Soil Testing Guidelines

However, a number of the larger laboratories have a range of standard tests that they commonly support. Since they also tend to run samples in batches, it often works out cheaper if one of the standard tests can be made to fit requirements, rather than specifying an individual test that may have to be processed on its own.

If there is little information known about a soil then it is advisable to have a comprehensive analysis done. Apart from nitrate N, the levels of most nutrients change relatively slowly so a comprehensive analysis only needs to be done every 5-7 years.

A Comprehensive analysis – usually involves analysing the samples for Nitrate (N), Colwell Phosphorus (P), Phosphorus BSES, Phosphorus Buffer Index (PBI), Sulphur (S), Exchangeable cations (calcium, magnesium, potassium and sodium), pH, chloride (Cl), Electrical conductivity (Ec), Organic Carbon (OC), colour, texture and trace elements.

The laboratory will normally calculate the Cation Exchange Capacity, sodicity and electrical conductivity of a saturated extract solution (ECSE) from this information.

Subsoil constraints (sodicity and salinity) – usually involve testing for pH, electrical conductivity, chloride and sodium. Sodicity is generally expressed in terms of the percentage of sodium ions relative to total cations (calcium, magnesium, potassium and sodium). Hence, when testing for sub-soil constraints it is generally necessary to have the samples analysed for pH, electrical conductivity, chloride and the cations of calcium, magnesium, potassium and sodium.

Nitrate nitrogen – levels can change quite rapidly depending on the quantities removed in grain or hay, mineralisation rates and soil organic matter levels. In cropping situations nitrate N levels need to be estimated annually using nutrient budgets, with soil testing every 2-3 years.

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Soil Testing Guidelines

Soil testing is useful to identify nutrient status of a soil and its ability to grow pastures and crops, especially when used in conjunction with crop and pasture performance and nutrient budgeting.

Soil test can also be a useful tool for determining and monitoring soil constraints, such as salinity and sodicity.

When collecting soil samples for analysis there are a number of key points.

- Most laboratories require about 500 grams of soil per sample.
- Nutrient levels vary across the paddock, as well as up and down the profile.
- Contrasting soil types within the same paddock.
- Nutrients like sulphur and nitrogen are ‘mobile’ and will move (leach) down the soil profile with water movement, accumulating lower in the profile. Other nutrients like phosphorus and potassium are non-mobile and will not move through the soil in water. Therefore a surface sample may be a poor indicator of the sulphur and nitrogen status of the soil.
- Nitrate nitrogen accumulates in fallows where weeds are controlled. However, nitrate nitrogen levels are always likely to be low in pastures where there are growing plants, with the nitrate being taken up almost as fast as it is mineralised. Hence, there is little point in soil sampling for nitrate nitrogen in a pasture. Alternate fertility indicators such as organic carbon may be more appropriate.
- How the soil test results are to be used to make informed management decisions. For example, if the results are to be used to see if a soil is deficient in nutrients before planting a crop or pasture, then a form of random or transect sampling across the paddock may be adequate. On the other hand, if there is also a need to monitor changes over time, then ‘fixed point’ sampling would be the most appropriate in order to minimise the effects of variability across the paddock.

Sampling strategy

Soil samples must be representative of the soil in the paddock from where they are taken. Therefore avoid sampling close to fence lines, water points, trees, contour banks or roadways, unless there is a good reason to do so. Similarly, avoid sampling areas such as old stump holes, ash heaps or stock camps, where abnormal nutrient levels might be expected. Do not mix samples from soil types that are markedly different (eg. sand *versus* clay). f both soil types occupy significant areas of the paddock (eg. more than about 20%), consider taking soil samples from each soil type. Also consider the practical implications of this, for example will it be feasible to treat the two soil types differently within the paddock. If not, then it may be possible to “get away with” sampling the dominant soil type and using this recommendation across the paddock, but closely observing crop / pasture performance in the other soil type at different stages of growth.

Sampling methods

Random sampling – usually takes the form of a zig zag transect across the paddock, with sampling “stops” every 300-500 metres, depending on paddock size. At each “stop” a deep core and 4-6 surface samples are taken. Samples are bulked by depth within the paddock or sampling unit.

Fixed point sampling – is usually employed where changes are to be monitored over time. Two or three sampling points are located in representative areas of the paddock. Their positions can be marked by a peg, a GPS point, or both. Deep core samples are collected at the four main compass points (north, south, east and west), at a distance of 4 to 5 metres from the central point. Surface samples are collected within the circle set by the bounds of the deep samples.

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Sampling equipment

If the soil is being sampled into 4 depth intervals, then 4 clean buckets, ideally of different colours, will be required. It is a good idea to label the buckets with the various depth intervals *(Figure 1)*.

Various designs of soil coring equipment with a range of core diameters is available. For the surface samples, where larger numbers of cores are required, a core sampler with a diameter of 15-20mm is best, as it minimises the volume of soil that needs to be sub-sampled. Deep coring can be done with hand augers, but is now more commonly done with a coring tube attached to a hydraulic ram mounted on a trailer or the back of a utility *(Figure 2)*.

These deep cores are generally 30-40mm in diameter and 1-1.2 metres long. The deep core samples are best laid out onto a 90-100mm plastic pipe that has been cut in half, longitudinally *(Figure 3)*. Depth intervals can be marked on the plastic tube to make sub-sectioning quicker and easier. The deep core is then cut into sections and broken up into the appropriate buckets *(Figure 3)*. An old knife is useful for sectioning sub-samples.

Figure 1: Colour-coded and labelled buckets with soil sampling equipment

Figure 2: Hydraulic ram on utility for deep coring

Figure 3: Deep soil core laid out in tube and cut to depth sections

Number of samples

Sufficient numbers of samples need to be collected in order to minimise the effects of nutrient variability across the paddock. These samples are bulked by depth within the paddock or sampling unit. Adequate sample numbers, supported by a sound sampling strategy, provide confidence in the results of the tests, particularly where unexpected results are obtained. Since there is generally more variability associated with the surface layer of the soil a greater number of samples needs to be taken from this layer.

For example, in a 40 hectare (100 acre) paddock, at least 20-30 sub-samples need to be taken from the surface layer, while only 8-10 deep samples are required to provide a reasonable estimate of nitrate N that is within 20% of the true mean of the lower layers.

Where paddocks are larger than about 60 hectares the number of surface samples needs to be increased to around 50 and the deep cores to around 12 per paddock. It is generally impractical to sample more intensely than this, except in research projects.

Sampling depth

Sampling depth is largely determined by the questions being asked and how the information is to be used. However, economic response curves have been derived for different nutrients, crops and pastures based on specific sampling depths during years of research and local trials.

Standard sampling depths should therefore be adhered to if fertiliser rates based on economic responses are required, especially for surface samples. Most non-mobile nutrients like phosphorus, potassium and zinc, are often heavily stratified towards the surface.

Hence, a larger sampling interval (eg. 0-5 versus 0-10 or 0-15 m) will dilute the nutrients in the sample when compared to the standard with which they are being compared.

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Table 1. Recommended surface soil sampling depths for Queensland and New South Wales

Crop	QLD	NSW
Pasture	0-10 cm	0-7.5 cm
Cereal, Oilseed and Grain Legume crops	0-10 cm	0-15 cm (north) 0-10 cm (south)
Cotton	0-15 cm	0-30 cm
Sugar cane	0-25 cm	0-25 cm
Horticulture - Row	0-15 cm	0-15 cm
Banana	0-25 cm	0-10 cm
Horticulture – trees (establishment)	0-30 cm	0-30 cm
Horticulture – trees (bearing)	0-15 cm	0-15 cm

The “standard depth” for surface samples in Queensland for most dryland crops and pastures, where non-mobile nutrients are being assessed, is the top 10cm *(Table 1)*, generally known as the “0-10cm” sample. For some irrigated crops such as cotton, where the soil will be later hilled up for furrow irrigation, a sampling depth of 30cm is used. Sampling for horticultural crops is different again, often depending on the crop concerned *(Table 1)*.

Always check which standards the results will be compared with for determining likely fertiliser responses and rates before sampling.

Where deep cores are being taken, sample depths are set by the depth of the soil and the questions being asked.

Depth intervals of 30-50 cm are generally adequate for calculating nitrate nitrogen levels but smaller depth intervals are required in order to detect and locate nutrient stratification, salinity and sodicity levels. The smaller the depth intervals, the more samples there will be, and the higher the overall cost.

The following depth intervals are generally recommended where soils are being characterised, either for nutrient stratification or sub-soil constraints: 0-10cm, 10-30cm, 30-60cm, 60-90cm and 90-120cm. Quite often the 90-120cm layer is omitted, but this again depends on the questions being asked. Likewise, a 120-150cm sample is sometime taken as well.

Sample preparation

Once the paddock sampling is complete, the samples in each bucket should be broken down and mixed thoroughly before a sub-sample of at least 500 grams is taken, making sure to remove any gravel or larger pieces of litter. Make sure that your hands are clean and free of oil or grease before handling samples.

Label and send soil samples to a recognised NATA Accredited laboratory for analysis.

Tests required

Samples despatched to the laboratory must be clearly labelled with an identifier for each sample. This may take the form of a number or alphanumeric code. Some laboratories supply sample bags that are bar coded, as well as having a label for sample description.

An order form must accompany the samples, so that the analyses required on each sample is clearly specified. It is possible to specify the nutrients required in any analysis.