SOIL TESTING

for productive pastures in the Burnett

The Burnett catchment lies within the southern black speargrass region of Queensland's pasture communities with a significant portion of its 33,000 square km area dedicated to beef cattle production on extensive pastures.

Pastures are frequently seen as less prioritised compared to crops in terms of preparation for sowing and ongoing management. However, considering the considerable costs linked with establishing productive pastures and the productivity potential of a successful pasture, it becomes evident that dismissing their importance is misguided. Ensuring proper soil nutrition can greatly influence yield and the long-term carrying capacity of the paddock therefore getting soil nutrition right is paramount!

Therefore, soil testing & laboratory analysis is the only way to truly understand soil fertility & potential constraints.

HOW TO MEASURE

- To identify potential nutrient deficiencies and potential subsoil constraints in the plant root zone, soil samples should be taken from the surface layer and subsurface layer. Actual soil depths may vary with location and plant type, however consistency is the key.
- With the depth of sample decided, a range of equipment is permissible to extract the soil sample from soil pits. At depth, specialised soil sampling equipment is needed therefore, it's often performed by agronomists or other experienced consultants.
- The more soil samples taken per unit area, the more reliable the soil analysis will be.
- Soil samples can be collected using a number of methods (transect, zig-zag, GPS and grid) - each with their own merits. The greater the distance travelled in order to collect the soil samples then the greater potential for natural soil variability to affect the accuracy of the results. Samples should be collected from areas with uniform soil type and management history. For paddocks with multiple soil types, sample the dominant type.
- The samples collected from within each surface and subsurface layer will be bulked together and then sub-sampled. The sub-sample will be bagged, labelled and submitted to a laboratory for testing. The samples need to be stored in a cool place if immediate submission isn't possible.

Correcting soil nutrient deficiencies can significantly improve productivity & long-term carrying capacity

WHAT SHOULD BE MEASURED

There are many parameters that can be tested from a soil sample - broadly categorised as physical, chemical or biological. Not all of them have the same level of relevance, accuracy or repeatability; especially some biological tests. It is important that a discussion is had between the farmer and agronomist prior to sampling to determine what is being tested. Below are some common chemical tests. Generally trace elements are not warranted in subsoil testing.

Nutrient	Units	Nutrient	Units
Soil **pH** (CaCl)	pH units	**Sulphur** (MCP)	mgS/kg
Electrical Conductivity (EC) (1:5water & Saturated Extract)	dS/m^2	**Calcium** (Amm-acet.)	% of ECEC & cmol(+)/kg
Organic Carbon (Walkey- Black or LECO)	%	**Magnesium** (Amm-acet.)	% of ECEC & cmol(+)/kg
Nitrate **Nitrogen**	mgN/kg	**Sodium** (Amm-acet.)	% of ECEC & cmol(+)/kg
Phosphorus (Colwell)	mg/kg	**Potassium** (Amm-acet.)	% of ECEC & cmol(+)/kg
Phosphorus Buffer Index (PBI-Col)	mg/kg	**Zinc** (DTPA)	mg/kg
Cation Exchange Capacity (CEC)	cmol(+)/kg	**Copper** (DTPA)	mg/kg
Chloride	mg/kg	**Iron** (DTPA)	mg/kg
Calcium/Magnesium Ratio		**Manganese** (DTPA)	mg/kg

KEY THINGS TO NOTE:

- There are normal trends in relation to nutrient levels down the soil profile due to a nutrients solubility, soil changes and ability to bind to clay particles. Typically:
  - Phosphorus, potassium and organic carbon *decline* down the soil profile; and
  - Soil chlorides, sodicity & electrical conductivity *increase* down the soil profile.
- Organic carbon levels in the surface layer is important as it's the active zone for soil microbiology, mineralisation and soil conditions crucial for organic matter decomposition.
- Soil nitrate Nitrogen needs consideration across the entire soil profile, as plant roots will seek this nutrient at deeper levels as they extend into the soil profile.
- Phosphorus is not as mobile through the soil as Nitrogen.
  - Colwell Phosphorus give an indication of what quantities the plant roots are able to utilise.
  - Phosphorus Buffering Index (PBI) quantifies soil's capacity to adsorb or fix Phosphorus, with higher values indicating faster and stronger binding of Phosphorus to soil particles, consequently reducing Phosphorus availability to plant roots.
- When submitting soil samples for analysis, it's crucial to select a reputable laboratory that is certified by the Australasian Soil and Plant Analysis Council (ASPAC). The ASPAC logo will generally be displayed on the soil results.

Soil nutrient levels do not always have definitive values; instead, a range of values, including both upper and lower limits, as well as specific ratios, to ensure optimal nutrient balance.

This information is summarised from "Productive pastures - Focus on soils" compiled by David Hall & Jill Alexander

WHEN SHOULD SOILS BE TESTED

Soil testing should be conducted sufficiently ahead of pasture sowing to allow time for sourcing and applying any necessary soil additives or pre-plant fertilisers. For instance, if planning to sow pasture in mid-Spring, soil testing should be performed in May or June.

If fertilising established pastures consider application of fertiliser prior to rains (especially nitrogen) and growth flushes.

CONSIDERATIONS WHEN INTERPRETING RESULTS

Interpretation of soil results is complex with many factors to consider and many interactions between soil ameliorations and/or fertiliser additions. Over and under application of nutrients is quite common so is the application of the incorrect product for the nutrient required. Be cautious about the application of obscure untested products with little to no analysis provided.

It is always best to consult a reputable, unbiased agronomist for an accurate interpretation and recommendation.

KEY THINGS TO CONSIDER:

- Soil **pH** (water1:5)- Ideal range for plant growth is pH 5.5 to 8.0.
- **Organic Carbon** (OC) (Walkley-Black) - Aim for more than 1.5% in the top layer of soil. Don't confuse it with organic matter, they are not the same thing.
- Nitrate **Nitrogen** (N) - A very mobile macro-nutrient. Consider soil nitrate N across the entire profile since plant roots search for N deeper as they grow.
- **Phosphorus** (P) - Not mobile in the soil. Essential building block providing energy for pasture growth.
- **Potassium** (K) - Macro-nutrient essential for plant growth. Not mobile in clay soils.
- **Sulphur** (S) - Important nutrient for legumes as it aids in nitrogen fixation and amino acid production.
- **Electrical Conductivity** (EC) - A measure of soil salinity.
- **Cation Exchange Capacity** (CEC) - Indication of the type and amount of clay or organic matter in the soil. Generally, the higher the number, the more fertile the soil.
- Exchangeable **Sodium** Percentage (ESP) - Soils higher than 6% may see soil structural problems.
- **Calcium/Magnesium** Ratio - Ratio would ideally be >1.5:1 as magnesium can cause dispersive effects like sodium. The ratio generally declines down the soil profile.
- Trace elements (**Zinc, Copper, Iron and Manganese**) - Consider in the surface layer only and treat as a guide. Any that are particularly low (or higher) can be confirmed with a plant sample test for deficiencies.

***Source**: "Productive pastures - Focus on soils" compiled by David Hall & Jill Alexander*

SHOULD PASTURES BE FERTILISED

Whether it is worth applying fertiliser or soil amendments to pastures is dependent on what deficiencies are identified in the soil tests, what the productivity potential of the soil is and of course, if it is economically viable.

A Producer Demonstration Site (PDS) conducted from 2018-2021 on the Western Downs of Qld looking at the economic viability of fertilising sown pastures found:

- Fertilising sown pastures appears to be economically viable especially for pastures situated on deep soils with high water-holding capacity that show signs of nutrient rundown.
- The benefit of the applied fertiliser was the significant increase in quantity and quality of plant biomass produced with the average pasture yield of the fertilised paddocks consistently double that of un-fertilised paddocks.
- A simple cost benefit model found that in all scenarios tested, the pay off was positive.
- Participants noted that good grazing management, timeliness of application and following the full fertilising plan was crucial and variation from this reduced the results.
- More information on this PDS can be found at: *https://www.mla.com.au/research-and-development/reports/2023/l.pds.1902---pds-is-fertilising-pastures-economically-worthwhile/*

One effective method for addressing minor soil imbalances and deficiencies is by increasing soil organic matter. This can be done by retaining substantial grass stubble consistently year round and implementing rotational grazing (with paddock rest periods during the growing season) to facilitate plant root and shoot system regeneration. Fertilisers can be employed to enhance plant growth and yield, expediting this process.

Another option for building nutrition in pasture systems is to incorporate legumes into the pasture system. Diversity in pastures is important and to have an impact on pasture production aim for at least 4 legume plants per square metre.

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Other great soil resources including soil test results from BCCA's "Invest in a Test" project can be found at: www.burnettaghub.com.au/land/soils

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