# Soil assessment for pasture production that considers both physical and chemical factors in the topsoil and subsoil

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**Abstract:** In the past, most farm managers on the Tablelands of New South Wales have only assessed the top 10 cm of soil, even though the root systems of most pasture and crop species extend well below a depth of one metre. The soil samples tend to be bulked rather than being kept separate. There has been a focus on soil chemical factors rather than soil physical conditions, despite the emphasis on issues such as soil compaction severity and water holding capacity in other rural industries such as cropping and viticulture.

This paper describes a soil assessment and management exercise that was carried out in 2003 at "Belgravia" near Orange. It was designed in a way that overcame these concerns. The pasture performance observations of the farm staff had a major influence on where the soil was sampled.

Visual-tactile methods were used to assess the soil quickly via the use of 1.4 metre deep inspection pits. Selected samples were sent away for accurate laboratory analysis.

Colour-coded "Soil factor" maps were produced using soil data that were kept separate for different sites, rather than being bulked. The next stage in this process is to produce "Soil amelioration maps", which can then be converted into "cost of repair" maps.

The study allowed soil improvement strategies to be prioritized across the property. The so-called high production areas had soil limitations such as phosphorus and sulphur deficiency that can be easily corrected. Some problem areas were surprisingly easy to repair via improved soil management. However, there were other small areas where the soil limitations were very expensive to correct, and alternative native plant species may have to be encouraged that are more adapted to the conditions than the preferred pasture species.

The soil data also allowed saline "hot spots" to be identified and described so that appropriate management can be applied.

## Introduction

Progressive pasture producers in the Central Tablelands of NSW recognize that soil information is of critical importance for 2 main purposes:

1. Production related issues such as acidity, salinity, sodicity, compaction, nutrient deficiencies, and poor water holding capacity;
2. Environmental side-effects such as the salinisation of creeks and rivers.

Clearly, soil data are essential for the design of sustainable rural landscapes.

### How big an issue is cost when assessing soil under pasture?

In geologically complex regions (for example, the Orange-Molong district), the spatial variability of soil condition creates major challenges for pasture managers. The price of accurate and comprehensive soil sampling, laboratory analysis and "key soil factor" mapping (approx. $22 per hectare) can be daunting. However, this one-off cost is not huge when considered in relation to land values, current expenditure on pasture improvement, and the potential returns from better soil management over future decades.

### How deeply should soil be sampled under pasture?

The realization that most pasture plants have root systems that should be extending well beyond a depth of one metre is encouraging producers to sample soil throughout the root zone, rather than just the upper 10 or 20 cm, through the use of soil inspection pits.

### Which is most important: soil chemistry, soil physics or soil biology

It is also being recognized that soil physical factors such as compaction and aeration status and water storage capacity are very important factors to measure and manage under pasture. These issues are well understood by farmers growing crops such as cotton and winegrapes.

The correction of soil physical and chemical limitations – through the use of techniques such as deep tillage and the application of lime, gypsum and nutrients – improves the chances of soil quality being improved under pasture via biological processes.

### Should soil samples be bulked or kept separate?

Bulking of soil samples across management units is used by many graziers to deal with local patterns of variation, but an average soil test result invariably leads to over-amelioration of some areas and under-treatment of others. When soil data from individual sampling points is kept separate, variable rate application of inputs becomes possible. Pasture researchers in New Zealand have shown that variable rate phosphorus application from GPS-guided aircraft is feasible (Yule & Gillingham 2002).

### Will traditional soil assessment systems be superceded by Precision Agriculture techniques?

Modern remote sensing procedures (for example, EM maps) can be useful components of a soil assessment, but often they do not have a strong enough correlation with key soil factors to be useful at the paddock scale. Nevertheless, geology maps – which are produced using a broad range of geophysical techniques – can provide an excellent overview of the likely soil conditions across a Tablelands landscape.

National soil classification schemes such as The Australian Soil Classification are of limited value for soil management at the paddock scale because it is difficult, if not impossible, to disentangle the complex jumble of soil factors within a "soil mapping unit" when developing detailed whole-farm soil management plans.

This paper describes how the best features of old and new approaches to soil assessment and management can be combined to improve the profitability and sustainability of pasture production systems.

Further information about the soil assessment and management techniques used in the study are described by McKenzie (1998, 2003).

## Case study

The managers of "Belgravia", an 1800 ha property near Orange NSW, are developing an Environmental Management System for the monitoring of pasture, winegrape, and restored woodland zones. They are also considering a range of variable rate soil improvement strategies that have the potential to improve commercial returns.

Data were collected from 65 soil pits in late-2003 to a depth of 1.4 metres. Visual-tactile methods were used to assess the soil quickly. Selected samples were sent away for accurate laboratory analysis. There was no bulking of soil samples.

This has allowed "key soil factor" maps to be produced in the rain-fed pasture areas for the topsoil/sub-surface (0-30 cm), upper subsoil (30-60 cm) and mid-subsoil (60-90 cm). The maps are colour coded with red dots indicating action required to improve soil fertility, green showing no problems for the soil factor of interest, and yellow suggesting that soil amelioration may be required.

This information can be used to prepare "cost of repair" maps, thus allowing an optimal allocation of funds for soil amelioration, damage prevention and on-going monitoring of the soil.

Dispersibility (related to an excess of exchangeable sodium and a lack of electrolyte), pH, compaction severity, water storage capacity, and nutrient (phosphorus, sulphur, potassium, zinc) and salinity status of the topsoil/sub-surface (0-30 cm) and subsoil (60-90 cm) correlated strongly with the estimates of pasture production made by "Belgravia" staff.

The study allowed soil improvement strategies to be prioritized across the property. The so-called high production areas had soil limitations such as phosphorus and sulphur deficiency that can be easily corrected. Some problem areas were surprisingly easy to repair via improved soil management. However, there were other small areas where the soil limitations were very expensive to correct, and alternative native plant species (for example, eucalypt trees) may have to be encouraged that are more adapted to the conditions than the preferred species (for example, lucerne).

Information from EM-31 and radioactivity surveys proved to be a poor predictor of the key soil factors at this site. Therefore, it was concluded that future soil assessment at this site will have to be based mainly on pit measurements, in conjunction with the observations of experienced farm staff. Digital Elevation Models may also be useful.

The soil data also allowed saline "hot spots" to be identified and described so that appropriate management can be applied to use the excess water that is mobilizing soluble salts. This allows "Belgravia" to quantify its environmental management credentials in relation to the other properties that are part of the Bell River Catchment.

## Conclusions

The comprehensive topsoil and subsoil assessment at "Belgravia" cost more than traditional soil assessment for pasture production. However, many benefits were identified.

The practical application of this soil information to farm business planning and management is discussed in the following paper by Ben Watts.

## References

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