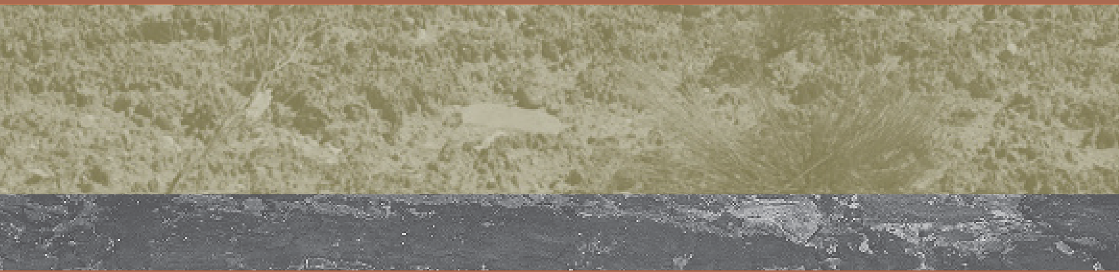
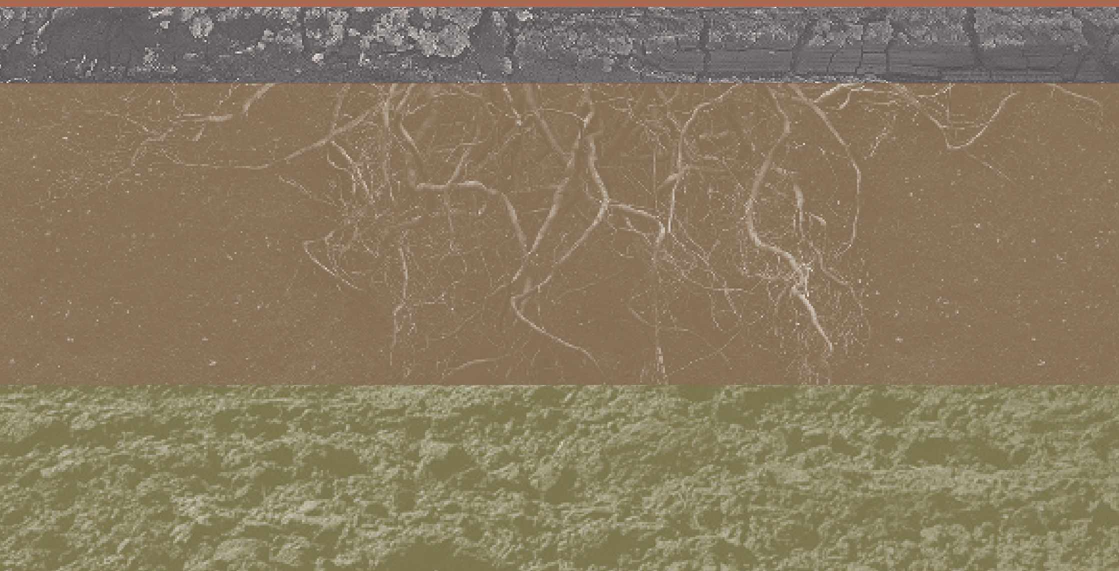


SOIL
HEALTH GUIDE

North Central Victoria



Acknowledgment of Country

The North Central Catchment Management Authority (CMA) acknowledges Aboriginal Traditional Owners within the catchment area, their rich culture and their spiritual connection to Country. We also recognise and acknowledge the contribution and interests of Aboriginal people and organisations in the management of land and natural resources.

Acknowledgments

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More information

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Australian Government | National Landcare Programme

VICTORIA State Government

Regional Landcare Facilitator

NORTH CENTRAL Catchment Management Authority
Connecting Rivers, Landscapes, People

CONTENTS

INTRODUCTION

Healthy soils are fundamental to rural living and food production. Australian soils are among some of the oldest and most weathered in the world. They generally contain low levels of organic matter and if not carefully managed can erode and degrade easily under traditional European farming practices.

Maintaining healthy soils is essential for farmers and land managers in north central Victoria to support productive agricultural industries, contribute to food security and deliver soil related ecosystem services (e.g. clean water and air). A healthy soil is defined as a state of a soil meeting its range of ecosystem functions as appropriate to the environment. Healthy soils are essential for healthy plant growth, human nutrition, drinking water filtration and a landscape that is more resilient to the impacts of drought or flood (Soils For Life, 2015).

For farmers or rural property owners soil is their most valuable asset. It provides structural support, water and nutrients for plant growth. Understanding soil types, applying the appropriate management practices and monitoring soil quality are all important steps in protecting and enhancing soil health.

AIM

This *Soil Health Guide for north central Victoria* is a easy-to-read, practical guide to understanding soil types in north central Victoria.

The guide provides information to help identify possible soil health issues using nine simple visual tests conducted in the paddock. The tests are cheap and easy, and can be undertaken using home-made equipment such as wire quadrants.

Observations and results can be used to determine management actions to improve soil health and assess differences in soil health between paddocks, farms, management practices and/or growing seasons. Together with the Soil Health Score Card (see inside back cover), the guide aims to complement laboratory test results, providing real-time information on a soils physical, chemical and biological characteristics.

NORTH CENTRAL CMA REGION

HOW TO USE THE SOIL HEALTH GUIDE

1. Read all the information first

Before heading out into the paddock it is important to read all the information and organise the equipment.

2. When to test

The Soil Health Guide contains a series of tests which should be carried out at least once a year during the main growing season (e.g. late winter or early spring). Avoid taking samples during very dry or wet conditions, extreme heat or cold temperatures and after fertiliser or lime applications (wait at least three to four weeks after applications before testing). To compare results between years or across paddocks, carry out the tests at similar times of year, under similar conditions and in the same location(s).

3. Prepare your equipment

Prior to testing collect and/or make the equipment (refer to equipment list).

TIP: Set up Test 9 first, as this will take 30 minutes and can be assessed at the end.

4. Select test sites

Firstly, select the paddock(s) for assessment – it could be the farm's best and worst soils, or paddocks under different management. For example, perennial versus annual pastures, or rotational versus continuous grazing. It is important to select a test site that is representative of the paddock. Try to avoid stock camps, headlands, watering points or any other sites of unusual traffic. Refer to sampling procedure. (Adapted from the Soil Structure Assessment Kit – Shelley McGuinness, Centre for Land Protection Research, 1991).

5. Decide how many cards you need

The score card has provisions to record three results for each of the nine tests. More cards will be required for additional testing.

TIP: Conduct tests in undisturbed areas of the paddock and along the fence line to compare results.

6. Carry out the tests

The Soil Health Guide lists 9 tests. The Soil Health Score Card offers space to record paddock information (e.g. rainfall, pasture type, site location/map, grazing frequency and so on) and up to three sets of test results. The more tests conducted within a site/paddock, the better the understanding of soil health, as results will be more representative. Once confident with the tests, it will take approximately 30 minutes to carry out all 9 tests.

TIP: Record the date on the score card before filing to compare results over-time.

7. Review the test procedure

Review the selected sites to ensure results are indicative of the area tested.

TIP: It's also important to regularly review testing procedures to make sure procedures are consistent between sites over-time.

8. Review the results and follow up on low scores

Line up the test sheets for the areas/paddocks or compare and identify any differences or similarities across the 9 tests.

TIP: If neighbours or members of the local Landcare or farming group are also carrying out the tests, get together as a group to compare results and discuss possible causes and management options.

9. Make a note to repeat the tests after one year.

By carrying out the tests regularly throughout the season and across multiple years, it will help identify soil health conditions and the implications of different management practices on soil health.

Note: To complement this guide, ongoing soil extension support is recommended.

EQUIPMENT

A plastic tub is recommended to hold equipment

- Shovel
- Tape measure
- GPS or farm map.
- Home-made wire quadrant
- Hand magnifying lens
- 0.5 Litre water bottle
- Large plastic tub
- Large garbage bag or tarp
- Home-made penetrometer
- Soil pH kit (available from gardening supply stores)
- 1 litre bottle of rain or distilled water
- Shallow dish or transparent cup.

Home-made equipment

A quadrant is used to show a known area when placed on the ground.

Wire quadrant

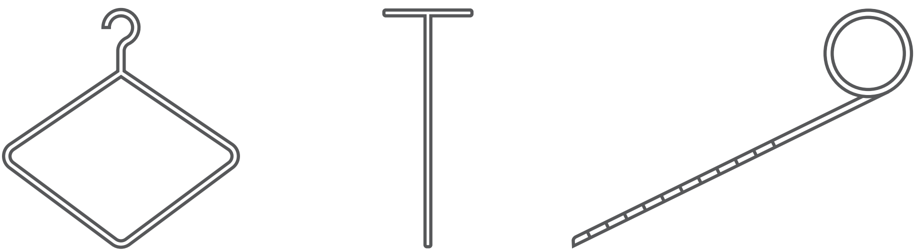
Make a 30 cm x 30 cm quadrant (square) out of sturdy cardboard or wire. Alternatively a wire coat hanger can be used, which measures 24 cm by 24 cm when opened out to form a square.

Penetrometer

A penetrometer is a device to test compaction in the soil. The depth to which the average person can push the penetrometer into the soil is usually a good indication of compaction (Shelley, 1991).

A scientific penetrometer with a gauge can be purchased or a home-made one can be constructed using a piece of wire or steel.

Figure 1: Home-made wire quadrant, steel-rod penetrometer and wire penetrometer



Option 1 - For the wire method, take a 500mm length of 3.15mm/10 gauge high tensile wire. Curve 120mm of the length into a handle, the remaining length forms the penetrometer.

Home-made equipment: Care needs to be taken. Before undertaking rigorous testing, please ensure equipment is check by a local soil specialist.

Option 2 - Alternatively a home-made penetrometer can be simply constructed using two pieces of steel rod. Weld a 1100mm length of 10mm steel rod at right angles to a 400mm length of 20mm steel rod. The tip of the shaft can then be sharpened into a point. If a hollow piece of rod is used, a hardened tip will need to be welded to the end.

Modest effort is required when using a penetrometer. If you hit a rock or tree root, choose another spot. The easier it is to penetrate the soil, the better the deep root development and water infiltration.

Using a penetrometer in the field to test compaction.

Photo: North Central CMA

DIGGING THE HOLE

TIP: *Dig a hole large enough to have a clear view of one face (Shelley, 1991)*

Equipment: Shovel, tape measure and GPS or map to record the location of the hole(s).

Instructions: Locate the site for the hole(s). If a farm is made up of different soil types consider completing the tests for each soil type. Record the GPS location or mark on a map the location of where the tests were completed so tests can be undertaken at the same location again in the future. (Victorian State Government, 2001)

Dig a hole 50-60 cm deep (or until rock is hit) by 50-60 cm wide. A hole of this measurement allows visibility of soil that is most important to plant roots. Try and remove the first 20 cm of soil as a solid cube in preparation for the soil structure test. (Victorian State Government, 2001)

Photo: Poprotskiy Alexey, Shutterstock.com

SAMPLING PROCEDURE

Taken from: http://www.depi.vic.gov.au/agriculture-and-food/farm-management/soil-and-water/erosion/groundcovering-measuring-tool

When monitoring it is important to make sure that the areas being assessed are representative of the entire area. If a soil sample is a different colour from the other sample it should be discarded. The best way to achieve this is to walk along an imaginary transect line, diagonally across the paddock from post to post, Figure 2 or take 10 steps in one direction then randomly turn and take 10 steps in the other direction, Figure 3. Points. (Victorian State Government, 2001)

The larger the area the more tests are required. Take a quick walk over the general area to understand how variable the paddock is and how many tests should be undertaken. (Victorian State Government, 2001)

Draw a transect roughly on the Soil Health Card and note approximately where the tests were undertaken, remember to mark on the drawing where north or the top of the paddock is as a reference point.

TIP: If available, consider (not necessary) using a GPS (Global Positioning System) to record test site

Figure 2: Transect

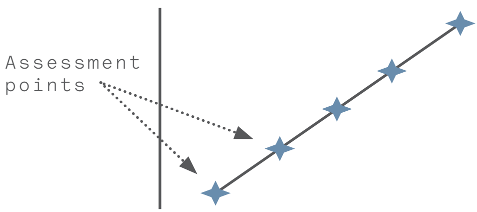
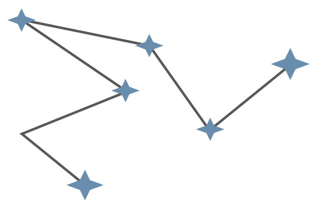


Figure 3: Zig zag - random



TEST

1

GROUNDCOVER

BIOLOGICAL

Why do we need to know about groundcover?

- Groundcover includes both living and dead plant material and litter.
- By understanding and managing groundcover, soils become less susceptible to degradation caused by erosion from wind and water.
- A healthy soil contains a broad diversity of microbial types and plants depend on these beneficial soil organisms to help them obtain nutrients and water from the soil (Victorian Government of Primary Industries, 2005).
- It is beneficial to measure groundcover each year, not only when pasture growth is low.

Equipment: Wire quadrant.

Test (the best time to assess is prior to the autumn break):

Randomly place the wire quadrant using the sampling patterns on page 9.

Estimate the proportion of groundcover inside each quadrant (includes both living and dead plant material and litter). (Victorian Government of Primary Industries, 2005)

Interpretation of results:

Estimating groundcover levels in pasture

20% Groundcover

40% Groundcover

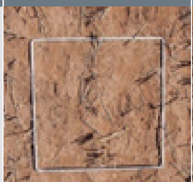
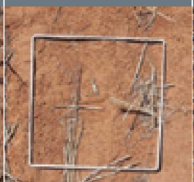
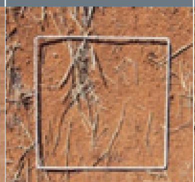
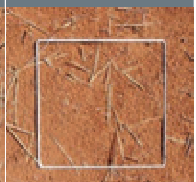
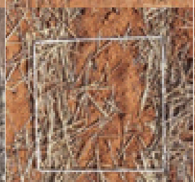
50% Groundcover

80% Groundcover

90% Groundcover

100% Groundcover

Table 1: Estimating groundcover levels in a cropping situation

Coverage	Standing Stubble	Rolled Stubble	Chained Stubble	Cultivated Stubble
20%				
50%				
80%				

Pasture photos: Greg Lodge, NSW DPI – 20% and 40% cover photographs. Primary Industries South Australia, 1996, Pasture Pics: easy estimation of pasture dry matter levels, Appila / Bundaleer Pasture Group, Appila, SA - 50, 80 and 100% photographs; Cropping photos: Mallee Sustainable Farming Inc., 2013, Improving Soil Health and Reducing Wind Erosion project of the Murray Catchment Management Authority.

TEST

2

EVIDENCE OF SOIL BIOLOGICAL ACTIVITY

BIOLOGICAL

Why a diversity of soil organisms is important?

- A healthy and functioning soil ecosystem contains a wide diversity of soil organisms.
- Soil organisms play an important role in cycling carbon, nitrogen, sulphur, phosphorus and all other nutrients. (NSW DPI, 2002)
- These organisms range from tiny bacteria, viruses, protozoa and fungi to large soil animals like centipedes, earthworms, spiders, earwigs, springtails and termites.
- Earthworms have an additional role to play as they tunnel through the soil creating mixing and new pathways for nutrients, water and roots to move. They are good indicators of the soil health and structure. The more organic matter the greater the potential number of earthworms and macropores.
- Worms are migratory; even if not visible in the dig it doesn't mean they are not doing a job to improve soil (DCE, 1991). It is important to look out for old tunnels.

Equipment: Wire quadrant, hand magnifying lens, shovel.

Test (as you measure groundcover, also assess the range of soil animals on the surface of the soil):

Move away from the hole and take a shovelful of topsoil, approximately 20 cm square and 10 cm deep.

Carefully sift through the plant litter and soil and note how many different soil animals you see, such as worms, ants, beetles, spiders, millipedes, etc. Fungi may also be present as a network (often white) of hyphae structure in the soil. It is the variety of different soil organisms that is important, not the numbers of individual soil organisms (NSW DPI, 2002).

Earthworms tend to be concentrated in the root zone therefore it may be necessary to pull apart the root mass to locate them.

Building a healthy and functioning soil ecosystems.

Photos: Agriculture Victoria, DEDJTR

TEST

3

SOIL COLOUR

PHYSICAL

Why do we need to know about soil colour?

- Soil colour is related to chemical properties, aeration or drainage, and organic matter. (Baxter. N and Williamson. J (1963)
- Soil colour is an important characteristic of the soil as it can provide an indication of the soil's drainage characteristics.
- Soil colour may also help determine the different layers (horizons) of the soil, such as topsoil and subsoil (Shepherd, T.G. 2000).

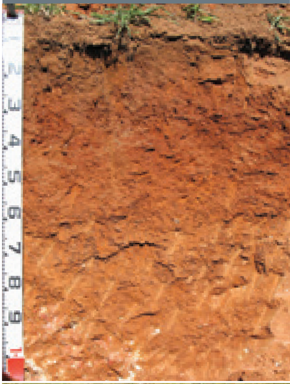
Equipment: Tape measure.

Test (the best time to assess is prior to the autumn break):

Once the hole is dug (refer to page 9), assess the colour of the soil using the colour chart below. Record the colour as one of the following colour:

- Red
- Yellow
- Black
- Brown
- Grey
- Pale

Table 2: Soil Colour Chart and Characteristics

Soil	Soil colour class	Interpretation
	**Red** Red sodosol: Howard Hepburn (Source: Richard McEwan, Agriculture Victoria, DEDJTR)	Suggests the presence of un-hydrated iron oxides that indicates good drainage and aeration. Generally water can drain quite quickly through the profile of red soil and oxygen can therefore be stored in the macropores.
	**Yellow** Yellow duplex soil (Source http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/NC_soils)	Suggests inadequate drainage. The yellow colour indicates the soil remains saturated and is therefore starved of oxygen for several weeks after rainfall. Yellow soils may also have a perched water table.
	**Black** Black Vertosol near Cardinia (Source http://vro.agriculture.vic.gov.au)	Indicate high organic matter content or high clay content. Black soils can have variable drainage characteristics ranging from moderately well drained to poorly drained.

Soil	Soil colour class	Interpretation
	**Brown** http://vro/agriculture.vic.gov	Suggests reasonable drainage. The brown colour often (but not always) indicates high amounts of organic matter.
	**Grey** http://vro.agriculture.vic.gov.au/dpi/vro/nthcenregn.nsf/pages/NC_soils	Soils with grey subsoils are poorly drained, generally remain wet, and are starved of oxygen for many months, usually all winter. Subsoils of this colour often have a perched water table.
	**Pale** www.geo.msu.edu/soilprofiles Pale or light-coloured soils (particularly topsoils) are an indication that soil has been strongly leached of nutrients (iron oxides, aluminium and organic matter) which have been moved by water to a lower layer.	They are commonly referred to as a 'bleached' layer as they usually occur when there is a problem soil layer below, which stops water moving through the subsoil (e.g. clayey subsoil). The saturated soil results in no oxygen which changes the chemistry of the soil. This change allows the chemicals that give the soil it's colour to become soluble and leach out of the soil layer.

Various soil colour classes.

Soil colour helps to determine different layers of the soil.

Photos: North Central CMA

TEST

4

SOIL PH

CHEMICAL

Soil pH in the north central Victoria region:

- Soil pH in north central Victoria is influenced by the soil parent material, past climatic events and annual rainfall. Generally, the higher the annual rainfall, the more likely the topsoil will be naturally acidic.
- Most sedimentary and granitic soils are naturally acidic. In contrast, lower rainfall zones tend to have more neutral topsoils and alkaline subsoils.
- Soil that is too acidic can be treated with lime. Keep in mind, though, that pH should only be changed to enhance introduced pasture and crop species. Native grasslands are perfectly adapted to the natural pH of the soil and do not require treatment.

How is soil pH measured?

The water component of soil is where pH is measured; where dissolved chemicals cause the soil to be acidic or alkaline.

The pH of a soil will change over time that is influenced by factors including parent material, weathering and current agricultural practices. pH levels will fluctuate through the year and affect how plants grow.

The acidity or alkalinity of soil is measured by the pH scale. Less than seven is acidic, greater than seven is alkaline and seven is neutral. Most crop plants prefer a pH close to neutral.

Figure 4: Plant growth and pH (CaCL2) scale

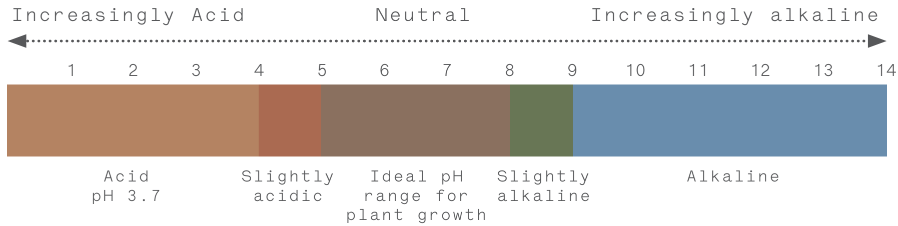


Diagram: NSW Agriculture Acid Soil ACTION

Low pH - beneficial elements such as molybdenum (MO), phosphorus (P), magnesium (Mg) and calcium (Ca) become less available to plants

High pH (greater than 7.5) – calcium can tie-up phosphorus making it less available to plants

pH can also influence the toxicity of elements (e.g. aluminium in acid soils), decrease plant production and water use and impact soil biological functions (e.g. reduced nitrogen fixation).

Note: pH values measured using a soil pH kit are similar to those measured in water. Laboratories may provide pH results in calcium chloride ($CaCl_2$) and/or water. pH values in water are typically 0.5 to 1 values higher than in $CaCl_2$. Take note when comparing results.

Equipment: Soil pH kit.

Test:

1. Take two small samples of soil from the side of the hole, one from 10 cm and one from 20 cm depth.
2. Test each sample for pH following the instructions included in the kit.

Color chart is used to read soil pH values.

Photo: North Central CMA

TEST

5

TEXTURE

PHYSICAL

Why is soil texture important?

- Soil texture is the measure of sand, silt and clay proportions in soil and is an indicator of capability rather than soil health.
- Soil texture influences other soil properties such as water holding capacity, porosity, permeability and the soils behaviour in water.
- The sand fraction allows the soil to drain and the silt improves the water holding capacity of the soil
- The clay fraction is perhaps the most important as it enables the soil to hold water and nutrients. Silt and sand however hold little water and nutrients in comparison (McGuiness, 1991).

Equipment: Water bottle.

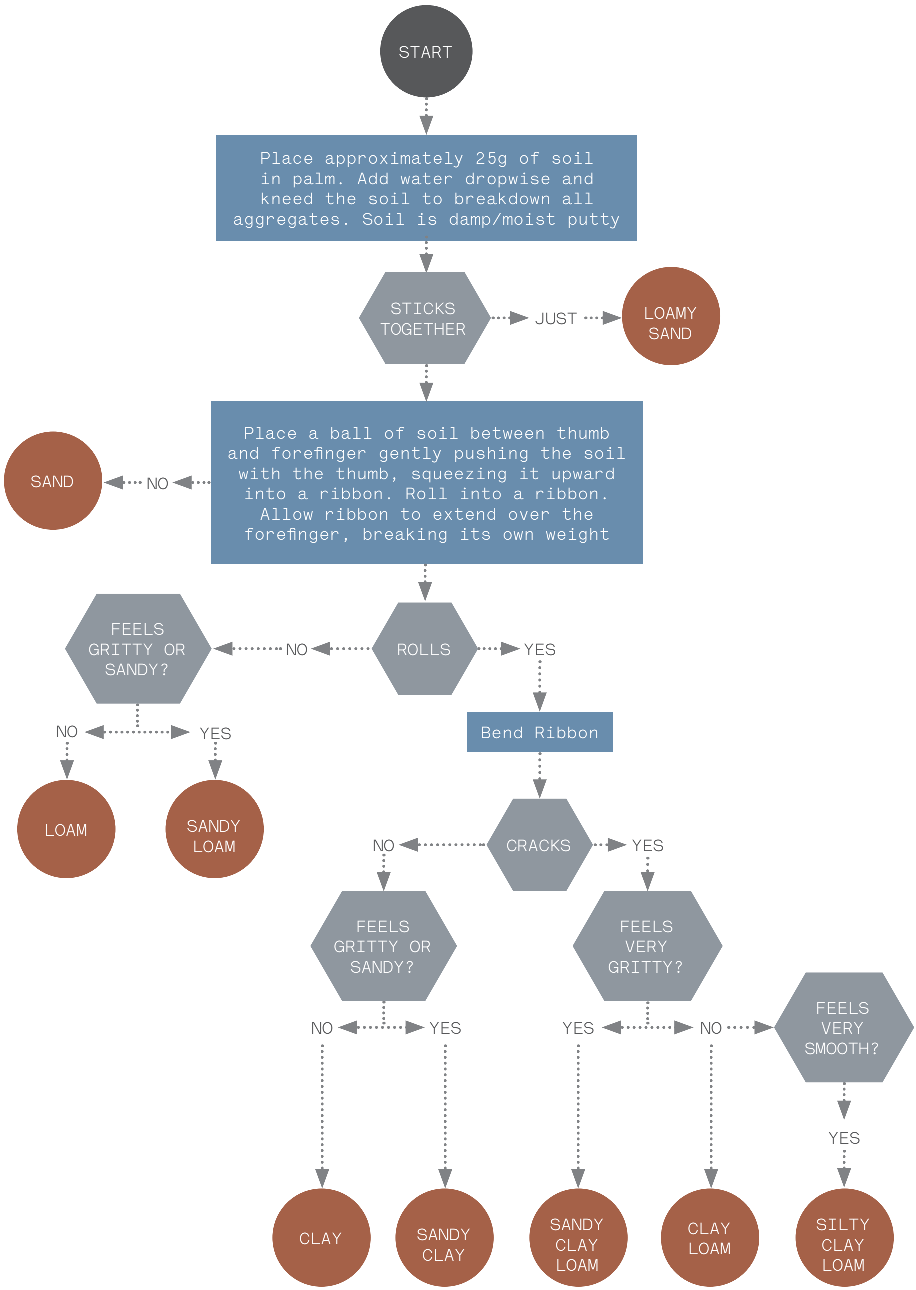
Test (repeat for subsoil once this has been identified in test 6):

1. Soil texture can be estimated by feel. Take a small handful of soil from the top 10cm of soil, at the side of the hole. Remove any gravel, stone or organic matter.
2. Add water drop-by-drop and knead to break down aggregates. The soil has reached the proper consistency when it is plastic and mouldable like moist putty.

Soil texture should be measured separately for the topsoil and subsoil. Follow the flow chart below to determine the soil texture for each soil layer. (Source: NSW Agriculture, 2002)

Diagram: S.J. Thien, J. Agric. Ed. 8:54-55, 1979

Figure 5: Flow chart for determining soil texture



TEST

6

TOP SOIL

PHYSICAL

What is topsoil?

- Topsoil is the most organic-rich layer in the soil and the main zone for water and nutrient uptake by plants and thus should be protected.
- The soil beneath the topsoil is known as the subsoil and is often identified by a change of colour as described in Test 4 and texture change as described in Test 5. However there is not always a difference in these, and other indicators are used.

Equipment: Tape measure.

Test: Dig a hole (refer to instructions) and, depending on the type of soil, use one of three methods to determine topsoil:

Method 1 – Obvious difference in colour and texture

- Obvious difference in colour and texture between the topsoil and subsoil. The topsoil is typically darker in colour (often brown) and of a lighter texture, while the subsoils are a brighter colour and has a heavier texture (i.e. higher clay content).
- A variation of the above can occur when there is a 'pale layer' above the subsoil layer. This pale layer has a similar texture to the layer above, is lower in organic matter levels but is still referred to as the topsoil. For a further explanation on 'pale layer', please refer to the colour chart (refer to test 3). The subsoil begins when both texture and colour changes.
- Once the boundary between the topsoil and subsoil layers is identified, measure the depth of the topsoil layer.

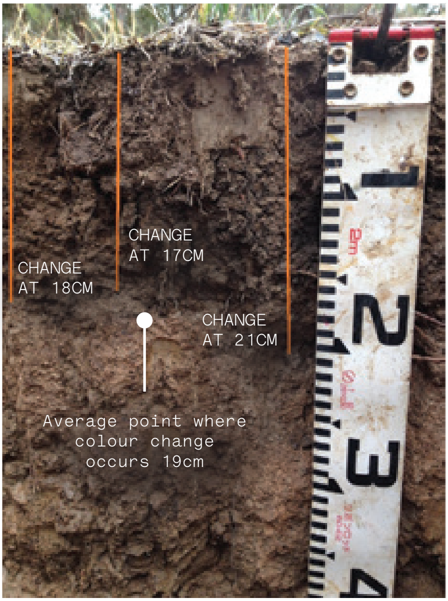
Method 2 – Changes in structure down the profile

- The depth at which it becomes harder to dig usually indicates a change in soil layer. Measure the depth at which these changes occur.

Method 3 – Similar colour, texture and structure

- Look at where most of the plant roots have accumulated; this is a good indicator of the topsoil layer. Measure the depth at which plant root mass declines, this is where the subsoil starts.
- Sometimes where the changes occur the boundaries are uneven so record the average boundary depth

TIP: Take a photograph of the soil profile. This will become a good future reference point.



Measuring the depth at which these changes occur.

Photos - Left: Agriculture Victoria, DEDJTR; Right: North Central CMA

TEST

7

SOIL STRUCTURE

PHYSICAL

What is soil structure?

- Soil structure is the arrangement of soil particles in the soil. The spaces between the aggregates/particles allow for adequate aeration and good drainage, as plants need air and water near their roots to grow well.
- Soil requires pores and channels large enough to be readily seen by the eye – e.g. worm burrows or old root channels. These pores are called macropores and allow the ready movement of air, water and roots through the soil and are therefore very important for drainage.
- Pores within the aggregates/particles are called micorpores and are important for water storage.

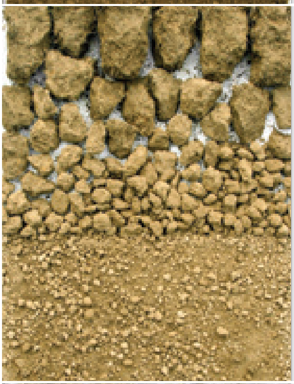
Equipment: Plastic tub and large garbage bag.

Test:

1. Take the 20 cm cube of soil that was removed when digging the hole
2. Drop it into the plastic tub from a height of one metre.
3. If large clods of soil break away from the cube after the first drop, drop them again one to two times. If a clod shatters after the first or second drop, don't drop it again. Don't drop any piece of soil more than three times. If your soil has a sandy loam texture (refer to test 5), don't drop the soil more than once and reduce the height to 0.5 metres above the plastic tub.
4. Transfer the soil from the plastic tub to the large garbage bag spread out on the ground.
5. Applying only gentle pressure, attempt to split any large clods by hand along any exposed cracks. If the clod can't be easily parted do not apply further pressure, as it is unlikely the cracks are continuous and transferring air and water.
6. Sort the soil pieces on the plastic bag from small to large, with the height of the soil roughly the same over the whole surface area of the bag. This provides a measure of soil aggregate size distribution.
7. Take a photo of the soil for future reference and comparisons.

Results:

Table 3: Interpreting soil structure results

Visual appearance	Assessment score	Interpretation
	Poor soil structure.	• Soil dominated by large soil clods. • Very few fine soil aggregates. • Soil clods are very firm and/or angular in shape. • Soil clods have very few pores. Note: some 'poor' soils can have no structure at all, like a sand because of the absence of clods.
	Fair soil structure.	• Soil contains roughly equal proportions of large soil clods and fine aggregates. • Soil clods are very firm and/or angular in shape. • Soil clods have very few pores. • Comparisons.
	Good soil structure.	• Soil is dominated by fine soil aggregates. • There is only a small amount of large soil clods. • Soil aggregates are generally rounded and often quite porous.

Photos: Shepherd, G. (2000)

TEST

8

SOIL COMPACTION LAYERS

PHYSICAL

Why should I worry about it?

- Soil compaction layers (sometimes called hard pans or plough pans), are layers of very dense, hard soil within the topsoil layer, having lost adequate macropores and structure.
- Compacted layers can slow down or even stop plant root growth and water infiltration.
- Compacted layers are often caused by heavy equipment travelling across the soil surface (especially when it is moist) and from the types of cultivating equipment cutting at the same depth year after year. Stock can also cause compaction of soils.

Equipment: Penetrometer and tape measure

Test:

1. Choose sites a few metres from the dug hole.
2. Using only moderate pressure, push the penetrometer into the soil. Feel for any differences in the strength required to push the penetrometer into the soil and note the depth at which this occurs. If a rock or tree root is hit move to another site. Repeat a few times to get a feel for the soil.

Compaction layers are usually found 5—10 cm below the soil surface. The subsoil is denser than the topsoil and could be mistaken for a compaction layer. Compare the depth to the compaction layer with the topsoil layer determined in Test 6.

Result: There is no evidence of compaction if the top of the subsoil is reached.

Note: Perform the test where there is stock or wheel tracks and under plants to note differences in soil strength. Keep a look out for any J roots in plants as this is also a sign of compaction.

Table 4: Assessing and interpreting compaction using a penetrometer

Penetrometer	Assessment score	Interpretation
Home-made penetrometer will not penetrate the soil.	Poor	• Soil is generally hard and/or hard at surface. • Usually an indication that the soil surface has been compacted by machinery traffic, livestock or overworking, especially if wet at the time. • Low soil organic matter levels.
Home-made penetrometer penetrates with difficulty to less than 15 cm.	Fair	• A dense layer of soil is present in the topsoil. • Root growth is stunted and roots tend to grow horizontally above the compacted layer. • Often caused by heavy machinery traffic, especially when it's wet. Can also be caused by the types of cultivating equipment cutting at the same depth each year.
Home-made penetrometer easily penetrates the soil to 15 cm deep.	Good	• No compaction layer before reaching the top of the subsoil. • Plant roots grow freely through the soil profile. • Water infiltrates the soil easily.

Table: NSW Agriculture, 2002

TEST

9

SLAKING & DISPERSION

PHYSICAL & CHEMICAL

Why is it important? Indicators

- Slaking occurs when weak soil aggregates break down as a result of rapid wetting. This results in the blocking of macropores, which in turn reduces the movement of water and air into and through the soil.
- Dispersion is a chemical process whereby clay particles separate from soil aggregates when the soil is wet. Clay particles carry a negative electrical charge and repel each other. Dispersive soils are usually sodic, structurally unstable, and require special consideration for development.

Figure 6: Flow chart of slaking and dispersion

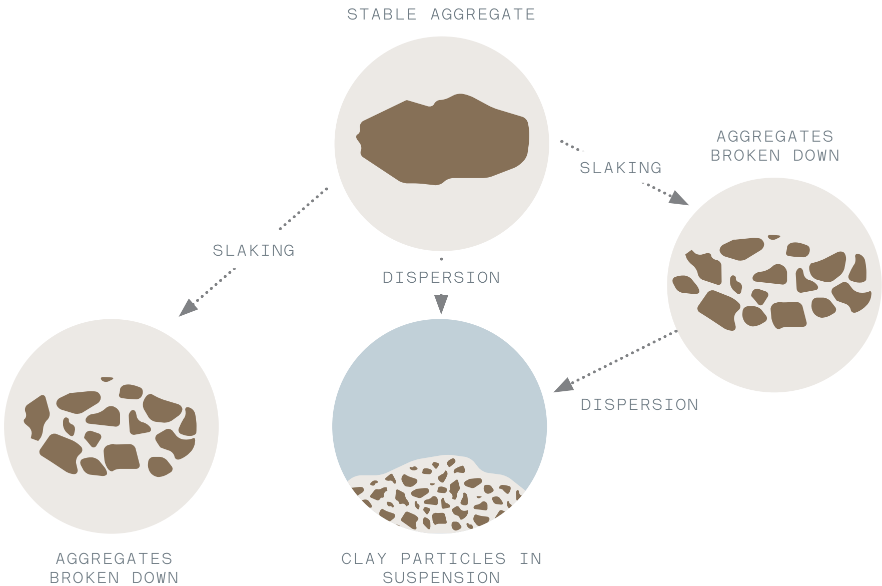


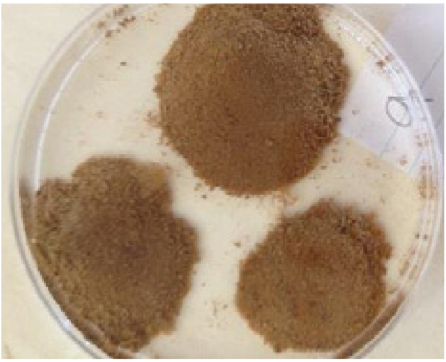
Diagram: Agriculture Victoria, DEDJTR

Equipment: Bottle of rain or distilled water, shallow dish or transparent cup.

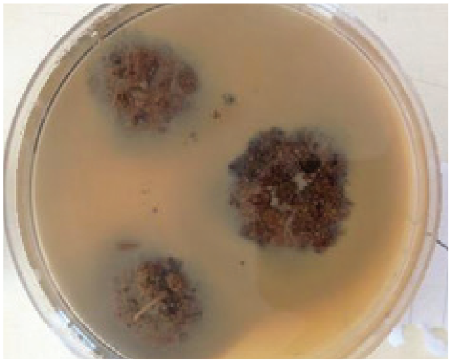
Test

1. Place two samples (about the size of a marble), one from the top soil and one from below, in a shallow dish or transparent cup of distilled water or clean rainwater without shaking or stirring the samples (do not use mains or bore water as they contain chemicals which may prevent slaking).
2. Slaking clay will slump and fall apart in the water forming a small blob of mud however the water will remain clear.
3. Dispersion will result in a milky layer forming around the soil crumb after 30 mins.

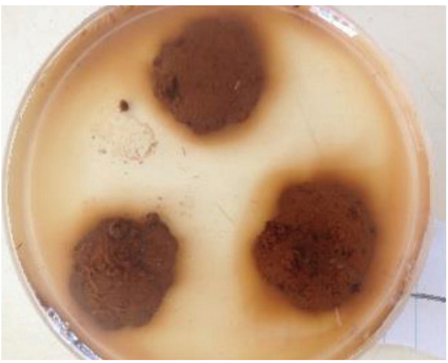
Note any differences between the top and sub soils. If dispersion is evident in the sub soil, it has implications for management as it is best not to pull up this soil to the top.



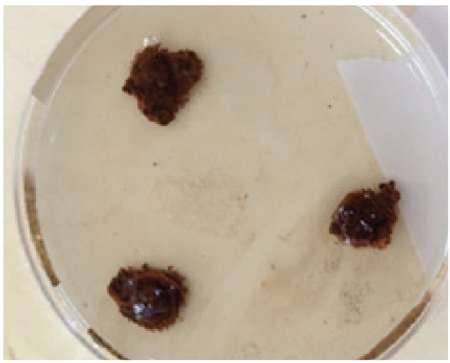
Slaking



Complete dispersion



Incomplete dispersion



No dispersion or slaking

Photos: Agriculture Victoria, DEDJTR

SOIL HEALTH SCORE CARD

Test	Poor Score = 1	Fair Score = 2
1. Groundcover	Less than 50% groundcover (plants dead or alive; stubble)	50% to 70% groundcover (plants dead or alive; stubble)
2. Evidence of soil biological actiivity	Fewer than two types of soil organisms	Two to five types of soil organisms
3. Soil colour	Grey	Light (Yellow/ Red/Brown)
4. Soil pH (water) (use lowest pH value from top and/or sub soil)	pH 5.0 or lower; greater than pH 8.5	pH 5.0 - 6.0; pH 7.5 - 8.5
5. Soil texture	Soil texture abruptly changes from the top soil (e.g. sandy loam) to the subsoil (e.g. clay)	Soil texture is the same throughout the profile
6. Top soil	Top soil less than 10 cm deep	Topsoil greater than 10 cm deep overlaying a pale layer
7. Soil structure	Cloddy, hard or crusty,few cracks/holes, no pores visible.	Some visible crumbly structure. Few pores visible
8. Soil compaction	Soil is hard; penetrometer will not penetrate the soil	Penetrometer penetrates with difficulty to less than 15 cm
9. Slaking & Dispersion	Unstable structure; aggregates break down and disperse; milkiness of water	Evidence of slaking; aggregates break down; no milkiness of water

Name:	Date:	Site location: *(Map transect location on following page)*		
Good Score = 3	**Weighting**	**Site 1**	**Site 2**	**Site 3**
		(score x weighting)		
More than 75% groundcover (plants dead or alive; stubble)	x3			
More than five types of soil organisms	x2			
Dark (Red/ Brown/Black)	x1			
pH 6 to pH 7.5	x2			
Soil texture gradually becomes heavier down the profile	x1			
Topsoil greater than 10 cm deep	x1			
Crumbly top soil. Soil forms stable aggregates	x3			
Penetrometer easily penetrates beyond 15 cm	x2			
Maintains structure; aggregates remain intact. No swelling of clay particles	x2			

Transect location

Refer to sampling procedure on page 9.

REFERENCES AND FURTHER INFORMATION

Baxter. N and Williamson. J (1963), Know Your Soil : Part 1 Assessing Your Soils, Retrieved from URL http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/0d08cd6930912d1e4a2567d2002579cb/71de891c76430335ca2576cb00031fdd/$FILE/NRE%20Soil%20Book%201_LR.pdf

Baxter. N and Williamson. J (1963), Know Your Soil : Part 2 Assessing Your Soils, Retrieved from URL http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/0d08cd6930912d1e4a2567d2002579cb/71de891c76430335ca2576cb00031fdd/$FILE/NRE%20Soil%20Book%201_LR.pdf

McGuiness, S (1991), Soil Structure Assessment Kit; a guide to assessing the structure of red duplex soils – Victoria-Measurement, Soil Management, Centre for Land Protection Research, Department of Conservation and Environment, Bendigo

NSW Agriculture (2002), Northern Rivers Soil Health Card; A soil management tool developed by farmers for farmers, New South Wales, Retrieved from URL http://www.dpi.nsw.gov.au/data/assets/pdf_file/0007/168703/northern-rivers-soil-health-card.pdf

P.Mele and C.Hollier (1995), Worm Wise II; A pictorial guide to the paddock of earthworms of south eastern Australia, Retrieved from URL http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/0d08cd-6930912d1e4a2567d2002579cb/71de891c76430335ca2576cb00031fdd/$FILE/worm%20wise%20II.pdf

Shepherd, T.G. (2000), Visual Soil Assessment. Volume 1. Field guide for cropping and pastoral grazing on flat to rolling country. Horizons.mw & Landcare Research, Palmerston North. 84 p.

Shepherd, T.G. (2009), Visual Soil Assessment. Volume 1. Field guide for pastoral grazing and cropping on flat to rolling country. 2nd Edition. Horizons Regional Council, Palmerston North. 119 p.

Thien, S.J. (1979), A flow diagram for teaching texture-by-feel analysis. Journal of Agronomic Education 8: 54-55.

White. E (2015) Understanding Vineyard Soils (Sec Edition) Oxford University, UK

Website Links/URL

Agriculture Victoria, (2005) 'Groundcovering Measuring Tool' http://www.depi.vic.gov.au/agriculture-and-food/farm-management/soil-and-water/erosion/ground-covering-measuring-tool

New Mexico State University, 'Procedure and key for estimating soil texture by feel' http://aces.nmsu.edu/pubs/_circulars/CR667/welcome.html

NSW Department of Primary Industries, ' SOILpak series on-line' http://www.dpi.nsw.gov.au/agriculture/resources/soils/guides/soilpak/south-dryland

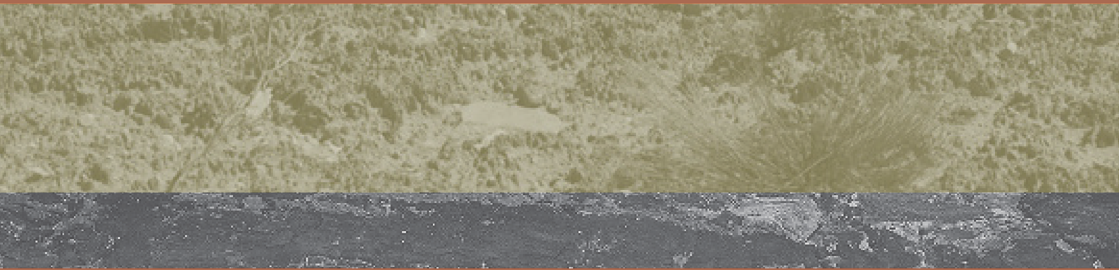
NSW Department of Primary Industries, 'Soil management guides' http://www.dpi.nsw.gov.au/agriculture/resources/soils/guides

Soils for Life http://soilsforlife.org.au

Victorian State Government, 'Know Your Soils; Introduction to Soils' http://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/0d08cd6930912d1e4a2567d2002579cb/71de891c76430335ca2576cb00031fdd/$FILE/NRE%20Soil%20Book%201_LR.pdf

Victorian State Government, 'Victorian Resources Online'' http://vro.depi.vic.gov.au/dpi/vro/vrosite.nsf/pages/soil

Victorian State Government, 'Victorian Resources Online'' vro.depi.vic.gov.au/dpi/vro/vrosite.nsf/.../worm%20wise%20II.pdf



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