Soil sampling

To get the best out of any paddock it is vital to know its condition so it can be managed effectively.

KEY POINTS

- Know your purpose for soil sampling and devise an appropriate strategy.
- Have 30-40 subsamples combined thoroughly for each sample.
- Exclude atypical areas in your subsamples.
- Sample areas of different landscape, land use or production separately.
- Ensure the sample represents the soil into which the seed will be sown.
- Use a corer to ensure that the same amount of soil is sampled from each depth.
- Allow enough time to analyse, obtain results and decide on a management option:
  - within 1 month (or 4 – 6 weeks) prior to fertiliser application or grazing or
  - 6-12 months after liming
- Farming operations can stratify soil properties – sample accordingly.
- If monitoring annually, sample at the same time each year.
- Keep accurate records so you can use the information to make management decisions and monitor trends over time.
- Keep sampling gear clean.
- Clearly label all samples and send them off quickly.
- Always use a NATA accredited lab and check the analysis method used is ASPAC accredited.

Why sample

Soil sampling and testing can provide invaluable information to direct management decisions and keep track of how successful those decisions are at maintaining soil fertility. However, sampling must be carried out in a way that accounts for the incredible variability that is often present in a paddock / area of interest. The sampling stage is a major source of error in assessment of soil conditions and can be upwards of 30% of the entire cost of soil testing. It is important to note two things before you start sampling that;

1. Natural variation in a paddock/hectare can be huge, soils vary both horizontally and vertically due to the processes that are involved in their formation.

2. In any sampling strategy only a very small amount, some 1-2g for each nutrient, is analysed to represent a given area that can have 1000+ times more soil. That is, the analysed sample may only be less than 1/10000 of the area being tested.

Natural variation is such that testing the same paddock twice using the best sampling procedures can still produce different answers. This is not the problem of any laboratory analysis but the natural soil variation.

For your soil test results to have any value your sampling strategy must be designed to collect a representative sample(s). To develop an effective sampling program the goals of soil testing must be clearly defined. What is it you want to know from your soil test results? Are you trying to diagnose a problem, or are you planning on commencing a monitoring program, or is there some other reason? Giving the question: Why am I sampling? Some thought will help determine your sampling strategy and ensure the results you get from your soil test are useful.

"The whole activity of sampling, analysis, recommendation and interpretation is based on a sample that must be representative given that quite a small proportion of what is collected in the paddock is actually delivered to a laboratory for analysis."

David Weaver in the Fertcare industry publication: A guide for 'fit for purpose' soil sampling. Image courtesy D Gourley.

How many samples?

How many samples for lab analysis?

Where a paddock has been subjected to uniform management on its entirety over the recent past and where the soils are known to be reasonably uniform, only one sample (made of 30-40 subsamples) needs to be dispatched from the paddock. However, It is not always appropriate to treat the paddock as a single management unit. Where variation is known to exist, separate sampling of areas may be necessary. Where there are major areas of difference; plant production, amalgamated paddocks or recent management, a separate sample should be collected from each major area. This is effectively "zone management". Although the number of samples sent to the lab increases, efficiencies are gained by applying fertilisers (or ameliorants) in more appropriate or required rates such that less wastage occurs and better returns from inputs are obtained.

How many subsamples to account for variability?

Because of natural variability in soil properties, many sites need to be sampled to get a representative sample. The normal number of sites for subsampling ranges from 30 to 40. Improving precision by increasing the number of subsamples is often not proportional to the increase in the effort of taking additional subsamples BUT there is a considerable loss in precision if the number of subsamples is reduced below 20.

The multiple sub samples should be taken from across the area/zone that you want to analyse to account of the natural variability present in all soils and landscapes. Use your knowledge of the area you want to sample plus any additional resources such as soil maps, yield maps, and photographs to estimate how uniform the soil is in the area you want to examine.

Where do I take my subsamples?

Most farms are subdivided to include areas with uniformity (often as paddocks) as this minimises variation in crop performance and makes management easier. If a paddock includes a small area of different soil or known low production, one sample may be sent away BUT that small area is NOT included in the sampling pattern.

The aim of taking many subsamples from one area that you need to manage is to ensure that the entire area is represented in the sample(s) you send to be analysed. For this reason, odd, atypical or unusual areas such as animal camps, headlands, old fertilizer stores, feeding zones, watering points, laneways and high traffic areas should be omitted.

In addition, practices such as control traffic, permanent beds or row crops and recent fertiliser /amendment application or grazing all affect soil and can increase the spatial variability and soil chemistry.

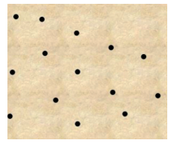
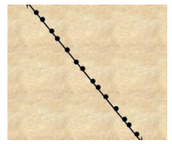
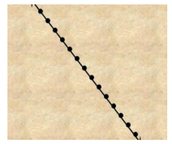
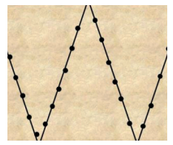
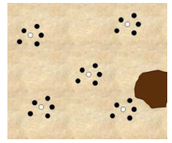
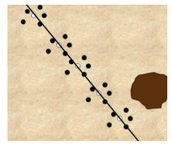
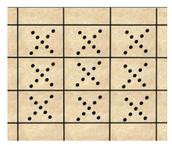
To reduce the effect of grazing and fertiliser/amendment applications, soil should not be collected within 1 month of fertiliser application or grazing or 6-12 months after liming. The surface litter (stubble, leaves, animal manure) is normally removed from the soil surface before a soil sample is taken. In the case of control traffic, and permanent row crops remember to exclude those areas that are atypical or are not going to be used by plants in the paddock. Remember that the sample sent to a lab should represent the soil into which the seed will be sown.

Tools

All the implements used in soil sampling should be clean to avoid contamination. Including the containers used to mix and hold samples. Once collected soil should be contained in an esky until it can be refrigerated or air dried. Once cooled or dried, the microbial activity decreases such that the chemical and biological conditions within the sample will be stable until analyses are conducted.

Remember the sample sent to a lab should represent the soil into which the seed will be sown.

There are a number of different sampling methodologies or patterns you can use to gather your representative sample

	Method	Pros	Cons
	**Random**	Simple. If truly random will be representative.	Not repeatable as locations of samples cannot be revisited. Risk of sample not being representative as operator determines subsample location.
	**Transect – random** Samples taken at random along a marked transect across the sampling area.	Simple.	Not totally repeatable due to random site selection. Large % of area unsampled. Time consuming.
	**Transect – systematic** Samples taken at specific points along a transect across the sampling area.	Simple. Fast. Repeatable.	Large % of are unsampled.
	**Zigzag** Similar to transect with a zigzag pattern over entire sampling area.	Simple and repeatable. More of sampling area potentially sampled.	Time consuming.
	**Cluster** Small number of target sites used to collect multiple subsamples.	Fast. Repeatable. Sites can be georeferenced and randomly chosen for repeat sampling.	Not totally representative of entire sampling area. Time consuming. Requires a very good understanding of variability within the sampling area to select sampling sites and reduce bias.
	**Cluster multistage** Cluster sampling along a transect.	Simple. Repeatable.	
	**Uniform grid** A grid of cores taken in a pre-planned grid pattern across the entire area/ paddock.	True representative sample. Very little bias.	Very time consuming. Expensive.

Depth

The depth of sample taken will be determined by the purpose of sampling. For fertiliser management, as a general rule, samples should be collected from the same depth for the original calibration of the soil test. Where mobile nutrients (eg nitrate) are of interest deeper (eg 60cm) samples will be required.

It is now common practice for a 0-10 cm soil sample to be taken for cropping and pasture production on non-cracking soil (0-30cm depth samples are often used on cracking clays). In the past for pastures, soil was collected from 0-7.5cm depth while for crops 0-10 or 0- 15cm depth samples were taken. If you plan on comparing historical tests from similar sites you should check your records to ensure you are comparing the same sampling depth.

It is important to make sure the entire depth you have chosen is sampled equally. Using a corer ensures that the sample contains the same amount of soil from each depth within that sample. A spade or trowel can bias a sample as it is easier to collect more sample from the top than the bottom of the subsample. If you only get soil from part of the sampling depth this will bias your sample, so discard the subsample and take another.

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In crops and pastures there are changes in soil properties with depth. Soil properties that are relatively immobile are often stratified with depth on a cm or mm scale. For example, soil pH can decrease by 1 pH unit as the depth increases from 0-2 to 8-10cm (Figure 1). If only a portion of the depth is sampled, pH for example, would be higher than it is for the whole 0-10 cm interval. Similar trends occur with available P and organic carbon, nitrogen mineralisation and biological parameters such as enzyme activity. The latter is associated with the organic carbon stratification. That is, the microbial activity is stratified because their food source is stratified, therefore, the pH effects of the biological activity is also stratified.

Sometimes deeper samples are required for specific nutrients or soil features. Samples from below 15cm are required are when there are suspected problems of

- Sodicity
- Salinity
- Acidity
- Boron toxicity
- Sulphate or nitrate deficiencies
- Other subsoil constraints

Banding, stratification and soil sampling

Some farm management practices result in variation in soil characteristics across a paddock in the case of row cropping fertigation, banded fertiliser application and control traffic or down the profile in the case of application of some fertilisers or amendments with no till farming methods. Soil subsampling strategies need to be altered to reflect the variation in soil conditions that exist in these cases. Vertically these bands can be as narrow as 5cm but can have significant effect on plant root growth if seed is planted into a hostile layer.

When to sample?

Samples should be taken 4-6 weeks before amendments or fertilisers are to be applied. This is for the very practical reason that time needs to be allowed for analysis and reporting.

Some plant nutrient availability fluctuates over the year and or in relation to the presence or absence of oxygen/ water. For examples pH values are higher in winter and lower in summer. Nutrients that are influenced by oxidation/ reduction reactions, such as aluminium and manganese (Figure 3.) will be highly variable as conditions fluctuate through time.

If your aim is it compare from year to year then a set sampling date is needed to remove the effect seasonality may have on soil features.

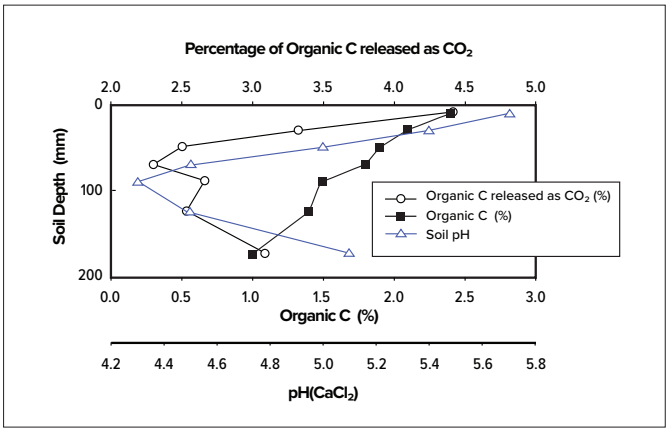

Figure 1: variation in Organic Carbon and pH with depth

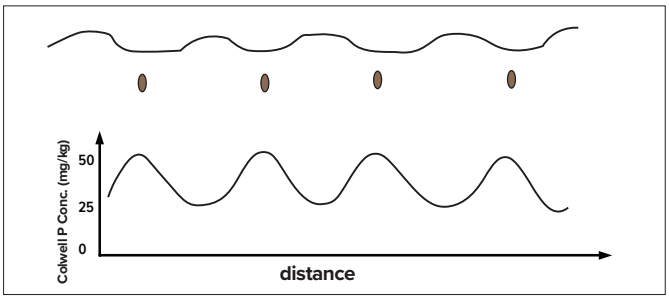

Figure 2: crop row fertiliser placement affects available P concentration (Colwell P)

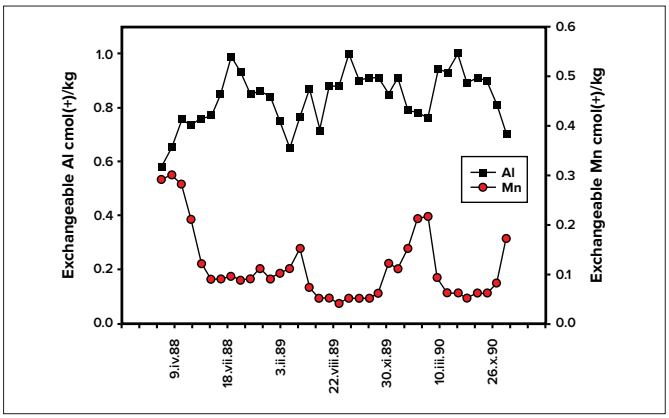

Figure 3: concentration of exchangeable aluminium and manganese in soil through time (1988 - 1992)

Figure 1: Black, A. S., Condon, J. R., Conyers, M. K., and Swan, A. (2004). Sampling scale to assess soil fertility processes –a brief review. Supersoil 2004: Program and Abstracts for the 3rd Australian New Zealand SoilsConference, University of Sydney, Australia, 5 – 9 December 2004. www.regional.org.au/au/asssi/supersoil2004/s9/oral/1669_blacks.htm

Figure 2 Acknowledgment: Jason Condon NSW DPI and CSU teaching notes pers comm

Figure 3: Conyers M. K. , Uren N. C. , Helyar K. R. , Poile G. J. Cullis B. R. (1997) Temporal variation in soil acidity. Soil Research35, 1115-1130. hps://doi.org/10.1071/S97022

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