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Soil sampling guide

Soil sampling can be an important tool when making pasture and grazing management decisions. Soil information can help you:

- determine soil health at one point in time
- determine soil health changes over time
- assess soil nutrient status and management requirements for pasture improvement, e.g. legume incorporation
- assess causes for differences in plant growth,
- grazing pressure
- assess the impact of management changes.

Depending on the reason for collecting soil information, two types of methods can be used. First, you can do basic in-field tests using a soil kit. These kits indicate soil health levels for things you can see, i.e. soil density, water infiltration, presence of earthworms, surface texture, plant growth and vigour, etc. To determine soil health levels for things that you cannot see (e.g. nutrient concentrations), you need to collect soil samples and send them to a soil testing laboratory for analysis.

Frequency

The information here covers taking soil samples in the paddock to be sent for nutrient analysis. Significant changes in soil nutrient levels in extensive pasture systems typically take years to occur, unless sudden, intensive management changes are employed. For example, blade ploughing for sucker control will significantly change the availability of soil nutrients such as nitrogen, sulphur and phosphorus. However if the soil is not disturbed and grazing management remains consistent, measuring changes in soil nutrient levels will usually only be possible after a number of years. Sampling frequency largely depends on the reason for collection. However, every five years should provide enough time between measurements and allow you to track changes over time.

What soil parameters should I measure?

A large number of soil parameters can be measured and the selection will depend on your specific needs. To determine changes in soil health over time, you can use the six parameters in Table 1.

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These parameters are measured in the top 10 cm of the soil profile, as the interpretation and any recommendations made are calibrated to this sampling depth. It is very important to accurately measure sample depth. If subsoil issues are suspected, deeper sampling is required. Most root activity occurs in the top metre of soil, and samples should be taken to this depth or down to a physical barrier, e.g. rock layer. The parameters measured at depth are typically water soluble nutrients such as nitrate-nitrogen, sulphur, salts (chloride and electrical conductivity) and soil structure (cations).

Table 1. Suggested soil parameters for determining soil health in pastures

Parameter	Role and reason for measuring
Organic carbon (OC) %	Role in soil nutrient supply, soil structure, biological activity and resilience.
Total nitrogen (TN) %	Indicates soil nitrogen reserves, important for sustained plant growth.
Phosphorus (P) mg/kg	Important nutrient for plant growth and animal production.
Sulphur (S) mg/kg	Important nutrient for plant growth and animal production.
Trace elements (Zn, Mn, Cu, Fe) mg/kg	Important nutrients for plant growth and animal production.
Cations (Ca, Mg, K, Na) meq/100g	Cations are valuable plant nutrients, and have important roles with soil structure.

Procedure

Soil sampling usually requires specific equipment so is generally performed by experienced personnel, however you can do this with knowledge and adequate equipment. Soil samples should be extracted using an auger, soil tube or spade (if an auger or tube is not available) from the surface of the soil to a depth of 10 cm. Remove leaf litter and organic matter from the surface before taking soil cores. Provide a composite sample of 500 g and send to a soil testing laboratory as soon as possible. If you cannot send samples on the same day as collection, store them in a fridge or freezer to minimise biological activity which could change nutrient availability.

Equipment

The following equipment can be used to collect soil samples:

- A sampling tool such as a probe; thin walled deep soil probe; hydraulic/motor-driven probe/ augers; an auger (either a turning auger or a soil tube). If a spade is used ensure the correct sampling depth is marked on the face.
- New plastic bags
- Clean plastic bucket for mixing cores
- Labels
- Marker for labelling samples
- Record sheet.

Where to take soil samples

Take representative soil samples from areas that have a uniform soil type and management history.

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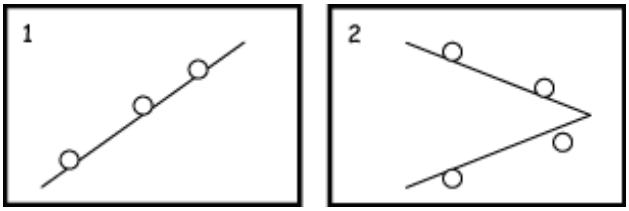
Where paddocks have a number of soil types or land systems, take soil samples from the dominant soil type that is representative of the paddock being assessed. However if the reason you are sampling is to determine differences in specific areas, i.e. grass growth or grazing pressure differences, collect separate samples.

You need a number of soil cores to make up a representative paddock sample. At least 20 cores are required to properly represent the soil fertility of the paddock (or soil type). The more cores that you take the more reliable the soil analysis results will be. In order for the soil test not to be influenced by dung, urine or other sources of nutrients avoid sampling in:

- stock camps
- gateways
- fence lines
- dams or watering points
- areas where fertiliser or manure has been stored
- paddocks that have had fertiliser applied in the last three months

Take samples from a fixed transect (a straight line on which cores are collected). Ideally the ends of the transect should be GPS referenced or some marker installed to allow re-sampling over time for monitoring long-term trends in soil fertility. The following diagram outlines some suggested core collection patterns across a paddock. Plot transect locations on a property map to assist with the interpretation of test results and enable monitoring of soil fertility trends.



Examples of soil collection transects (NSW DPI)

Soil core collection

Take cores of soil from the surface down to a depth of 10 cm, preferably with an auger (either a turning auger or a soil tube). Avoid collecting material such as leaves, dung or other organic matter from the surface. If you use a soil tube, make sure it isn't lubricated or galvanised as this can affect the soil test results.

Put all soil cores in a clean plastic bucket and mix the cores together thoroughly to form a composite sample and put the sample into a new plastic bag. If the composite sample is too large, a portion (500 g) should be selected and bagged.

Using a permanent marker pen, label the bag containing the composite sample with the date and paddock sampled and submit straight away/as soon as possible to an accredited laboratory for testing. The soil sample needs to be stored in a cool place if it cannot be sent to the lab immediately.

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Soil laboratory analysis
When testing for phosphorus, specify the Colwell (or bicarbonate) extraction method for analysis. This analysis is required to indicate the full nutrient requirements of pastures.

Laboratories performing the chemical analysis of soil samples must be able to demonstrate that their operations comply with the Australian Standard ASISO/IEC 17025-2005, 'General requirements for the competence of testing and calibration laboratories', and have the technical expertise for the nominated methods.

The National Association of Testing Authorities (NATA) accreditation provides evidence of compliance to this standard. Laboratories are required to participate in Australasian Soil and Plant Analysis Council (ASPAC) proficiency trails and maintain certification for the nominated methods where available. ASPAC website (www.aspac-australasia.com.au).

Queensland laboratories listed on the ASPAC website include:

Australian Laboratory Services—Brisbane Lab
32 Shand Street, Stafford Qld 4053
Email: Kerri.Taylor@alsenviro.com
Phone: 07 3243 7222

BSES
50 Meiers Road, Indooroopilly Qld 4068
Phone: 07 3331 3361

Hortus Technical Services—Bundaberg
Website: www.hortus.net.au
Email: techservices@hortus.net.au
Phone: 07 4132 5000

Nutrilab
Lot 14 Troy Drive, Goondiwindi Qld 4390
Email: nutrilab@bigpond.net.au
Phone: 07 4671 5155

SGS Aritech
214 McDougall Street, Toowoomba Qld 4350
Phone 07 4633 0599

Andrews
PO Box 2594, Burleigh Qld 4822
Email: rcirocco@phosyn.com
Phone: 07 5568 8700

Record keeping
Soil test results and any associated reports should be stored on-property. Other records that should be kept where applicable include:

- A property map identifying the pasture(s) being assessed and where the soil samples were taken.
- A record of the amount of nitrogen and/or phosphorus applied to pasture and a record of how the nutrients were calculated.

Table 2. Soil parameter explanation

Parameter	Optimum range / Critical values	Comments
Organic carbon (OC)	1-2%	Organic carbon makes up 58% of organic matter in the soil. Up to 50% of the soils OC is contained in the top 30 cm.
Total nitrogen (N)	0.1-0.2%	Associated with organic matter and is the source of plant available nitrogen.
Phosphorus (P)	10 mg/kg (Colwell test)	Levels below 10 mg/kg will limit grass growth, however soil levels below 8 mg/kg will result in wet season P supplementation response.
Sulphur (S)	5 mg/kg	Plants require 1 unit of S for every 10 units of N (i.e. 1S:10N). Sulphur moves with water so can accumulate down the profile and provide adequate levels for plant growth (even if the surface test is less than 5 mg/kg).
Zinc (Zn)	0.3 mg/kg for pH <7 0.8 mg/kg for pH >7	Zinc is commonly marginal in most Central Queensland soils due to pH typically being above 7, however zinc fertiliser responses in permanent pastures are unlikely.
Copper (Cu)	0.3 mg/kg	Copper is immobile in the soil and availability reduces once pH is greater than 7. Generally Cu availability is rarely a problem.
Iron (Fe)	2 mg/kg	Like Cu, Fe is relatively immobile in the soil and less available above pH 7.
Manganese (Mn)	2 mg/kg	Manganese availability reduces above pH 7. Generally not a problem however is relatively mobile in the soil so can be leached into the subsoil.
Calcium (C)	<65% of CEC	Calcium is a major plant nutrient, and high calcium relative to other cations (Mg, Na) provides good soil structure.
Magnesium (Mg)	>25% of CEC	Magnesium is an essential plant nutrient, however excess relative to other cations contributes to soil dispersion, see sodium.
Potassium (K)	0.4 meq/100g or 155 mg/kg or 1-5% of CEC	Most of the K is tied up in vegetative tissue, so large amounts of K is removed if cutting crops for silage or hay. Clay soils typically have good levels of K in reserve.
Sodium (Na)	>5% of CEC surface >15% of CEC subsoil	Excess sodium relative to other cations causes the soil to disperse – crusting on the surface; hard, dense subsoils.
Electrical conductivity (EC)	0.2-0.4 dS/m ($EC_{1:5}$) 2-4 dS/m (EC_{se})* *se-saturated extract	Electrical is a measure of overall salinity in the soil. Grain crops grown in Central Queensland can tolerate moderate levels; legumes are more sensitive. Naturally occurring gypsum can elevate salinity readings but won't restrict root development (unlike chloride, see below). Saturated extract (se) takes into account soil clay content so it better reflects the soil solution that the plant roots will encounter; hence is a better measurement than $EC_{1:5}$.
Cloride (Cl)	Less than 300 mg/kg	High chloride levels disrupt plant growth and decrease water extraction by roots. Can be a major component of salinity (EC), is leached easily so can accumulate at depth in poorly drained soils. Brigalow soils have high (natural) levels of chloride; open downs clay soils are typically low.

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Table 2 provides critical values and indicative ranges for parameters tested.

Sources

- 'Fertilizer Handbook', Incitec Ltd 1990
- 'Crop King Information Bulletins' (Various titles) Incitec Ltd 1983-1990
- 'The Nitrogen Book', DPI&F 2008
- 'Soil Matters', APSRU 1998
- 'Rain to Grain', DPI 1994

Acknowledgements

Information was sourced from 'Reef Wise Farming, Reef Protection Package; A guide for applying nitrogen and phosphorus on grazing properties regulated under the Environmental Protection Act 1994', DERM, 2009.

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