture and Water Resources, ABARES 2010

**1 Estimate the land use of the following as a percentage**

Nature conservation \_\_\_\_\_ Dryland cropping \_\_\_\_\_

Grazing native vegetation \_\_\_\_\_ Water \_\_\_\_\_

**2 Think about these land classifications.**

Write a sentence for each of the below, describing what land use factors each title covers.

Nature conservation: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Dryland cropping: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Urban intensive areas: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**3 Producing grains and pulses is economically important generating \$13 billion in Australia in 2014/2015, on more than 22 million hectares of cropping land.**

Calculate how much one hectare of grain is worth.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

The MCG covers 1.7 hectares. If a summer crop was planted on the oval during the football off season, how much profit could be made?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

The Grains Research and Development Corporation (GRDC) invests \$160 million dollars each year into grains research and development in many areas including marketing, crop yield, crop protection, farming system knowledge, farm resources, skills and applications. Impressively for every \$1 the GRDC invests, a \$5 return is made!

Soil constraints are one of the biggest challenges for grain growers and therefore one of the most important investments. If the GRDC invested \$8 million dollars into soil biology research each year calculate

a) The investment into soil biology per hectare (\$) \_\_\_\_\_

b) The return on this investment per hectare (\$) \_\_\_\_\_

**Let's take a closer look at what we know about soils.**

# INSIGHT

## Horizons and soil type overview

### Horizons

Soils are complex structures! They are made up of several layers of different classifications of soils. These layers are called *horizons* and each horizon is differentiated by a change in colour and/or texture.

**O horizon:** Loose soil, full of decaying plant matter.

**A horizon:** Soil is full of minerals with some further decayed plant material (humus).

**B horizon:** Material from the above layers leaches into this horizon through drainage. This layer often has more clay.

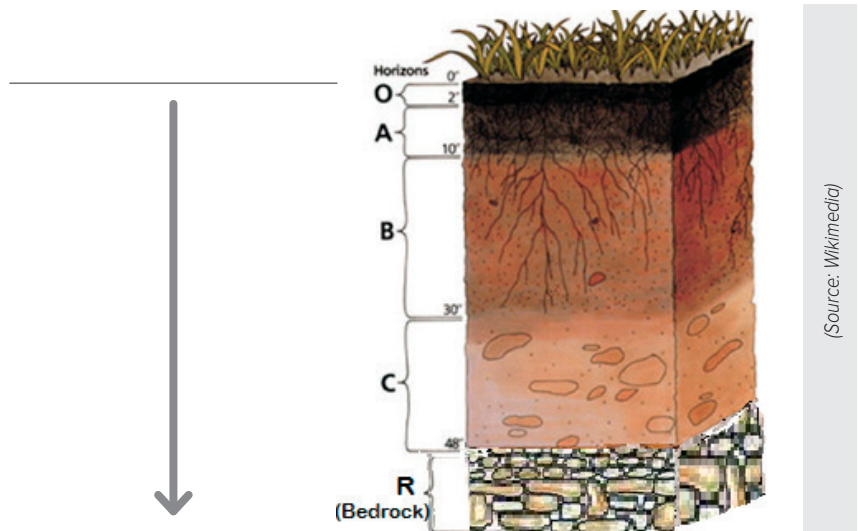
**C horizon:** Parent material which has partially degraded. The parent material comes from the below horizon.

#### Soil classifications:

Soil types can differ over short and long distances, be unique or appear in many spots all over the world. And there are many factors which shape soils

Read the description of horizons. What horizon do you think would have *high weathering* and which would have *low weathering*.

Label on the diagram below



'sol'  
means  
soil



### Brainstorm

Discuss how each of these factors influence the soil:

climate,  
location,  
vegetation,  
time.

To help us understand, collaborate research and utilise soils better, classifications have been created. Here are some examples below.

*Anthroposols:* Soils which are created by human activities.

*Organosols:* Soils which are not by the sea and have lots of organic matter in their top layer.

*Podosols:* B horizon which has a lot of organic matter, aluminium and/or iron.

*Vertosols:* Mostly clay with a thin crusty horizon on top.

*Hydrosols:* Typically very wet soils for most of the year.

*Kurosols:* Soils which have clear soil texture changes in each horizon.

*Sodosols:* Soils which have clear soil texture changes between horizon A and horizon B.

*Chromosols:* Soils which have clear soil texture changes at B2 horizon and a pH of 5.5 or great.

*Calcarosols:* Soils which contain a lot of calcium carbonate and do not have clear texture changes between horizons.

*Ferrosols:* Soil which has a free iron oxide content which is greater than 5 per cent.

*Kandosols:* Have a maximum clay content in horizon B2 which exceeds 15 per cent.

*Rudosols:* Horizons which are hard to distinguish due to minimal differences in colour or texture.

*Tenosols:* Slightly more profile development than rudosols.

# 6.0 ACTIVITY

## Grains of Soil

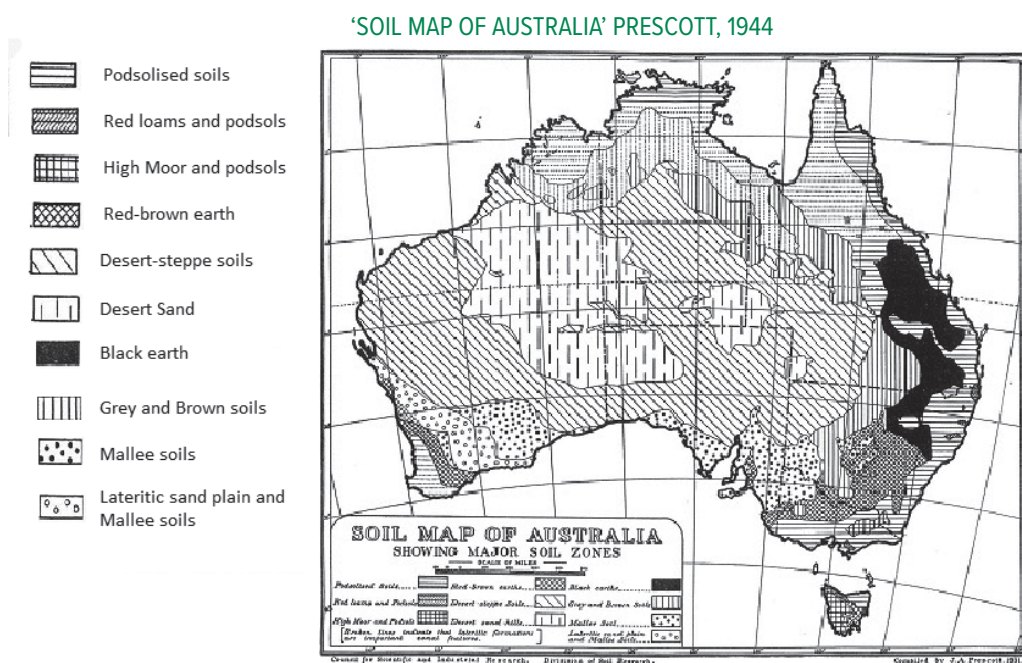
### Development in mapping

Soil mapping is a very useful tool for grain growers and researchers. The soil can be mapped using in the field surveying and laboratory analysis technology to show the diversity and properties across the land. New technologies, techniques and understanding have led to more detailed and accurate maps.

## THEN...

### Soil Map of Australia, Prescott, 1944

While working at the Waite Institute in South Australia early in the last century, James Arthur Prescott generated a soil map of Australia. Prescott looked at the different layers of soil to create profiles. His research produced both a continental map of Australia and localised soil surveys. In this work, nine different soils groups were identified.



Looking closely at the Prescott's map, what type of soil was thought to cover a large part Australian landscape in 1944? What characteristics do you think this soil might have?

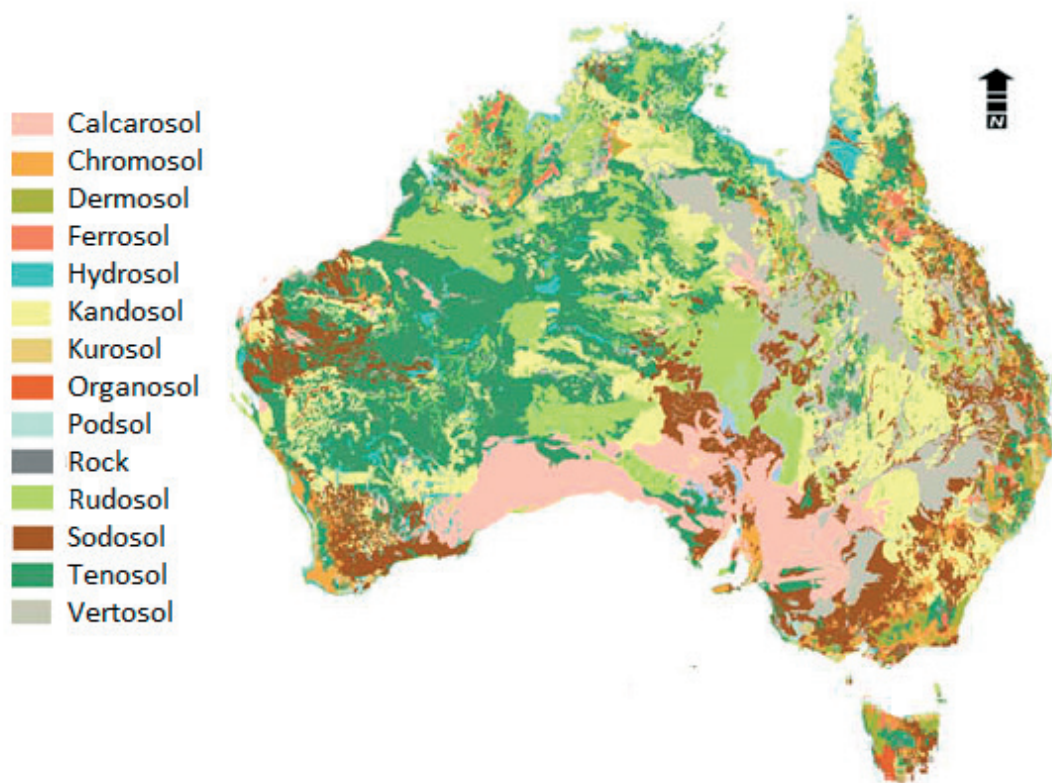
In your local area, what soil type would have been thought to be the most predominant?



# NOW...

In current times, organisations work together to research and collect data, with the goal of improving the grains industry. CSIRO Land and Water, Australian Government Department of Agriculture and the National Committee on Soil and Terrain collaborate to generate information and collaborate data for better natural resource management. The Australian Soil Resource Information System is an example of their work.

SOIL MAP OF AUSTRALIA, CSIRO, 2015



ASRIS. (2015). ASRIS - Australian Soil Resource Information System. <http://www.asris.csiro.au>. Accessed September 15, 2015

**Is there one type of soil that is dominant in Australia? Comment.**

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**In your local area, what soil type appears to be most predominant?**

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# INSIGHT

## Getting the dirt of soil

Growing grains requires large amounts of data to help with decision making to correctly use, manage and care for our soil. Technologies like satellites and in-field sensors are allowing us to generate data about the varying soils across Australia so the latest information can be accessed by grains researchers and farmers.

The Soil and Landscape Grid of Australia provides high-resolution maps of the country and better scientific data. This has been achieved through collating existing regional soil and land attribute data and digital mapping technology which includes remote and on-site sensing.

This information is freely available. Visit the [Soil and Landscape Grid of Australia](#)

**Watch: 'The Soil and Landscape Grid of Australia' (CSIRO)**

**Providing information about the soil to a depth of two metres, the generated grid of Australia is made up of two million pixels, with each pixel representing 90 square metres or the size of a football field.**

### Growing plants in the soil

#### Bulk density:

The weight of the soil. The volume of solids, pores and water. Anything with a density higher than  $1.6\text{g/cm}^3$  makes it hard for the roots of a plant to grow.

#### Organic carbon:

The amount of carbon in the soil influences the soil characteristics, how well the soil holds onto nutrients, aeration and more.

#### Available water:

The amount of water the soil is able to store for the uptake by plants.

#### Nitrogen:

The main nutrient that plants need to grow. Most Australian soils contain 0.15% of this important building block. This is quite low.

#### Soil characteristic:

Composition of soil whether it be mostly sand, silt or clay.

#### Soil pH:

Different plants prefer different levels of acidity in the soil. For example, wheat prefers pH  $>5.5$  in top soil and 4.8 in subsoil.



# 7.0 ACTIVITY

## Getting the dirt on soils

A cereal farmer is hoping to start growing wheat in your region, focusing on the soil attributes at 5 – 15cm. The farmer would like you to review the grid and comment on the following soil attributes for the area.

### EXPLORE

Look at The Soil and Landscape Grid of Australia.

**Visit the**  
**Soil and Landscape**  
**Grid of Australia**

Follow: View Maps → Quick View  
→ National Maps which illustrates  
Australian soils.

Report on the distribution using the  
*Soil Grid Report Card*.

### Research

- Available water
- Soil characteristics: sand, silt, clay
- Soil pH
- Nitrogen

### Key phrases

Topsoil – Generally, the first 5cm to 15cm of soil.

Subsoil – Soil layer underneath the top soil and mostly characterised by sand/silt/clay.

Nitrogen – Soil nutrient which plays a role in soil-atmosphere interactions and plant growth.

pH – Scale of soil acidity where 7 is neutral, with values below this acidic and values above this alkaline.

## Soil Grid Report Card

Region \_\_\_\_\_

These maps are small so zoom in on your computer to take a closer look and complete the report card by looking in the approximate region of your chosen area. The farmer hopes to farm wheat. How will each aspect affect the success of the wheat crop?

MEANING	INTERPRET THE MAP AND COMMENT ON YOUR ANALYSIS		
<b>Available water:</b> The amount of water the soil is able to store for uptake by plants.	Comment:		
<b>Soil characteristic:</b> Is the soil comprised of mostly sand, silt or clay?	Sand %		Comment:
	Silt %		
	Clay %		
<b>Bulk density:</b> The weight of the soil. Anything with a density higher than 1.6g/cm <sup>3</sup> makes it hard for the roots to grow.	Comment:		
<b>Organic carbon:</b> Total amount of carbon in the soil.	Comment:		

MEANING	INTERPRET THE MAP AND COMMENT ON YOUR ANALYSIS
<b>Soil ph:</b> Wheat prefers pH >5.5 in top soil and 4.8 in subsurface.	Comment:
	<b>Low pH?</b> Advise the farmer to seek information on liming. Lime sand is sourced from coastal dunes and from crushing limestone. When added to the soil it can increase its pH. <b>Advise / Do not advise</b> (Circle)
<b>Nitrogen:</b> Most Australian soils contain 0.15 per cent of this important building block, but this is quite low.	Comment:
	<b>Low nitrogen?</b> Advise the farmer to seek information about planting pasture legumes between wheat cropping times. Planting this between wheat growing season helps to fix nitrogen into the soil and increase its levels. <b>Advise / Do not advise</b> (Circle)
<b>SELECTING A VARIETY - Advise the farmer on what characteristics they will need to look for when selecting a wheat variety to grow, in relation to what you have learnt about the soil from The Grid.</b>	

## EXPLORE

Look at the Quick View Maps for your state or a neighbouring state.

Select two soil factors and explain why you think these are of importance.

Comment on the distribution of these factors throughout the state/territory.

FACTOR: WHY IS THIS FACTOR IMPORTANT?	DISTRIBUTION ACROSS STATE/TERRITORY
	Comment:
	Comment:

# 8.0 PRACTICAL

## Investigating soils

It's now you turn to be a soil scientist! Get out and explore the soil around you and report on its properties.

### Location of soil samples

- Record the GPS coordinates of the position the soil sample will be taken. It is important to note the exact location that a sample is taken, so that samples can be collected from the same spot in the future and soil data compared.
- Avoid sampling from an area where the soil may have been contaminated e.g. near a gateway, where machinery is used, animal thoroughfares or near drains.

### Safety

- Permission needs to be gained from the owner of the land before a soil sample is taken.
- Soil contains a variety of organic matter. To ensure hygiene, wear gloves when working with soil samples.
- It is best to sample when the soil is dry. The soil sample needs to be clean (pure) with no plant or other material.

### Investigations

- Soil profile
- Soil texture
- Soil pH



# 8.1 PRACTICAL

## Soil Profile

### Get your hands dirty!

#### Testing soil in the field

Soils are made up of different layers. These layers are called horizons.

Choose an area which you would like to investigate and record below. This may be an area within school, community or at home.



AREA	
GPS LOCATION	

### Materials

- Thin clear container/cylinder, sealed at one end
- Gloves
- Spade
- Ruler

### Method

- 1 Dig a hole 40 – 50cm deep so that you can see changes in the soil. The depth of the hole should match the length of your container. At each point where the soil changes, create different piles of soil.
- 2 Working from the pile collected last, pop the samples into your container. You want to ensure the soil profile you create in the cylinder represents the layering of the sample plot.

# Profile your soil

Draw a picture of your soil profile and add descriptions of the soil at each horizon.

	PICTURE	DESCRIPTION
<b>Ground Level</b> <b>O horizon:</b> Consists of organic matter – plant and animal litter. Darker layer.		
<b>Topsoil</b> A horizon: Similar amount of organic matter to the O horizon. Also dark in colour. Seeds germinate and roots grow in this layer. Worms, fungi and bacteria live here.		

	PICTURE	DESCRIPTION
<p><b>E horizon:</b> This layer is usually a light colour. It usually contains sand and silt. Soil particles here are larger than soil particles in the A horizon.</p>		
<p><b>Subsoil</b>  <b>B horizon:</b> This layer is rich in clay and minerals. It is usually a reddish or brown colour. Sometimes roots can be found here.</p>		
<p>There are other horizons which exist below this which incorporate rock.</p>		

## 8.2 PRACTICAL Profile Soil Texture

### Get your hands dirty!

In this practical you will use your own soil sample to explore soil texture, its definition and classifications.

Choose an area which you would like to investigate and record below. This may be an area within school, community or at home.

*\*Note: You will need to make an approximation of the size of the area within your report.*

AREA	
GPS LOCATION	

### Materials

- Gloves
- Soil sample. Collect two soil samples from the same spot: top soil sample and A or B horizon samples. Repeat the steps for both.
- Water

### Method

- 1 Collect a small handful of soil.
- 2 Add a small amount of water to moisten the soil.
- 3 Knead/mould this into a ball which is slightly larger than a golf ball.  
**What does the soil feel like in a ball? (e.g. plastic, smooth, does not mould)**

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- 4 Using your thumb and forefinger, try to make the ball into a ribbon. Record the length of the soil ribbon (mm).  
**What is the texture of the soil when you do this?**

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Use the table 'Field texture of soils'. Identify the type of soil you have by comparing your descriptions and the length of the ribbon to the information in the table.

DESCRIPTION OF SOIL AND ITS BEHAVIOUR WHEN MADE INTO WETTED BALL	LENGTH OF RIBBON
	TEXTURE GRADE

## Field texture of soils

DESCRIPTION OF SOIL AND ITS BEHAVIOUR WHEN MADE INTO WETTED BALL	LENGTH OF RIBBON	TEXTURE GRADE	APPROX. CLAY CONTENT
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.	<b>Heavy clay</b>	 >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.	<b>Medium clay</b>	
Ball feels like plastic. Smooth to touch.	Approximately 75 mm Moderately hard to mould into ribbon.	<b>Light medium clay</b>	
Ball feels like plastic. Smooth to touch.	50 – 75mm Can be a little hard to mould into ribbon.	<b>Light clay</b>	
Ball feels like plastic. Small to medium grains of sand can be seen and felt in clay-like texture when made into a ribbon.	50 – 75mm	<b>Sandy clay</b>	
Holds together well, feels smooth. When moulded into ribbon feels plastic and often silky to touch.	40 – 50mm	<b>Silty, clay loam</b>	
Holds together well, feels like plastic. Medium size grains of sand can be seen.	40 – 50 mm	<b>Clay loam, sandy</b>	
Holds together well, feels like plastic. When made into ribbon feels smooth.	40 - 50 mm	<b>Clay loam</b>	
Holds together strongly, sandy to touch, medium grains of sand.	25 – 40 mm	<b>Sandy clay loam</b>	
Holds together, when made into a ribbon feels smooth to silky.	Approximately 25mm	<b>Silty loam</b>	
Holds together well and feels spongy. When made into ribbon feels smooth. Does not feel very sandy. Sometimes feels greasy if it has a lot of organic matter (e.g. broken down leaves).	Approximately 25mm	<b>Loam</b>	
Holds together but sandy, medium sized grains of sand can be seen easily.	Small ribbon of approximately 5 – 25mm	<b>Sandy loam</b>	
Holds together slightly, sticky when wet, lots of sand grains stick to fingers, clay stains hands.	Small ribbon 5 – 15mm	<b>Clayey sand</b>	
Holds together slightly.	Small ribbon of approximately 5mm	<b>Loamy Sand</b>	
Ball easily breaks down, cannot be moulded, singular grains of sand stick to fingers.	Cannot be made into ribbon	<b>Sand</b>	< 5%

Source: GRDC Fact Sheets, Brown, K

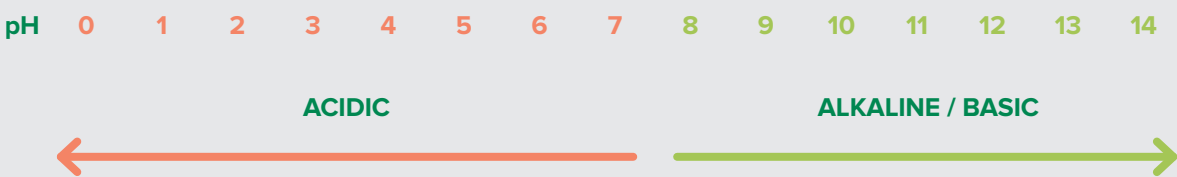


# 8.3 PRACTICAL

## Acid or Base

### Testing soil in the field

Soil pH is an important aspect of choosing a variety of grain to grow. In fact, a simple pH test is just as helpful in choosing plants on the farm as it is in the veggie patch. Different plants prefer different levels of acidity in the soil. For example, wheat prefers pH >5.5 in top soil and 4.8 in subsoil.



You are tasked with investigating a parcel of land which will be used to grow grains. Using the local area as an example, you will investigate the characteristics of the soil.

Choose an **area** which you would like to investigate and record below. This may be an area within school, community or at home.

*\*Note: You will need to make an approximation of the size of the area within your report.*

### Materials

- pH soil kits
- soil sample

### Method

- 1 Collect a soil sample from the layer of soil where seeds are sown and roots grow.
- 2 Use your pH soil kit to collect a reading of the soil. Complete the test twice to ensure your findings are accurate.

- 3 Record.

AREA	
GPS LOCATION	
PH READING	

When growing crops, the environment of the soil changes and without management, soil acidification can occur. This can be treated by adding lime (calcium carbonate) to make the soil more alkaline.

**After completing the soil pH practical answer this question:**

**DISCUSS** How would the soil you tested be affected by the addition of lime?

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To achieve optimum crop growth and yield, farmers aim to maintain a pH of more than 5.5 in the topsoil and 4.8 in the subsurface.

About half of all agricultural land in Australia is affected by soil acidification. Soil acidification in the surface soil affects the soil organisms, leads to nutrient deficiencies, reduces the amount of carbon stored in the soil and lowers the growth potential of crops and vegetation which in turn increases the risk of erosion. Due to these factors, soil acidity leads to more economic losses than the effect of soil salinity in Australia.

**Compare the maps 'Soil acidification in Australia' and 'Australian wheat belt' on the following pages. Comment on your observations.**

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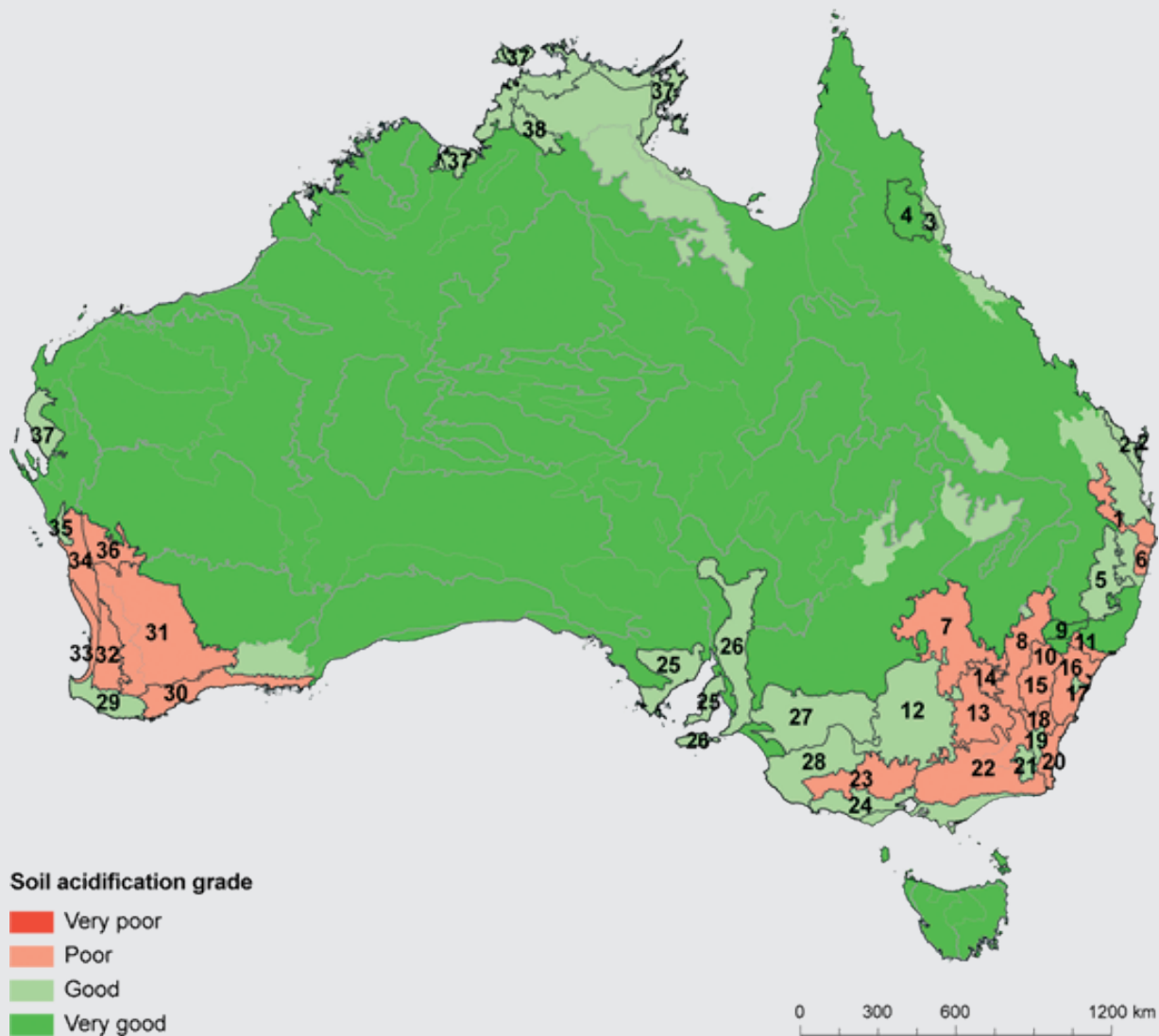
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# Soil acidification in Australia

Compare the two maps. What observations can you make about soil acidification in Australia and the Australian wheat belt?



Source: Department of Environment, Australian Government, 2011

## KEY

**Numbers:** Physiographic region.

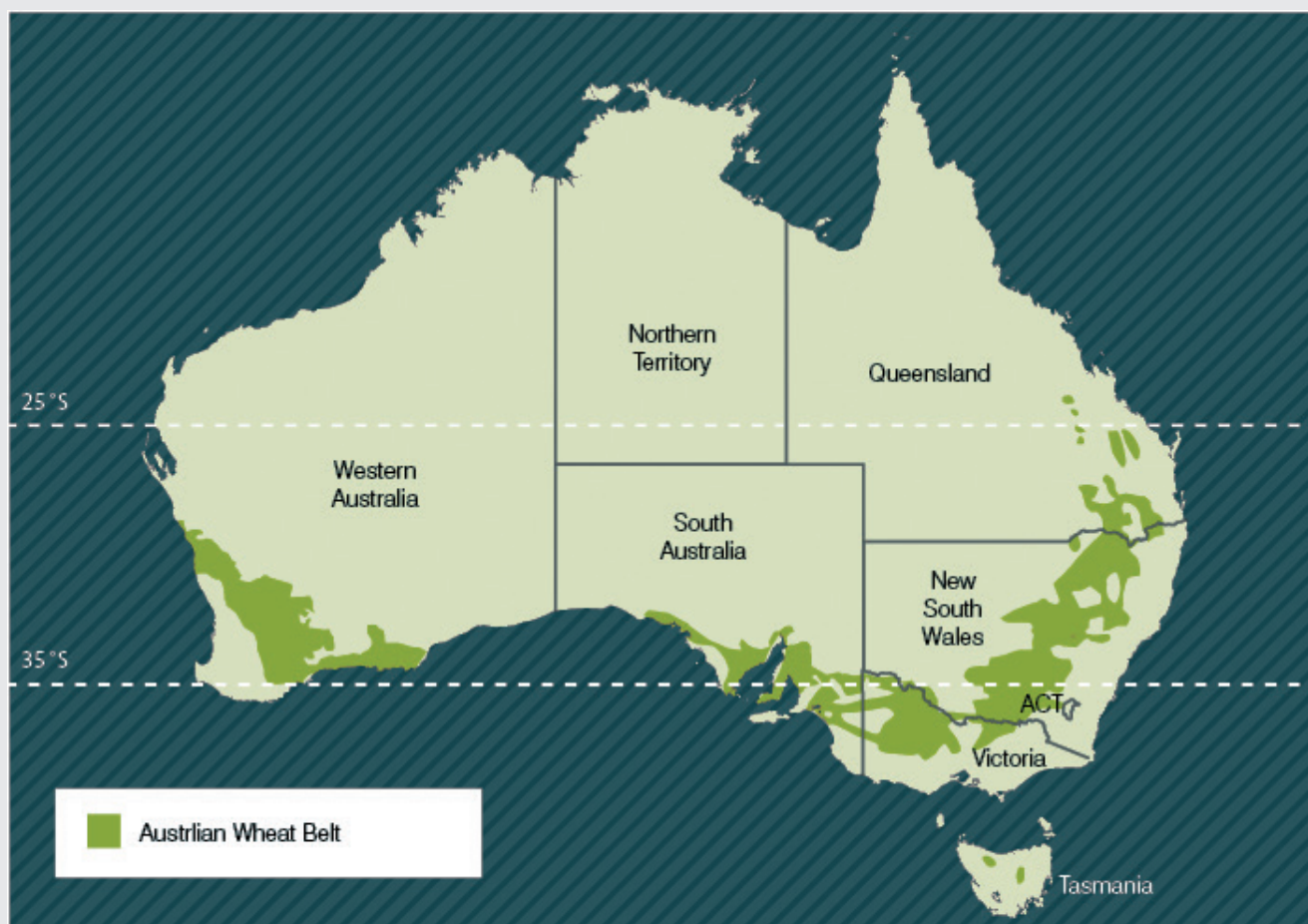
**Very good:** Current management adequate – low level of monitoring.

**Good:** Needs management and monitoring, otherwise returns on produce threatened.

**Poor:** Urgent enhancement. Yield and returned compromised and threatened.

**Very poor:** Beyond economic recovery. System unsustainable with limited options.

# Australian wheat belt



Source: Australian Centre for International Agricultural Research, Australian Government, 2011

Wheat is Australia's most commonly grown grain, occupying 55 per cent of the cropland making it an important example when looking at soil acidification and where crops are grown.

# 8.4 REPORT

## Advise the farmer what to grow

Using the data you have generated from your soil investigations, write a report. Your report will describe the characteristics of the soil from the area you sampled, summarise your data and discuss the potential challenges and benefits of growing grains in the selected area.

### Area

Describe the area sampled (e.g. grassy oval, bushland, native/non-native garden). Include the GPS coordinates. (two sentences)

### Test results

List the tests that you conducted (soil texture type, soil profile, soil pH). Describe the characteristics of your soil sample. (one paragraph per test)

### Data

Include a table which summarises the results from each of your tests and soil sample(s).

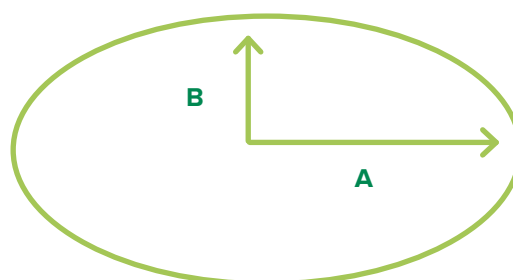
#### Example

GEOLOCATION: 303-305 MAGILL RD, TRINITY GARDENS, SA, 5068, AUSTRALIA LATITUDE: -34.91449 LONGITUDE: 138.645425			
Soil sample	Soil texture type	Soil pH	Soil profile
Topsoil	Loamy	5.5	See attached
Horizon B	Heavy clay	6.0	

### Plotting area

Either

- Calculate or estimate the size of the sample area (e.g. paddock) in meters
- Use your school oval as an example area size. Calculate the area of the school oval in square metres.



#### Step 1.

Measure from the middle point of your school oval to the edge for A and B in metres.

#### Step 2.

Complete the following equation. Record the area of the oval in metres.

$$\text{Area} = \text{Pi} * A * B$$

#### Step 3.

Convert the size of your oval in metres to hectares. A hectare equates to 10,000 square metres, so to convert your area, divide by 10,000.



## Grain type

Compare your soil characteristics to the preferences of the below examples.

**Which grain types would you choose that would be able to grow in this soil?**

**Explain why you have made this choice. (one paragraph)**

**Grain and pulse varieties growing in Australia**

GRAINS TYPE EXAMPLE VARIETY	pH	SOIL TYPE	YIELD IN TONNES PER HECTARE	PRICE PER TONNE
<b>Chickpeas A</b>	6 – 9	Loam or clay-loam	1.2t/ha	\$650
<b>Lentils G</b>	5 – 8	Heavy clays to loamy sand	1.5t/ha	\$500
<b>Cereal rye T</b>	4.2 – 7.5	Clay or sandy	1.0t/ha	\$295
<b>Faba beans Y</b>	5.5 – 7.5	Clay or loams	1.4t/ha	\$360
<b>Wheat J</b>	4.2 – 7.5	Sandy or clay or loams	2.10t/ha	\$270
<b>Field pea K</b>	>5.0	Sandy loams or heavier	1.4t/ha	\$460
<b>Lupins E</b>	4 – 7.5	Sandy	1.3t/ha	\$380
<b>Canola W</b>	4.5 – 7.5	Sandy clay – clay	1.4t/ha	\$510

*\*Note: These figures differ across plant type, variety and time of year.*

## School's economic benefit

Choose one type of grain or pulse that you would be able to grow in relation to your soil characteristics.

### Calculate

- Amount of grains or pulses (in tonnes) which could be grown on the school oval.
- The profit you would make from turning your school oval into a crop.

## Grower's economic benefit

Now imagine your soil samples had been taken from a farm. In Australia, the national average for a cropped area per farm is about 800 hectares.

### Your task is to

- Advise the farmer on what grain or pulse will grow in their soil.
- Calculate the income this crop would generate if the grower's cropping land was of national average size.

## Discussion

Summarise your findings and the recommendations you have given to the grower.

## Conclusion

What do you believe are the potential benefits to the grains and pulse industry from research and development into soils of Australian cropping land?

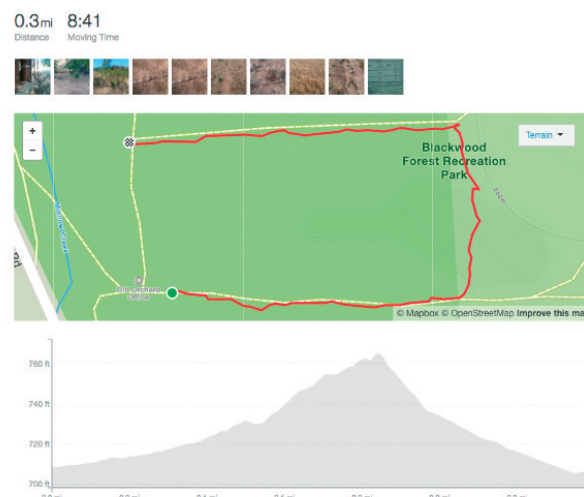
# Appendix A

## Example of using tracking apps on smartphones to plot trial area.

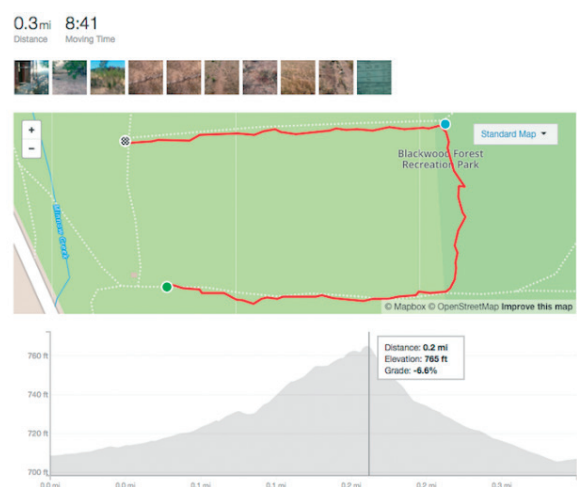
### Satellite Map



### Terrain Map



### Standard Map



**Co-ordinates of trial site:**  
**-35.028273, 138.62306**



**Evidence of natural water trough splitting paddock in two.**



**Pest trees in the lower south west corner. Approximately 60 small to medium in size.**



## 9.0 Good reads

Soil Quality, Accessed August 2015, <http://soilquality.org.au/>

Healthy Soils Australia, 2010, <http://www.healthysoils.com.au/soil.html>

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- Pulse Australia, 'Growing Pulses', 2015, <http://www.pulseaus.com.au/>
- Australian Government, ABARES, 2010, <http://www.agriculture.gov.au/abares/aclump/land-use/land-use-mapping>