GREENHOUSE GAS EMISSIONS AND SOIL NITROGEN FOLLOWING THE FIRST TILLAGE EVENT IN THE FALLOW PHASE OF THE LONG-TERM NO-TILL WINTER WHEAT

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INTRODUCTION

There is an increasing interest in organically certified winter wheat production (3.2 thousand acres increased between 2005 and 2008, *Ag Census*). As this practice requires high intensity of tillage to control weeds, there is a concern about it's long-term sustainability due to high losses of greenhouse gases (GHGs). On the other hand, no-till system often practiced by dryland winter wheat farmers, enhances carbon (C) and nitrogen (N) sequestration and offsets GHG emissions. However, we do not understand the magnitude of C and N losses following the introduction of tillage to no-till system during the transition to organic production and whether this form of transition would be a viable alternative to establish more sustainable production practice.

HYPOTHESIS

Tilling of a soil that had been under dryland no-till for long period of time will generate a pulse of soil N mineralization and GHG emissions that will be significantly greater than the magnitude of the repetitive tillage events under conventional and organic winter-wheat production.

OBJECTIVE

Compare the short-term (50 hrs) effects of first-time tillage event applied to long-term no-till system to tillage in long-term conventional and organic on GHG and soil labile N.

MATERIALS AND METHODS

Site description: Semiarid temperate climate with average annual precipitation 300-400 mm mostly in winter. *Soil type:* mixed active mesic loamy skeletal Ustic Torriorthent

Cropping systems: Winter wheat-fallow managed as long-term (1) conventional (*tillage with chemical weed control*), (2) no-till (*chemical weed control only*), (3) organic (*tillage only*), and (4) no-till transition to organic (*tillage only*)

Experimental Design: 30 x 30 feet plots in 5 replications arranged in randomized complete block design.

Measurements and Analyses:

GHG and soil samples were collected5 times: before tillage (0 hr), and at 1 hr, 5 hrs, 25 hrs and 50 hrs following the single tillage operation. **Gas samples** were collected using enclosure technique by Hutchinson and Mosier (1981) and analyzed for CO_2, CH_4 and N_2O on Schimadzu GC-2014 Gas Chromatograph equipped with auto-sampler, and flame ionization thermo-conductivity and electron capture detectors. Global warming potential (GWP) was calculated using CO_2:CH_4:N_2O ratio of 1:21:310 . **Soil samples** (0-10 cm) were analyzed for water content and inorganic nitrogen (NO_3^- and NH_4^+), and potentially mineralizable nitrogen (PMN).

RESULTS AND DISCUSSION

Table 1: Cumulative Global warming potential (GWP) in kg C equivalents per hectare per year of different management systems after 50-hrs.

Time after tillage (hr)	No-till	No-till transition	Organic	Conventional
50	1444	1895	2980	2233

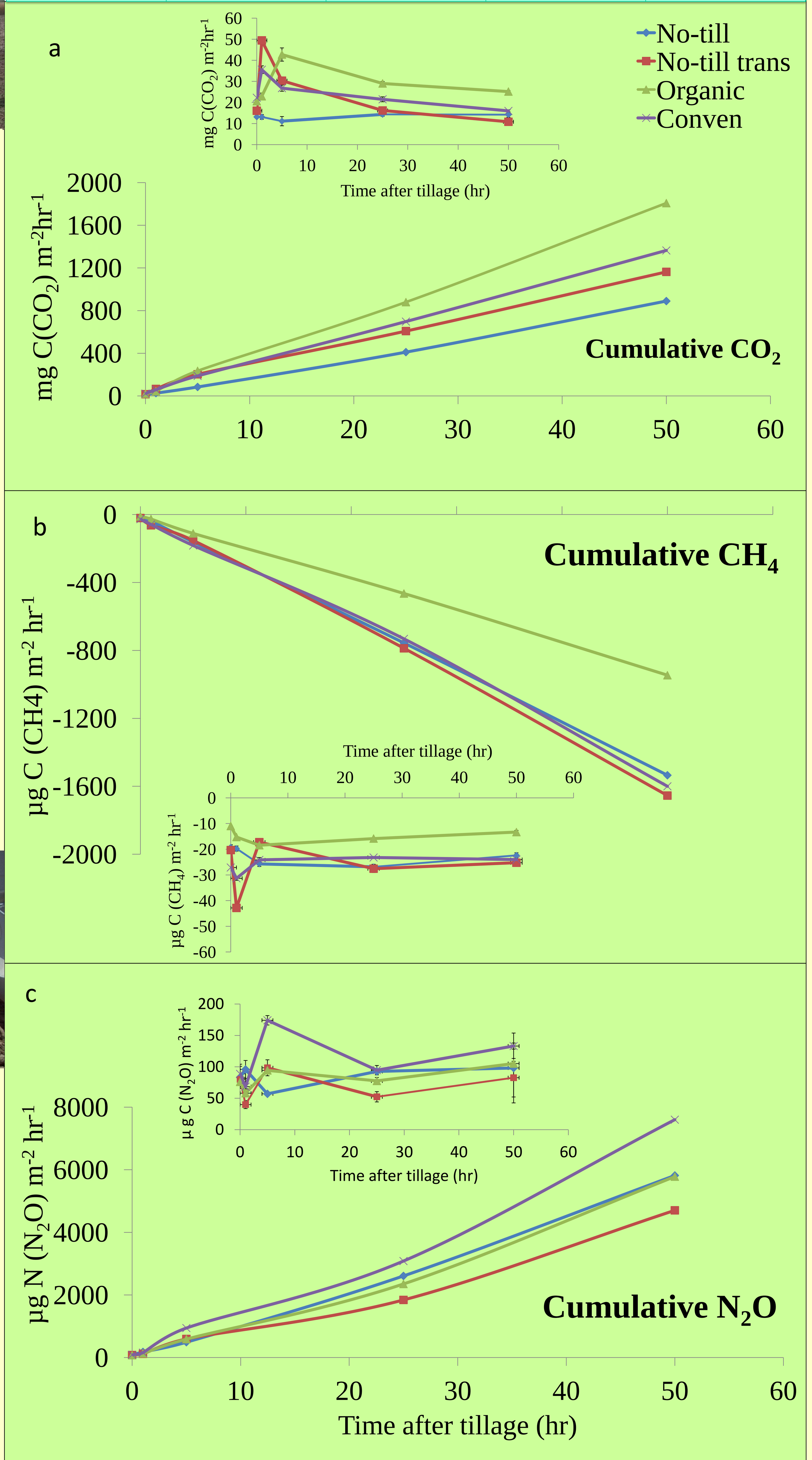

Figure 2: Cumulative CO_2 (a), CH_4 (b), N_2O (c) greenhouse gases pulse in different management systems in 50 hours. Figure insets represent GHG evolution rates

Table 1: Surface soil organic carbon and nitrogen, and residue carbon

Management systems	Soil TOC (Mg ha^{-1})	Soil TN (Mg ha^{-1})	Residue C (Mg ha^{-1})
Conventional	2.8	0.4	1.15
No-till	4.0	0.6	1.75
Organic	3.8	0.7	1.74

➢ **GWP**

- The first tillage event in no-till system generated 24% more GWP compared to no-till control. However it was on average, 36% lower than tillage in organic system and 15% lower than conventional tillage.
- This response was driven by low CO_2 and N_2O emissions compared to conventional and organic, and high CH_4 assimilation compared to organic systems.

➢ **CO_2**

- First tillage after seven years of no-till management resulted in pulse of CO_2 within one hour of the first tillage.
- Cumulative CO_2 emissions of the first 50 hours were 24% larger in no-till transitional plots than long-term no-till plots but it was 36% lower than long-term organic systems.
- Tillage-induced oxidation of soil and residue C (Table 2) in long-term no-till plots might have resulted in short-lived but large pulse of CO_2 immediately after first tillage that exhausted the labile C released during disturbance.

➢ **CH_4**

- Sharp increase in CH_4 assimilation within the first hour after tillage occurred in no-till transitional plots only.
- Cumulative methane assimilation was 72% greater in no-till transition to organic plots than long-term organic plots.
- Aerobic environment created by tillage disturbance in long-term no-till soils might have favored methanotrophs over methonogens thus enhanced sink capacity in those soils.

➢ **N_2O**

- Maximum rate of N_2O emissions occurred 5 hours after the tillage.
- The cumulative N_2O emissions for no-till transitional system was 38% lower than conventional and 19% lower than organic system.
- In addition, increased PMN after one hour of tillage (Figure 2a) suggest that inorganic N might have been immobilized by microbes resulting decline in N_2O emission.

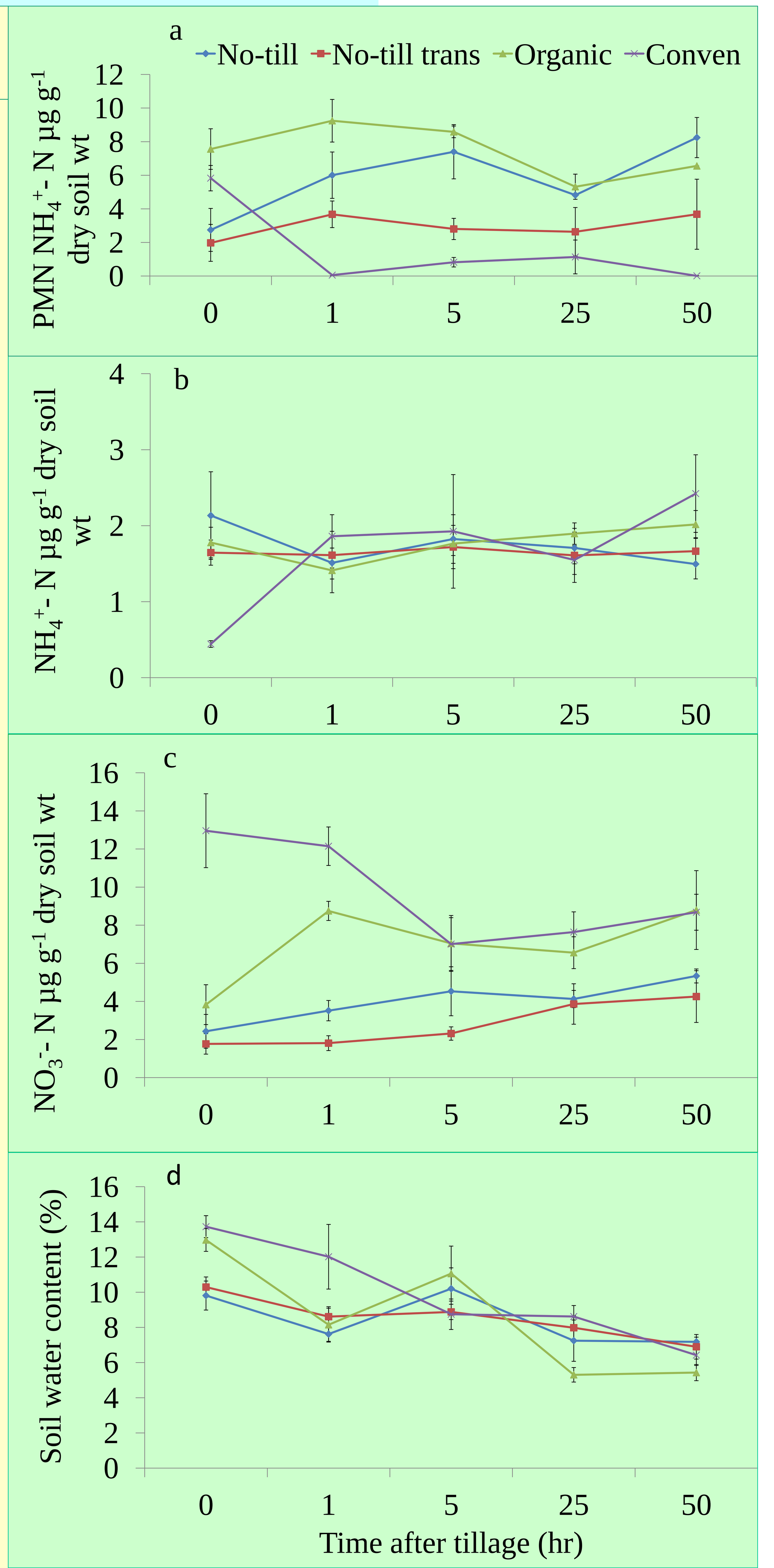

Figure 2: PMN (a) , NO_3^--N (b), NH_4^+-N (c), and soil water content (%) (d) measured in different time before and after tillage in different management system

CONCLUSIONS

- Tillage events create large changes in GHG emissions and soil labile N as early as within one hour after.
- The magnitude of the changes are notably smaller during the transition from no-till to organic compared to lob-term organic and conventional systems.
- On-going research includes biweekly GHG monitoring, residue inputs, plant growth parameters (biomass and yield), weed population and soil sampling. These data will be utilized to validate Day-Cent model simulations.

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