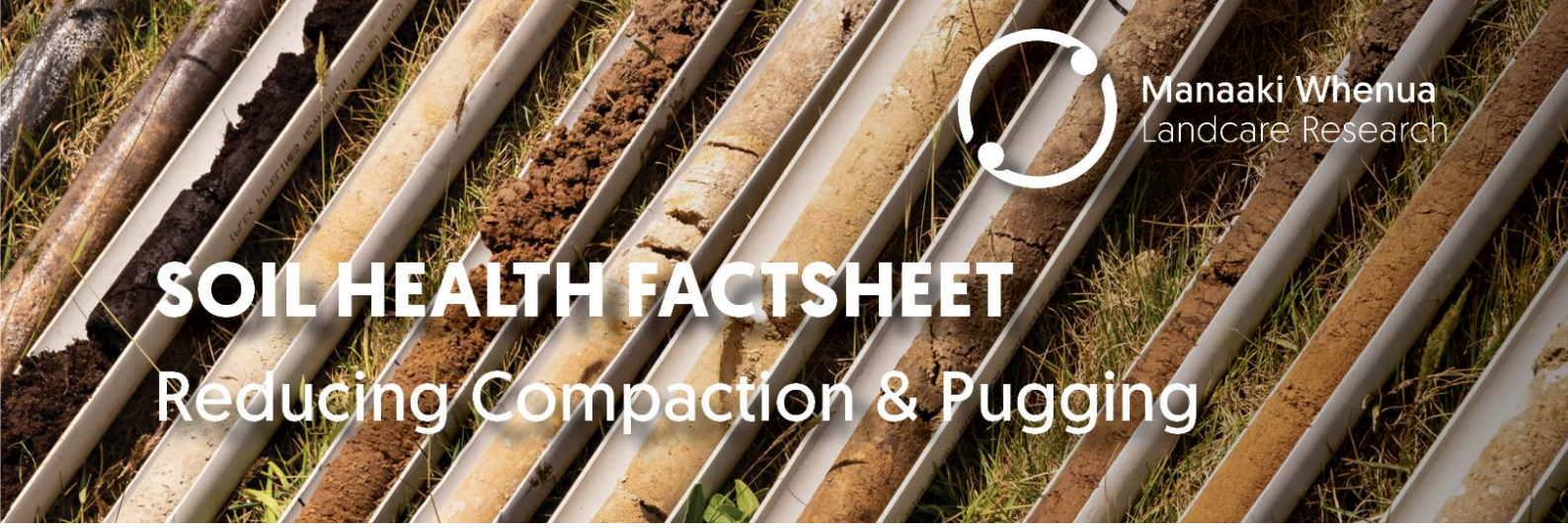

Manaaki Whenua
Landcare Research

SOIL HEALTH FACTSHEET

Reducing Compaction & Pugging

This factsheet is part of a series on Soil Health that provides summarised information on a wide range of soil related topics. A summary of information on good management practices for reducing or minimising soil compaction and pugging when grazing pasture is presented in this factsheet.

Best management practice guidelines

Soil health and pasture grazing

Soil health is defined as "*the continued capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans*" (Doran & Zeiss 2000). This concept is broad and holistic but encourages increasing the functionality of a soil to maintain a well-balanced ecosystem. When soils are healthy and functioning well, they support agricultural production and help prevent contamination of waterways. Soil health encompasses many aspects, which includes a soil's physical properties or soil structure.

In New Zealand soils, large soil pores (the space between soil particles) are responsible for air movement and drainage but are the most susceptible to compaction and pugging damage.

*A **compacted** soil (left) and a **non-compacted** soil (right). (Photos John Drewry)*

Soil compaction occurs when soil pore space is compressed, and typically occurs in moist rather than saturated soils. Soil compaction also affects soil structure, soil water transmission and storage, root penetration, and plant yield.

Pugging typically occurs when the soil is very wet and soil pores are filled with water. Trampling creates a pugged surface, or in extreme cases, slurry, with considerable soil and pasture damage. When grazing pasture in winter, wet conditions and high stocking rates when break-feeding can cause pugging and damage to pasture, resulting in an increase in weeds, pasture pulling, and damage to the soil structure.

Soil structure changes from compaction and pugging can result in greenhouse gas emissions, nutrient leaching and a loss of nutrients such as phosphorus, loss of sediment and bacteria via surface runoff.

Pasture showing the effects of pugging on the right *(Photo Nadia Laubscher).*

Best management practices

Table 1 summarises best management practices that can reduce the risk and degree of compaction and pugging.

Table 1 Best management practices to reduce the risk of compaction and pugging

Management type	Best management practices
Grazing and paddock management	• Identify 'at-risk' paddocks and plan accordingly. Past experience can be a good indicator of where pugging is likely to occur given the soil conditions. • Build up pasture cover on paddocks before grazing • Consider larger breaks between grazing • Decrease paddock grazing duration to around 3–4 hours in very wet conditions • Avoid grazing pastures that have been recently irrigated • Graze higher risk paddocks with lighter animals at lower stocking densities, or not at all during high-risk periods • Graze wetter paddocks earlier in the season to reduce the number of times they are grazed in waterlogged conditions. • For temporary 'block-grazing', make breaks as square as possible. Set up fences so that they can be easily lowered. Use a temporary back fence to prevent stock from causing further damage to the previously grazed pasture • Stand stock off paddocks when soils are very wet or waterlogged, i.e., consider using stand-off pads • Fencing off wetter areas of the paddock during periods with high soil moisture (see critical source areas)
Soil management	• Manage the more susceptible soils differently to the more resilient ones • Avoid driving heavy machinery over wet soils • Avoid cultivating wet soils • Avoid pugging of stream banks and areas close to riparian margins to prevent loss of soil, pathogens and nutrients to waterways • Re-sow areas of bare or damaged soil as soon as possible (to minimise nutrient or sediment loss).
Other management	• Have a 'Plan B' for wet weather events. • Check regional and national government regulations.

Critical source areas

Critical source areas (CSAs) on farms are small, low-lying parts of farms, including swales (shallow depressions in the landscape) and gullies, where overland flow and seepage occur or accumulate, which may then flow to waterways while carrying sediment and suspended nutrients.

Buffer zones or grass strips in and around CSAs and next to waterways act as filters by slowing overland flow to trap suspended contaminants. The buffer zone should be left uncultivated and ungrazed to operate effectively.

Strategic grazing of winter forage crops is when grazing animals are grazed at the top end of the paddock and then strip grazing is carried out in a downhill direction towards the CSA. A buffer zone, such as grass, should be left around the CSA. By grazing downslope, the remaining pasture and the buffer act as a filter for sediment and other contaminants carried in surface runoff.

Research on strategic grazing has been undertaken with cattle on winter grazing of forage crops. It is quite likely that strategic grazing could be a useful practice on pastures but has not been thoroughly researched on pastures. It is also likely that similar best management practices will apply with deer and sheep.

Other management practices to consider

Table 2 summarises management practices designed for winter forage grazing, but some may be very relevant for pasture in some situations, especially in winter.

Table 2 Management practices for winter forage grazing

Management type	Management practices
Soil Structure	• Preference should be given to free-draining soils so soil structure damage, and overland flow are minimised. Free-draining soils are likely to be more resilient to damage and be able to recover more quickly after winter pasture grazing.
Stock management	• Consider stock management, e.g., avoid grazing heavy stock on steeper, more vulnerable soils, especially when wet. • Supplementary feed (e.g., hay and baleage) needs to be placed away from CSAs, waterways and ideally fed in drier parts of the paddock. Supplementary feed should be put into the paddock prior to grazing. This will help reduce stock movement on wet soils, helping to reduce damage to the crop and soil. • Is there appropriate shelter for stock? If necessary, use a stand-off area or temporary bedding to allow stock to rest on firm, dry ground. • Back-fence land that has already been grazed to minimise further soil damage, especially when soil is wet. Back-fencing can be done every 4–5 days.
Grazing strategy and troughs	• Work out a grazing strategy before putting up strip- or block-grazing fences and think about the location of stock water sources. Do you need portable water troughs? • Consider trough location. Avoid areas that are near CSAs for troughs (to reduce 'hot spots'). • Graze from the top of the slope, downwards toward the CSA. • On a sloping paddock, fence across the slope, and start grazing at the top of the paddock, so the standing crop acts as a filter. Make breaks "long and narrow", so the crop will be utilised more efficiently by animals. • Ensure the CSA is the last break to be grazed by stock (if it is grazed at all). Restrict the time spent grazing in the CSA to 3–4 hours so stock get their maintenance feed requirements. This minimises the extent of soil treading damage and potential for surface runoff. On-off grazing of a CSA should be done when soil moisture content is not too high.

Links to further information

Beef+Lamb. Pugging, soil compaction and winter grazing.

https://beeflambnz.com/knowledge-hub/PDF/FS265-pugging-and-soil-compaction
https://beeflambnz.com/wintergrazing

DairyNZ. Pugging, compaction, and feed management

https://www.dairynz.co.nz/feed/feed-management/managing-pugging-damage/
https://www.dairynz.co.nz/environment/on-farm-actions/land-management/critical-source-areas/

References and further reading

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Drewry JJ, North H, Belliss SE, Amies A. (2020) Winter-forage crop grazing in the Gore-Mataura area of Southland: Using time-series mapping to estimate location and frequency of cropping. Journal of New Zealand Grasslands 82:129-137.

Drewry JJ. (2022). Digging deeper on soil compaction and pugging. Manaaki Whenua - Landcare Research Link Seminar 27 January 2022. https://www.landcareresearch.co.nz/uploads/public/Events/Link-series/Digging-deeper-on-soil-compaction-and-pugging-Presentation.pdf

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