Impact of conversion and post-conversion management on soil organic carbon in farmed boreal Podzols

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Purpose: Conversion of boreal forests to agricultural farmland involves the total or partial removal of the carbon-rich forest floor, i.e., the Podzols' organic horizon, leaving behind the soil organic carbon (SOC) and nutrient-poor subsurface E and principally B mineral horizons. These new agricultural "soils" require substantial management to correct their acid pH and increase the soil organic matter content to reach a productive state. Furthermore, these are sandy soils with limited mineral surface area in a climate with net infiltration, projected to experience increased precipitation. These conditions may favour rapid mineralization of organic matter, and thus high perceived fertility under constant organic fertilisation, but, arguably, have limited capacity to store resilient SOC.

Methods: A multi-year agronomical trial was initiated on three farms in central Labrador, Canada. Each farm has distinct conversion and post-conversion management and, thus, distinct fertility and SOC. The impact of various locally relevant and organic fertilizers (e.g. fish waste compost, raw shrimp waste), carbon-rich amendments (e.g., biochar, peat), liming (yes/no), and the role of a cereal (oat) and/or a nitrogen-fixing (peas) crop on apparent soil fertility, bulk SOC storage and stocks (agronomic and 1 m depths, sampled in 10 cm increments), and SOC pools is being verified. The possibility for vertical carbon transfer and their apparent stability is also being verified. Adjacent forest sites, replicating pre-conversion status, are employed as references.

Results: An ~78% loss of SOC occurred due to removing the forest organic layer during conversion, an indication of how sensitive these lands may be to this land use change (LUC). Initial tests, however, suggest that long-term organic fertiliser addition might limit these losses and bring the SOC stock to levels equivalent to forest stocks. SOC pool dynamics may inform how distinct conversion protocols and management histories affect carbon balances at landscape levels and distinctly between and within fields.

Conclusion: Long-term research is critical to understanding the impact of conversion and management options on soil health, fertility, and, critically, SOC dynamics and storage in the climate-change-sensitive boreal ecosystem.