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# 8. Effects of Organic Amendment Pre-Treatment on Soil Carbon and Nitrogen Dynamics

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## Introduction

Soil serves as a crucial carbon sink, yet it has the potential to emit considerable quantities of greenhouse gases (GHGs) as well. Soil organic amendments (OAs) serve to restore carbon and nutrients in the soil, thereby preventing degradation and enhancing fertility. However, OAs can also lead to GHG emissions. The fate of C and N from OAs in the soil is complex, and there is limited knowledge about the long-term effects in aggregates and GHG emissions. This study investigates the impact of OA-pre-treatment on soil C and N concerning aggregate formation and GHG emissions.

## Methodology

We utilized five distinct OAs, including compost, solid fraction of digestate, fermented product (similar to Bokashi), raw substrate, and a 1:1 mixture of compost and fermented product, all derived from the same initial substrate type. The physical distribution of C and N along different particle size fractions and POM were analysed. The study also measured GHG emissions ($CO_2$, $N_2O$, and $CH_4$), gene copy numbers (genes related to nitrification and denitrification using DNA extraction and qPCR), and microbial activity to assess the correlation between OAs and aggregate formation. We observed the alterations in a soil column experiment at the 6-month and 12-month marks. Confounding factors were controlled using a model soil without aggregates with low C content.

### Results and discussion

Initial and final C content were not significantly different among treatments, but the pre-treatment technologies affected the distribution of C and N in the soil, GHG emissions, microbial cell formation, free-POM, micro- and macroaggregate formation, and time persistence. The use of compost resulted in reduced greenhouse gas emissions; however, there was no observable benefit for aggregate formation. In contrast, the raw material and the fermentation product demonstrated the highest GHG emissions with different effects on aggregation. The raw material had a transient effect that disappeared after 6 moths while macroaggregates in the soil treated with fermented product persisted after 1 year. Digestate produced intermediate levels of greenhouse gases and reported the highest amount of macroaggregates after 1 year. The total N content changed after 6 and 12 months, possibly due to the depletion of readily available C sources and differences in total N content among OAs. After 1 year, the results showed that soils treated with compost and the mix had the highest bacteria biomass formation. The soils treated with the raw material and the fermented product released one order of magnitude more $N_2O$ that other treatments. The gas release and gene analysis suggested that pre-treatment of OAs can also influence the $N_2O$ emission mechanism in soil which was different among the treatments. This observation was attributed to the differences in chemical composition and microbial communities present in the studied OAs.

## Conclusion

This study showed that OA pre-treatment has a lasting indirect impact on the distribution of C and N in soil, including in micro and macro aggregate formation and persistence, affecting overall GHG emissions, $N_2O$ formation processes, and biomass formation. These findings suggest that GHG production can only be reduced to intermediate levels without compromising OAs benefits on soil structure and carbon storage.

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## References

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