Circular Economy Organics R&D Fund

Impact Summaries

Unique long-term trial generates valuable data

Sustainability Victoria

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Sustainability Victoria acknowledges Aboriginal and Torres Strait Islander people as the Traditional Custodians of the land and acknowledges and pays respect to their Elders, past and present.

Background

Sustainability Victoria (SV) delivered funding to enhance the market for recycled organics under the Circular Economy Markets Acceleration Program. Impact Summaries are a brief outline of the accomplishments by recipients of this funding. SV expects the information in these summaries will generate discussion, stimulate ideas, inspire action and ultimately contribute to a more profitable and sustainable organics sector.

Nihill Farms is a progressive broadacre dryland (not irrigated) cropping business located in the Elmore district of northern Victoria. They grow crops such as wheat, barley, canola, oaten hay and faba beans in rotation, to manage weeds and crop diseases. The crops are grown minimum till (little cultivation) to reduce soil moisture loss, preserve topsoil, and improve soil health. Crop inputs such as fertiliser are applied judiciously to optimise yield and profitability. GPS tractor guidance is used to improve machinery efficiencies and minimise soil compaction.

Farm profits are heavily influenced by seasonal conditions, and facing an increasingly variable climate, the management of Nihill Farms are cognisant of ensuring a consistent income regardless of season. Scientific research has demonstrated that recycled organics can improve soil health and improved soil health can deliver more consistent crop yields and higher crop yield potential.

With access to recycled organics nearby at Elmore Compost and Organics, Nihill Farms had opportunity to test recycled organics on a commercial scale. In partnership Elmore Compost and Organics, and with support from SV, Nihill Farms have established and managed a commercial scale recycled organics trial. Noting that soil health takes many years to improve, the trial was established in 2019 and expected run for ten years till 2029 making it the longest continually managed and monitored recycled organics trial in Victoria.

Figure 1: Healthy soils can make farms more resilient to climate extremes. The darker soil coloured soil in this image has high levels of organic carbon

Research questions

1. What are the effects of long-term repeated recycled organics compost applications on soil in a minimum till dryland cropping system?
2. Can long-term annual applications of recycled organics reduce yield variability?
3. Can long-term annual applications of recycled organics increase crop yields?
4. Is a broadacre minimum tillage farming system that includes recycled organics profitable?

Methodology

A 66 hectare (ha) paddock on Nihill Road near Elmore was selected for the trial. The paddock has been farmed for since the 1900s and managed under a minimum till system since the mid-1990s.

Starting in 2019, recycled organics compost was applied yearly in four strips with each strip receiving a different application rate (16, 12, 8, and 4 tonnes/ha). Untreated (no compost) strips were located between the treated strips. Since the farm is a minimum till farm the compost was broadcast and not incorporated into the soil with tillage. Annual winter crops were managed according to Nihill Farms standard practice. Lime was applied on all treatments in 2021 (2 tonnes/ha) and in 2023 (2.6 tonnes/ha) to reduce soil acidity.

Forty-five individual georeferenced soil tests were collected from the same sites in the trial area in 2019 and 2024. Crop yields were determined using georeferenced real time yield monitoring equipment on the grain harvester.

Crop input costs (e.g. fertiliser) and revenue from grain sales were recorded and used to calculate crop gross margins.

Figure 2: Aerial photo of the trial site, showing recently applied compost. The 16 tonnes/ha rate is far left, 12 tonnes/ha second from left, 8 tonnes/ha third from left and 4 tonnes/ha fourth from left.

Results

There were 33 different soil laboratory analysis performed on the 2019 samples and 52 on the 2024 samples, too many to include in this summary, however four analyses are included that demonstrate important changes to the soil induced by compost.

Soil organic carbon is a useful measure of soil health. Organic carbon supports beneficial soil microbes and the ability of soil to hold nutrients, air and water. Figure 3 shows a measure of total organic carbon[1] and a measure of labile carbon. Labile carbon is the carbon most readily available as a carbon and energy source to microbes.

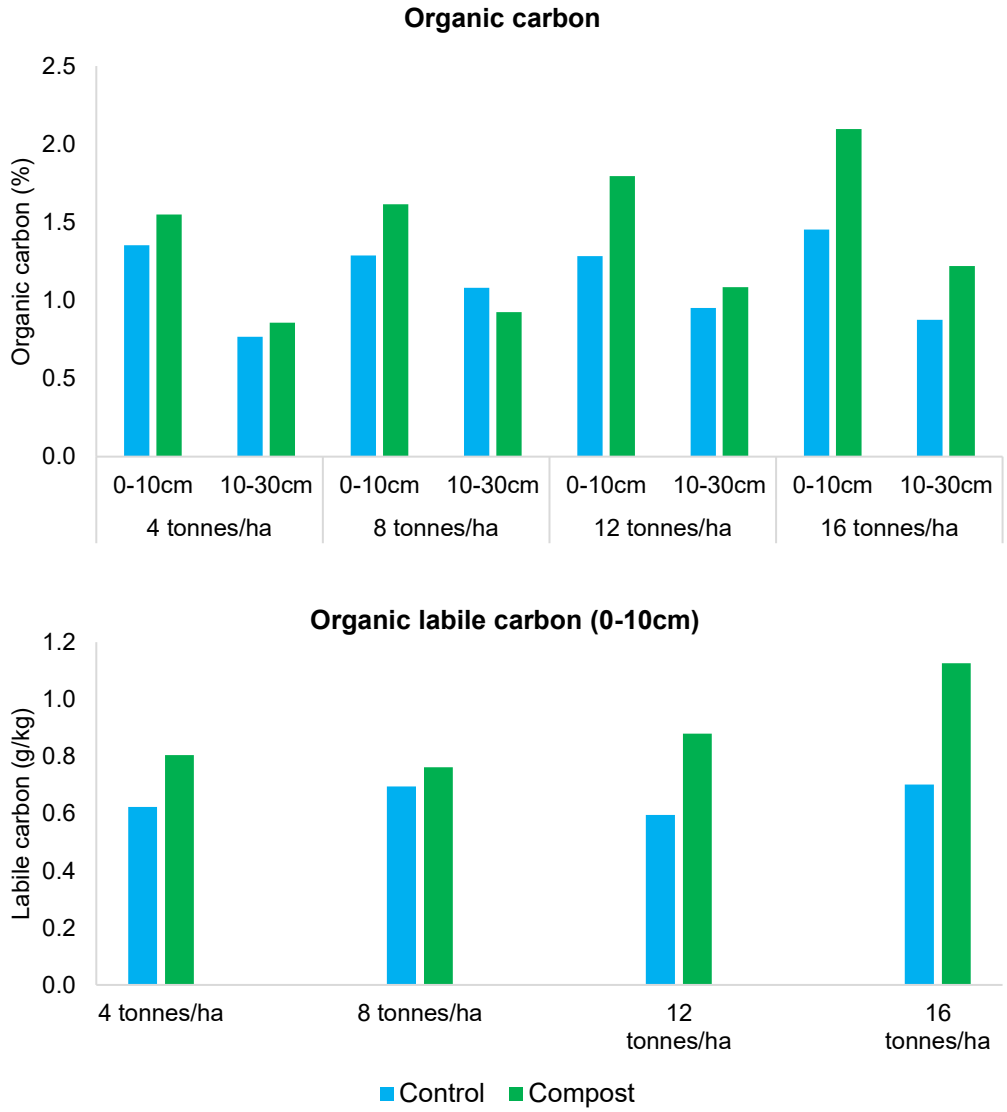

Figure 3: Organic carbon from 0-10cm and 10-30cm depth and labile carbon 0-10cm in the treated and control zones in 2024.

The top chart in Figure 3 shows that compost treatments had higher total organic carbon than the control treatments at 0-10cm depth. Even though the compost was not buried with tillage, the organic carbon levels were higher at 10-30cm in all treatments except the 8 tonnes/ha treatment. Labile carbon was also higher in compost treatments than control treatments.

[1] Soil organic carbon percentage determined with the Walkley and Black method

Soil pH at 0-10cm and 10-30cm depths is shown in Figure 4. Soil pH influences the availability of crop nutrients, the amount of soil microbial activity and the type of crops that can be grown. A pH of 6.5 is often considered ideal, however a pH above 5 and below 8 is acceptable for many crops.

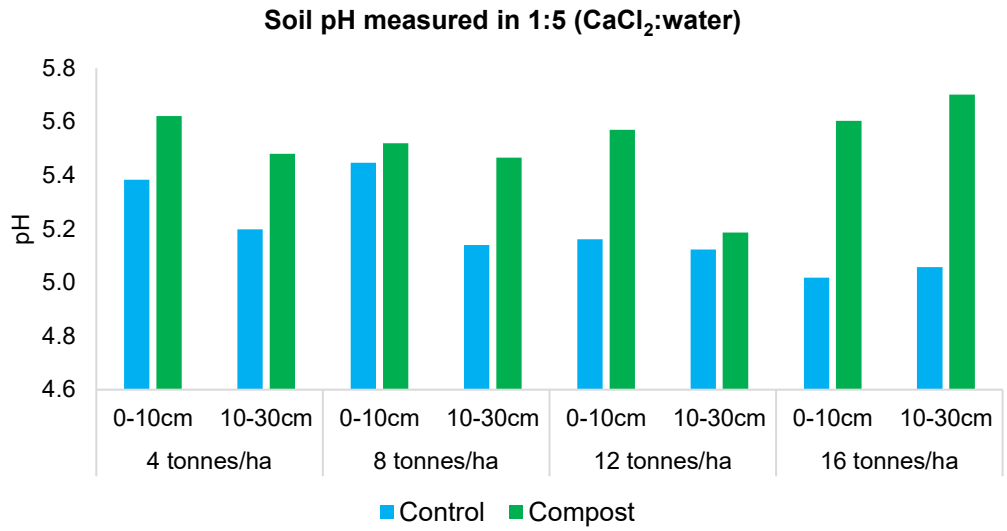

Figure 4: Soil pH at 0-10cm and 10-30cm in 2023

Soil pH was higher in all compost treated strips than in corresponding control strips. Importantly, the pH at 10-30cm was also higher. Lime, to increase soil pH, is not readily soluble so applying it below 10cm is difficult in a minimum tillage system. This data suggests that certain nutrients in the compost treatment strips at both depths would be more available to plants.

Soil Cation Exchange Capacity (CEC) is a measure of the ability of soil to hold nutrients such as phosphorus, potassium and the ammonium form of nitrogen. In general, soils with high CECs are less likely to lose nutrients in drainage water. Figure 5 shows the change in CEC from 2019 to 2024.

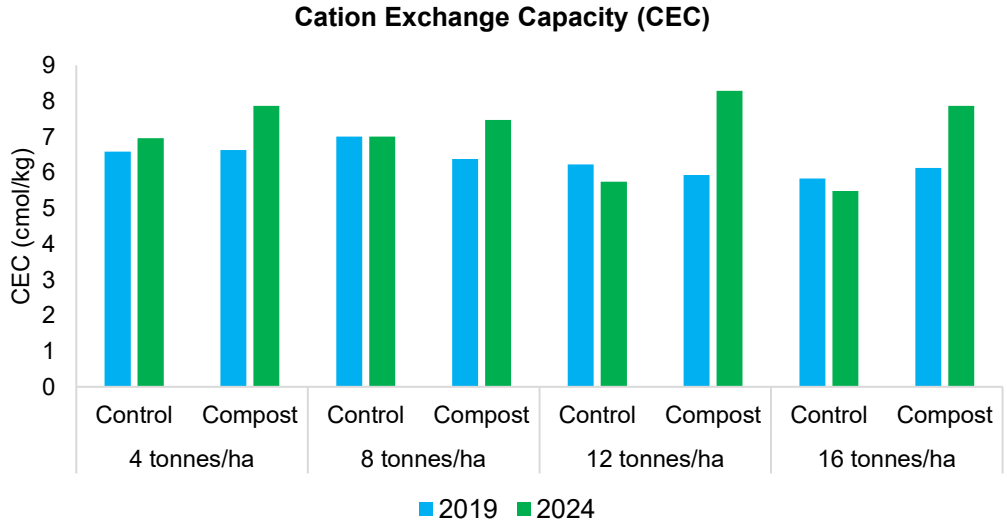

Figure 5: Change in soil Cation Exchange Capacity (CEC) from 2019 to 2024

Soil CEC increased in all compost treated strips between 2019 and 2024 whilst it remained approximately the same in control strips. This indicates that the organic carbon from the compost is increasing CEC.

The crop yield results in Table 1 demonstrate that there were no yield increases from applying compost in the first year of the trial and minor, variable increases in subsequent years. In 2024, however, crop yields were consistently higher in compost treatments. There are several possible reasons for this pattern. For example, soil can take many years to change, spatial variability in soil characteristics can mask the influence of compost, and the compost treated strips could be better able to compensate in a season less favourable to crops.

Table 1: Crop yields (tonnes/ha) from 2019 to 2024

Treatment	Crop yield (tonnes/ha)					
	2019 (Barley)	2020 (Canola)	2021 (Wheat)	2022 (Wheat)	2023 (Faba Bean)	2024 (Canola)
Untreated control	4.79	3.00	4.77	5.92	3.52	3.85
4 t/ha/year compost	4.72	3.21	4.95	6.10	3.54	4.03
Untreated control	4.74	3.32	4.97	6.11	3.53	3.87
8 t/ha/year compost	4.66	3.45	4.96	6.07	3.53	4.10
Untreated control	4.55	3.17	4.85	5.85	3.41	3.78
12 t/ha/year compost	4.55	3.32	4.92	6.02	3.34	3.81
Untreated control	4.69	3.41	4.88	6.21	3.43	3.45
16 t/ha/year compost	4.61	3.44	4.96	6.07	3.65	3.74

The data in Table 2 are weather readings from the trial site that influence the amount of soil water that a crop uses each day (evapotranspiration) the data is from August, September, October and November, these are the months where winter crop yields are most influenced by weather. The table shows that in 2024 these months had; the lowest rainfall after 2019 and 2023, the warmest mean temperature, the lowest mean humidity after 2019, and the highest mean wind speed after 2020.

This demonstrates that 2024 had high evapotranspiration rates and it is possible that the compost treated strips were better able to compensate for adverse weather conditions.

Table 2: Weather data that determines crop evapotranspiration from August, September, October and November at the trial site

Year and crop	Total rainfall (mm)	Mean tempreature (^{0}C)	Mean humidity (%)	Mean wind speed (km/hr)
2019 Barley	69	12.3	67.4	8.1
2020 Canola	188	13.6	77.8	9.4
2021 Wheat	175	11.8	82.6	5.9
2022 Wheat	435	11.8	82.0	7.6
2023 Faba Beans	126	13.4	69.7	8.1
2024 Canola	131	14.1	67.9	9.3

At this stage compost application has not been profitable on this farming system. However, fertiliser rates on compost treated strips have been identical to control strips, so reducing fertiliser rates on compost treated strips could make compost more economically viable. For example, starter fertiliser rates (fertiliser applied at planting) could be halved saving approximately $49/ha.

Opportunities

Valuable long-term data on recycled organics

Soil can take many years to change and the long-term data from this trial can help farmers make more informed decisions about recycled organics.

Recycled organics have created better soil

The trial has identified beneficial changes in soil characteristics produced by recycled organics over a long period of time. These changes can be communicated to farmers.

Emerging evidence that recycled organics can make farming systems more resilient

The difference between compost treated strips and control strips was more apparent in a season with unfavourable climatic conditions

Further information

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