## l.c Soil structure

**Objective** – soil structure is suitable for root growth, water infiltration, aeration and drainage needs of the crop.

Deep well-structured soils grow the best crops. A well-structured soil has pores, channels and spaces between aggregates (clumps). Water can drain quickly, roots go through the soil easily and there is no hard crust on drying.

Degraded soil has a high proportion of small particles with few water stable aggregates. The reduction of pore size and continuity results in massive blocks that restrict root growth and plant productivity. Compacted soil requires more cultivation to prepare a seedbed and this additional cultivation causes further deterioration in soil structure.

To maintain and improve good soil structure you should establish an appropriate crop rotation, increase organic matter in the soil and follow good tillage practices.

### Risk assessment

Can the soil be easily dug with a spade (before cultivating) at ideal soil moisture content?  

- **NO**
- **YES**

**LOW RISK**

Do any of the following describe the paddock?  
- Water ponds on the surface  
- Plants and roots appear stunted  
- Few pores in soil when dug

- **NO**
- **YES**

**HIGH RISK**  
Re-test when soil not so wet or not so dry.

**LOW RISK** – You probably don’t have a significant problem in this area. You may like to read the Suggested Practices section to check your understanding of the issue.

**HIGH RISK** – You need to take some action. Read the Suggested Practices for that topic.
Suggested practices

- **Cultivation method**

Most tillage for fruit and vegetable crops occurs prior to planting to enable suitable contact between the soil and the planted material. This primary tillage is an important part of initial land preparation and cannot really be avoided. Secondary tillage operations should be minimised where possible.

Machinery can cause compaction, so the following points should be considered:
- minimise traffic in the paddock;
- keep trucks to headlands;
- use low weight spray rigs;
- consider the effects of axle load, tyre width and inflation pressure, aiming to maximise weight distribution; and
- make contractors aware of compaction issues.

Consider using a minimum-tillage approach such as tramlining or semi-permanent beds.

When choosing cultivation, consider the crop stage, soil moisture and soil condition. Rotary hoes are generally used to pulverise the soil for primary tillage. Along with disc cultivators, they should be used as sparingly as possible as their use leads to reduced soil organic carbon and soil compaction. Tyred and non-inverting implements are kinder on the soil structure.

Blunt tools can also add to compaction. Use sharp and correctly-adjusted tools to till the soil. Use implements that mainly apply an upward force to the soil.

Minimise the number of soil workings.

Avoid overworking with powered implements.

Consider using semi-permanent beds.

- **Cultivation timing**

The soil moisture content during tillage has an important effect on soil structure. Where the water content is too great, the soil acts like plasticine, smearing and compacting with tillage and traffic. Don’t go onto paddocks with machinery when the soil is wet. Similarly, soils can be too dry to work, requiring excessive amounts of energy to produce a seed bed.

Ideal moisture levels depend on soil type and texture. You can check by working some soil from the plough layer in your hands. If the soil is too wet it will work like plasticine, if it is too dry it will be hard to work and tend to shatter to dust.

- **Remedial action**

If a hard pan or compaction layer is present, then additional cultivation may be needed depending on whether the cause is cultural or due to sodicity (see Section 1f – Sodicity). If the condition is not due to sodicity, cross-ripping under the correct soil moisture levels will help to shatter the pan, loosening and breaking clods that will break down further when exposed to the weather.

Deep ripping needs to be done early enough to allow weathering, or else try to leave your deepest working to last in the soil preparation sequence, because after ripping the soil is highly susceptible to recompaction.

The benefits of deep ripping can be short term (~1 year) unless actively-growing roots enter the fracture lines.
Soils with shallow sodic subsoils should not be ripped. This can bring sodic soils to the surface and create problems with surface crusting (see Section 1f – Sodicity).

- **Increasing organic matter**

Increasing organic matter through use of crop rotations and green manure crops promotes good soil structure. Stubbles and crop residues can also be returned to the soil.

You can also apply organic matter such as greenwaste compost.

- **Crop rotation**

Using rotations and green manure crops will provide short-term soil structure benefits through better soil aggregation. This helps optimise the soil’s water-holding capacity, ability to hold nutrients, workability and water infiltration.

Rotating crops also assists soil structure, with crops such as grasses and legumes increasing the spaces or pores through the soil. Deep-rooted crops can also recycle excess soluble nutrients like nitrate and sulphur from deeper in the soil and these crops add organic matter as the deep roots eventually break down. Roots help break up the soil and create pores to assist with movement of water through the soil.

Other organic amendments can be added to soils to boost organic matter levels. These include fowl manure, feedlot manure, fish emulsion, humic acid, composts and biosolids.

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**Monitoring and recording**

Soil compaction can be assessed by determining how difficult it is to dig. The assessment should bear in mind any short-term tillage and effects of soil moisture.

- **Spade test**

The following scale can be used:

<table>
<thead>
<tr>
<th>Hand</th>
<th>Soil that can be dug easily by hand has a poor structure or is very sandy. Maintain and improve structure by increasing organic matter. Use minimum tillage for all crops.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spade</td>
<td>Soil that can be dug easily using a spade has good or very good structure.</td>
</tr>
<tr>
<td>Standing on spade</td>
<td>If you have to stand on the spade, the soil may be compacted or have high clay content. Aim to break up compacted areas and improved drainage.</td>
</tr>
<tr>
<td>Jackhammer</td>
<td>This soil is highly compacted or has a very high clay content. Good management is required to improve the drainage. Consider long-term or permanent crops/pasture.</td>
</tr>
</tbody>
</table>

Record the result of spade test.

(Taken from *Spade Test for Soil Management*, Department of Primary Industry and Fisheries, Tasmania, 1997)

- **Penetrometer (screwdriver) test**

A simple test of compaction is to see how far you can push a screwdriver into the soil using reasonable
hand pressure. It is a way of simulating the difficulty that roots have pushing through the soil. Try it after decent rainfall or irrigation.

- **Visual assessment**

Soil compaction affects the ability of plant roots to penetrate the soil and root systems are often stunted. Dig up some plants and assess their root systems and also assess the overall vigour of the plants. Stunted or sharply-bent roots mean small, feeble, low-yielding plants that are prone to drought. It can be useful to compare roots from different areas, such as under fencelines where compaction may be less.

Take a closer look at the clods and aggregates. Many large clods mean the soil will need to be kept wetter to allow roots to penetrate. Sharp angular aggregates with smooth faces indicate poor structure. Well-structured soils have a range of aggregate sizes (2-10 mm), with irregular or rounded shapes and porous faces.

Look for areas where water ponds. Ponding is a way of measuring compaction and soil structure. Water lying around in the paddock means that there are few soil pores in and below the plough level. Soil compaction is one cause of this.

- **Soil test**

Organic matter content can be included on regular soil tests. Natural levels of organic matter in the soil depend on factors such as climate, site drainage and soil texture. A heavy soil will generally have higher levels of organic matter than light, sandy soils. Measured as organic carbon content, an approximate guide is as follows:
  - very low (below 1%)
  - low (1-2%)
  - satisfactory (2-4%)
  - high (above 4%)

**References and further resources**

Australian Institute of Agricultural Science and Department of Primary Industry and Fisheries, Tasmania, (1997) *Krasnozem Topsoil Structure*.


Department of Primary Industries, Water and Environment, Tasmania, 1997 – *Spade Test for Soil Management*.


University of Western Australia (1992) *Farm Monitoring Handbook*.