The Role of Methane in Carbon Cycling within Organic Crop Production

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Introduction

- **Reliance on tillage** for weed management is one of the greatest challenges for **organic agriculture on the western prairies**
- **Carbon storage** and cycling processes vital to the **greenhouse gas (GHG) balance[1]** of organic agricultural systems are jeopardized by tillage practices
- Alternative management systems such as **Integrated Crop-Livestock** and **Reduced Tillage** have the potential to improve carbon sequestration and reduce greenhouse gas emissions[2]

Common tillage	• 3 passes per growing season • Fall green manure incorporation
Integrated crop-livestock	• Cattle grazing 3 times/ growing season • Tillage only during plot establishment
Reduced tillage	• 2 passes per growing season • Biannual cover crop

Which management practice strongly impacts the carbon dynamics that govern GHG emissions?

How does methane contribute to the overall GHG balance?

Methodology

Figure 1. Static gas chamber, with exetainer sampling vials (left)

✓ Measurement of GHG fluxes every week that soil temperature is above 4°C , increase in frequency with precipitation events, soil disturbance, grazing

✓ Soil sampling in increments to 60 cm depth, in combination with bulk density data gives an estimate of carbon storage potential over 4 years

Figure 2. Soil in Lacombe, AAFC following tillage in the common tillage system

✓ GHG balance will be calculated using carbon dioxide (CO_2) equivalents for methane (CH_4) and nitrous oxide (N_2O) according to their global warming potential (27 and 273 respectively) on a mass basis

Results

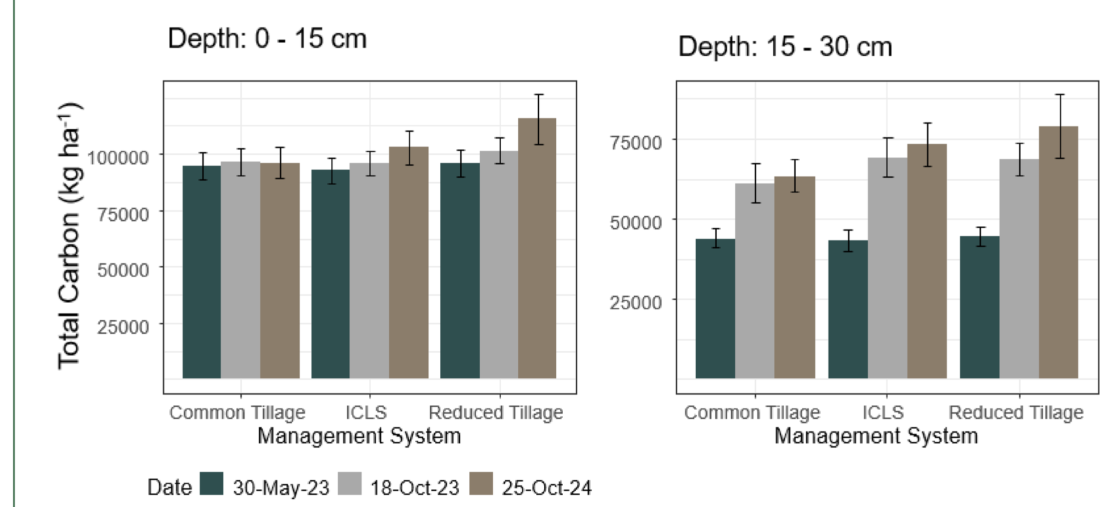

Figure 4. Total soil carbon (kg ha⁻¹) at two depths (0–15 cm and 15–30 cm) across organic management systems on three sampling dates:. Bars represent mean values with error bars ± SE .

➢ Carbon storage did not differ between treatments in the top depth of 0-15cm, but increased across all treatments after the first year in the 15-30cm soil layer

Results

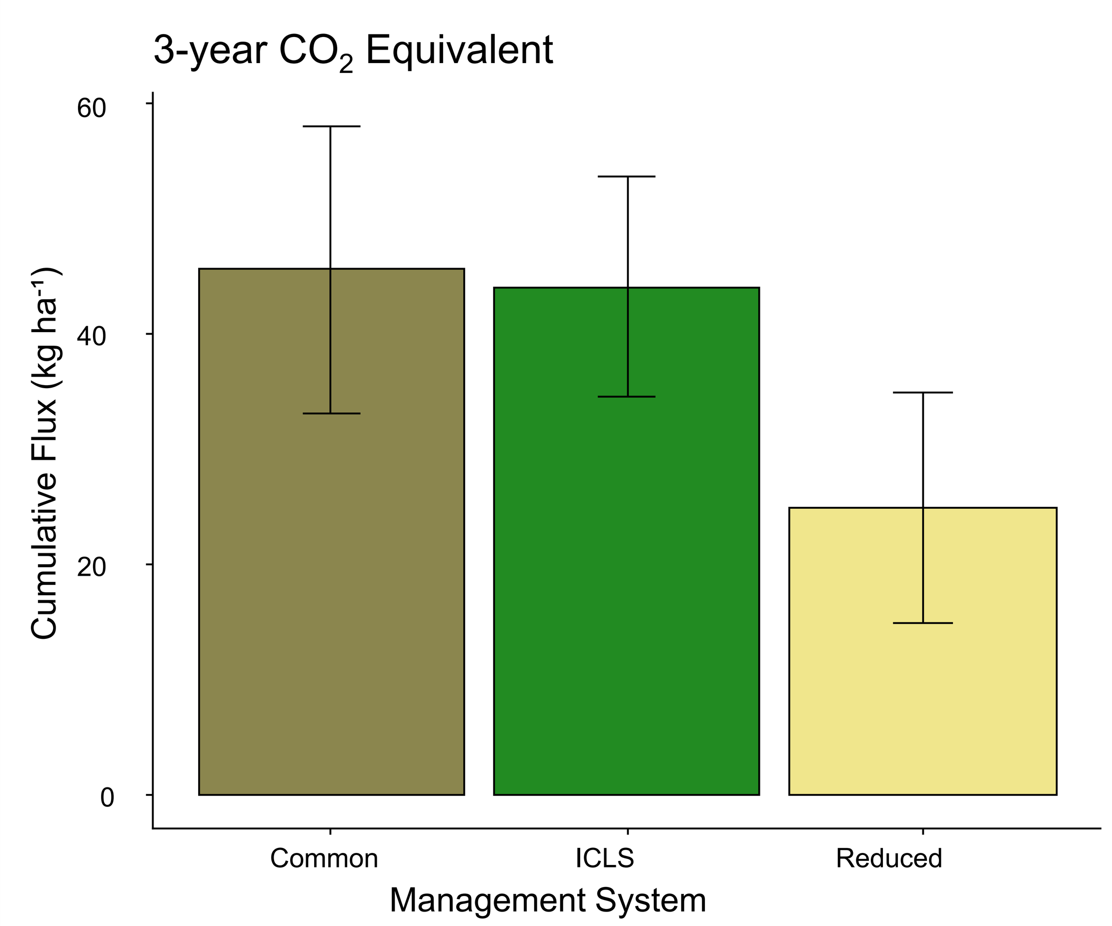

Figure 3. Three-year cumulative CO_2-equivalent emissions by management system. Solid bars show the measured total (N_2O + CH_4), while the shading represents the hypothetical CO_2-equivalent contribution if CH_4 were a positive source. Error bars indicate ±1 SE.

➢ There were no significant differences between management type for methane or 3-year average CO_2 equivalents

➢ Methane was a large portion of the cumulative flux for the **reduced tillage** system, which exhibited lower N_2O emissions in the three years

➢ In each year of the study across all management systems soil in the organic transition acted as a **methane sink**

Table 1. Cumulative average CH_4 uptake across three years in each management system. Means were not significantly different ($p > 0.05$)

Management System	3 year cumulative CH_4- C flux uptake (g ha⁻¹)
Common tillage	311.5 ± 43.1 a
Integrated crop-livestock	339.8 ± 56.8 a
Reduced tillage	323.5 ± 39.2 a

Conclusions

➢ CH_4 represents a large portion of the GHG balance in organic transitions systems, given that N_2O emissions are limited because of the omission of nitrogen fertilizer

➢ In systems that include livestock it could be an important consideration to balance enteric CH_4 produced from including ruminants

➢ Further work is necessary to create a complete budget which incorporates carbon storage, GHG emissions, and enteric CH_4

Acknowledgements

1. Krauss, M., Ruser, R., Müller, T., Hansen, S., Mäder, P., & Gattinger, A. (2017). Impact of reduced tillage on greenhouse gas emissions and soil carbon stocks in an organic grass-clover ley-winter wheat cropping sequence. Agriculture, Ecosystems & Environment, 239, 324-333.
2. Thiessen Martens, J., Entz, M.J.C.J.o.P.S., 2011. Integrating green manure and grazing systems: A review. 91, 811-824.

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