Rapid Assessment of Soil Health (RASH) manual

A landholder's guide

NQ DRY TROPICS

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Limitations of the document

This document is a guide only. Seek professional advice if more comprehensive information about soil is required.

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SOIL LAND FOOD
ECOLOGICAL AGRICULTURE

LANDHOLDERS DRIVING CHANGE
BURDEKIN MAJOR INTEGRATED PROJECT

Contents

Australian Government | National Landcare Program

Queensland Government

Landholders Driving Change is a Burdekin Major Integrated Project funded by the Queensland Government through the Queensland Reef Water Quality Program.

Using this manual

This Rapid Assessment of Soil Health (RASH) Manual is a tool to help assess soil health across a range of land types.

Soil is the most valuable natural asset on any property. Without a well-functioning soil, landscape health will be poor and grazing productivity will not be optimal. This manual can be used to objectively assess the condition of soil on land types across a property.

This manual demonstrates how to quickly assess some key aspects of soil and land to determine if the soil is healthy, or has constraints.

Monitoring the condition of land and soil can help landholders:

- make decisions for better paddock management;
- identify major constraints to achieving healthy and productive land; and
- track whether current management practices are maintaining, improving or degrading the soil.

An introduction to using this manual, assessing soil texture and the five soil health tests will be available as short videos.

5 Steps to doing a RASH

1. **Check equipment:** Ensure the equipment needed is in working order. The equipment list for doing a RASH is on page 6.
2. **Identify the soil monitoring site:** Determine a well thought out monitoring site and decide when, and how often a RASH assessment should be carried out. A guide to how to set this up is on page 7.
3. **Assess each soil health indicator** using the guidelines in this manual: Follow the steps in this manual to complete a RASH. The tests start on page 10.
4. **Score each soil health indicator** against benchmarks and complete a Bullseye Score Card, provided as part of this manual. Print extras if required. See instructions on using the "Bullseye Score Card" on page 9.
5. **Review the results:** Scoring soil health helps identify constraints and areas where action may be necessary. See "Management options" on page 23.

Soil health indicators

Soils have three key aspects to their condition: physical, chemical and biological. All are important and each influences the other.

Healthy soil is in good condition across all three areas, resulting in a well performing soil ecosystem and grazing landscape.

More rainfall will infiltrate into the ground and soil nutrients will be able to cycle effectively.

The RASH approach assesses key indicators relevant to grazing systems in the region.

It uses practical indicators that can be measured easily and are known to be key properties strongly influencing soil health and land function.

There are five main indicators used as part of the RASH approach.

This manual also demonstrates how to assess soil texture. This is important in determining different land types.

RASH indicators

Indicator	Description
Ground cover condition	Describes what is covering the soil surface, as it: a. assesses how well the surface of the soil is protected by ground cover such as plants, plant litter, fallen branches and manure; and b. assesses how much of the landscape is covered by productive plants such as perennial grasses and legumes.
Water infiltration	Describes how effectively rainfall enters the soil during rainfall events.
Aggregate strength	Indicates two features of soil strength, as it: a. assesses the stability of the aggregates that make up soil structure; and b. indicates the possibility of soil with excess sodium content in its clay (sodic soil).
Soil organisms	Counts the diversity of soil organisms in the soil.
pH	Measures the acidity, or alkalinity of the soil.

Grazing RASH equipment

Most of the equipment needed to monitor soil health is easy to source from either the farm shed or a shopping centre.

These items are listed below.

Before doing a RASH it is a good idea to check that all equipment is in working order.

Keep the RASH gear clean and contained in a toolbox or lidded tub.

Square spade or shovel	1L distilled water or rainwater (not bore water)
Mortar and pestle	Low-sided plastic containers or small paint pallet
Drinking water bottle	pH colour test kit
Infiltrometer ring (steel or PVC)	Magnifying glass or hand lens
Ruler or tape measure	White plastic tray (approx 30x50cm minimum)
Heavy duty hammer or sledge hammer	Paper towel or cloth
Hardwood board (30x30cm minimum)	Stopwatch or smartphone
10L bucket	Bullseye Score Card
20L clean water in a jerry can	RASH Manual
Shears or secateurs	Plant and insect identification guides
Scissors or secateurs	Grass/plant identification guides

Soil and land monitoring

It is important to take a consistent approach to sampling when assessing landscape and soil health. Effective monitoring is done routinely at the same site. Monitoring sites should be chosen based on land type. Ideally, set up a permanent RASH monitoring site in each major land type on the property so soil and land changes can be tracked.

Monitoring can be time-consuming, but with practice can be performed efficiently during a normal work day. Keep the RASH equipment, this manual and scoring sheets together so monitoring can be done efficiently. If time is limited, choose the tests most important to monitor.

Tips for monitoring

1. **Locating a monitoring site:** Decide where to set up monitoring sites. Use a property map and personal knowledge to identify land types. Set up one, or more monitoring sites in each important land type. Use GPS, landmarks and posts to ensure a permanent location for future monitoring. Choose monitoring sites at locations typical of that land type. Avoid hotspot areas such as laneways or water points. Also avoid sites remote from stock water as they are seldom grazed. Alternatively, choose an area where land is degraded, so improvements achieved through management activities can be monitored.
2. **Deciding when to monitor:** Save time by including soil monitoring with other regular jobs on the property. All five tests can be carried out when the soil is moist (but not saturated) a week or two after the last rain event of the wet season in March or April. Alternatively choose to split the tests to:
    - end of dry season – test for soil infiltration rates, and ground cover; and
    - end of wet season – test for soil aggregate strength, pH, productive plant cover and soil organisms when soil is moist, but not saturated.
3. **Use a monitoring transect:** The RASH method recommends sampling along a transect or straight line. A transect is a line between two markers on the ground. This needs to start from an identifiable point such as a post or from a GPS point. For most RASH indicators, monitoring will be along this transect. See next page for details.

Either way, for best long-term results monitoring needs to be done consistently. If it becomes burdensome, chances are it will not be done.

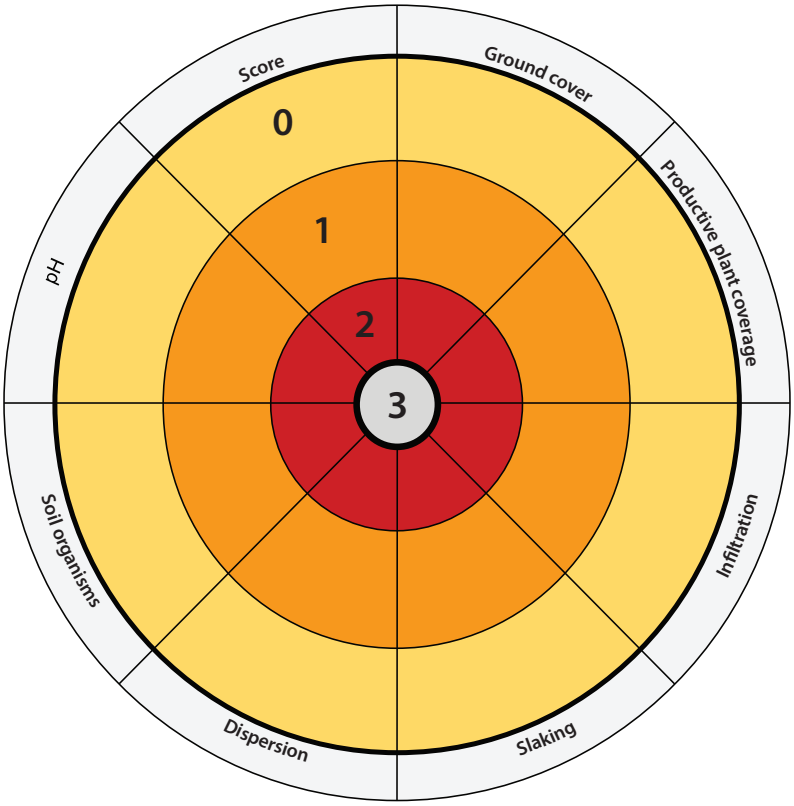
Setting up a monitoring transect

Setting up a transect at monitoring sites is straightforward in a grazing landscape:

1. Organise the equipment – two steel posts, two plastic post caps and a post driver.
2. Drive one post into the ground and cap it.
3. Step out 25 paces in a straight line away from the first post.
4. At the end of this line, drive in the second post and cap it.
5. This is the monitoring transect.

It is a good idea to GPS this site in case something happens to the posts; and to use brightly-coloured post caps easily seen from a vehicle.

A photo monitoring point at the transect will help to track changes in landscape health.



Using the Bullseye Score Card

The RASH approach uses a visual way to score soil health – the *Soil Health Bullseye Score Card* – making it easy to quickly spot poor aspects of soil health.

To complete the RASH using the Soil Health Bullseye Score Card, follow these steps:

1. **Write the name of the monitoring site** at the top of the Bullseye Score Card.

2. **Complete the texture test** and write this at the top of the card. The texture needs only to be tested the first time soil at that site is monitored. It is a permanent property of the soil and will not change.

3. **Assess each RASH soil health indicator**, and evaluate these against benchmarks, scoring them from 0 to 3. Note the Ground Cover Condition worksheet is on page 26 on the back of the Bullseye Score Card.

4. **Fill in the score for each indicator** onto the relevant section of the card.

5. **Review the Bullseye Score Card** and identify those indicators that score below 2. For any low scoring indicators see "Management options" on page 23.

The aim is to score a bullseye for each indicator!

Soil texture

What is it?

Soil texture is determined by the proportion of sand, silt and clay it contains. A soil sample will either feel gritty, silky or smooth depending on the relative quantity of those components.

Why it is important:

Texture strongly influences a number of soil properties including structure, water infiltration and water holding capacity. Texture does not readily change as it is an inherent property of the soil. A soil's texture depends mainly on the type of rock from which it was formed. Soil texture is a key characteristic of any land type.

How to assess it:

Soil texture is assessed by the *Ribbon Test* – which is the way a soil behaves when a small handful of soil is moistened and rolled into a bolus (ball) in the palm of the hand. This bolus is then pressed out between thumb and forefinger to form a ribbon. The strength and feel of the bolus and the length of the ribbon formed are rated against a chart to determine soil texture. There is no good, or bad value for soil texture. All soil textures, sandy, silty and clayey, have advantages and disadvantages. Write the soil texture on the Bullseye Score Card.

Measuring method:

Soil texture needs to be assessed only once at each monitoring site. Use a spade to take a sample from halfway along the transect, between two grass plants. A large golf-ball sized amount of soil from 5-10cm deep is enough. Use this sample to carry out the Ribbon Test shown on the next page.

Equipment:

Spade, water bottle, water, ruler, rag or paper towel, mortar and pestle, RASH Manual.

Soil texture only needs to be assessed once at each monitoring site. It is an inherent property of the soil and will not change – determining texture is not a soil health test.

Soil texture table

Evaluate samples against this table for **bolus coherence**, **feel** and **ribbon length.**

1	2	3	4	5	6
Bolus coherence	**Feel**	**Approx. ribbon length**	**Soil texture type**	**Comments**	**Approx. % clay content**
Nil to slight	Sandy and gritty	Less than 15mm	**Sand**	Unable to form a ball, single grains stick to fingers	Up to 10%
Slight to just firm	Sandy	15-25mm	**Sandy loam**	Sand grains can be seen or felt	10-25%
Firm	Smooth, spongy and may be greasy	Approx. 25mm	**Loams**	Can feel spongy or silky, no sand can be felt	20-30%
Firm to strong	Sandy	25-40mm	**Sandy clay loam**	Sandy to touch with grains visible	20-30%
Firm to strong	Smooth	40-50mm	**Clay loam**	Smooth to touch	30-35%
Strong plastic bolus	Plastic	50-85mm	**Light clay**	Smooth like soft plasticine	35-45%
Strong plastic bolus	Plastic	Greater than 85mm	**Medium – heavy clays**	Smooth and handles like plasticine	Over 45%

Assessing texture

1 Crush the soil sample by hand, or with a mortar and pestle if necessary. Remove any roots and gravel. The sample should be the size of a golf ball.

2 Hold the sample, moisten it, and work it by hand until it is consistently moist throughout. It should not be sloppy or drip water. Note: heavy clays will take time.

3 Shape the sample into a bolus (ball). Assess it for ***coherence*** against the first column of the Soil texture table.

4 Next feel the bolus of soil between the fingers and evaluate its ***feel*** against the second column of the table.

5 Now shape the sample into a thick cigar shape.

6 Finally flatten the cigar gently to about 10mm thick by pressing it out between thumb and forefinger. Push it away from you as a ribbon of soil.

7 When the ribbon breaks, measure the length of the section it forms. Do this a few times to get an average ribbon length. Evaluate the average length against the third column of the table.

Determine the soil texture by looking at the fourth column on the table opposite. Write the soil's texture on the Soil Health Bullseye Score Card.

Soil health tests

Ground cover condition

What is it?

Ground cover condition assesses ground cover and the type of productive plants. Ground cover is any material that covers bare soil and protects it from exposure, evaporation and erosion. It includes grasses, shrubs and trees, plant litter, fallen leaves, branches, manure and rocks.

Productive plants are species that contribute to grazing productivity, landscape and soil health. For the purpose of this test, these plants include healthy perennial, palatable and productive (3P) grasses as well as legumes and forbs.

Why it is important:

Ground cover condition is important for soil, landscape health and grazing productivity. Groundcover levels at the end of the dry season are crucial going into the next wet season, as good levels protect soil from erosion and surface capping by rainsplash. Without ground cover, water infiltration is reduced and the soil is exposed to greater temperature fluctuation and evaporation rates.

Soil health and productivity is increased where groundcover is composed of productive plants such as 3P grasses. The root systems of these plants contribute to soil organic matter, soil structure and water infiltration in a landscape. Legumes and forbs contribute nitrogen and increase nutrient cycling. Trees also play a role in cycling nutrients by drawing nutrients to the surface from deep within the soil.

How to assess it:

Ground cover condition is assessed by two tests that can be carried out at the same time for groundcover and productive plants. The *Step Point* method is used.

Use the worksheet at the back of the manual.

Walk along the sample transect. At each step, record the type of ground cover touching the toe of your shoe and whether it is a productive plant.

Note this on the Ground cover condition worksheet located on the back of the Bullseye Score Card.

Tally the results to get the percentage of groundcover and the percentage of productive plant coverage figure for the monitoring site. Score this result using the Groundcover and Productive Plant Scoring table and complete the Bullseye Score Card.

Measuring method:

Assess and record groundcover and productive plant cover for 25 steps along the monitoring transect.

Start at the beginning of the transect and take 25 evenly spaced paces along it, recording observations at each step.

Equipment:

Ground Cover Condition Worksheet, Plant Identification Books, pen, clipboard, calculator.

Ground cover condition

1 Prepare the *Ground Cover Condition Worksheet*, pen and clipboard.

2 Stand at the beginning of the monitoring site transect.

3 Step out along the transect for 25 even paces.

4 At each step look down and note the ground cover and productive plants visible at the toe of your shoe.

5 Record each observation on the Score Sheet.

6 Tally the observations and calculate percentages for groundcover and productive plants coverage.

Note: Carry out the assessment of productive plants at the same time as the groundcover assessment.

Scoring Ground Cover Condition

Score groundcover and productive plants coverage using the table below:

Results %	Less than 50	50 to 70	70 to 90	More than 90
Scoring guide	Poor	Moderate	Good	Very good
Score	0	1	2	3

Enter the groundcover and productive plants coverage percentages on the Bullseye Score Card.

Water infiltration

What is it?

Infiltration measures how readily water enters the soil through the surface. It shows how quickly rainfall will enter the soil and how much will run off.

Why it is important:

The more rainfall that enters the soil profile, the more will be available for plant growth. So it is important that as much water enters the soil during each rainfall event as possible for that land type. High levels of runoff lead to erosion and gully formation. The infiltration capacity of soil is related to its texture, structure and pasture cover levels. For any given soil type, the better the structure, the better the infiltration. This results in more plant-available water for pasture growth through the year.

How to assess it:

Infiltration is measured by pouring a volume of water into an infiltrometer ring (a piece of PVC or steel pipe about 120 to 200mm in diameter) hammered partially into the ground.

Where possible, pour the water gently onto an open hand, through cheesecloth, or onto a sponge into the infiltrometer. Use a stopwatch and ruler to measure how quickly the water soaks into the ground in six minutes. Multiply by 10 to estimate the infiltration rate in millimetres per hour. Score the result using the Water Infiltration Score system and complete the Bullseye Score Card.

Measuring method:

At a minimum, water infiltration can be assessed at one point along your transect. Walk 15 paces along the transect and use this point to conduct the test. If the monitoring point has a high tussock grass, or shrub, conduct the test directly adjacent to the plant. If the plant is low to the ground, cut it off close to ground level and test at that point. Be consistent. Note if the test was carried out over, or adjacent to, a plant to ensure consistency the following year.

For more accurate monitoring, conduct the test three times along the transect and calculate an average. Walk along the transect and stop every seven paces to conduct the test.

Equipment:

Hardwood board, mallet or small sledge hammer, infiltrometer ring, ruler, stopwatch or smartphone, shears,10L bucket, a few litres of water.

Scoring the Water Infiltration Rate

Score results using the table below:

Results mm/hr	0 to 25	25 to 10	100 to 250	More than 250
Scoring guide	**Poor**	**Moderate**	**Good**	**Very good**
Score	**0**	**1**	**2**	**3**

Write the infiltration rate score on the Bullseye Score Card and fill in the bullseye. If three tests were conducted, use the average score.

Assessing water infiltration

1 Organise equipment and pace out to the monitoring point.

2 Avoid obvious cracks in the soil surface.

3 Use shears to cut vegetation if required.

4 Use the board and hammer to firmly hammer the infiltrometer tube into the ground. It needs to be level and a few centimetres into the ground to seal the tube.

5 Position the ruler inside the tube against the edge.

6 Pour water from the bucket into the tube until near the top. Avoid pouring water directly onto the soil surface. Pour it onto an open hand or through cheesecloth onto the soil. Working quickly, note the depth of water on the ruler.

7 Wait six minutes.

8 Measure by how many millimetres the water has dropped. Multiply this result by 10. This will be the infiltration rate in millimetres per hour (mm/hr).

Score the water infiltration rate using the table opposite.

Aggregate strength

What is it?

In healthy topsoil, minerals combine with organic matter, soil life and plant roots to form small discrete pieces of soil. These small pieces of soil are known as *aggregates* and they are the small building blocks of soil structure. They are also referred to as *crumbs* or *peds*.

Aggregate strength refers to the ability of soil aggregates to keep their structure under stress. Soil aggregates that hold together indicate stable soil structure in good condition.

When placed in water, unstable soil aggregates can either:

1. **remain intact;**
2. **slake** – where the soil falls apart into very small crumbs; or
3. **disperse** – where the individual clay particles in soil aggregate disperse into a fine suspension in water. The water then becomes cloudy.

Clay content, organic matter, soil organisms and fine plant roots give soil good structure and reduce slaking and dispersion. Dispersion is also a potential indicator of soil sodicity. This is where there is excessive exchangeable sodium in the clay minerals of a soil.

Why it is important:

Good structure is important for all soil functions. It ensures vigorous plant root growth, good soil aeration, and an effective water cycle. It also provides habitat for soil organisms critical for nutrient cycling. Sodic soil (with a relatively high sodium content in its clay) compromises the growth of many plants. Sodic soil is also highly prone to rill and gully erosion, as the clay in it is unstable. This is a problem in some land types where this soil property is present.

How to assess it:

Aggregate strength is measured using the Aggregate Stability in Water Test (ASWAT). A small dry aggregate of soil (3-5mm) is placed into a shallow dish of distilled water, or rain water and is monitored for *slaking* and *dispersion* during the 10-minute test. Score the soil sample using the Aggregate Strength Score system, and complete the results on the Bullseye Score Card. If possible, select a dry sample, or air dry the soil for 24-48 hours before conducting the test.

Measuring method:

At a minimum, assess aggregate strength at one point along the transect. Walk 15 paces along the transect, then use a spade to dig out a sample of soil. Try to keep it as an intact cube and try to get to 10cm deep if possible. Use this sample for the aggregate strength test. If the monitoring point consists of grasses or shrubs, get a sample that includes a plant, or is directly adjacent to one if possible. Take soil aggregates from between 5-10cm deep. Test three soil aggregates and get an average result. For more accurate monitoring, conduct the test three times along the transect and calculate an average. Walk along the transect and stop every 15 paces to dig a sample and do the test.

Equipment:

Drinking water bottle with distilled water, small plastic containers or small paint pallet, stopwatch or smartphone.

Assessing aggregate strength

1 Pour distilled water into small dishes or a paint pallet on a flat stable surface.

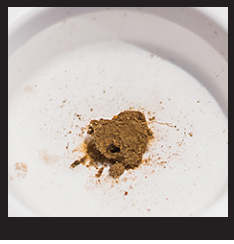
2 Get three soil aggregates from the soil sample. They need to be around 3-5mm in size. Air dry for 24 hours first if possible.

3 Place the aggregates carefully into the water and leave for 10 minutes.

4 Observe how much slaking and dispersion has occurred at the 10 minute point. Use the photos below to help assess strength and stability.

Scoring the aggregate strength

The Aggregate Strength Score has two parts – for slaking and dispersion. Score results using the table below:

Slaking results	More than 70% slaked	20 to 70% slaked	Slight slaking around edges	No slaking
				
Dispersion results	Strong dispersion. Completely cloudy	Moderate dispersion	Partly cloudy around aggregate	No dispersion
				
Scoring guide	**Poor**	**Moderate**	**Good**	**Very good**
Score	**0**	**1**	**2**	**3**

Soil organism diversity

What is it?

As well as microorganisms such as fungi, bacteria and protozoa, a healthy grazing topsoil should contain a diverse range of larger organisms and insects.

These include earthworms, dung beetles, springtails, ants, nematodes, mites, potworms, millipedes and a range of other insects.

Many of these are visible to the naked eye. These larger organisms are called soil invertebrates or soil organisms.

Why it is important:

A diversity of soil organisms is important to soil health in a number of ways. All soil organisms are important in helping to break down organic matter and cycling nutrients in the soil.

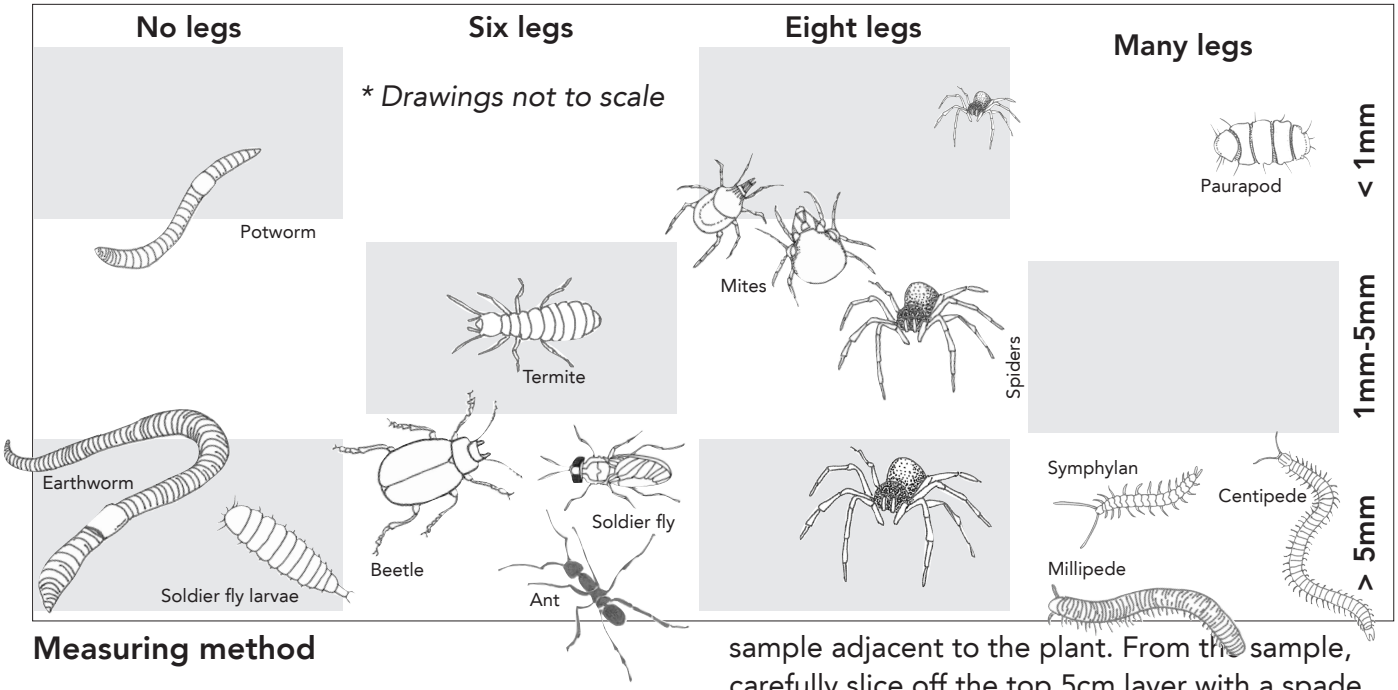
Some, such as earthworms and dung beetles, also have a positive influence on soil structure and water infiltration. Although some soil organisms feed on living plant roots, and are pathogens, most do not. In fact many soil organisms are predators of pathogens and can keep those populations under control.

Generally the more diverse the community of soil organisms, the more effective nutrient cycling, soil structure maintenance and disease suppression will be.

How to assess it:

Soil organism diversity can be assessed by counting the number of different types of organisms seen in a soil sample in a set period. Taking a sample of topsoil from an intact soil cube, the soil organisms can be observed with the naked eye or with the aid of a hand lens, or magnifying glass. Make a note of each different type of organism seen.

A simple way to identify organisms in the soil is by two characteristics – its size (less than 1mm, 1mm-5mm and bigger than 5mm) and the number of legs (none, six, eight or many).



Measuring method

At a minimum, soil organism diversity can be assessed at one point along the transect. Use the same sample of soil collected to assess aggregate strength. Alternatively, walk 15 paces along the transect and, using the spade, dig out an intact sample. Try to keep it intact as a cube and at least 10cm deep if possible. If the monitoring point consists of a high tussock grass or shrub, take the sample adjacent to the plant. From the sample, carefully slice off the top 5cm layer with a spade. Keep this top layer. Divide it in half. Keep one half – this will be the sample. Evenly spread it out on a flat board or plastic tray.

Equipment:

Spade, tray or board, magnifying glass or hand lens, RASH Soil Organisms ID Chart or Field Guide to Insects, stopwatch or smartphone.

Assessing soil organism diversity

1 Dig out an intact sample of topsoil at least 10cm deep and 15cm square.

2 Carefully take off the top 5cm layer of the sample with a spade.

3 Spread the sample out thinly leaving bare spaces between the soil.

4 Allow your eyes to adjust to the soil scale and do not move the soil around.

5 Spend five minutes observing the different types of organisms present. Occasionally gently shift and spread the soil sample around to help disturb the sample. A hand lens or magnifying glass can be used.

6 Count how many different types of soil organisms are visible. Use the table opposite or a Field Guide to Insects to help identify them.

Scoring soil organism diversity

Score results using the table below:

Results	Nil seen	1 to 2 types only	3 to 5 types	More than 5 types
Scoring guide	Poor	Moderate	Good	Very good
Score	0	1	2	3

Write the soil organism diversity score on the Bullseye Score Card and fill in the bullseye. If three tests were conducted, use the average score for the bullseye.

pH

What is it:

pH is a measure of the acidity, or alkalinity of the soil. It really measures the amount of free hydrogen (H) and hydroxyl (OH) ions present in soil.

The biochemical processes that occur daily in soils always result in a balance of acidity and alkalinity and give a soil its pH. pH is measured as a number from one to 14. Seven is neutral, below seven is acidic, and above seven is alkaline.

The pH levels are influenced primarily by soil type and climate, but management also plays an important role.

Why it is important:

Soil pH can influence a number of processes including nutrient availability and biological processes.

Under highly acidic or highly alkaline conditions, a number of nutrients may become tied up and unavailable for plant uptake.

Under acidic conditions in some land types, elements such as aluminium may also release and create toxic conditions for plant growth. In many Queensland grazing landscapes, most pasture species present have adapted to the local pH conditions of the area. However, when considering sowing introduced pasture species it is useful to know the pH of the soil as some species will not be suited to extreme pH levels.

How to assess it:

pH in the field can be assessed by using a pH Colour Indicator kit (Rapauch Method). Using the kit, a sample of soil is mixed with a solution and then dusted with a reagent powder.

Changes in sample colour can be assessed in good light against a colour chart to determine the sample's pH.

Measuring method:

At a minimum, soil pH can be assessed at one point along the transect. Take the sample from the same cube of soil used to assess aggregate strength.

Alternatively, walk 15 paces along the transect, and, using a spade, dig out a sample of soil. Try to keep it intact and at least 10 cm deep if possible.

Use it to take samples for the pH test. If the monitoring point consists of a high tussock grass or shrub, take the soil sample directly adjacent to the plant. Take soil from 5-10 cm deep in the sample.

For more accurate monitoring, conduct the test three times along the transect and calculate an average. Walk along the transect and stop every 15 paces to dig a sample and test.

Equipment:

pH Colour Test Kit.

Assessing soil pH

1 Get a small sample of soil at 5-10cm deep and place it on the test card or a flat surface.

2 Squirt on indicator dye and mix well with soil if needed. The sample should be wet, but not sloppy.

3 Dust the reagent powder onto the sample. Do not mix.

4 Leave it for a minute then evaluate the results against the Colour Chart. Use full light. This will indicate the pH of the soil.

Scoring soil pH

Score results using the table below:

Results	Under 5 Above 8.5	Between 5 and 5.5 Between 8 and 8.5	Above 5.5 or below 8.0	Between 6 and 7.5
Scoring guide	**Poor**	**Moderate**	**Good**	**Very good**
Score	**0**	**1**	**2**	**3**

Write the soil pH score on the Bullseye Score Card and fill in the bullseye. If three tests were conducted, use the average score for the bullseye.

Management options

Improving soil health

In livestock enterprises, grazing management is the most important influence on soil health and function. Planned grazing optimises soil nutrient cycling, water infiltration, pasture composition and forage quality – and minimises evaporation rates and soil erosion.

Implementing a planned grazing regime is strongly recommended to improve a poor score on any one of the key soil health indicators on the Bullseye Score Card. This can help improve key soil health properties such as soil structure, groundcover, water infiltration and soil organism diversity.

There are a number of terms used for planned grazing, including *rotational* grazing, *managed* grazing, *time controlled* grazing, *natural* grazing and *holistic* grazing. Whatever the term, here are the key points to any effective grazing approach.

1. **Maintain high levels of groundcover** at all times. More than 70% at most times is a critical target.

2. **Adjust stocking rate to ensure sustainable utilisation of available forage.** Develop a forage budget using sustainable utilisation rates. This will ensure long-term pasture vigour, protection of growing points and a competitive edge against weed invasion. A forage budget maximises diet quality for cattle and ensures adequate residual ground cover levels that will promote infiltration and reduce runoff during the next wet season.

3. **Aim for even grazing pressure** across all areas of each paddock. Use management options that promote evenness of grazing including subdivisions, watering points, fencing to land type and self-herding tactics.

   Self-herding is a behaviour and landscape based approach to managing animals and grazing pressure across the landscape. It includes using a range of tactics including guidance fences and tracks, signals and attractants and sometimes fire to manage grazing pressure across landscapes. More information is available at selfherding.com.

4. **Allow adequate recovery periods** for pasture recovery by moving stock between areas, including wet season spelling. Have a good number of subdivisions or use self-herding tactics to allow areas to be rested adequately, depending on season and rainfall.

5. **Maintain pasture species diversity** and maintain a balance between trees and grasses. This is achieved through being able to control animals on and off areas. In some situations sowing alternative pasture species is also useful. Appropriate use of fire can promote 3P grasses such as black speargrass, and manage the density of woody plants.

Soil chemical constraints

Some land types in North Queensland have soil chemical constraints that may affect soil health. These soil constraints include acidity, salinity and high levels of sodium (sodic soils). See "Further information and resources about soil health and sustainable agriculture" on page 27 of this manual.

Sodic soils

Sodic soils result when sodium is dominant in the minerals that formed the soil. They can often be part of the subsoil in some land types. Sodic soils disperse and are prone to severe erosion when exposed to water. This can lead to scalds, rill erosion and then severe gully erosion. Grazing management that maintains maximum ground cover and productive plant coverage is recommended to prevent loss of top soil and sodic erosion.

Acid soils

Many native grasses and legumes in North Queensland grazing landscapes are adapted to naturally occurring acid soils, however, historical land use and some pasture practices such as dominance of legumes can increase soil acidity on light textured soils. Grazing management practices that build soil carbon and humus are important, as soil organic matter can provide a buffer against extremes in soil acidity. Fire can be used to reduce legume dominance and encourage 3P grasses.

Saline soils

Salts naturally occur in some land types. Salts dissolved in groundwater can also find their way to the topsoil. This process can take many years and be revealed as surface scalds with white crusts. It is generally a response to the removal of perennial vegetation and the consequent rising of the water table. Grazing management that maintains maximum ground cover and productive plant coverage, and achieves a good balance of trees and grasses, is recommended to prevent soil salinity.

When considering sowing new pasture species, it is important to identify if any of these chemical constraints are present. The best approach is to choose pasture species adapted to match the soil conditions. Some improved pasture species are intolerant of extreme soil constraints, and addressing these with inputs is often uneconomical due to the scale of grazing properties in North Queensland.

Bullseye Score Card

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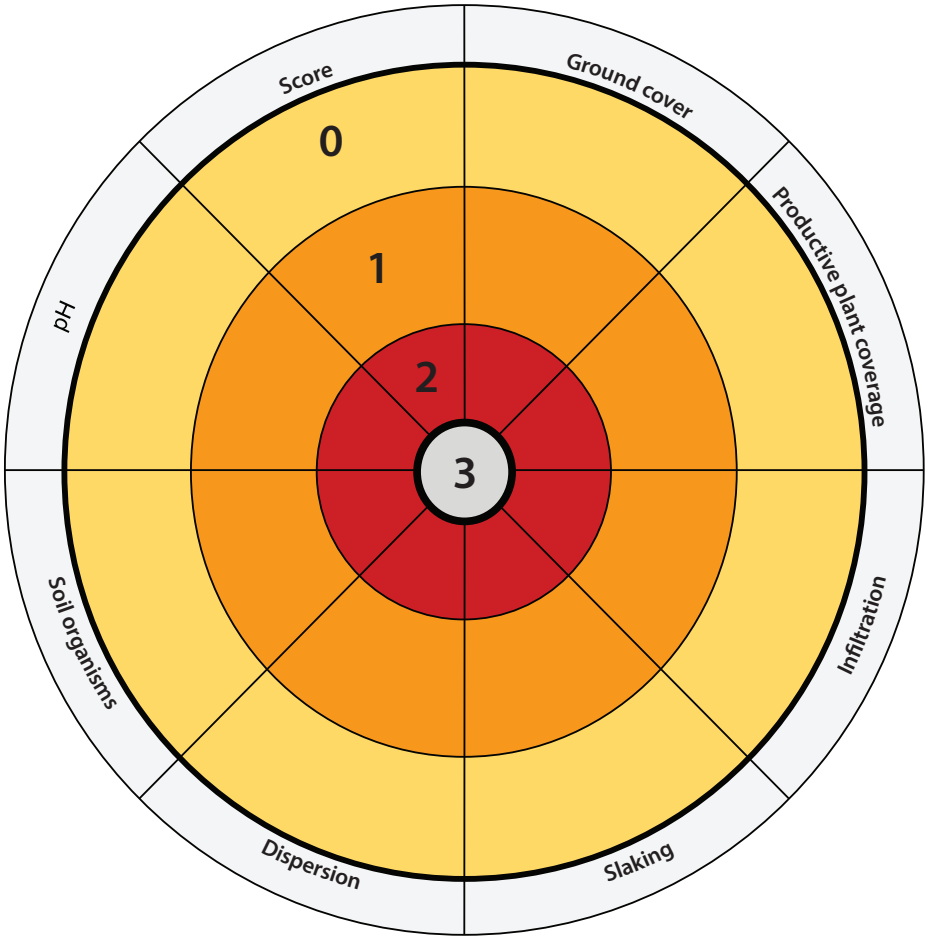
Days since last significant rain:	Soil texture (do this once):
Notes:	



Score on the Bullseye on the sheets provided (photocopy more or print out the Scoring Sheet available at *nqdrytropics.com.au/projects/sustainable-agriculture/sustainable-soils-project/* and compare it to the results next year.

	Score			
TEST	**POOR 0**	**MODERATE 1**	**GOOD 2**	**VERY GOOD 3**
Groundcover %	Less than 50	50 to 70	70 to 90	More than 90
Productive plant %	Less than 50	50 to 70	70 to 90	More than 90
Water infiltration mm/hr	0 to 25	25 to 100	100 to 250	More than 250
Slaking	More than 70% slaked	Between 20 to 70% slaked	Slight slaking around edges	No slaking
Dispersion	Strong dispersion, completely cloudy	Moderate dispersion	Slightly cloudy around aggregate	No dispersion
Soil organisms	Nil	1 to 2 types	3 to 5 types	More than 5 types
pH	Under 5 Above 8.5	Between 5 and 5.5 Between 8 and 8.5	More than 5.5 or below 8	Between 6 and 7.5

Ground cover condition worksheet

The step point method is used for both tests. Record results and calculate percentages using Table 1 and 2. Score results using Table 3 and note these on the Bullseye Score Card.

Table 1. Percentage groundcover

Type		Tally	Total #	Calculation	
Plant				A	
Leaves, branches				divide by	
Manure				A + B	
Rock, gravel				=	
TOTAL	A			x 100	
Bare ground	B			= % Groundcover	

Table 2. Percentage productive plant coverage

Plant type		Tally	Total #	Calculation	
Productive plants 1. 2. 3. 4. 5. 6. 7.	A			A	
				Divide by	
				A + B	
Non-productive plants 1. 2. 3. 4. 5. 6. 7.	B			=	
				x 100	
				= % Productive Plant Coverage	

Table 3. Scoring results

Results	Less than 50%	50% to 70%	70% to 90%	More than 95%
Scoring guide	**Poor**	**Moderate**	**Good**	**Very good**
Score	**0**	**1**	**2**	**3**

Score each result from 0-3 and note this on the Bullseye Score Card.

Further information and resources about soil health and sustainable agriculture

Soil health projects, events, grants, case studies, grazing BMP

NQ Dry Tropics nqdrytropics.com.au

GBP Qld (Grazing Best Practice) grazingbestprac.com.au

Soils for Life soilsforlife.org.au

Technical information, courses and consultation:

Agricultural Information Monitoring Services Consulting aimsag.com.au

Future Beef https: futurebeef.com.au

Inside Outside Management insideoutsidemgt.com.au

Maynard and Revell selfherding.com

Meat and Livestock Australia mla.com.au

Resource Consulting Services rcsaustralia.com.au

Soil Land Food soillandfood.com.au

Videos

NQ Dry Tropics Youtube channel: youtube.com/users/nqdrytropics

Future Beef 'Why you Need Ground Cover' youtu.be/GPfsE3_wXD4 and 'Growing Grass for Ground Cover' youtu.be/Em9eOp5TmCE.

Soils for Life, search 'Regenerating Australia's Soil health' Webinars Part 1 and 2.

youtu.be/qtkZz6Sicj8

Soil management

Sodic, saline and acidic soil qld.gov.au/environment/land/soil

Stirling et al. (2016): Soil Health, Soil Biology, Soilborne Diseases and Sustainable Agriculture: A Guide. CSIRO Press.

Field ID Guides

Anderson (2016): Plants of Central Queensland: Identification and Uses of Native and Introduced Species. CSIRO Publishing

Hooker. N and B. Jackes (2009): Grasses of James Cook University, Townsville Campus Part A: a pictorial key to grass genera in North Queensland. researchonline.jcu.edu.au/2103/

Zborowski. P and R. Storey (2017): A Field Guide to Insects in Australia. New Holland Publishers.

Rolfe J. et al (1998): Is Your Pasture Past It? The Glove Box Guide to Native Pasture Identification in North Queensland. Department of Primary Industries Publishing.

Milson J. (2002): Pasture Plants of North-West Queensland. Department of Primary Industries Publishing.

References

DPI QLD (2005) Grazing Land Management – Technical Manual, DPI and MLA.

Hazelton and Murphy (2007) Interpreting Soil Test Results: What do all the Numbers Mean? CSIRO Publishing.

Nicholls K. et al. (2007): Planned Grazing Management Fact Sheet, Land and Water Australia.

Bullseye Score Card

*Extra score card for future use

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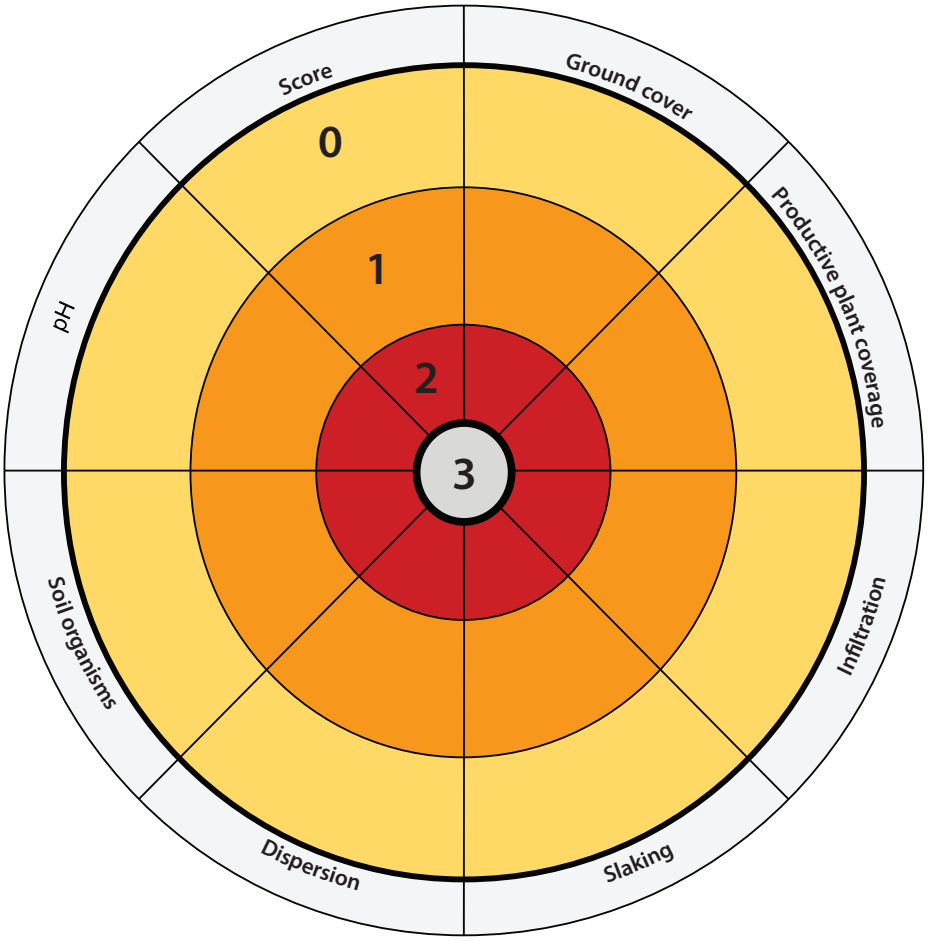

Score on the Bullseye on the sheets provided (photocopy more or print out the Scoring Sheet available at *nqdrytropics.com.au/projects/sustainable-agriculture/sustainable-soils-project/* and compare it to the results next year.

	Score			
TEST	**POOR 0**	**MODERATE 1**	**GOOD 2**	**VERY GOOD 3**
Groundcover %	Less than 50	50 to 70	70 to 90	More than 90
Productive plant %	Less than 50	50 to 70	70 to 90	More than 90
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Slaking	More than 70% slaked	Between 20 to 70% slaked	Slight slaking around edges	No slaking
Dispersion	Strong dispersion, completely cloudy	Moderate dispersion	Slightly cloudy around aggregate	No dispersion
Soil organisms	Nil	1 to 2 types	3 to 5 types	More than 5 types
pH	Under 5 Above 8.5	Between 5 and 5.5 Between 8 and 8.5	More than 5.5 or below 8	Between 6 and 7.5

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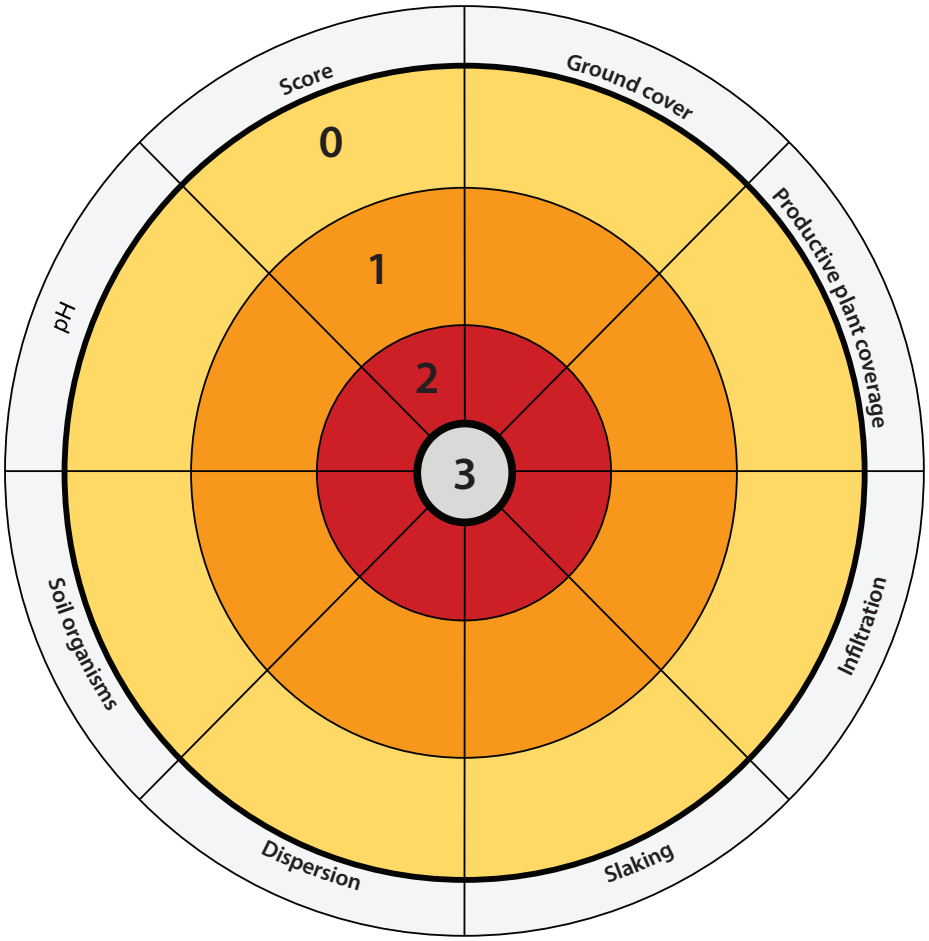

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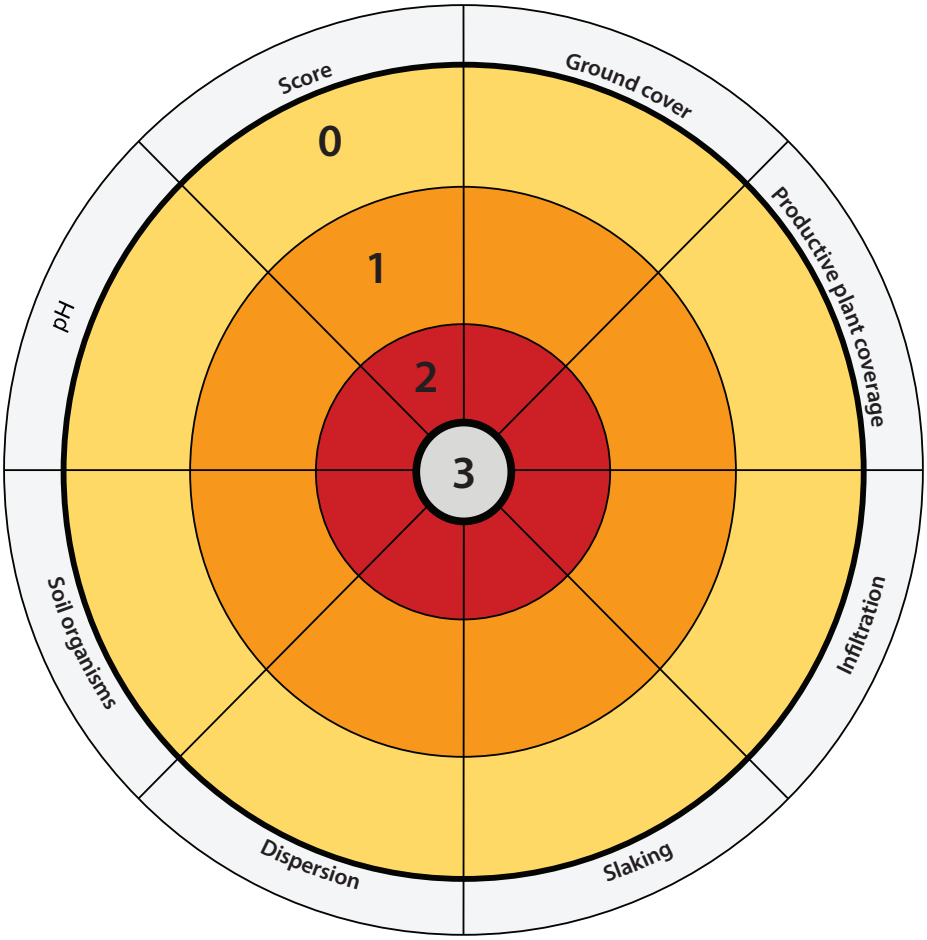

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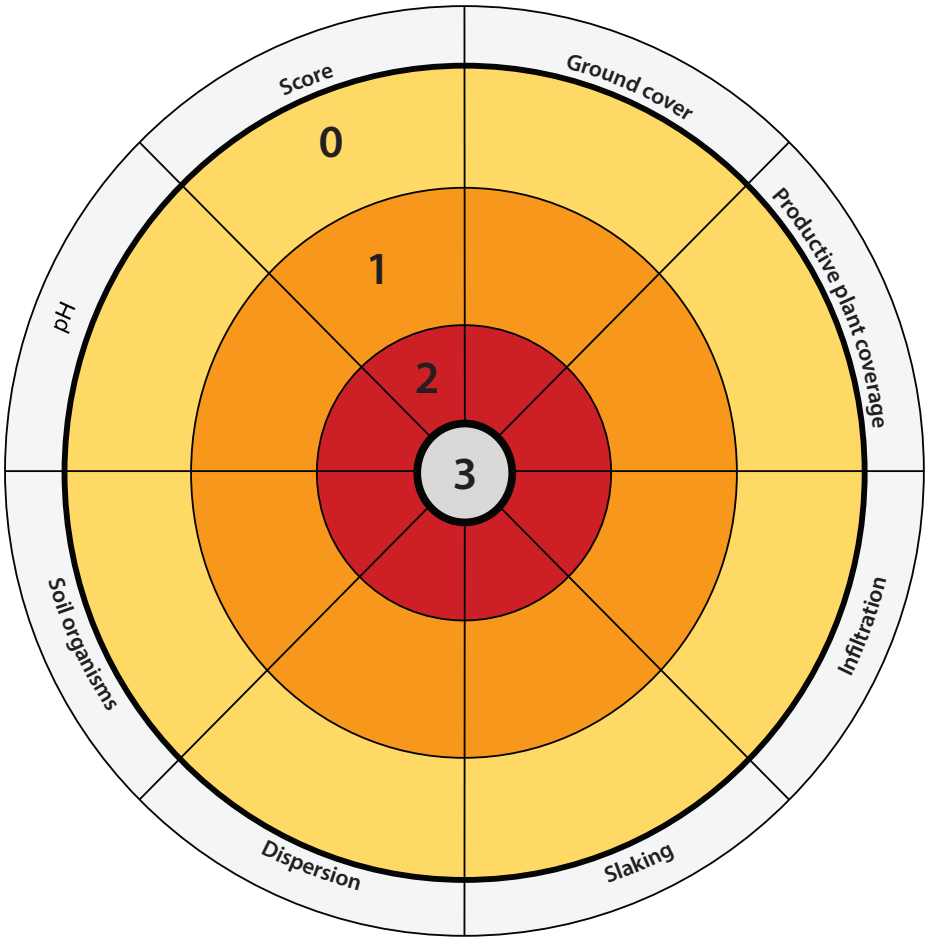

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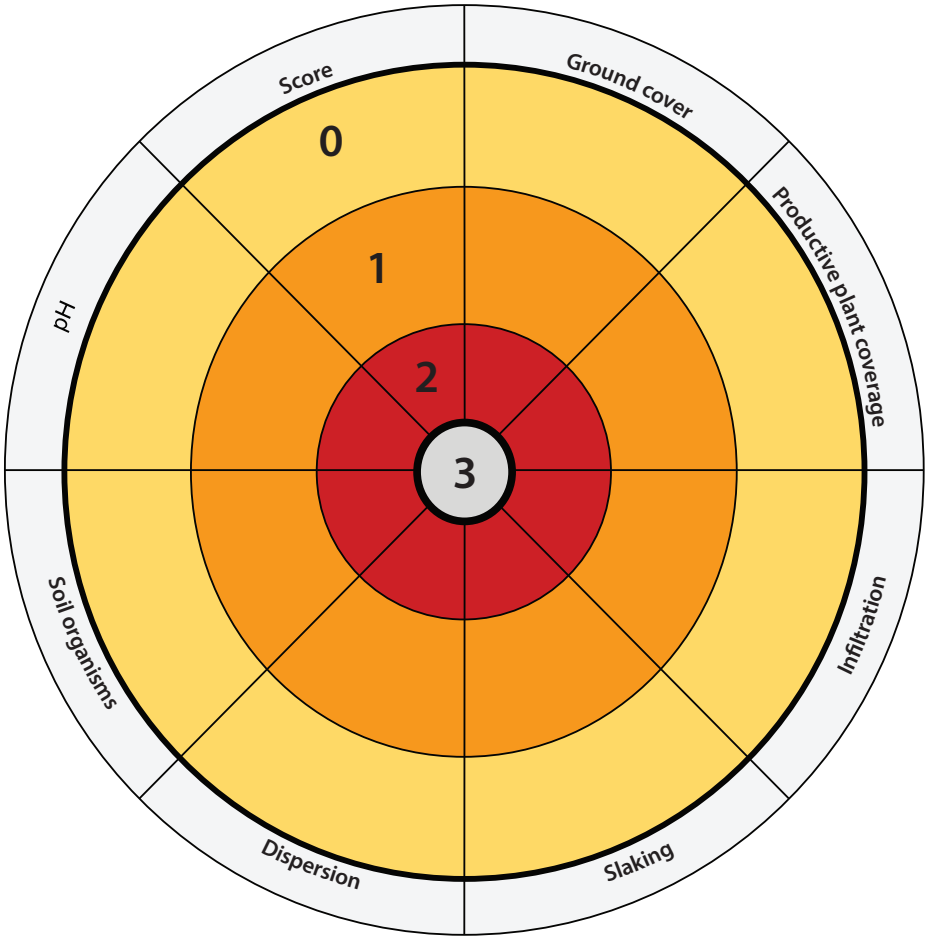

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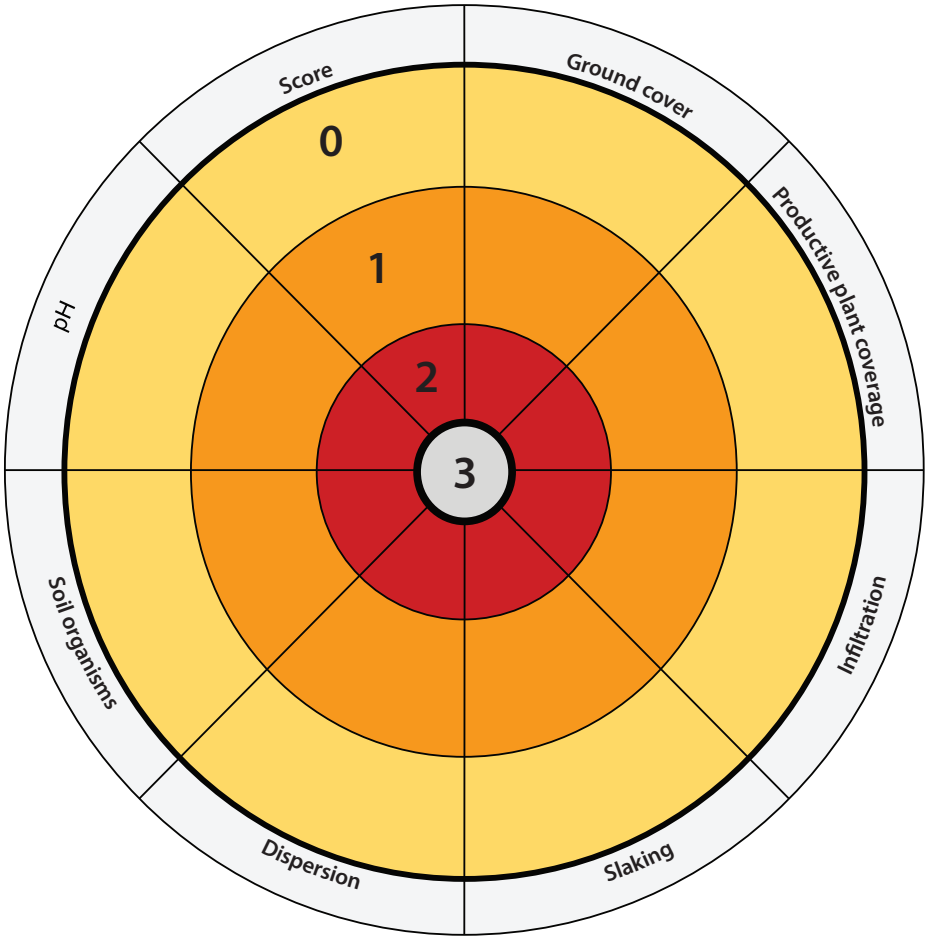

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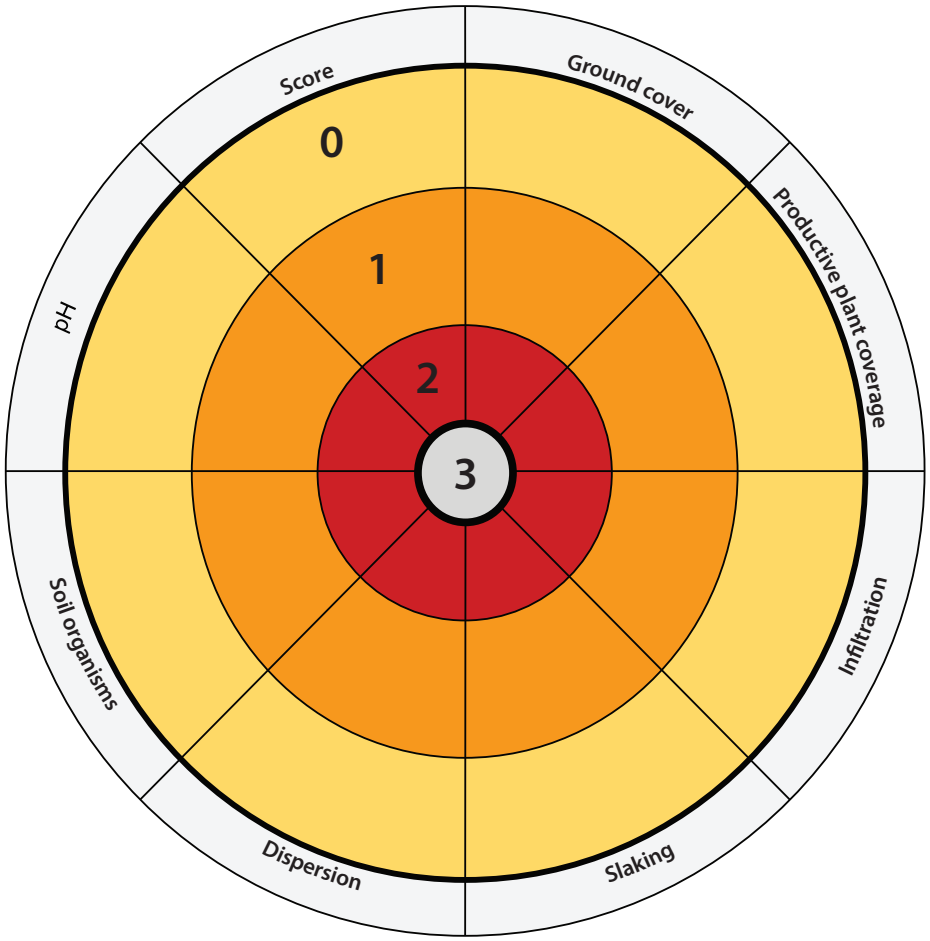

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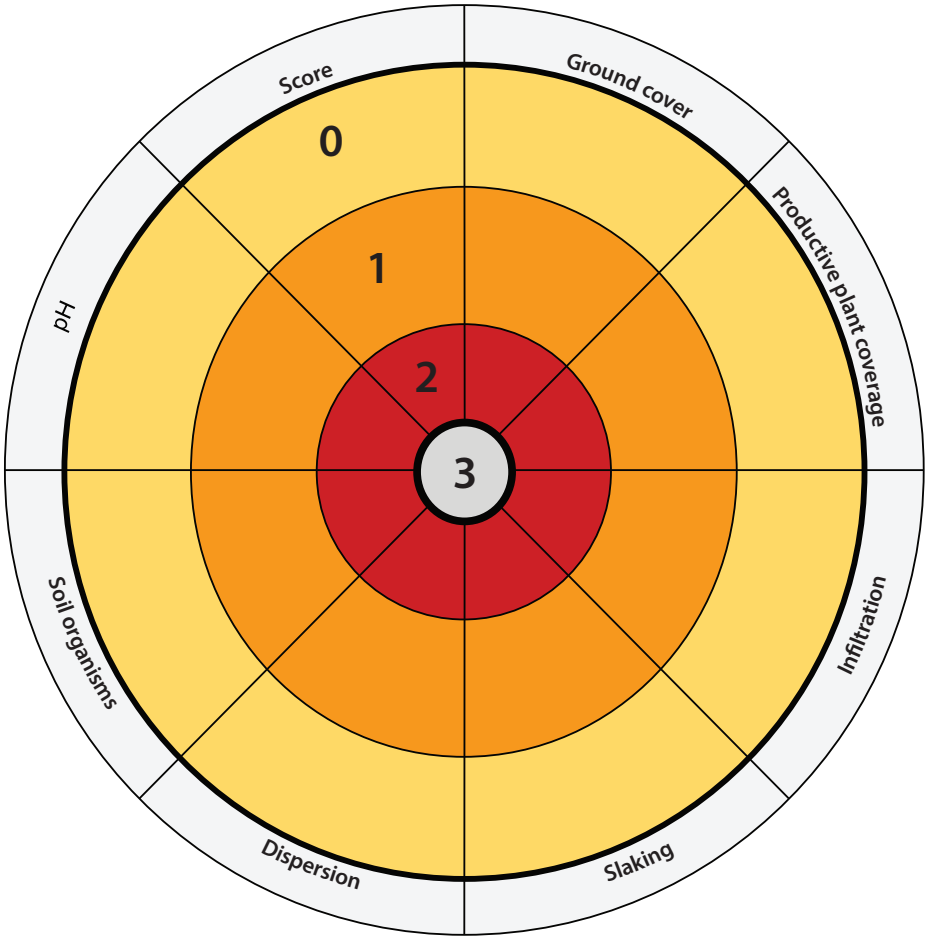

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RASH manual

A landholder's guide to the
Rapid Assessment of Soil Health