Technical Note

Soil Texture Measurement

Introduction

Soil texture is a general term that describes a soil class according to the proportion of the different particle size fractions in soil i.e. % sand, silt and clay. Soil is made up of mineral particles of different sizes, and the relative proportion of these minerals affect the soil's physical properties. Particles greater than 2mm in diameter are considered as gravels or stones and are excluded from most soil tests, as it is the fraction less than 2mm that make up the bulk of most soils. Clay particles are the smallest and contribute significantly to a soils chemical and physical properties. Silt and sand particles are larger, and while less important chemically, play a part in the physical characteristics of soil.

The textural classification is arrived at by various methods of particle size analysis (sometimes known as mechanical analysis) and also according to a specific classification scheme. Hill Laboratories have adopted the widely-accepted hydrometer sedimentation method and have used the Standards Association of New Zealand (1986) schema to define the particle size, to align with the NZ Soils Portal (MWLR) classification.

The following particle size ranges apply:

Sand: 2 mm – 63 µm

Silt: 63 µm – 2 µm

Clay: <2 µm

Soil physical properties are often determined at different depths through the soil profile, because sub-soil (below 15-30cm) will have a significant effect on drainage and structural properties. Soil classifications are also available through various models e.g. S-map (Manaaki Whenua Landcare Research), but these are often made at quite a large scale. There is some interest in being able to measure soil physical properties such as soil texture in the topsoil, as the physical properties of soil are part of assessments of soil health. While soil texture cannot be changed (it is a fixed feature of soil based on the parent materials that formed the soil), the classification at farm-scale can help with evaluation of farm management practices and potential changes towards better environmental stewardship e.g. irrigation, agrichemical application, stocking rate, cultivation practices.

Principles of the Method used by Hill Labs

Soil organic matter is removed by hydrogen peroxide digestion. Dispersion is achieved using sodium polymetaphosphate (hexametaphosphate) buffered at ~pH 8 and physical mixing. Sand is separated by a 63 µm wet sieve procedure and determined gravimetrically. The remaining silt and clay fractions are determined by ASTM 152H hydrometer utilising Stokes Law. Stokes Law states: the force that impedes a sphere moving through a viscous fluid is directly proportional to the velocity of the sphere, radius of the sphere, and viscosity of the fluid. Results are reported as %Sand, %Silt and %Clay in the inorganic soil fraction. The sand fractions are not differentiated to reduce complexity and cost, and are generally not required for agronomic purposes.

Note, for raw peat soils the particle size results for sand, silt and clay may not reflect the true nature of the soil as results are reported on the inorganic fraction only. For developed peats that behave more like mineral soils, then this artefact will be less important.

This sedimentation and hydrometer method is a two-day laboratory test, and is very labour-intensive. As such, the laboratory capacity for this method is relatively low and not suited to large sample numbers. It is likely most useful for investigative purposes for landscaping and farm management where developments or improvements are being planned.

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Textural Classes

Soil textural classes are arrived at by use of a “texture triangle” (see Fig. 1), where the individually measured percentages of sand, silt and clay are read off each axis of the triangle to intersect in a textural class zone. The example in Fig. 1 (sourced from McClaren & Cameron, 1990) shows a silt loam – the point where the directional lines for a soil with relative particle sizes 40% sand, 40% silt and 20% clay meet. Another example might be a soil with 30% sand, 20% silt and 50% clay would be classed as a clay.

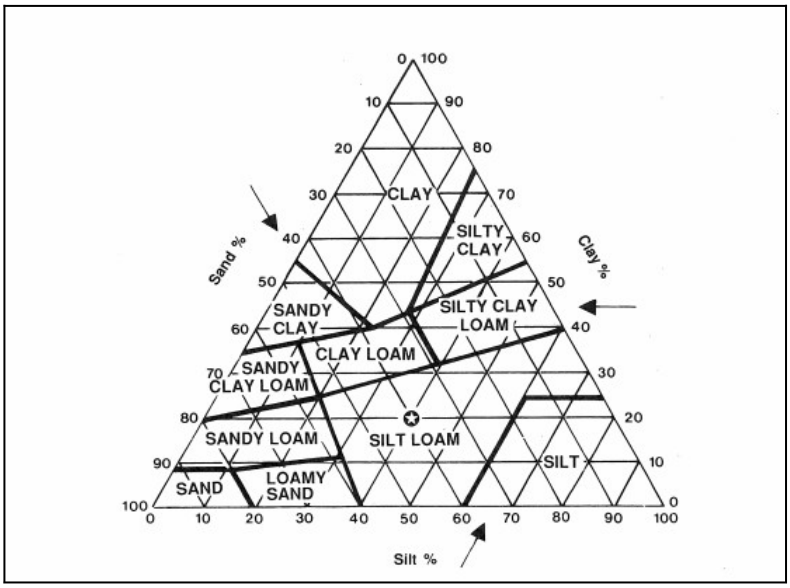

Figure 1: Texture Triangle. Soils contain a range of particle sizes and the relative proportions of sand, silt and clay define the soil texture. In the example shown, a soil with 40% sand, 40% silt and 20% clay is classified as a **silt loam**. (Source: McClaren & Cameron, 1990)

The identified textural class can then be used to help guide management decisions, as these classes have known properties as described in Table 1 below.

	Textural Class				
Property	**Sands**	**Sandy Loams**	**Loams**	**Clay Loams**	**Clays**
Total available water	very low to low	low to medium	high to medium	medium to high	medium to low
Rate of water Movement	very fast	fast to medium	medium	medium to slow	slow
Drainage rate	very high	high	medium	medium to low	low
Nutrient supply capacity	low	low to medium	medium	medium to high	high
Leaching of nutrients & herbicides	high	high to moderate	moderate	moderate to low	low
Tendency to hard setting or surface sealing	low	high	high to moderate	medium	medium to low
Rate of warming after wetting	rapid	rapid	rapid to medium	medium	slow
Trafficability & workability after rain or irrigations	soon	intermediate	intermediate	intermediate	long
Susceptibility to trafficking	low*	moderate	moderate to high	low	high

*Sands are naturally in a compacted state and are rarely further compacted by traffic.

Table 1: Physical properties of soils in different texture classes *(Source: A Cass - CRC for Soil and Land Management)*

Conclusion

Soil texture is an important measure that can help with management decisions, as the relative particle size distribution gives soils properties that affect water-holding capacity, permeability and soil workability. Soil texture measurements are most beneficial when taken from different levels in the soil profile, as sub-soil texture has a big effect on drainage in particular. The water-holding capacity of a soil is almost wholly dependent on soil texture. Clays can store water but this water is not readily available to plants, whereas loams can also store water but it is more accessible to plants. Sands have a low water holding capacity due to their nature as shown in Table 1 – low total available water and are very fast draining.

References

1. Standards Association of New Zealand (NZS 4402: 1986) Soil Testing Methods. Determination of the Particle Size Distribution subsidiary method for fine soils (Hydrometer method).
2. A Cass – CRC for Soil and Land management
3. McLaren, R.G. & Cameron, K.C. 1990. Soil Science – an introduction to the properties and management of New Zealand soils. Chapter 5. Oxford University Press
4. New Zealand Soils Portal - Manaaki Whenua Landcare Research (MWLR)