STIRLINGS TO COAST FARMERS

FACTSHEET: SubSoil Manuring

BACKGROUND

With investment from the Australian Government through the 'National Landcare Program', Stirlings to Coast Farmers explored the use of organic material amendments to ameliorate the poorly structured subsoils of the sandy duplex soils typical to the Albany Port Zone (APZ). Subsoil manuring has been successfully implemented on dense, dispersive, and sometimes sodic clay subsoils in the Eastern States, whereby an organically rich amendment is placed deep within the soil profile which alters and improves the soil structure by increasing soil porosity and water holding capacity.

Where subsoil manuring has been successful, it encourages extra root development as the roots follow the rip lines down to where the amendment is placed due to the roots seeking out the banded nutrition. The hypothesised co-benefit is that the increased biological activity associated with the breakdown of the manure will lead to an increase in soil structure in the hard packed clay layers.

METHODOLOGY

The SCF trial site, was located in Green Range on a deep sandy duplex soil type – non-wetting sand over gravely compacted clay. The depth from the soil surface to the compacted clay layer ranged from 55 to 65cm. A locally manufactured organic manure product known as bio-sludge or soil conditioner was used as the subsoil manure source. Clay was also included as a second soil amelioration tool to manage soil surface non-wetting. Both amelioration tools were used in isolation and as a combined treatment.

The bio-sludge was surface applied at 20 t/ha and worked into the soil profile via a deep ripper fitted with inclusion plates. The clay was also surface applied at 200 t/ha and incorporated via the same means. The treatments were applied in April 2021 and were as follows:

- 20t/ha Soil Conditioner
- 200t/ha clay
- 20t/ha Soil Conditioner + 200t/ha clay
- Untreated control

Barley was sown into the paddock in 2021 and 2022. The paddock was sown to legume-based pasture later in the growing season in 2023. A number of measurements were taken, however, only the most impactful have been reported in this factsheet.

RESULTS

The SCF trial showed limited crop yield response over the 2021 and 2022 seasons, largely due to waterlogging in both years. The manure amendment was supposed to increase crop yields after the first couple of years of placement due to the nutritional boost given to the soil (namely nitrogen). Given the severe waterlogging experienced in 2021, it is suspected (and backed up by soil tests) that the nitrogen was leached out of the soil before the crop recovered from waterlogging and was able to take it up.

SOIL TEST DATA

Soil test results in September 2021 showed nitrate nitrogen to be almost double in the manure treatments compared to the nil control and clay only treatments (Table 1). This showed that nitrogen was available early, however, it did not convert to yield. In 2022, there seemed to be a trend towards higher nitrogen in the clayed treatments, possibly due to the increased nutrient holding capacity of the clay compared to sand.

Table 1: Average Soil Nitrate Nitrogen for each treatment in 2021 & 2022.

Treatment	Average Nitrate Nitrogen 2021	Average Nitrate Nitrogen 2022
Nil Control	11	22
Soil Conditioner Only	15	12
Soil Conditioner & Clay	25	40
Clay only	4	36

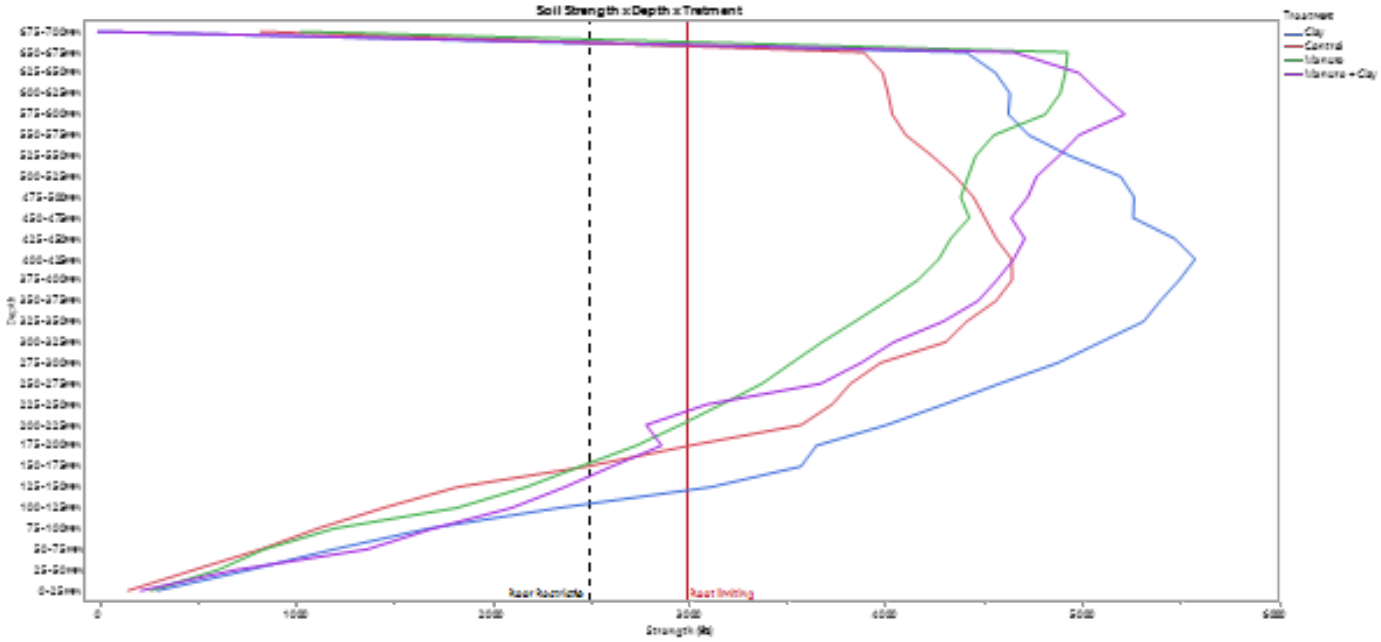

Figure 1: Graph showing the depth to compaction for each treatment in 2022 (note soil profile inverted, i.e., soil surface is bottom of graph).

DEPTH TO COMPACTION LAYER

Encouragingly, there seemed to be a positive trend in average depth compaction layer. Penetrometer (compaction) data taken in 2022 confirmed more depth to compaction in the soil conditioner (manure) treatments, both with and without clay, compared to clay only and the nil control treatments, a positive outcome for root growth and subsequent exploitation of soil water and nutrients (Figure 1).

SOIL MOISTURE AT DEPTH

Soil moisture (as volumetric water content) was recorded during the trial period. Of note from the recordings taken, Figure 2 shows data between a soil depth of 30 – 43cm, at the end of the 2022/3 summer fallow period. The soil conditioner (manure) only and clay + manure treatments resulted in more plant available water at depth than the untreated control and clay only treatments (Figure 2). This points to the addition of manure being able to hold onto more moisture after a dry fallow period. This was somewhat surprising, as it was predicted that the clay treatments would have similarly increase soil moisture retention at depth.

ECONOMIC ANALYSIS

A comprehensive economic analysis was completed using the 2021 yield data. Average variable operating costs were assumed to be the same across all treatments and were based on regional averages. The cost of claying, application of soil conditioner (manure) and incorporation of both was divided over 6 years.

The analysis showed that claying by itself had the highest economic return by far at $1,072/ha (Table 2). This least profitable treatment in 2021 was the manure (soil conditioner) only treatment, driven mostly by the lack of

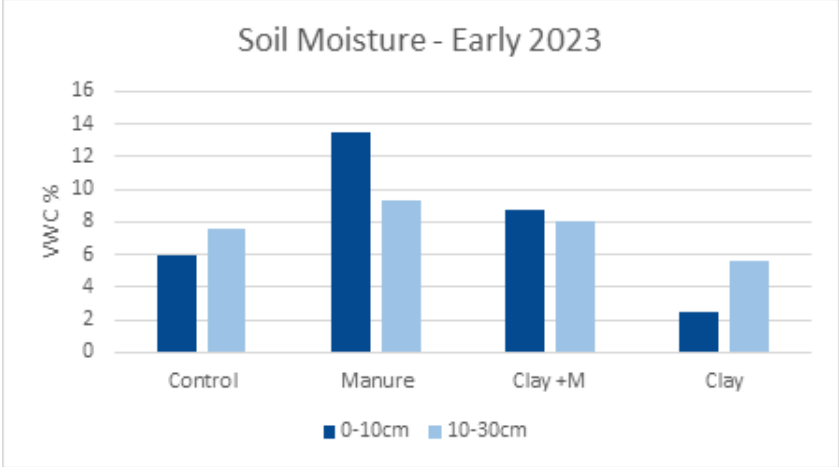

Figure 2: Volumetric Water Content (soil moisture) for each treatment after the summer fallow period 2023.

grain yield (waterlogging-impacted) and the expense of implementation. As it is an expensive exercise, this analysis clearly shows that if yield benefits are not seen, it can cost landholders a significant amount per hectare.

On the other hand, the clayed only treatment which yielded more than one tonne per hectare above the nil control, clearly showed a positive economic result. In is important to note, that if waterlogging had been absent (which caused leaching), the manure treatments would have likely yielded better and would have been much more profitable.

Table 2: Economic analysis for each treatment using yield data from 2021.

Treatment	Nil Control	Manure Only	Manure + Clay	Clay Only
Average Grain Yield (t/ha)	2.32	2.28	3.36	3.6
2021 Income ($/ha)	$672	$401	$728	$1,072

CONCLUSIONS

Eastern States data suggests that it is the nutritional benefit from the manure that drives increased crop yields in the first instance. This additional nitrogen did show up in the soil testing completed mid-way through the 2021 season but did not convert to yield due to waterlogging and subsequent leaching.

It is encouraging to see that the penetrometer data showed some increased depth to hard pan in the manure treatments of about 10cm. This essentially means that the roots in the manure and manure + clay treatments had a depth of 10cm of soil to exploit water and nutrients from over and above the nil control treatment. The soil moisture data recorded after the fallow period in early 2023 is also encouraging showing the subsoil manured treatments were able to store more water in the soil profile for the following crop (or in this instance the 2023 pasture).

Overall, if Eastern States research applies to this trial, it would be expected that we'd see continuous improvement in both moisture retention and depth to hardpan as the subsoil becomes more structured over the coming years. Stirlings to Coast Farmers will continue to monitor the paddock as more research is required to quantify these benefits for farmers over the long term.

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Figure 3: The subsoil manure source - a locally sourced bio-sludge hosted on wood chips, applied to the soil surface and incorporated by deep ripping with inclusion plates.