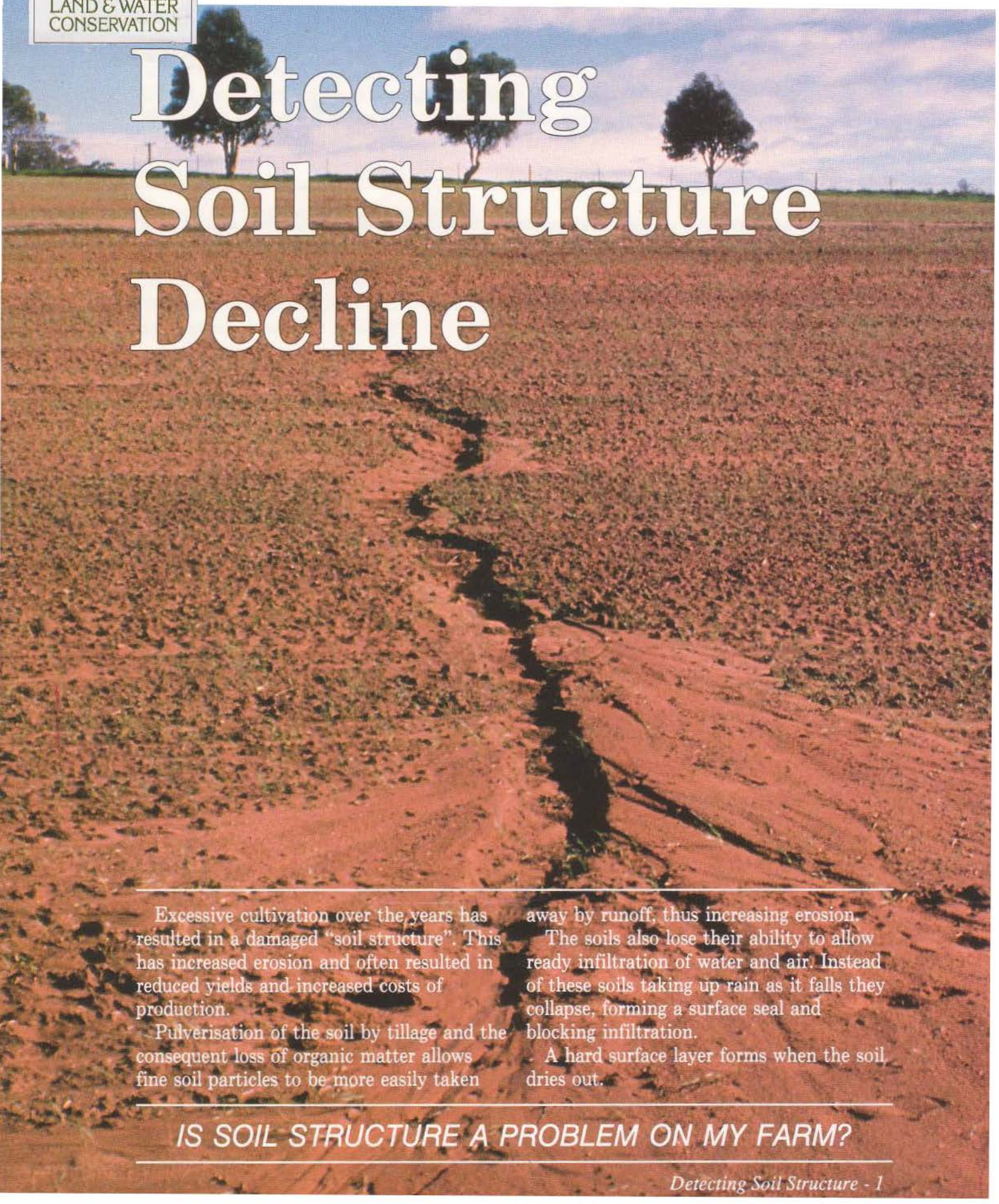
LAND & WATER CONSERVATION

Detecting Soil Structure Decline



Excessive cultivation over the years has resulted in a damaged "soil structure". This has increased erosion and often resulted in reduced yields and increased costs of production.

Pulverisation of the soil by tillage and the consequent loss of organic matter allows fine soil particles to be more easily taken away by runoff, thus increasing erosion.

The soils also lose their ability to allow ready infiltration of water and air. Instead of these soils taking up rain as it falls they collapse, forming a surface seal and blocking infiltration.

A hard surface layer forms when the soil dries out.

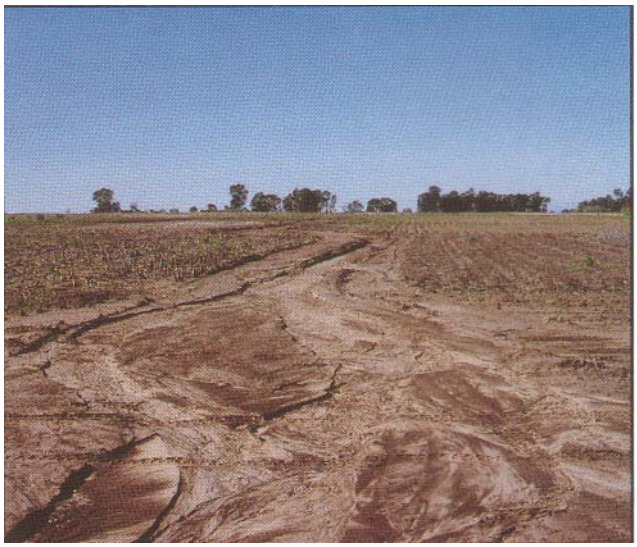
IS SOIL STRUCTURE A PROBLEM ON MY FARM?

8 field indicators of soil structure decline

There are a number of `paddock' indicators of soil structure decline that can be easily observed. The best way to make these observations is to look at the area suspected of being affected by soil structure decline and compare it with an area of similar soil type that may have better soil structure.

1. Rill and sheet erosion

Soil structure decline leads to increased runoff and low resistance to erosion. This increases rill and sheet erosion.



2. Surface crusts

Severe surface crusts develop in soils showing soil structure decline. The crusts reduce infiltration and can restrict seedling emergence if they become dry.

3. Cloddiness

After a single cultivation, 'bricklike' clods are formed and further cultivation is required to produce suitable seedbed. (This should not confused with clods held together by grasses in soils coming

4. Toad rush

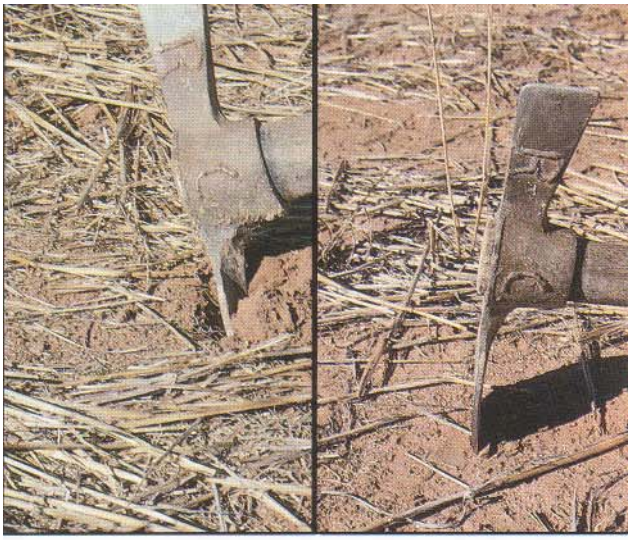
In southern NSW Toad rush *(Juncus bufonius)* can be an indicator of soil structure decline. It grows where water has been ponded on the surface.

5. Ponding

Water ponding after relatively light rain or remaining ponded for several hours after rain can indicate soil structure decline.

6. Hard surface

Soil structure decline is indicated by a very hard surface when the soil dries out. The depth of penetration of a falling mattock or pick can be used to test this. The soil with poor structure



7. Poor infiltration

After the first rains following a dry spell, take a shovel and dig down to see how far the rain has infiltrated. Compare soils under pasture with soils of different cultivation histories. The photographs opposite show the difference in infiltration between direct drilling (left) and traditional tillage. Infiltration has been greater with direct drilling because water has been able to follow root channels.

8. Presence of organic matter

A degraded soil tends to be brittle and paler in colour (right). The same soil with better soil structure (left) is indicated by a darker colour due to organic matter and the more friable nature of the soil.

If you suspect that your soil is suffering from structure decline there is a range of scientific measurements that can be made. Consult your local soil conservationist.

What is 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

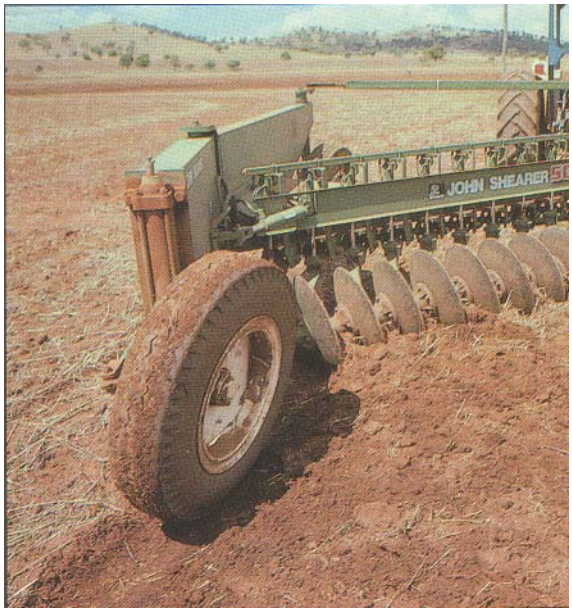
A soil with low organic matter readily collapses when wetted reducing infiltration of rain and increasing runoff. Weakened by the loss of organic matter, soil particles readily break down under raindrop impact and are more easily carried away by the increased runoff.

Erosion rates can be five to ten times higher for poorly structured soil than for well structured soil.

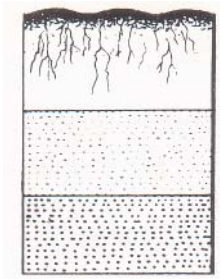
Soil structure, productivity and profitability

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.



Overcultivation with implements, such as the disc plough, is a major cause of soil structure decline.



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.

This pamphlet generally refers to the surface soil.

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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