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LAIDLAW SCHOLARS

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Climate Change Mitigation: Investigating the impact of land use on soil organic matter (SOM)

Introduction

Over the last century, the Earth has experienced a rapid increase of carbon dioxide concentrations (Hairiah, et al., 2010). Climate change mitigation is crucial to regulate large scale changes in our global circulation systems (Hairiah, et al., 2010). Soils are the largest active terrestrial carbon reservoir on the planet (Van-Den-Berge, et al., 2021). Soils contain soil organic matter (SOM) which improves the physical and chemical properties of soils and increases the efficiency of carbon sequestration within the soil (Fernández-Romero, 2016). Additionally, trees are effective carbon pools. When managed appropriately, both can provide an incredibly valuable carbon pool for climate change mitigation (Smith, 2008). Measuring and reporting fluctuations of SOM from both cropland and woodland soils is critical when researching the impact of land use management and its potential to mitigate climate change (Precision Decisions, 2021).

Methods

The SOM content of 100 soil samples was measured from 20 sample sites with various land use types across Balcaskie Estate, a farming estate spanning 2000 hectares in the eastern corner of Fife (Balcaskie, 2022). In each field, 5 soil samples were taken in order to calculate an average across the field. Loss-on-ignition (LOI) was the method chosen to analyse SOM within the samples. LOI determines the percentage weight loss of a sample after combustion at 450 degrees for 4 hours.

Organic content was calculated using the following formula:

D = Dry soil sample + crucible weight
A = Soil sample after the furnace + crucible weight
C = Crucible weight
Organic content (%) = $\left(\frac{D-A}{(D-C)}\right) * 100$

Results

Results shown in figure 1 represent the average organic content of field sample sites as a percentage. On average, woodland sample sites have the highest organic content reaching a peak of 48.6%. Woodland sample sites 3, 18 and 19 display significantly high organic content results between 37.94-48.6%. Crop and grassland land use types show a much smaller margin and fall between 4.43-12.2% with the exception of a grassland outlier with 18.78% organic content.

Colour	Land Use Type
orange	grassland
purple	green manure
green	woodland
blue	wheat winter
red	wheat spring
pink	beans spring
yellow	spring rye
lime green	oats winter

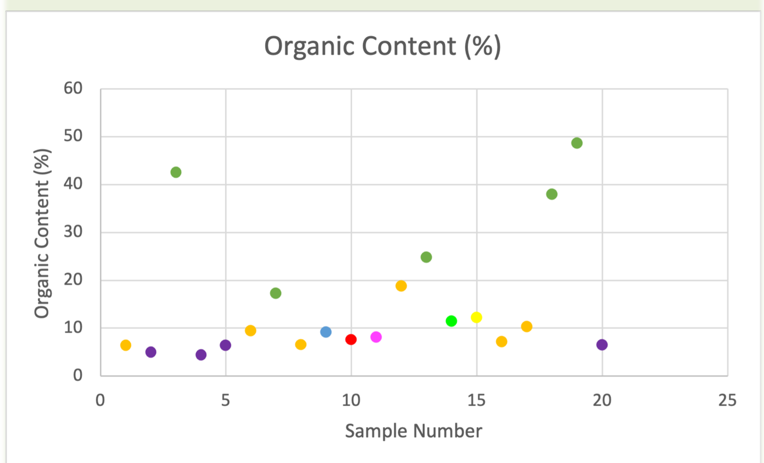

Figure 1

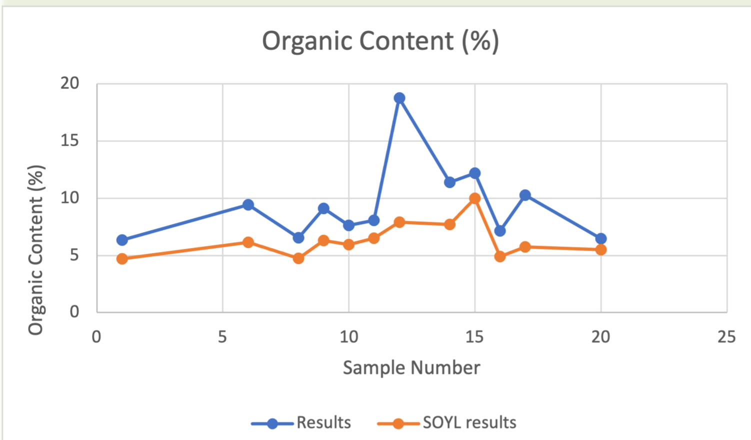

Figure 2

Discussion

The results of this study were also compared with baseline results of SOM from Balcaskie in 2017 (Ward, 2017), conducted by SOYL (SOYL, 2022). Figure 2 represents the comparison between current SOM results and results from 2017. Figure 2 shows an increase in organic content from 2017 to current which generally shows a trend with the exception of a few outliers.

There are various ways to further increase SOM and carbon stocks such as increased crop rotation, crop diversity, manure management and reduced tillage, residue removal and agroforestry. Arguably most importantly, agroforestry is defined by Van-Den-Berge, et al. (2021) as the "integrated management of trees and permanent vegetation on croplands or grasslands". Agroforestry systems provide various beneficial ecosystem services such as biomass for biofuel plants, biodiversity restoration, watershed management, sustainable food production and increased carbon stocks (George, et al., 2012).

Summary

This poster was created to distinguish the difference in SOM across different land use types and the potential of adding carbon through woodland restoration. It is concluded that intensive land use management in agriculture can have degrading impacts on soil and SOM. However, also highlights that organic and regenerative practices adopted by Balcaskie Estate may be increasing the SOM. Firstly, woodland restoration should be the foremost priority for boosting carbon stocks and mitigating climate change (George, et al., 2012). Secondly, it is emphasised that land use can also have a profound effect on carbon stocks and land mitigation potential (Smith, 2008). Lastly, it is therefore imperative to conserve existing woodland areas and increase the connectivity between these areas with new on-farm trees to maximise the productivity and climate change mitigation potential of Balcaskie Estate (George, et al., 2012).

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