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SOIL ESSENTIALS – UNDERSTAND IT OR LOSE IT

PART 1

Soils in South West Queensland vary from being deep, rich and fertile to some of the poorest. The region has a diverse range of soil types as a result of variation in climate, topography, soil organism populations, time and weathering of parent material.

The issue for farmers and land managers is how to use and manage these soils productively and sustainably.

This fact sheet aims to provide farmers with important soil science information that will help them manage soils on their properties within their local landscape. This is one of a five-part 'soils' fact sheet series.

Soil Attributes

Floodplain, ridge country, light, heavy, hard, cracking and non-cracking soil are some of the common terms used by landholders to describe soils across the landscape.

These terms are derived from specific soil attributes such as soil texture, structure and topography.

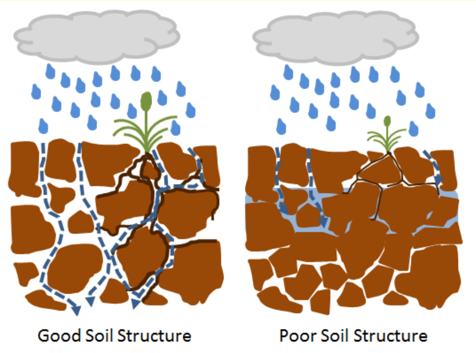
Soil texture is determined by the proportion of sand, silt, and clay particles in a soil. Textural classes of soil range from sand, sandy loam, loam, sandy clay loam, clay loam, light clay to heavy clay.

Soil structure is the arrangement of soil particles into aggregates and blocks. Soil structure is heavily dependent on the texture of the soil and varies from granular (sands) to blocky (clays). Good soil structure is a result of soil particles being able to form together to create stable aggregates.

These stable aggregates act as the vital framework for the soil to provide a balance of soil voids (cracks) that enable the free movement of nutrient, plant roots, air and soil organisms. (Figure 1).

Poorly structured soils have limited to no voids (cracks) throughout the profile and can become an inhospitable environment for plant roots leading to waterlogging (Figure 1).

Figure 1: Good soil structure and poor soil structure



Soil Fertility

Soil fertility describes the composition of inherent or 'naturally available' soil chemicals and biological organisms.

Each soil type supports a unique living ecosystem of biological and microbiologic organisms which is forever changing.

These components plus water, sunlight, air, nutrients and warmth in the right proportions provide the best environment for plant growth.

Factors affecting soil fertility

Nutrients - The level and balance of nutrients are critical components to plant growth.

Too much of one nutrient may result in a potentially toxic environment. Conversely, not having enough can lead to a deficiency which can either drastically reduce plant growth or kill it.

Some nutrients are selectively available and require chemical reactions or soil organisms to consume them to breakdown insoluble compounds and make them available for plant uptake.

Macronutrients are the essential nutrients for plant growth, and are required in large quantities. Macronutrients include: Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg) and Sulphur (S).

Micronutrients are required in smaller quantities and are needed for cell formation in plant and animal growth. Micronutrients include: Boron (B), Chlorine (Cl), Cobalt (Co), Copper (CU), Fluoride (Fl), Iodine (I), Iron (Fe), Manganese (Mn), Molybdenum (Mo), Selenium (Se), Silicon (Si), Sodium (Na), and Zinc (Zn). For healthy plant growth, these nutrients need to be in balance. Adverse effects can lead to disease, predation from insects and limited plant growth.

Leaching is the removal or percolation of nutrients by water down the soil profile and away from the plant root zone. This occurs mostly in lighter soils that are freely draining and with poor soil structure (i.e. soils with high sand composition).

Leaching mainly applies to soluble nutrients like nitrogen and sulphur. Leaching of these nutrients occurs on clay and sandy soils. In contrast, nutrients such as phosphorus, potassium and zinc are relatively immobile and move very little from where they are placed, even in sandy soils.

Soil pH is a measure of soil acidity and/or alkalinity, where 1 is strongly acidic and pH 14 is strongly alkaline. The ideal level is pH 7 which is neutral and where most soil nutrients are available for plant uptake.

The accumulation of strongly acidic ions such as sulphate or nitrate increases acidity levels and lowers pH readings. The accumulation of strongly basic ions such as calcium and sodium increases alkalinity levels and raises pH levels.

In terms of productivity, the level of pH influences availability of trace elements in the soil. Soils with high pH (strongly alkaline) have common deficiencies with zinc, iron, copper, and manganese. This is indicated in crops or fruit trees by colour loss in the leaf, leaf thinning and tip curl in severe cases.

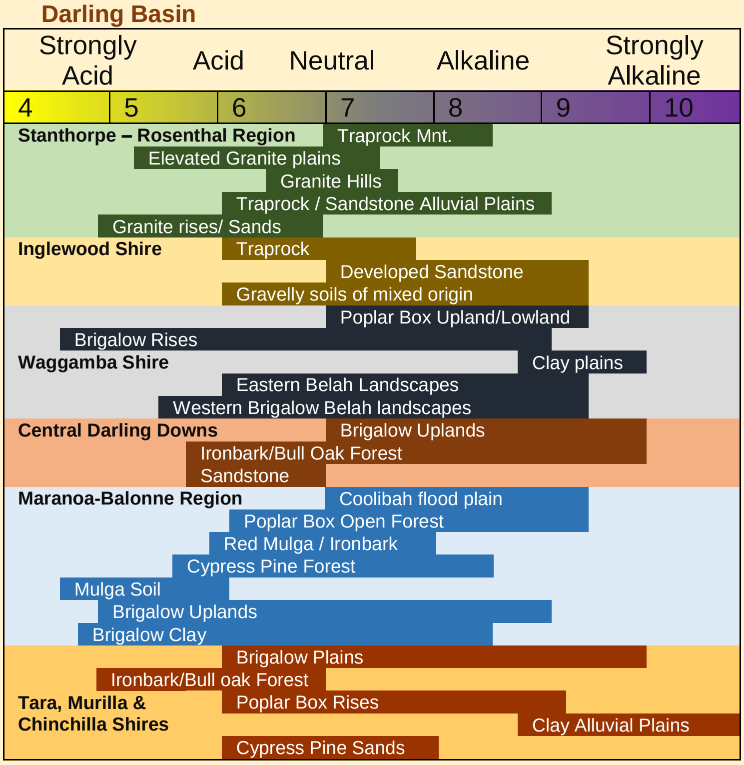
Soils with low pH (strongly acid) may have an abundant and sometimes toxic supply of aluminium, boron, sodium, and manganese. Aluminium in acid soils causes root damage, and high levels of manganese causes stunting and yellowing in plants.

Differing levels of pH can also affect soil biology activity. Some plants species have a tolerance towards particular pH levels.

If selecting a crop or pastures species make sure to select a species which will grow best in the level of acidity or alkalinity of your soil.

Table 1 provides an illustration of the different pH ranges for certain soil types and locations across the Queensland Murray-Darling Basin catchment.

Table 1: pH ranges across the Queensland Murray-Darling Basin



Note: The information provided in the table above has been derived from the land management manuals for each of the shires outlined in the table and a report by Harms, Hughes and Payne 2008.

Cation Exchange Capacity (CEC) is the "capacity of the soil to hold exchangeable cations" and is calculated by adding the cations of calcium, magnesium, sodium and potassium.

Soils with a high CEC are not necessarily "fertile soils", especially if those exchange sites are highly dominated by, for example, sodium.

The CEC of a soil is dependent on the amount and type of clay present in a soil, as well as soil organic matter content.

It is preferred to see the CEC dominated by calcium, followed by magnesium and potassium.

Sodium levels above 5% of CEC start to have detrimental effects on soil structure. Levels higher than this can lead to sodic soils that are highly dispersive, resulting in poor soil structure.

The dominance of sodium can be reduced by adding calcium ions in the form of either gypsum (alkaline soils) or lime (acidic soils). This can be an expensive operation as the rates required are measured in tonnes per hectare.

Organic matter is the measure of non-living plant and animal material which remains in the soil. Organic matter provides food for soil organisms to release usable nutrients for plants. Organic matter also:

- Enhances soil structure,
- Increases water holding capacity and infiltration rate,
- Provides structure for organisms to interact with the surrounding soil, and
- Gives soil a dark colour.

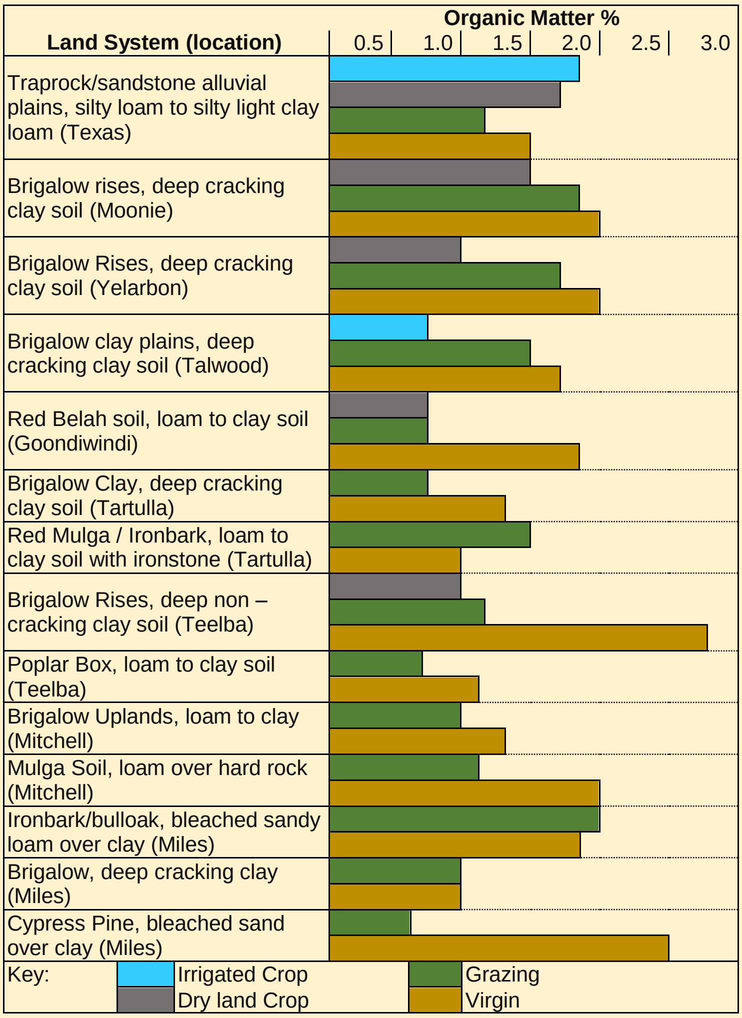
Soils with high organic matter content usually have higher soil fertility and have less of reliance for fertiliser application over the long term.

Organic matter and nutrients levels decline rapidly after few years of cropping or heavy grazing. Landholders today have changed management to maximise organic matter retention (zero or minimum tillage) and rotational grazing to help with organic matter and nutrient levels and to improve overall soil quality.

Table 2 provides an illustration of the affect land use has had on soil organic matter composition within the soil.

The information used in this table was derived from various land management manuals across the Queensland Murray-Darling Basin (QMDB) and a report by Harms, Hughes and Payne 2008.

Table 2: Organic Matter levels for different land systems



Water holding capacity describes the ability of soil to hold or retain water. Soils with higher clay content and organic matter are able to hold larger amounts of water due to fine pores, smaller soil particle size and greater surface area.

Sandy soils, on the other hand, have very poor water holding capacity because they contain larger pores, larger soil particles, less surface area and drain easily.

Having adequate water supplies is very important for plant and animal growth/interaction. Water infiltration rates throughout the soil profile depend on good soil structure.

Plant available water capacity (PAWC)

Refers to the amount of water a plant is able to extract from the soil. Factors that limit the amount of water held in soils and subsequently made available to plants include water holding capacity, soil depth, soil structure and organic matter levels.

Crops differ in their ability to extract water from soils, for example, mung beans have a much shorter growth period and shallower rooting depth compared to cotton which has a much longer growth period and an extensive root system.

How to assess soil fertility

There are a number of tools to assess soil fertility, namely:

Do It Yourself Field observation tools:

- GRDC glove box guides on nutrient deficiencies.
- PAWC Guide
- Subsoil constraints
- Sap test kits
- pH and EC field test kits
- QMDC land condition monitoring manual.

LINK

The most accurate option is to take soil samples, have them tested in a National Association of Testing Authority (NATA), Australia approved laboratory and analysed by a consultant or agronomist.

An alternative to soil testing is to conduct plant tissue analysis as this indicates plant nutrient availability, however, it may indicate total nutrients in the soil (Hall 2008).

Further Information: To obtain resources cited in this document contact QMDC's Soil Conservation officers on phone: 07 4637 6200 or email: info@qmdc.org.au

If you are viewing this fact sheet online – try these links:

- Fact Sheet – Sub Soil Constraints;
- GRDC
- Soil Quality Fact Sheets;
- QLD DAFF Southern Queensland Farming Systems project;
- The proof is in the pasture—addressing fertility rundown.

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