soilquality.org.au

Physics

MAKING SENSE OF PHYSICAL INDICATORS—NEW SOUTH WALES

Many indicators of the physical quality of soil measure *inherent* characteristics of the soil, which means they are largely outside a farmer's control. These are derived largely from the parent material of the soil and change very little over time or as a result of management. These properties can be measured once and used to group sites that are likely to respond in similar ways to management e.g. sand soils; seasonally waterlogged soils.

Soil texture

Soil texture is a key foundational property of the soil which affects the movement of air, water and nutrients in the soil. The 'Measuring Soil Texture in the Field' fact sheet gives details of how soils can be allocated to one of the 15 texture grades (loam, silty clay etc) in the field. The 'Measuring soil texture in the laboratory—New South Wales' fact sheet shows how the % sand, silt and clay can also be converted using the texture triangle. To simplify the interpretation of the other indicators of soil quality, within soilquality.org.au, soil texture classes are grouped together into sand, loam and clay soils (figure 1). Figure 2 shows typical soil profile textures for NSW.

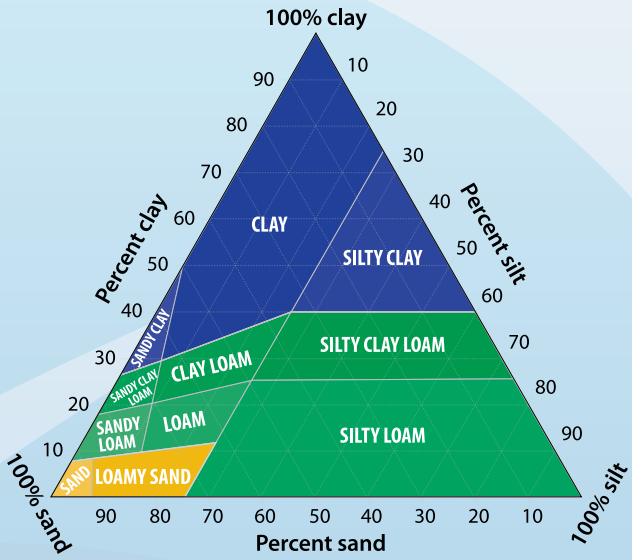


Figure 1: Grouping of textural classes to simpler groups of clay (blue), loam (green) and sand (gold) superimposed on the full textural triangle showing the definition of soil texture classes based on % sand, silt and clay.

Gravel content

Gravel is common in many soils. Gravel content can range from minor (<10%) to dominant (>50%) in the soil. High gravel contents affect the interpretation of other soil quality indicators, as most of the indicators are measured once the soil has been sieved (<2 mm) and all the gravel has been removed. Gravel content should therefore be known to help correct other indicators and give the true field values. See "Bulk Density—On Farm Use" fact sheet to understand how to adjust for gravel.

Effect of high gravel content

Bulk density—Gravel has a higher bulk density than a soil aggregate of similar size, hence the presence of gravel tends to give higher than expected soil bulk density values unless this is adjusted.

Water availability—Gravel does not store water, so the water availability is reduced in proportion to the amount of gravel present. Gravelly soils are often droughty.

Risk of compaction—a high proportion of gravel in the topsoil will reduce the susceptibility to compaction due to livestock or traffic.

Root growth—Roots grow through gravel layers, unless the gravel is cemented together to form a ferricrete pan.

Risk of erosion—Surface gravel reduces susceptibility to wind and water erosion.

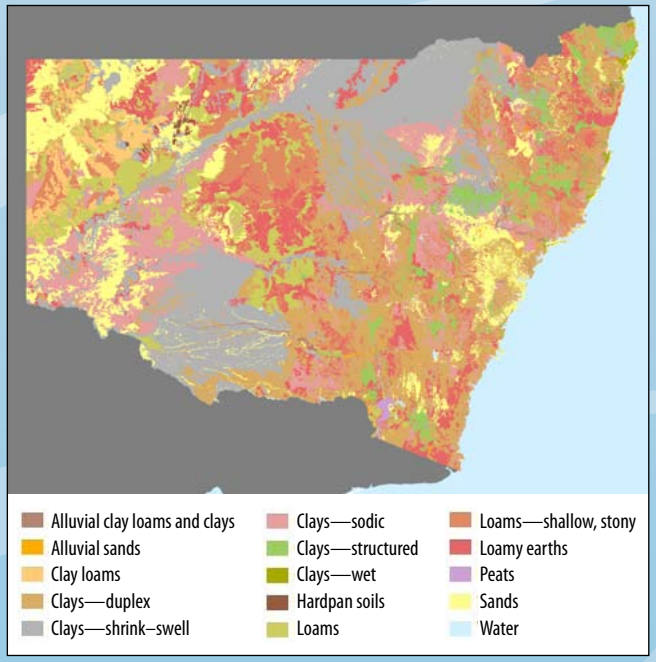


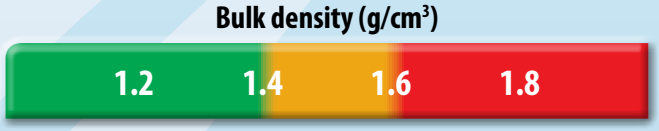
Figure 2: Map of typical soil profile textures across NSW. (Image: NSW Office of Environment and Heritage)

Some indicators of the physical quality of soil measure *dynamic* soil properties i.e. properties that are changed over time and with management. It is important to monitor these indicators as they can act as constraints to yield, restricting crop growth and preventing the yield potential from being achieved.

- Indicators falling in the **RED** zone are high risk and need to be investigated urgently.
- Indicators falling in the **AMBER** zone are moderate risk and should be investigated further.
- Indicators falling in the GREEN zone are low risk, regular monitoring should be continued.

Bulk density

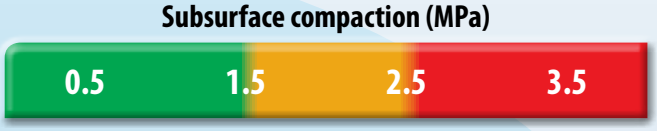
Bulk density is an indicator of the packing density of the soil measured in grams per cubic centimetre (g/cm^3). It indicates soil porosity, but it does not give any indication of the size or continuity of the pores. Bulk density values are affected by soil texture but are not easily correlated with soil types. Sand soils may be particularly prone to compaction.



Subsurface compaction

Bulk density tends to increase with depth and high values below 40 cm are usually an inherent characteristic of the soil. A cone penetrometer can be used to measure the force required to penetrate the soil in mega Pascals (MPa). However, compaction closer to the surface may indicate layers that form as a result of compaction by machinery (commonly at 10–40 cm) and livestock (commonly at 0–15 cm). Other indicators of a compacted layer are poor root growth, roots growing horizontally and thickened root tips. In NSW an extensive region of hardpan soils occurs in the northwest, west of Bourke.

It is important to note that some soils may have inherent compacted layers. This includes soils that are naturally hardsetting and soils that have hard pans, which are cemented layers resulting from chemical precipitation.



Water holding capacity

Water availability is strongly related to soil texture which largely controls the number and size of pores in the soil. However, for each field texture grade soil structure also affects water in the soil. Soil structure is the arrangement of soil particles into aggregates, which influences the pattern of pore spaces within the soil. The connectivity of pore spaces strongly affects the soil's infiltration capacity, drainage, water holding capacity and the efficiency with which plants can extract water from the soil. Increasing soil organic matter improves soil structure and the conditions for root development and function Structural improvement in clay soils will create more larger pore spaces (macropores) and increase the effectiveness of natural drainage when the soil is wet. In contrast, structural improvements in sand create more small pore spaces (micropores) which are able to hold onto water as the soil dries.

Further information

The NSW Department of Primary Industries maintains soil information resources on the website, www.dpi.nsw.gov.au/agriculture.

Author: **Elizabeth Stockdale** (Newcastle University, UK) Prepared based on findings from soil quality expert panel workshops; reviewed for New South Wales by **Stephanie Alt** (NSW Department of Primary Industries)

NSW GOVERNMENT Department of Primary Industries

Soil Biology Initiative II
Supported by the GRDC

The National Soil Quality Monitoring Program is being funded by the Grains Research and Development Corporation, as part of the second Soil Biology Initiative.

GRDC Grains Research & Development Corporation
Your GRDC working with you