Soil limitations to water entry

Understanding restrictive soil layers

Water entry and water storage are key factors for successful cropping in Queensland's variable climate. Restrictive soil layers (also known as infiltration throttles) can substantially reduce water entry into, and water movement through the soil profile. These layers may be inherent, resulting from natural soil formation processes or induced by land management practices. Figure 1 illustrates examples of potential infiltration throttles in a soil profile. One or more of these may be present.

Infiltration will be limited by the least permeable layer, so restriction near the surface may be more important than restriction deep in the profile. If water is unable to enter the soil profile due to sealing or hardsetting for example, the effective water storage (plant available water capacity) is reduced. Slow movement of water through the profile can cause waterlogging or increased runoff.

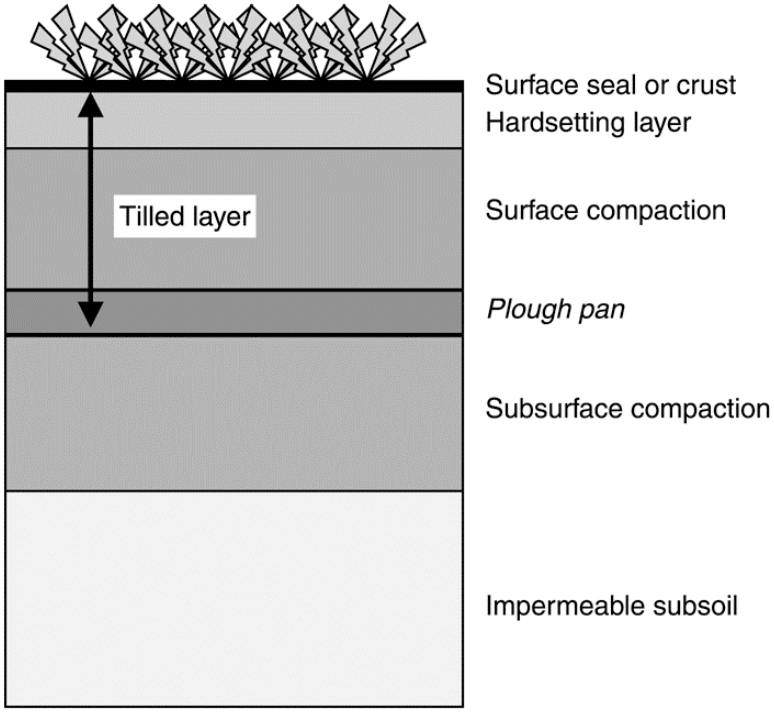

Figure 1. Soil profile with restrictive soil layers.

Surface seal

A surface seal or crust is a thin layer (1-10 millimeters) formed on the soil surface by water drop impact. Its porosity can be 90 per cent lower than that of unsealed soil. Permeability declines during rain or irrigation when surface aggregates break down and are compacted under drop impact. Surface sealing is largely responsible for restricted initial infiltration under rainfall or irrigation. Water that is unable to move into the soil profile will run off. Sealing and crusting may be natural, or induced when soil cover is removed. It is sometimes associated with sodicity.

Hardsetting layer

Hardsetting is an inherent feature of some soils (e.g. some texture-contrast soils and weakly structured cracking clays). Soil aggregates break down during wetting, then set to a hard, structureless mass during drying. This is exacerbated by over-cultivation and reduction in organic matter, which reduces aggregate stability.

Surface compaction

Surface compaction is induced by tillage tool smearing, tractor wheels and farm animals when soil is sheared or compressed at the critical moisture content known as the 'plastic limit'. It results in high soil strength and

reduced porosity, preventing water from accessing the root zone. In tilled soils, a plough pan can be created directly under the tilled layer by the smearing action of tines.

Subsurface compaction

Compaction below the tilled layer is created by high axle loads under moist soil conditions. Water is unable to move freely through the soil profile. In dry conditions, subsurface compaction will prevent roots accessing deep stored moisture.

Impermeable subsoil

An impermeable subsoil is an inherent feature of some soils and may be associated with a sodic B horizon or shallow soil profile on rock. Water entry is limited and under high rainfall, waterlogging may occur on top of the impermeable layer.

Questions to ask

If you suspect that your soil has a layer that restricts infiltration, check the following indicators:

- Is my soil wetting up adequately after good rain?
- Does the soil surface appear sealed after rain?
- Is water running off rather than infiltrating?
- Is waterlogging a problem?

What can I do?

Management practices that can help overcome restrictive soil layers include:

- maintaining stubble cover
- gypsum application
- cultivation
- pasture phase
- minimising traffic
- controlled traffic
- rotation with deep-rooting crops.

Each of these management tools will improve infiltration in only one or two of the restrictive layers. Since the most restrictive layer will control water movement, simply removing one infiltration throttle may not improve the overall physical ‘health’ of the soil profile. For example, trafficking a whole paddock regularly may counteract the benefit of retaining surface cover. A combination of practices may be required to achieve real benefits.

Inherent poor structure, such as hardsetting, cannot be permanently ‘fixed’ but the farming system can be productive with appropriate management. If chemical analysis of your soil reveals high sodium and magnesium relative to calcium, consider an application of gypsum or lime depending on soil pH.

Induced degradation, such as compaction and surface sealing can be reversed given time and correct management. Surface sealing can be prevented by maintaining cover. As a rule of thumb, aim to have 40 per

cent cover remaining on the surface at the end of the fallow. Compaction can be ameliorated by growing crops to promote aeration in the soil and only cultivating dry soil to fracture compacted layers.

It is important that crops are planted frequently enough to use the water (e.g. opportunity cropping), so that stored water does not contribute to deep drainage and increase salinity hazards.

Improved water storage and use of rainfall can lead to increased yields and reduced runoff, thus reducing off-site environmental risks and improving sustainability of the soil resource.

References

McGarry, D. 1993, 'Degradation of soil structure', in *Land Degradation Processes in Australia*, eds G. McTainsh & W.C. Boughton, Longman Cheshire.

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Silburn, D. M., Connolly, R. D., & Glanville, S. 1990, 'Processes of infiltration under rain on structurally unstable cultivated soils and prediction using a Green and Ampt model', *The Institute of Engineers Australia Conference on Agricultural Engineering*, Toowoomba Queensland, pp.182–6.

Further information

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- L84—Soil compaction in cropping lands
- L109—Deep drainage – a problem or an asset?

For further information on soil water visit < http://www.qld.gov.au/environment/land/soil/> or email soils@qld.gov.au.

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