



MAKING SENSE OF PHYSICAL INDICATORS

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" 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).

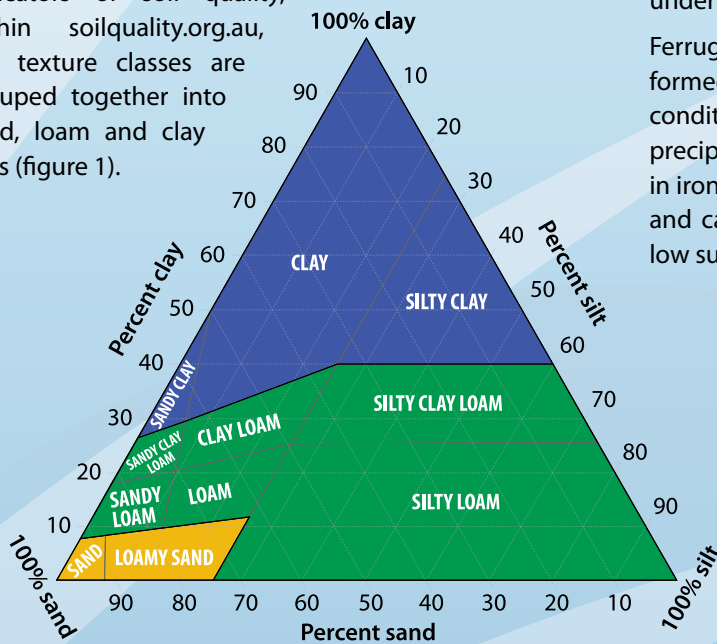


Figure 1: Grouping of textural classes to simpler groups of clay (blue), loam (green) and sand (gold) superimposed on the full textural triangle showing the definition of soil texture classes based on % sand, silt and clay.

Gravel content

Gravel is common in many WA 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.

Ferruginous gravels are most common in WA. They were formed in the past under warmer and wetter climate conditions by fluctuating water tables and the consequent precipitation of iron. Because ferruginous gravels are high in iron and aluminium oxides, they are chemically reactive and can fix phosphorus. However, they have a relatively low surface area compared to silt and clay in the soil.

Effect of high gravel content on soil physical properties

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.

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 per cm³). 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.

Bulk density (g/cm³)



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) (figure 2) and livestock (commonly at 0–15 cm). Other indicators of a compacted layer are poor root growth, roots growing horizontally and thickened root tips.

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.

Subsurface compaction (MPa)

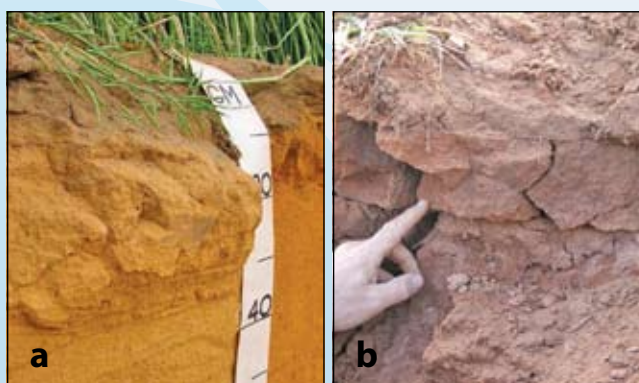


Figure 2: (a) A dense compacted layer in yellow loamy sand at 15–30 cm (Photo by Noel Schocknecht, DAFWA). (b) A distinct compacted layer in a sandy loam, note fractures in hard pan through which roots preferentially grow.

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 availability and the values of the lower and upper storage limits. Soil structure can be assessed descriptively in the field but it is difficult to measure objectively. Structural improvement in clay soils will create more macropores and increase the effectiveness of natural drainage when the soil is wet and reduce the upper storage limit. In contrast, structural improvements in sand create more micropores which are able to hold onto water as the soil dries.

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