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Short webinars for environmental policy-makers and practitioners

Digging deeper on soil compaction and pugging

The following questions were asked during our live webinar with John Drewry but due to time restrictions, we were unable to answer these in the session.

In the recent Canterbury study, was compaction evident in both the stony and deep soils?

Balin Robertson has published some information in *Geoderma* for stony soils, on the influence of stones etc. on field capacity. An unpublished MWLR report suggests there were some differences in macroporosity between irrigated stony soils and non-irrigated stony soils, with macroporosity being slightly less in those irrigated sites.

Is there any info that relates and quantifies compaction and reduction of pore space to readily available water?

Yes, the pilot study in Canterbury (in the presentation and follow up leaflet has the publication details), plus the paper we have submitted. We also did a review paper on RAWC and macroporosity etc. and includes a diagram of how those sizes of pores relate to each other. It's: Drewry JJ, Carrick S, Penny V, Houlbrooke DJ, Laurenson S, Mesman NL. 2021. 'Effects of irrigation on soil physical properties in predominantly pastoral farming systems: a review'. *New Zealand Journal of Agricultural Research* 64: 483–507. <https://doi.org/10.1080/00288233.2020.1742745>.

Has any research been done on the benefits of mechanical aeration in NZ?

Yes. Several studies in NZJAR. Many of these older ones are now freely available at: <https://www.tandfonline.com/loi/tnza20>

I've listed some below, including for that journal. Those articles also refer to previous studies, so you can look those up.

- Drewry, J. J., Paton, R. J. 2000. 'Effect of subsoiling on soil physical properties and pasture production on a Brown Soil in Southland'. *New Zealand Journal of Agricultural Research* 43: 259–268.
- Drewry, J. J., Lowe, J. A. H., Paton, R. J. 2000. 'Effect of subsoiling on soil physical properties and pasture production on a Pallic Soil in Southland'. *New Zealand Journal of Agricultural Research* 43: 269–277.
- Curran-Cournane F, McDowell RW, Littlejohn RP, Houlbrooke DJ, Condon LM 2011. 'Is mechanical soil aeration a strategy to alleviate soil compaction and decrease phosphorus and suspended sediment losses from irrigated and rain-fed cattle-grazed pastures?' *Soil Use and Management* 27: 376–384.
- Laurenson S, Houlbrooke DJ 2012. The effect of soil aeration on the recovery of soil structure in the North Otago rolling downlands following winter grazing of sheep and cattle. In: Currie

LD, Christensen CL ed. Advanced Nutrient Management: Gains from the Past - Goals for the Future. Palmerston North, Fertilizer and Lime Research Centre, Massey University. Pp. 9.

- Laurenson S, Turner J, Rendel J, Houlbrooke D, Stevens D 2015. 'Economic benefits of mechanical soil aeration to alleviate soil compaction on a dairy farm'. *New Zealand Journal of Agricultural Research* 58(3): 354-358.

Not so much a question but would love to see a webinar on the dung beetle research.

Here is a link to some work: <https://www.landcareresearch.co.nz/publications/soil-horizons/soil-horizons-articles/dung-beetles-nzs-missing-link-to-achieve-sustainable-pastoral-agriculture/>

What are your thoughts on why the macroporosity was lower under dairy than under cropping? One would have thought that Macroporosity would have been lower under cropping than under dairy due to the high soil disturbance due to activities such as ploughing and heavy machinery on the land.

Macroporosity is usually lower under dairy than mixed cropping. This was the case in the GWRC study paper (Geoderma Regional: dairy median 7.7%, mixed cropping median 13.6). Low macroporosity means more compaction, and high macroporosity means less compaction.

Are there tools available to measure macroporosity using field tools rather than lab tools? So farmers can keep track over time... Penetrometer? Drop test?

No, unfortunately not. One of the farmer/consultant tools include a grower kit that Plant and Food developed some years ago for one of their land management programmes. Landcare developed visual soil assessment (VSA) some years ago. These types of tools are useful. Some may not be as sensitive as some lab measurements, and can be subject to operator subjectiveness.

Is data available on the best types of deep rooted plants that make a material difference to compaction?

I'm not aware of any, but there may be.

If macroporosity for dairy land hasn't changed significantly for dairy (19 years data) AND there is an info gap about runoff and nitrate leaching, what can you tell us about adverse effects on water quality? What do you mean dig deeper - is there a link?

Some of this type of work is often based on plot studies, and difficult to scale up. We review some studies in the reviews I mentioned, especially in: Hu W, Drewry J, Beare M, Eger A, Müller K. 2021. 'Compaction induced soil structural degradation affects productivity and environmental outcomes: a review and New Zealand case study'. *Geoderma* 395: 115035.

<https://doi.org/10.1016/j.geoderma.2021.115035>

John, have you compared soil physical results like MP with impacts on biology? Gregor Yeates always used to complain about how his nematodes were left homeless by compaction.

Not personally. It's an area that needs more work. Nicole Schon (AgR) has done other work on worms. Plant and Food Research and MWLR have done recent work in Bryan Stevenson's programme, but that is microbial indicators. See: Lambie SM, Mudge PL, Stevenson BA 2022. 'Microbial community composition and activity in paired irrigated and non-irrigated pastures in New Zealand'. *Soil Research*. Just accepted.

There is also an interaction between labile SOM and soil structure. It's a chicken and egg situation, soil C is processed by microorganisms to a form that enhances soil structure but organisms and labile C (HWC) is reduced in compacted soils.

I'm less familiar with that work.

Agree we need to dig deeper. Two types of compaction: surface sealing type from animal hooves and deeper compaction at the plough layer and below, mainly associated with vehicle trafficking and cultivation.

Yes, that would be interesting.

In effect is the land use (heavy animals) a greater issue than the management (irrigation practice)?

A very interesting question. Difficult to pull out each of those into 'compartments' as they both interact strongly I would think. It might be possible with some statistical analyses and if we had enough data - but would be challenging. I expect it would need a robust study to pull this out. Our SFF project used 24 paired sites of deep soils to ensure adequate replication but was not designed to answer that question.

In the Canterbury paired sites did you record pasture production, pasture diversity and nutrient use?

No measurements of those. We did have a farmer questionnaire where we asked about the general management of the farm and sites.