greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

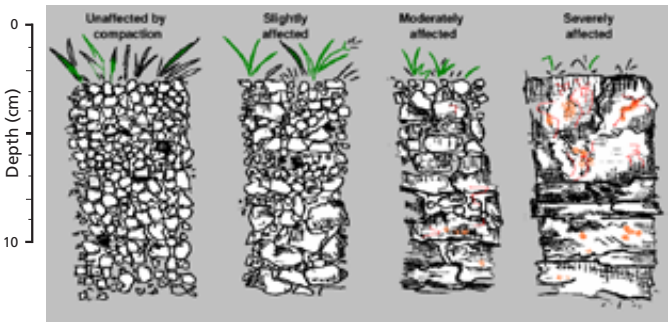
Soil compaction and pugging on dairy farms

What is soil compaction and pugging?

In New Zealand soils typically half of the topsoil volume is pore space which contains air and water. Larger soil pores are responsible for air movement and drainage, but are also the most susceptible to compaction and pugging damage.

Soil compaction happens when soil pore space is reduced or compressed (Figure 1), and typically occurs in moist rather than saturated soils.

Pugging typically occurs when the soil is very wet and soil pores are filled with water. In these conditions, trampling creates a 'hummocky' surface, or in extreme cases slurry. Usually there is considerable soil and pasture damage.



Unaffected by compaction
Topsoil is loose and crumbles easily into small, granular aggregates

Abundant roots throughout topsoil

Earthworms are common

Slightly affected
Upper part of topsoil is loose

Some larger, firmer aggregates between 10cm and 15cm

Roots do not commonly penetrate firmer aggregates

Moderately affected
Larger, firmer aggregates more common – sometimes have a horizontal apperance

Roots grow around rather then through aggregates

Reddish stains along some root channels

Severely affected
Lumpy, irregular surface

Aggregates are coarse or absent

Few roots below 5cm

Reddish stains along root channels – soil often greyish in colour and may have an unpleasant smell when wet

Figure 1: Diagram showing soil unaffected to severely affected by compaction

Effects of compaction and pugging

Soil compaction and pugging can cause:

- Reductions in pasture production and nitrogen fixation by clover
- An increase in weeds, water logging and greenhouse gasses emitted from soil
- Increased surface runoff, causing soil loss and release of sediment, nitrogen and phosphorus to waterways
- Degradation of soil structure (Figure 2)

How do you assess soil compaction?

When a soil is badly compacted it has a blocky appearance, dense aggregates that are hard to break up, poor root penetration, may be more drought prone and may have a greyish colour and unpleasant smell when wet. In contrast, a soil with little compaction tends to be much more 'crumbly' with abundant roots, deeper root penetration and many more worms.

Soil scientists have developed an indicator of soil compaction called macroporosity. This measures the volume of large pores (>0.03mm) which are responsible for air movement and drainage within the soil.

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Figure 2: Non-compacted soil (left) and severely compacted soil (right)

Effect of compaction on pasture production

Research shows that pasture production reduces as soil macroporosity reduces, ie, as soil becomes more compact (Figure 3).

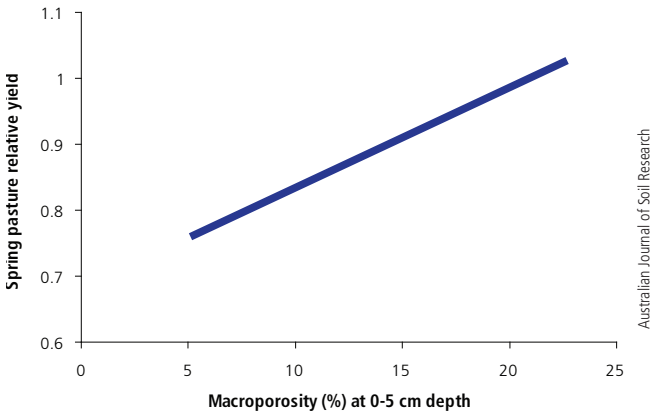

Figure 3: Effect of macroporosity on dairy farm pasture

Effect of pugging on pasture production

Research has also shown that pasture production can be badly affected due to pugging. Moderate pugging events can reduce dairy pasture production by 20-50% over several months to a year, and severe pugging events can reduce production by 40-80%.

This will typically occur during block-grazing over winter when cows are not being milked, such as on a runoff block. The amount of loss will depend on soil moisture, soil susceptibly, stock type, amount of pasture cover and grazing duration.

Soil compaction on dairy farms in the Wairarapa and Otaki regions

Greater Wellington Regional Council has monitored soil quality on dairy farms in the Wellington region since 2000 (Figure 4).

As a general rule of thumb, a soil macroporosity value of <10% indicates that pasture production could be affected. 65% of paddocks measured had soil macroporosity <10%, meaning that soil compaction is likely to be limiting pasture production on these farms.

Brown soils are more resistant to the effects of soil compaction. In the Wairarapa valley these generally occur in the western area of the valley. Pallic and Gley soils are more prone to soil compaction and generally occur in the eastern and southern areas of the valley.

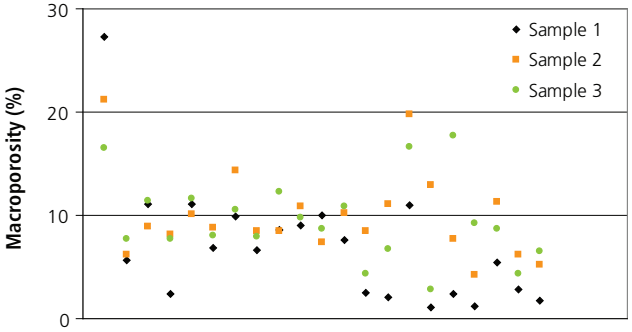

Figure 4: Macroporosity on dairy farms in the Wellington region 2000-09

Minimising or preventing compaction damage

There are a number of practices that can reduce the risk and degree of compaction and pugging:

- Build up pasture cover on paddocks before grazing
- Consider larger breaks between grazing
- Decrease paddock grazing duration to around 4 hours in very wet conditions
- Stand stock off paddocks when soils are very wet or waterlogged, ie, consider using stand-off pads
- In spring avoid grazing pastures that have been recently irrigated
- Manage the more susceptible soils differently to more resilient ones

Pugging of stream banks and riparian margins should be strictly avoided to prevent loss of soil, pathogens

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Follow the Wellington Regional Council

For more information on managing treading damage, see the AgResearch publication *Managing treading damage on dairy and beef farms in New Zealand.*

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