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Soil Health for pastoral systems

Soil health is defined as "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals and humans."

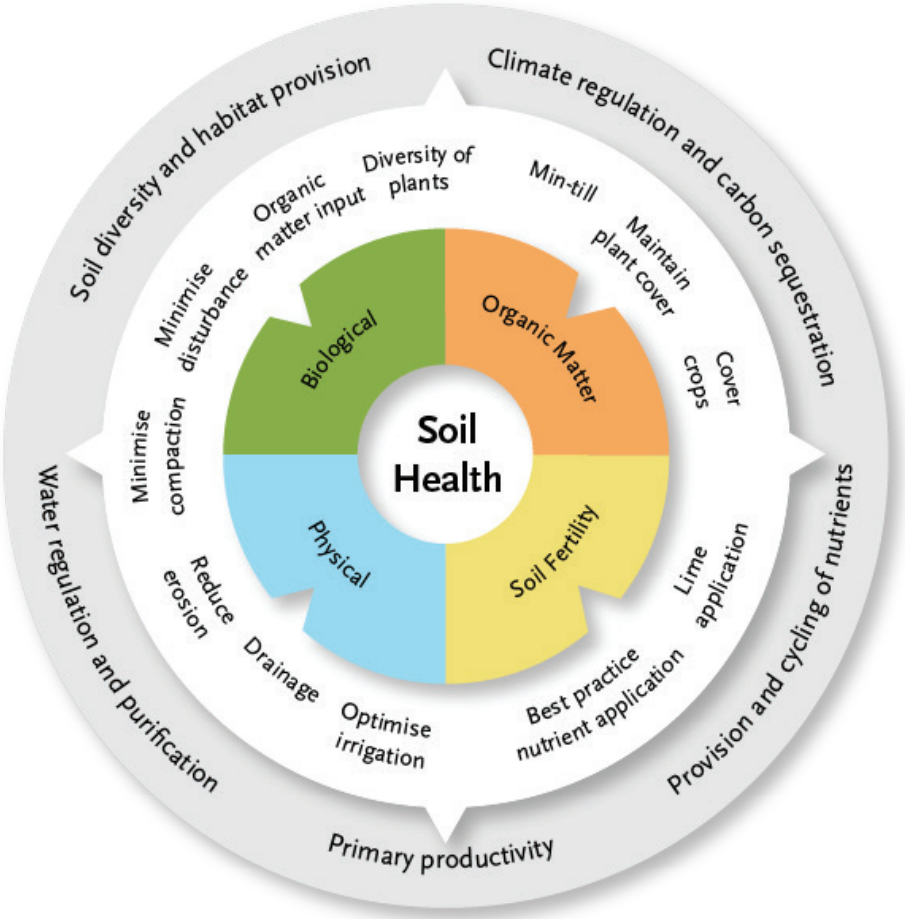


Figure 1: Linkages between soil health (inner circle), management practices (middle circle) and provision of services (outer circle).

Often when we think about soil within our productive systems, we think about its nutrient fertility. However, its physical properties, organic matter levels and biological activity are also important. Considering all these aspects together is the philosophy of soil health.

Healthy soils are ultimately soils that are functioning well (Figure 1). They:

- Support agricultural production
- Absorbs rainfall and decomposes organic matter
- Limits contaminate losses to waterways
- Are resilient and resistant to degradation

Soil health can be inferred by indicators. When indicators are outside the optimal range, soil function is impaired.Measures of soil health are typically dynamic, however, some soils are more limited in their ability to function due to their inherent properties that cant be changed (Figure 2).

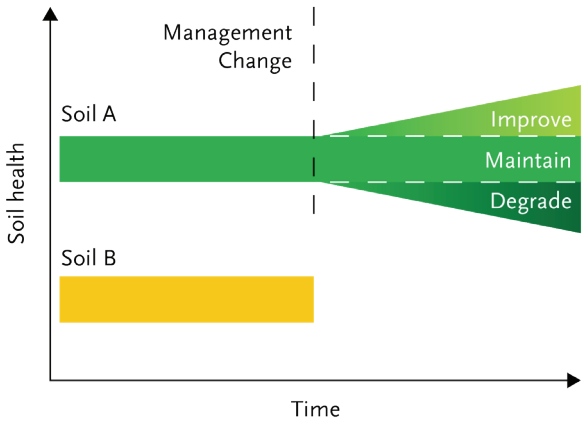
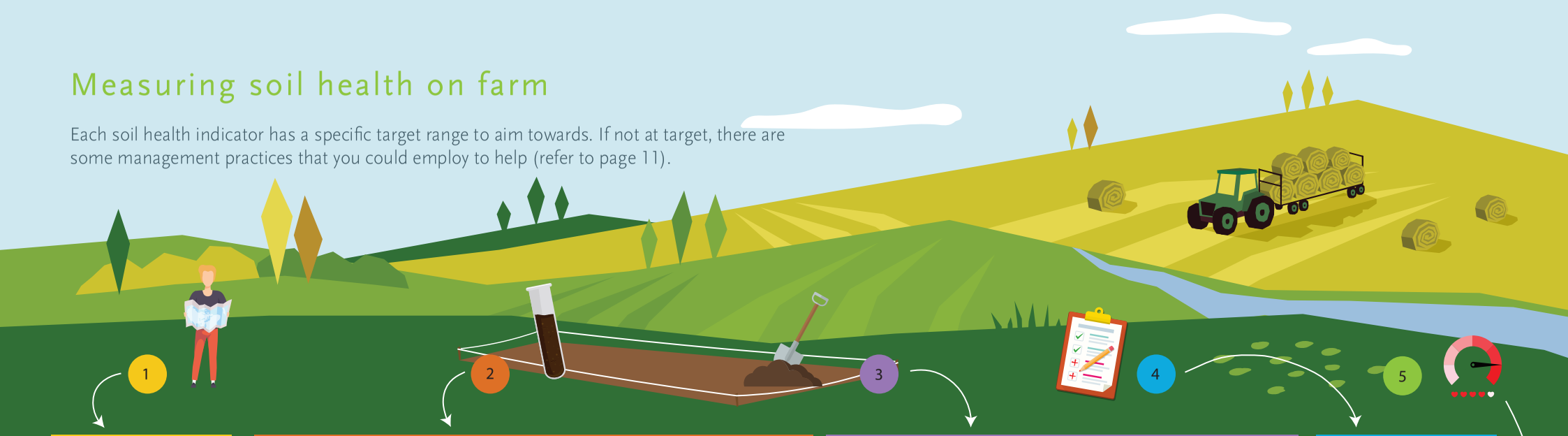


Figure 2: Differences in soil health as a result of inherent properties (soil A vs B), and how soil health changes in response to management.

Measuring soil health on farm

Each soil health indicator has a specific target range to aim towards. If not at target, there are some management practices that you could employ to help (refer to page 11).



1

2

3

4

5

SELECTING MONITORING SITES

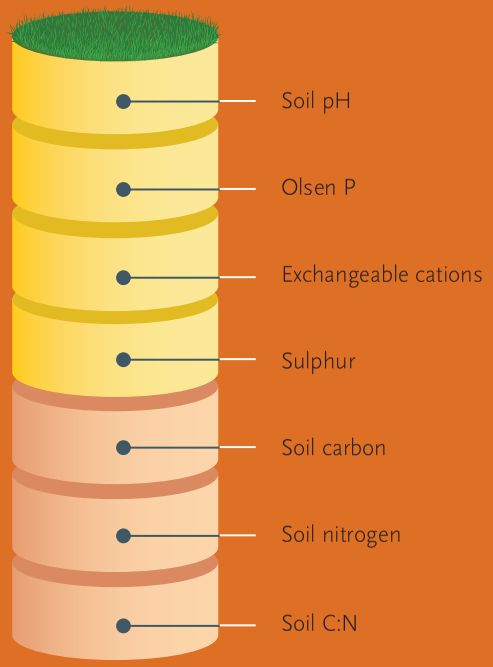
Identify land management units.

Establish representative transects or use those identified in soil fertility sampling.

Collect samples annually prior to spring.

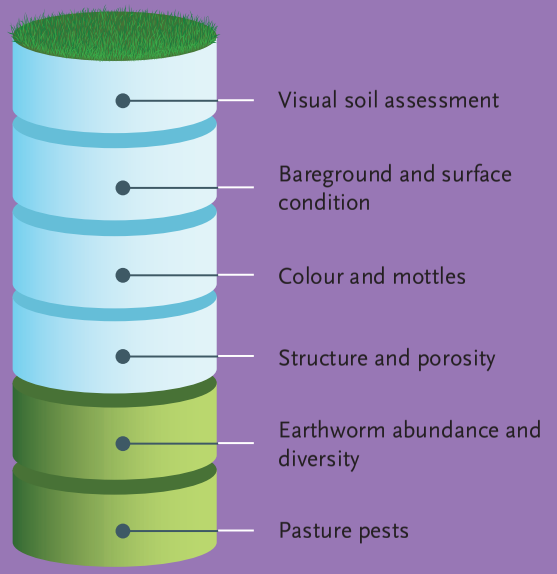
SAMPLE COLLECTION FOR LABORATORY ANALYSIS

Cores collected along transect



ON-FARM VISUAL SOIL ASSESSMENT

Assessed through Visual Soil Assessment at the beginning, middle and end of transect



INCLUSION OF ADDITIONAL INDICATORS

Additional indicators can be added to the assessment of soil health depending on the user's goals and this may require additional equipment.

INTERPRETATION OF SOIL HEALTH INDICATORS

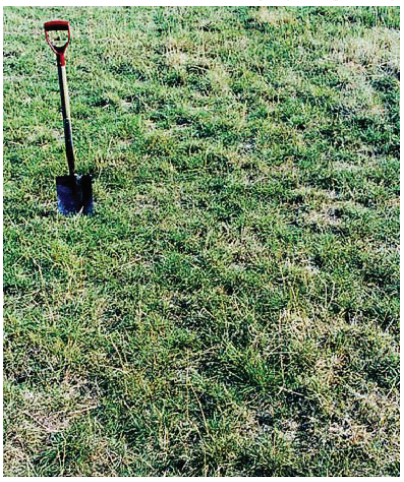
Determine which soil health indicators are not at target range to help inform on-farm decision making.

On-farm Visual Soil Assessment

The complete Visual Soil Assessment Field Guide can be downloaded from https://www.landcareresearch.co.nz/publications/vsa-field-guide/. Photos used here have been taken from the VSA guide from Graham Shepherd.

The following steps will take you through how to complete a Visual Soil Assessment.

1. At your sample site along transect assess bare ground.



GOOD CONDITIONS
VS = 2

Pasture growth is vigourous and covers almost the whole surface area.

MODERATE CONDITIONS
VS =1

Pasture shows significant areas of bare ground and sporadic growth with the ingression of weeds and white clover caused by treading damage.

POOR CONDITIONS VS = 0

Large areas of bare ground occur because of rteading damage and the subsequent reduction in the densit and vigour of pasture plants. White clover and less desirable pasture species and weeds may have invaded degraded and bare areas.

2. Assess surface condition.

GOOD CONDITIONS
VS = 2

Surface is relatively smooth and unbroken

MODERATE CONDITIONS
VS =1

Surface terrain is comewhat broken up and incised by occasional heavy treading events but it is not difficult to walk over.

POOR CONDITIONS VS = 0

Surface is very broken and deeply incised by severed repeated treading. The terrain is difficult to walk across and care must be taken to avoid twisting ankles.

3. Dig a spade square (e.g.: 20cm tube) on transect and a corresponding sample from under a nearby fence line. Assess soil colour.

GOOD CONDITIONS
VS = 2

Dark coloured topsoil indicating a well-aerated soil with a good turnover of organic matter

MODERATE CONDITIONS
VS =1

The colour of the topsoil is somewhat paler due to the early stages of gleying because of moderate pugging

POOR CONDITIONS
VS = 0

Soil colour has become significantly paler due to gleying because of persistent pugging

4. Assess mottles.

GOOD CONDITIONS
VS = 2

Mottles are generally absent

MODERATE CONDITIONS
VS =1

Soil has common (10-25%) fine and medium orange and grey mottles

POOR CONDITIONS
VS = 0

Soil has abundant to profuse (>50%) medium and coarse orange and grey mottles

5. Assess soil porosity.

GOOD CONDITIONS
VS = 2

Soils have many macropores between and within aggregates associated with readily apparent good soil structure

MODERATE CONDITIONS
VS =1

Soils macropores between and within aggregates have declined significantly but are present on close examination of clods showing a moderate amount of consolidation

POOR CONDITIONS
VS = 0

No macrpores or coarse micropore are visually apparent within compact, massive structureless clods that typically show smooth faces with sharp angles, and have few cracks or holes

6. Drop soil onto plastic sheet or wooden board from waist height. If large clods remain, drop once or twice more. Assess soil structure.

GOOD CONDITIONS
VS = 2

Good distribution of friable finer aggregates with no significant clodding.

MODERATE CONDITIONS
VS =1

Soil contains significant proportions of both coarse firm clods, and friable, fine aggregates

POOR CONDITIONS
VS = 0

Soil dominated by extremely coarse, firm clods with very few finer aggregates

7. Hand-sort, collect and count earthworms (www.earthworms.nz).

Earthworm counts (per spade square).		
>16 earthworms	10 –16 earthworms	<10 earthworms
Good score = 2 *	Moderate score = 1	Poor score = 0

* Note this differs to the abundance given in the VSA and is based on Schon et al (2022).

Using your sample, find our how diverse your earthworms are using the figure on the next page or visit www.earthworms.nz for a species key.

Is each earthworm ecological group (Dung, Topsoil, Deep Burrowing) present?

Pasture insect pests can also be identified and counted (www.agpest.co.nz).

8. Add the multiplied scores for surface condition, soil colour and mottles, soil structure and porosity and earthworms to get the combined VSA score.

Use the following table to record the results of your Visual Soil Assessment.

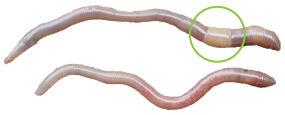
Visual Indicator	Visual Score (VS) 0 = Poor condition 1 = Moderate condition 2 = Good condition	Weighting (W)	Weighted Score (VS xW)
Surface relief		x1	
Soil colour		x2	
Number and colour of soil mottles		x2	
Soil porosity		x3	
Soil structure and consistence		x3	
Earthworm counts		x3	
Ranking Score (Sum of Weighted Scores)			

* Note bare soil is multiplied by 2 for the assessment of soil health (page 10) but is not included in the total VSA score.

8. Repeat process twice more along transect.

Identifying earthworm ecological groups

Use the adult earthworms in your sample to check your ecological groups



ADULT has a saddle

Head end

IMMATURE has no saddle

Ecological groups and their activity in the soil

Is your earthworm dark in colour? Is it less than 9cm long when not moving?

You likely have a dung earthworm.

Features: Red in colour, fast moving normal size

Is your earthworm pale in colour with the same colour underneath the head?

You likely have a topsoil earthworm.

Features: Tend to be grey but colours can vary, normal size

Note: Some topsoil earthworms can be dark in colour.

Is your earthworm dark in colour? Is it more than 9cm long when not moving?

You likely have a deep-burrowing earthworm.

Features: Larger, darkened head end

Common earthworm species

Lumbricus rubellus
'dung worm'

Aporrectodea caliginosa
'grey worm'

Aporrectodea longa
'blackhead worm'

Aporrectodea rosea
'pink worm'

Lumbricus terrestris
'nightcrawler'

Less common dung/compost earthworms:

Dendrodrilus rubidus
'bark worm'

Aporrectodea trapezoides
'southern worm'

Allobophora chlorotica
'green worm'

Amynthas corticis
'snake worm'

Eisenia fetida
'tiger worm'

Octolasion cyaneum
'yellow tail worm'

8cm

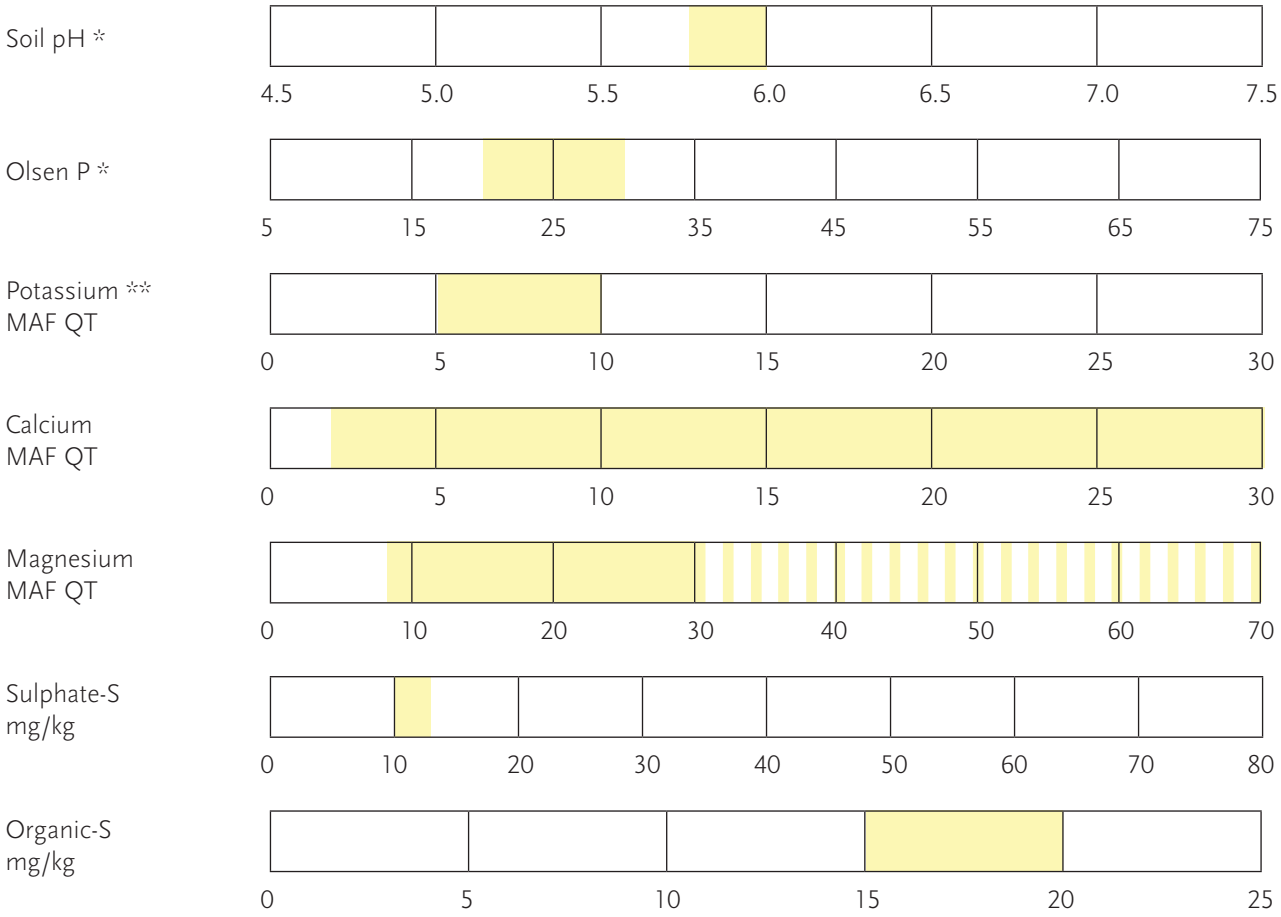
There are 200+ native species which vary in size and colour.

Disclaimer: This only provides suggestion of ecological diversity and species key is provided to get better representation of diversity in the soil.

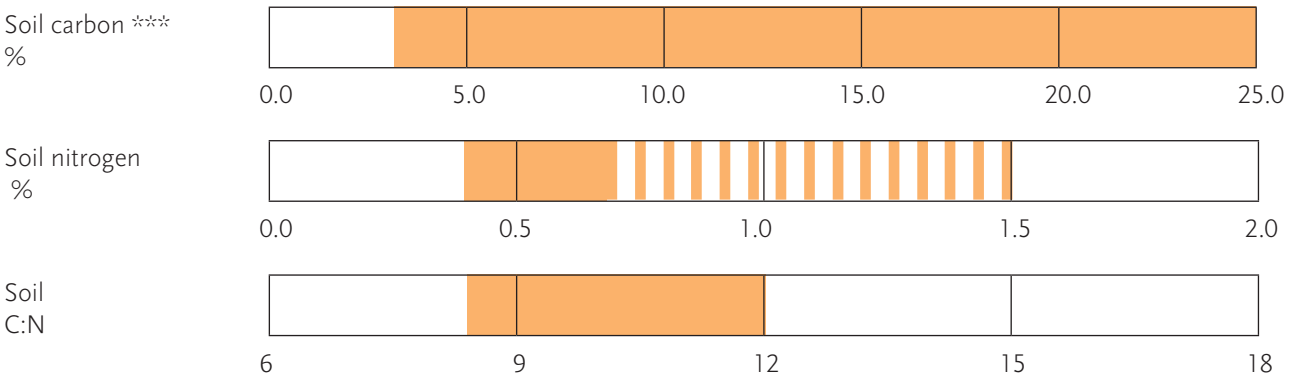
Find out how your soil health scores

Use the following tables to mark the results of your soil health assessment. Soil health target ranges are represented by the shaded areas. Shaded areas with vertical lines represent provisional targets or potential changes to target ranges.

SOIL FERTILITY



SOIL ORGANIC MATTER PROPERTIES

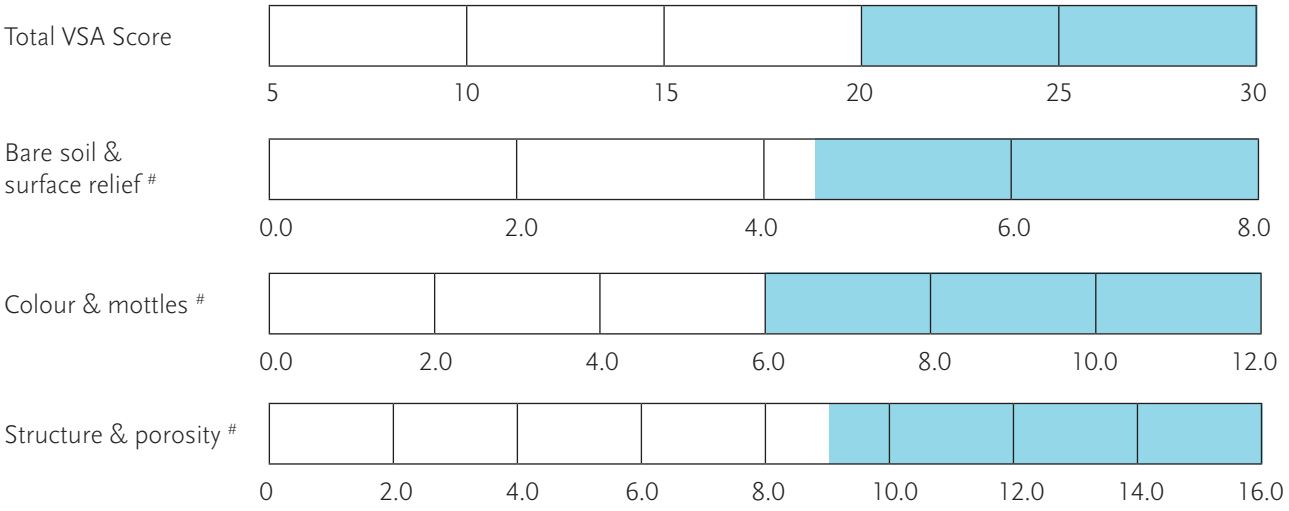


* Pumice and organic soils are excluded here. See www.fertiliser.org.nz for futher details.

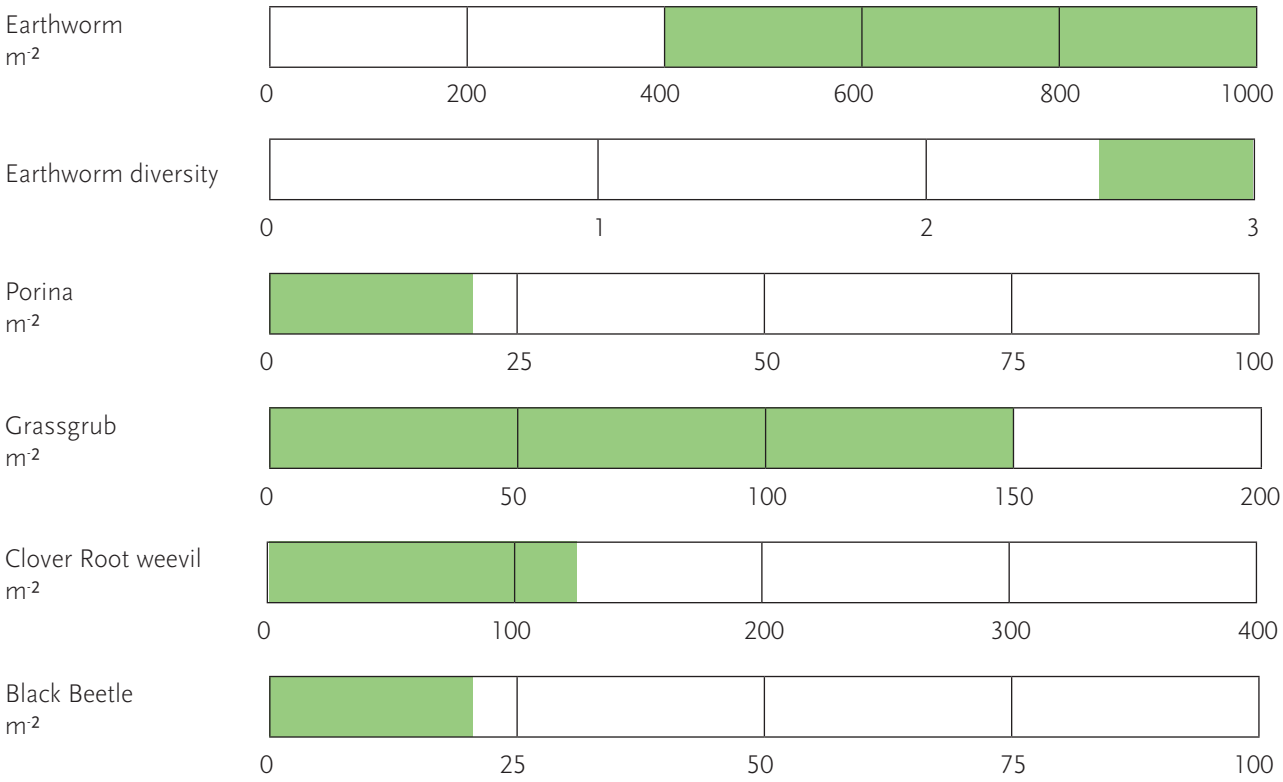
** Target range is dependent on soil type (7-10 for allophanic and pumice soils, 5-8 for sedimentary soils, and 5-7 for peat soils.)

*** Target range is dependent on soil type (>3 for allophanic soils, >2.5 for sedimentary soils, and >2 for pumice and recent soils, peat soils are excluded.)

SOIL PHYSICAL CONDITION



SOIL BIOLOGICAL ACTIVITY



Sum of weighted score

Managing for soil health

If soil health indicators are not at target there are some management practices that you could employ to help.

Soil fertility and chemistry
Either reduce or increase nutrient applications.
Nutrient application – right time, right place at the right time.
Lime to maintain optimum pH.
Soil organic matter
Maintain plant cover and/or use cover crops to protect bare soil.
Minimise soil disturbance and use minimum tillage practices.
Soil physical properties
Avoid pugging in winter when soils are wet and vulnerable.
Reduce erosion.
Optimise irrigation.
Improve drainage if water logging is an issue.
Understand soil vulnerabilities.
Soil biological activity
Maintain plant cover and diversity of plants.
Use of organic amendments.
Minimise disturbance.
Reduce moisture limitations.

Having soils at target will help ensure well functioning soils with reduced impacts to the environment.

Thanks to

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SCAN ME