

Soil structure

Soil structure is determined by:

- the volume and arrangement of pores in the soil. This dictates how easy it is for water and air to flow into and through the soil.
- the way soil particles are held together. This affects the soil's friability, the ease with which soil particles are detached by raindrops and runoff, and the resistance of the soil to the growth of roots and shoots.

Damaging soil structure

Organic matter is critical for maintaining good soil structure as it helps bind the soil together. Each time the soil is cultivated soil microbes attack the freshly exposed organic matter. Much of the organic matter is then lost as carbon dioxide, and soil crumbs (aggregates) lose their stability. Cultivation also pulverises the soil, destroying the continuous fine channels (biopores) created by plant roots and soil dwelling animals. It is these biopores that allow rapid infiltration of water and air. Stock hooves on a wet soil can cause serious compaction and breakdown of soil aggregates.

Soil structure decline and erosion

A soil with low organic matter readily collapses when wetted reducing infiltration of rain and increasing runoff. Weakened by the loss of organic matter, soil particles readily break down under raindrop impact and are more easily carried away by the increased runoff. Erosion rates can be five to ten times higher for poorly structured soil than for well structured soil.

Soil structure, productivity and profitability

Soil structure decline can reduce crop and pasture yields by:

- reducing infiltration of rain. As a general rule for every 1 mm. of rain that runs off, wheat yields are reduced by 10 kg/ha. Infiltration of rain in spring is particularly important for grain filling.
- reducing workability and trafficability of the soil. The range of moisture contents at which a soil is easily cultivated is reduced when it is poorly structured. The soil quickly moves from being too wet to cultivate to being too dry, reducing the time available for cultivation. This can limit the area of crop successfully established and restricts timeliness of operations. A poorly structured soil is not friable. This means it does not readily break up into soil aggregates of suitable size for a seedbed. Rather, it forms large hard clods which require further cultivation to form an 'ideal' seedbed, increasing costs of production.
- restricting root growth because of high soil strength and low aeration.
- increasing erosion which lessens the long term productivity of the soil.
- restricting seedling emergence if the surface crust dries out.

What part of the soil is affected by soil structure decline?

Surface soil is the cultivation zone and is affected by crust formation, hardsetting and soil crumb instability.

Subsurface soil is at the depth of cultivation and is affected by compaction, smearing and plough pans.

Subsoil is usually not affected by soil structure decline in the southern wheatbelt, however in the northern wheatbelt problems of compaction have been observed.

Improving soil structure

Soil structure can be improved and maintained by:

- increasing and maintaining plant productivity and therefore root activity. Increased plant activity adds organic matter and the roots help create pathways for water and air to infiltrate. A pasture phase is one of the best ways of improving soil structure. Preferably the pasture should have a grass component and grazing of the pasture should be restricted so that plant productivity and ground cover are maintained. Care should be taken not to graze the paddock when the soil is very wet as this compacts the soil.
- reducing cultivation for both pasture and crop establishment. Numerous trials have shown that a program of reduced tillage, direct drilling or no tillage results in improved soil structure. When cultivating the soil be sure the soil is friable to prevent shattering of dry soils and smearing and compaction of wet soils.
- ensuring a good ground cover of plants or crop stubble as long as possible to protect the surface soil from raindrop impact.

Conclusion

Soil structure decline can significantly increase soil erosion, resulting in the long-term degradation of the farm's chief asset, the soil. Poor soil structure can increase costs of production and reduce productivity. Prevention of soil structure decline requires maintenance of vigorous plant growth, reduced cultivation, maximising protection of the soil surface from raindrop impact and careful grazing management when the soils are wet to avoid pugging.

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Soil Aggregate Slaking

Slaking is a mechanical process and occurs when the soil structure is weak. When a dry soil is wet rapidly (e.g. with rapid rain), water moves into the pores within the aggregate and forces air out. If the aggregate is weak, the force of the escaping air causes the aggregate to burst. If the aggregate is strong, then it resists the force of the escaping air and holds together. (Raindrops falling on to the soil surface can also cause weak aggregates to fall apart).

Water moving into an aggregate forces the air out. If the aggregate is weak, the force of the escaping air causes it to burst and slake. The slaked soil particles are washed into the soil and block soil pores and form a crust on the soil surface.

Organic matter plays an important role in determining the structural strength of the soil. It is a most important binding agent or soil glue. Cropping soils generally contain little organic matter for a number of reasons including stubble burning and cultivation, both of which increase the rate of organic matter

destruction. Increasing the organic matter content of the soil will increase the soil strength and prevent slaking.

Test: place a pea size aggregate of dry soil into a dish of water, wait one minute and see if the aggregate falls apart or holds together. If it falls apart it has slaked. Note: the soil sample must be dry.

Based on “Soil Structure Assessment Kit” by Shelley McGuinness’ Dept. Cons. & Env. Vic. 1991