

Healthy soils and pasture systems – Western Dairy clay rate x incorporation demonstration

Hosts: Denmark – Jenkins Family

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KEY MESSAGES:

- Non-wetting did not have an observable influence on pasture production in 2023.
- In 2023, the Denmark site still showed evidence of a tillage effect on dry matter production, particularly where the heavy clay rates were left on the soil surface. However, this diminished as the season went on.
- Improvements to soil fertility were observed at the Denmark site in the second season.
- The 2023 season suffered from a particularly dry finish, and potential advantages in stored soil moisture were observed at the Denmark site. However, this did not result in a greater level of dry matter production.

Background

As part of the Healthy Soils and Pasture Systems project, Western Dairy has funded a project exploring the use of claying as an amelioration technique to improve pasture production (also to manage nutrient run-off and improve fertility). As part of this investment three trials have been established to examine the viability of claying to ameliorate sandy, low fertile soils that are typical to the Great Southern and South-West regions of WA. Stirlings to Coast Farmers are managing the Denmark site.

Clay spreading is a common practice for soil amelioration on light sandy soils in broadacre agriculture, however the practice is considered novel within the dairy industry. This is largely due to the high up-front cost, the need for specialised equipment to ameliorate at scale and the lack of available data on the economic and productivity returns for pastures. Ameliorating the soil by claying is the process of harvesting clay from a clay enriched source and spreading it on sandy soils that are low in fertility and often experience non-wetting. The primary outcome of claying is to alleviate non-wetting and improve soil water and nutrient holding capacity.

Given the novel nature of claying in the dairy industry and the difference in scale compared to broadacre claying,

this project utilised farmer held equipment to apply the treatments. The trials are examining three differing clay rates, as well as a nil control, to determine the most efficient level of clay to improve pasture production. Additionally, there is an incorporation treatment, where two replications of the plots have been incorporated with a speed tiller, while the clay has been left on the soil surface of the other two replications.

Methodology

The trial was replicated and blocked in a fashion to ensure trial rigour; however, randomisation could not be achieved with the farm scale equipment. A nil control has been implemented across both the incorporated and unincorporated zones to effectively show the incorporation effect. Figure 1 shows the Denmark trial layout.

Figure 1. Trial design and layout at the Denmark site.

The clay for the project was sourced on farm, and prior to spreading the clay was sampled and tested for both clay content and nutrients. The clay fraction, that is the percentage of clay that is actually clay, was assessed using the CSBP particle size wet chemistry method. Soil samples were also taken from the paddock to ascertain the baseline clay %, and soil nutrient status.

The clay was spread using a Marshall Muck spreader, and



rate was determined using a measurements of applied clay per m², per pass, the approximate incorporation depth, and the targeted clay percentage.

The site at Denmark was seeded with a pasture mix that contained 35kg/ha of a pasture mix comprising multiple varieties of ryegrass, clover, brassicas and perennial herbs along with 80kg/ha of oats.

Dry matter cuts were taken in-season to determine the treatment effect of claying and/or incorporation on pasture production. Four in season cuts were taken at the Denmark site prior to each grazing. Visual pasture composition assessments were taken at the same time as the dry matter cuts, to record the changes in pasture composition over time. Plant establishment counts were taken post germination. Plant health measurements were recorded in season via a handheld Trimble GreenSeeker (NDVI), and drone (green/red index). These were conducted to assess if the clay rate and/or incorporation influenced the plants health status.

Results

Initial soil and clay analysis

The soil clay fraction from the clay pits measured an average 38% clay. Soil samples from the site were tested for clay fraction, and the average clay percentage of the 10cm topsoil horizon was 2.94%.

Pasture composition and plant establishment – 2023

Year two (2023) of the Denmark claying project saw the paddock seeded in late April with a pasture mix containing: oats, barley, ryegrass, clover, lupins, turnip, chard, tillage radish, and chicory. The growth was initially slow due to the dry period after seeding (dry May). This pasture mix was similar to the mix sown in 2022, however, it had an addition of lupins and chard. The site had issues with red-legged

earth mite and nettle, which impacted early crop growth, and as a result the first grazing was delayed from the planned initial date.

Emergence counts were taken for the grass cultivars (only) on the 16 of May, three weeks after seeding. It was noted at this stage, very little broadleaf had emerged and there were large areas of nettle and water weed within the paddock. There was minimal difference in emergence, when comparing the clay rates (Figure 2). This was likely a result of seeding into a wetted-up profile (which subsequently dried somewhat in May), with Denmark receiving 152mm of rainfall in April 2023.

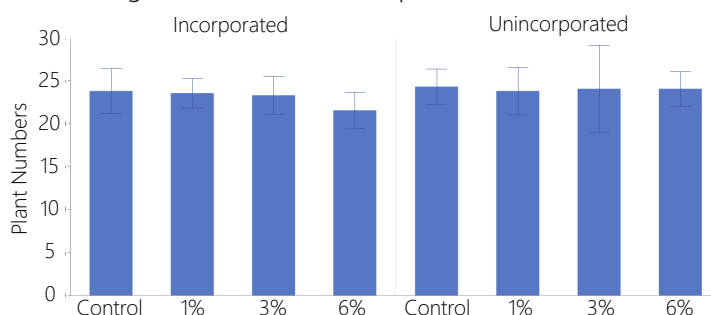


Figure 2. Plant establishment counts taken on the 16 of May for the cereal species. These counts were taken measuring two adjacent rows within a 33.33cm x 33.33cm, equating to plants per 0.1111m².

Dry matter production - 2023

In 2023, the Denmark trial showed no evidence that the presence of clay had a positive impact on the production of dry matter throughout the season. There was, however, an advantage of the incorporation of the clay at the timing of the first two cuts in the +6% and +3% plots. As the season went on this advantage was diminished in subsequent cuts.

Growth appears to be mildly suppressed where the higher clay rates were unincorporated. This is likely to be attributed to the heavier clay rates becoming a physical barrier to moisture penetration into the soil or possibly restricting growth of roots in early germination.

The 2023 season was highly variable, with a dry fallow period, a wet April, an extremely dry May, followed by an extremely wet period from early June through to early September, followed by an extremely dry finish. This dry finish likely skewed the results of the final dry matter cut taken in November, where there was significantly more growth in the control plots (Figure 3). Rather than being related to lack of clay, the control plots were located lower in the topography of the paddock, providing benefit (moisture at depth) as the season quickly dried.

The high amount of variability (climate and paddock topography) at the Denmark site meant we were unable to attribute the differences in dry matter to the clay rates in 2023.

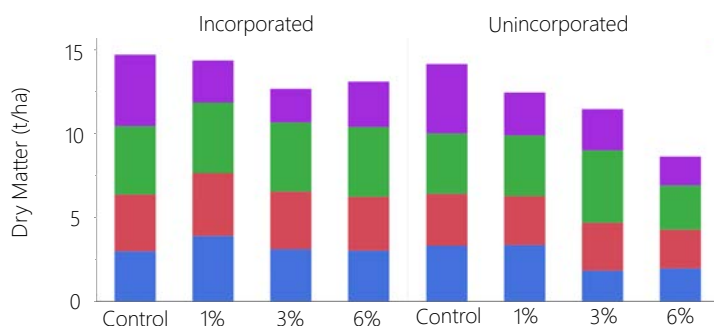


Figure 3. Cumulative yields from dry matter cuts taken on the following dates; Cut 1: 22/06/2023, Cut 2: 27/07/2023, Cut 3: 1/9/2023, Cut 4: 17/11/2023.

Soil strength

Soil strength was recorded at the Demark site with a Rimik Cone penetrometer to a depth of 700mm. The soil strength data showed that there was limited difference in soil strength between all treatments, particularly at a shallow depth (Figure 4). This highlights a diminishment of the tillage effect from the 2022 season. The heavy traffic from repeated rotations of cattle at high stocking rates has likely recompacted any of the areas that received the light tillage when working in the clay. This is unsurprising given that the site is particularly sandy and therefore prone to compaction. The paddock was, at times, also subjected to waterlogging, which would likely exacerbate the compaction caused by the cattle.

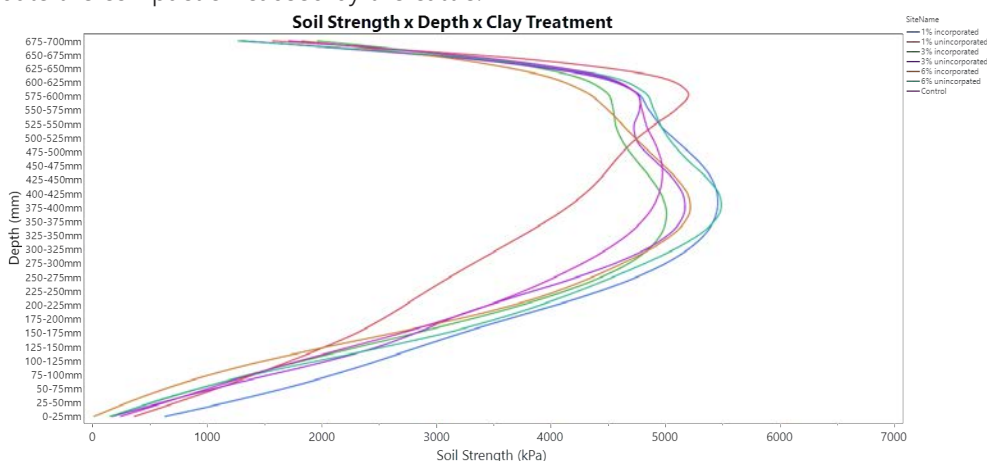


Figure 4. Average soil strength (kPa) x depth x clay treatment for the Denmark site.

Terminal soil moisture

A TDR soil moisture probe was used to measure volumetric soil moisture content to 12cm on the 17 November 2023, just prior to the final grazing at the Denmark site. While there was no difference in volumetric water content observed between claying treatments, there was a clear difference when comparing the unincorporated plots to the incorporated plots (Figure 5). The incorporated plots held, on average, 3% more water than the unincorporated plots. This is likely a combination of greater water penetration within the topsoil resulting from the shallow tillage incorporating the clay in 2022, and the clay in the unincorporated plots causing a

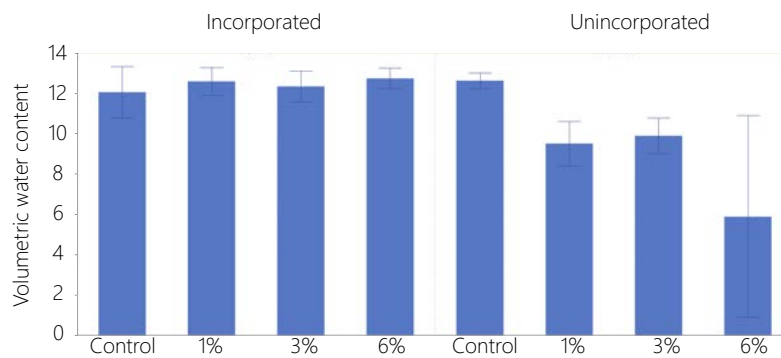


Figure 5. Volumetric water content measured on the 17 November 2023 for each treatment at the Denmark site.

physical barrier to water penetration within this zone under dry conditions. Interestingly, there was very little visual evidence of increased soil moisture between the two zones (incorporated vs. un-incorporated). These plots appeared patchy, with green areas within each at random. In contrast, the control overall looked “greener”, but this was likely due to its place lower in the landscape.

Conclusions

There were very little observable effects of the claying treatments on pasture production and plant establishment (non-wetting), however the claying treatments influenced soil nutrient availability and water holding capacity.

At the Denmark site the clay treatments had no effect on dry matter production in 2023. However, the surface applied clay at +3% and +6% was less productive during the first two cuts, than the remaining cuts. Given the control at these timings performed equally as well as the better performing treatment plots, the difference in dry matter is likely a result of surface (un-incorporated) clay forming a barrier to plant/root growth.

The re-compaction of the incorporated (tilled) zone in 2023 shown in the penetrometer data allows us to observe the impact of claying on pasture production independent of the tillage effect at the Denmark site. The 2023 dry matter results for the Denmark site showed no difference in dry matter production resulting from the claying when compared to the control, and no difference as a result of the 2022 incorporation.

Given claying has its greatest impact on plant establishment by alleviating non-wetting zones, it can be difficult to observe any impact of the treatment if non-wetting was not a factor, as was the case in 2022 and 2023. This challenge is amplified by the fact that in a diverse pasture system different species are seeded together, and the emergence of these species is likely to be spread out. The impact of staggered germination, which is extremely detrimental to broadacre cropping, is less detrimental in

a pasture system, where grazing resets the growth of the pasture, but only takes place when adequate biomass has been established to begin with.

In 2023, each trial site received ample April season rainfall (152mm at Denmark), and similar conditions were observed in 2022 when the trial was established. The early rainfall likely mitigated any non-wetting effect that could have been observed in the control plots, or where the clay had been applied at a rate too low to alleviate non-wetting. Given the location of the trial site, and the fact that dairy farming in Western Australia takes place in higher rainfall parts of the state, clay amelioration may have a limited scope to increase dry matter production within a pasture system. However, the dry start to the 2024 season might allow us to better measure the impact of the claying on plant establishment, and subsequent growth, given non-wetting may play a larger role.

Despite the lack of dry matter responses to claying in the second season, the soil indicators are showing some positive environmental gains. Other gains that may flow on to production, such as improved retention of cations and water, are expected to take a few years to develop as these depend on the added clay helping to increase soil organic matter. Given that claying is a permanent amelioration technique, small gains in productivity that can be hard to measure in the field, depend on the season start or finish, or that are not deemed statistically significant, can result in both positive economic returns and long-term environmental gains.

Acknowledgments

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