Soil management tool

1. Introduction

The aim of this practical soil management tool is so that all landholders can use it to monitor the health of their soils.

It is made up of straight forward visual tests that require simple equipment and can be carried out by one person in the field.

The soil health activities provides for you to rate your own soils after carrying out the tests. By testing regularly and keeping the data up to date, you can build up a record of your soil health, and understand the effect of management practices on soil health.
Regular testing will show improvements in response to more sustainable management such as use of mulch in orchards, or minimum tillage in crop rotations, and allow early detection of developing soil problems. Test results can also be used as the basis for discussion about management changes with other landholders and with agricultural advisers.

This tool is not intended to replace any soil testing that you may already carry out. It is another tool to help you understand your soils and their productivity. Maintaining soil health in the short term will undoubtedly increase the sustainability of farming into the future.

2. How to use your soil Management Tool

1. Read all the information first. This will help you go out into the paddock ready for action.
2. When to test
Best results will be obtained in autumn, two to ten days after good rain. To allow comparison of results from year to year, sample at the same time of year and under similar conditions. Avoid taking samples from overly wet soils or during drought, at times of extreme high or low temperatures and within a few weeks of fertiliser or lime applications.
3. Prepare your equipment.
You will need to make 3 simple pieces of test equipment, using the instructions on Sheet 3, and gather together all the other items listed in the equipment list on page 3.
4. Decide where you will test.
We recommend you start with two sites, one to represent your 'best' soil and the other your 'worst' area. This will give you a good overview of how the tests relate to soil conditions on your land. You can then select other areas to get a broader understanding of the health of your soil.
5. Decide how many record sheets you need.
At each site you select, you may want to use more than one record sheet if;

- there is more than one soil type within the selected area
- conditions under row crops are quite different in the inter-row (e.g. light, groundcover, traffic)
- conditions in the paddock are quite different e.g. cultivation; completing one record sheet for each situation will provide an interesting comparison
- for comparison perform one test in an undisturbed area outside but adjacent to the orchard

6. Carry out the tests.
Each record sheet lists the tests and has space on the back for you to draw a sketch map of the site and show the test sites. Once you are familiar with the tests it will take you around 20 minutes to carry out one set of tests. Each record sheet has room for you to record up to three sets of tests at the site. We recommend that you do the three sets of tests as they will provide a broad picture of the soil conditions at the selected site.
7. Review your test procedure.
As you become more familiar with the test procedures and your soils, check whether the sites you have selected are the best sites for the information you need. Also review the way you do your tests to ensure consistency. Make notes as you go to remind yourself next time.
8. Review your results and follow up on low scores.
Line up your test sheets for areas you wish to compare and look for similarities and differences among your scores for the tests. Can you explain the differences? If you have neighbours also undertaking tests, get together with them and compare notes.
Where you have low scores in the results, refer to sheet that lists possible causes; obtain and read the literature linked to those tests in order to find out how you might improve your soil health.
9. Make sure the test date is on all your soil health record sheets before you file them.
10. Make a note in your diary to repeat the tests after 6 or 12 months.

3. Test preparations

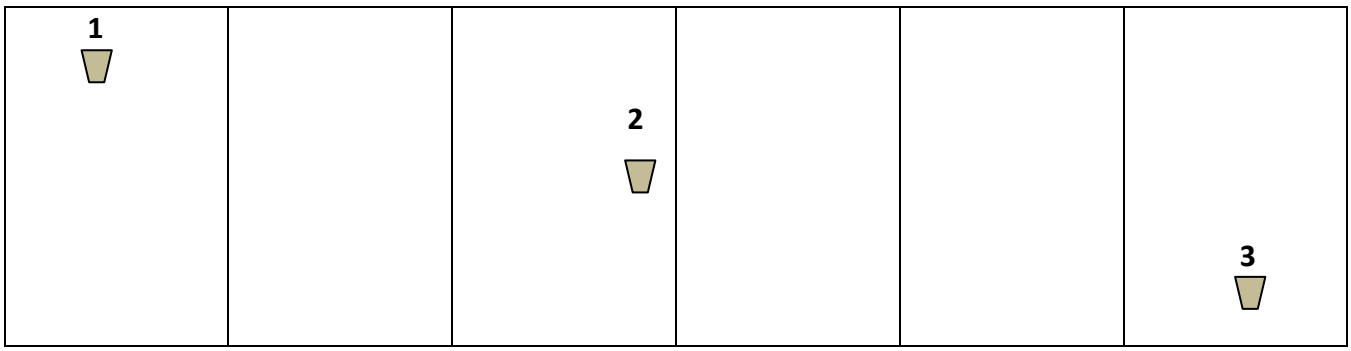
EQUIPMENT

- home-made penetrometer (see Sheet 3)
- home-made infiltrometer tube (see Sheet 3)
- clipboard and pencil
- one soil health record sheet for each set of tests planned
- spade
- clear plastic sheet 1m x 1m
- soil pH kit (available from rural stores)
- small, wide mouthed jar with a lid, marked to show 125 ml level
- 500 ml measure
- container of water (allow 1,250 mls water per sample point if soil is dry or 750 ml if soil is moist)
- watch with a second display

SAMPLING PROCEDURE
Suggested layout of sample points:

Notes

- Start from an identifiable point
- Stay within a single soil type for each sheet.
- Sketch a plan of the sample points on the back of the assessment sheet and mark any soil type boundaries.



Suggested layout of sample sites in an average 6 bay polyhouse.

4. Home-made equipment

1. PENETROMETER (Test 1)

A penetrometer is a device to test the compaction of the soil. While you can buy sophisticated penetrometers for hundreds of dollars, you can make your own inexpensive version. Take a 50 cm length of 3.15mm/10 gauge high tensile wire; use 12 cm of the length to make a handle and on the remaining 25 cm make file marks every 2.5 cm from the end.

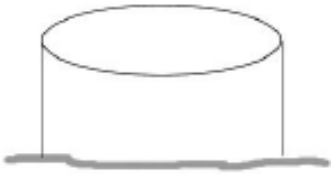
Metal rod (50 cm long, 3.15mm diameter) with file marks every 2.5 cm starting from end of rod.

Handle, 12 cm curved into a loop

Shaft 38 cm long

2. INFILTROMETER RING (Test 2)

An infiltrometer measures the rate at which a fixed volume of water soaks into the soil.
You will need a 150 mm diameter PVC pipe cut to 11 cm length.
Bevel the bottom end to make it easier to push into the soil and put a Black texter mark around the pipe 2cm up from the bottom.



5. The soil tests

1. Penetrometer

Push your homemade penetrometer into the soil as deep as you can with modest effort. Record the depth of penetration on your assessment sheet. 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.

2. Infiltrometer

If the top 7 cm of soil is dry you must perform this test twice in each location and record the time of the second test for an accurate assessment. If the soil is saturated (field capacity) you will need to wait two days for drying before conducting the infiltrometer test.

- Clear the area of residue and trim the vegetation as close to the soil as possible without disturbing the soil.
- Push the infiltrometer ring 2 cm into the soil, avoiding cracks and other holes in the ground. The ring should be nearly level for accurate testing. Use your finger to gently firm the soil around the inside edge of the ring to prevent leakage of water here.
- Carefully pour 500 ml of water into the ring and note the time.
- Stop timing when the water has soaked in and the surface is just glistening.

A higher rate of infiltration will mean your soil will absorb rainfall more quickly, resulting in less run off and erosion.

3. Root development

With your spade cut a 20 cm square hole to a depth of 20 cm. Lift the soil out, trying to keep it in one block, and place it on the plastic sheet. Examine the distribution of plant roots and complete the record sheet. The distribution of fine roots will show whether soil structure is restricting the plants' access to nutrients.

4. Soil structure

Break a small handful of soil away from near the original surface of the block you have dug up and examine the size and arrangement of the soil aggregates or 'crumbs' (discrete clumps of soil particles).

Under firm finger pressure soil should be friable, breaking into crumbs varying in size up to about 10 mm. There should also be evidence of root penetration throughout. Poor structure may be seen either as overly solid soil (hard crumbs, soil layers or clods) or as very loose soil (absence of even small crumbs, as for example in beach sand).

Good structure results in easy passage of air and water, an ability to hold water and superior resistance to erosion.

5. Aggregate stability

Select three or four pea sized soil aggregates from about 10 cm depth, avoiding small stones. Drop the aggregates into 125 ml water in the small wide mouthed jar and allow to stand for one minute.

Observe if the aggregates break apart or stay intact. If they are intact after one minute, gently swirl the bottle several times and observe again. If they are still intact, swirl the bottle vigorously and check again. The aggregates of a healthy soil are normally more stable than those of a less healthy one. Poor aggregate stability is associated with greater susceptibility to erosion. Repeat the test with a sample from a depth of 20 cm.

6. Earthworms

Break up your entire soil block into crumbs and place any worms found into a jar. When done, count any worms that are longer than 25 mm, record on the sheet and return the worms to the hole. Higher numbers of earthworms indicate conditions that are favourable (more organic matter, high pH, low chemical residues). Mostly these are also conditions favourable for plant growth.

7. Soil pH

Take two small samples of soil from the side of the hole, one from 5 cm and one from 20 cm depth. Test each sample for pH, following the instructions included in the kit.
Acidity has a strong effect on the ability of plants to take up soil nutrients as well as the wellbeing of soil organisms.

8. Leaf colour

Examining your vegetable crop, trees or pasture at the soil test site may reveal plant health problems not identified by the completed soil tests. In vegetable crops or orchards examine fully formed leaves about four leaves back from the growth tip. (Young leaves at the tip are often naturally pale or red leaves while old leaves nearer the stem may show mottling that is normal).

SOIL HEALTH RESULTS RECORD SHEET

Date: _____ Location/ID #: _____(sketch map overleaf)

Soil Type: _____ Crop Type: _____ Soil Moisture: dry/moist/water logged

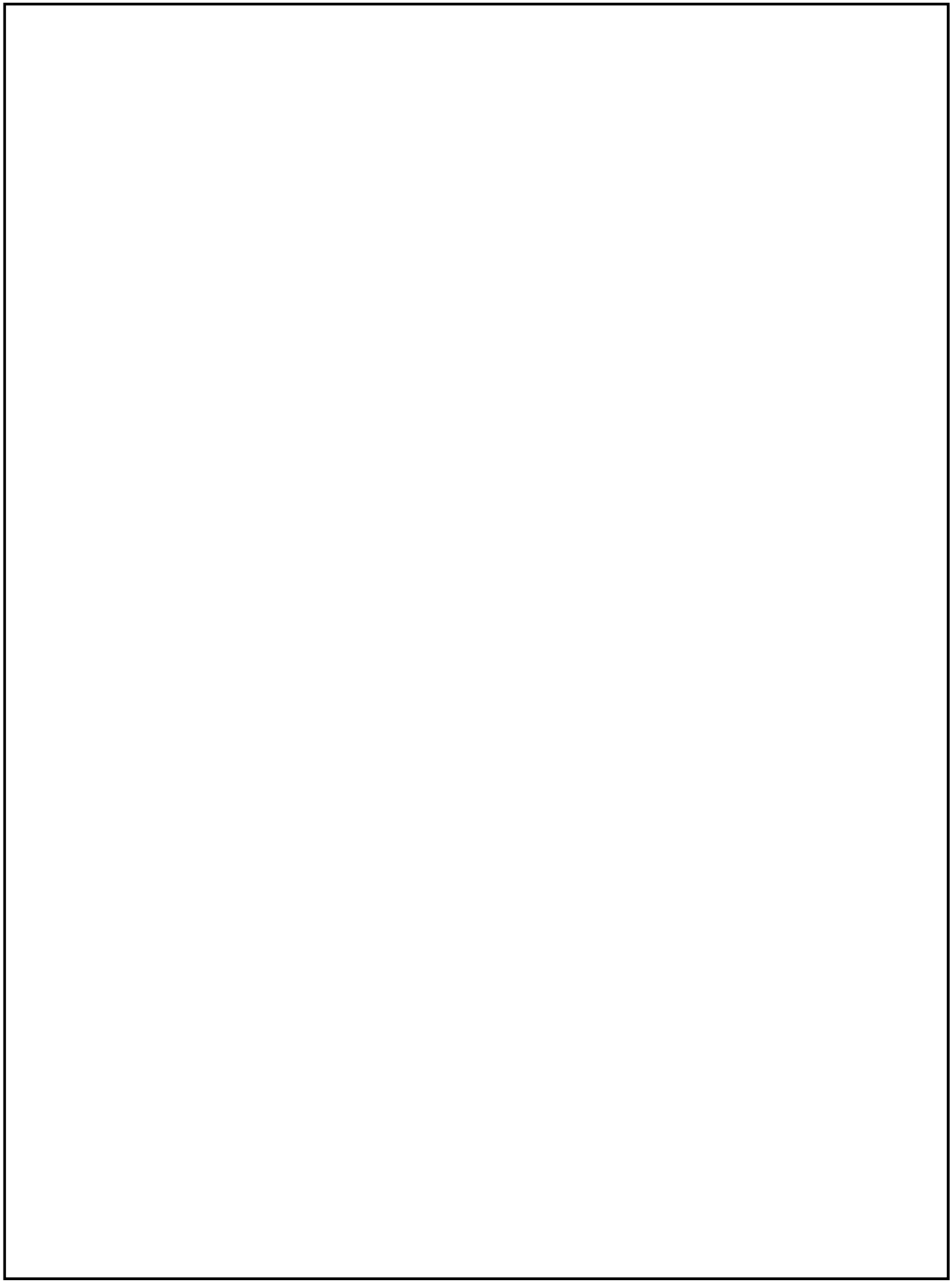
RESULT►	POOR	FAIR	GOOD	TEST SCORES (1 - 9)			
TEST▼	**1 -------- 2 -------- 3**	**4 -------- 5 -------- 6**	**7 -------- 8 -------- 9**	**1**	**2**	**3**	**AV**
Test 1. PENETROMETER	Wire probe will not penetrate.	Wire probe penetrates with difficulty to less than 20 cm.	Wire probe easily penetrates to 20 cm.				
Test 2. INFILTRATION	More than 7 minutes	3 to 7 minutes	Less than 3 minutes				
Test 3. ROOT DEVELOPMENT	Few fine roots only found near the surface.	Some fine roots mostly near the surface.	Many fine roots throughout.				
Test 4. SOIL STRUCTURE	Mostly in clods or with a surface crust, few crumbs.	Some clods but also many 10mm crumbs.	Friable, readily breaks into 10 mm crumbs.				
Test 5. AGGREGATE STABILITY							
10 cm depth →	Aggregate broke apart in less than one minute.	Aggregate remained intact after one minute.	Aggregate remained intact after swirling.				
20 cm depth →							
Test 6. EARTHWORMS	0 - 3	4 - 6	more than 6				
Test 7. SOIL pH							
5 cm depth →	pH 5 or lower	pH 7.5 to 9.0	pH 6.0 to pH 7.5				
20 cm depth →							
Test 8. LEAF COLOUR	Stunted plants, leaf discolouration.	Some variation in growth and colour.	Appropriate leaf colour and uniform plant growth.				

NB. To get the average score for each set of tests; Add the 3 test scores together and divide that total x 3 to get the average.

Site Plan Notes

Test site reference point (a description of where the tests were taken for future reference):	
Test #	**Test site notes**
Test 1	
Test 2	
Test 3	
Test Notes	

SITE PLAN SKETCH



LOW TEST SCORES, Possible causes

1) Low probe penetrability
Soil is generally hard; Compacted by traffic, livestock or by over-working.
Hard at the surface only:

- Organic matter content low
- Compacted by traffic or livestock, especially if soil is wet at the time.

Hard layer at greater depth; Compacted by heavy vehicles or 'hard pan' formed by soil inverting cultivators

2) Slow water infiltration

- Naturally high clay content of soil type, possible loss of topsoil
- Lack of spaces, channels or burrows in soil
- Soil compaction, poor soil structure, lack of earthworms, surface crusting

3) Poor root development

- Hard soil lacking spaces
- Poor plant nutrition (Soil pH not suitable for crop, lack of major or minor nutrients)
- Root disease or attack
- Loss of topsoil, poor soil structure, soil compaction
- Presence of soil borne pathogen, root feeding nematodes or root feeding insects

4) Low earthworm count

- pH unfavourable, soil pH naturally low, pH reduced by use of acidifying fertilisers
- Poor food supply; Sparse litter and/or ground cover (and roots), low organic content
- Lack of soil spaces; Dispersion, loss of topsoil, soil compaction or poor structure
- Predators or parasites present, such as flatworms or parasites e.g. parasitic fly may occur in 'plague' numbers mortality from recent use of insecticides or regular use of cumulative chemical(s) such as copper
- Presence of harmful chemical

5) Poor soil structure

- Powdery soil, few crumbs
- Excessive clods
- Lack of soil binding substances and processes, low soil organic matter (sparse ground cover), few worms topsoil loss, soil compaction, low organic matter, 'puddling' of wet soil by stock, excessive cultivation

6) High slaking soil particles disperse when wet
10 cm: topsoil loss, compaction, low organic matter, excess tillage
20 cm: poor mixing of soil by soil animals, acid conditions

7) Low pH high level of acidity
5 cm: Excess of nitrogen from inorganic fertilisers and legumes, poor drainage, low organic matter
20 cm: Shallow top soil, unused N leached from above, if pH is less than 4 consider acid sulphate soil (grey clay, sometimes with yellow veins)

8) Poor leaf colour; unthrifty plant soil problem as indicated in tests 1-9, one or more essential nutrients deficient or unavailable (confirm via soil or leaf analysis), low organic matter, disease or waterlogging.