Agricultural Management Impacts Greenhouse Gas Emissions

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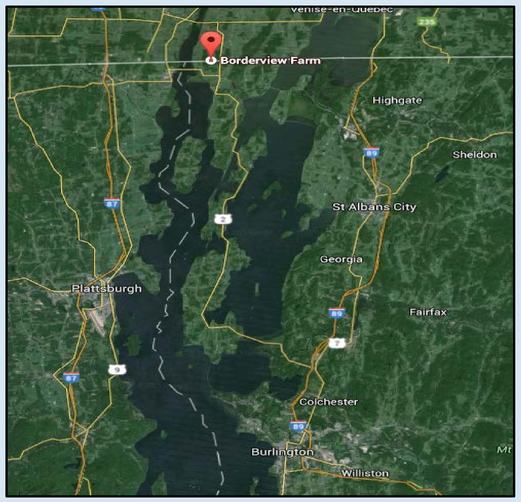
ABSTRACT:

A key question related to agriculture's mitigation potential is whether and how current farming practices affect carbon and GHG (greenhouse gas) balances. A farmer's land can act as a sink by capturing carbon in biomass and soils (taking up more CO_2 than it releases), but its net effect on climate will also depend on its trace gas emissions of N_2O. N_2O is a more potent GHG than CO_2, trapping 298 times more heat over 100 years than CO_2. Denitrification is the primary source of N2O from agricultural land. Losses of N_2O via denitrification are transient, driven by nitrate availability and precipitation events that produce anoxic conditions in the topsoil.

We measured GHG emissions and soil carbon storage in different agricultural practices: a selection of climate change best management practices (CCBMPs) and conventional practices. We studied relationships among N_2O and CO_2 emissions and the things that we think drive (increase) these fluxes – high nitrate availability, high moisture, and high temperature – by comparing tillage and manure spreading practices. These different practices gave results definite enough to establish concrete differences between the practices, and give insight into which CCBMPs are more efficient, by looking at N_2O and CO_2 fluctuation. We found that manure injection increased N2O and CO2 emissions and that no till systems decreased CO2 emission, but had no impact on N2O emissions.

Borderview Farm, Alburgh, VT



METHODS:

PVC pipe anchors embedded in the ground were used with a specialized chamber lid to collect data on soil emissions. We measured CO_2 and N_2O emissions using a photoacoustic gas monitor (PAS).

There were three tillage treatments and two manure application treatments in a continuous corn field:

Type of Tillage	Manure Treatment
No Till	Broadcast, Inject
Vertical Till	Broadcast, Inject
Strip Till	Broadcast, Inject

Each manure by tillage treatment was replicated three times (three plots/treatment combination). Emissions were measured from one chamber in each plot. CO_2 and N_2O emissions measurements were made from May-September, approximately weekly. Air temperature, soil temperature and moisture measurements were also recorded.

We also collected soil cores (0-1 m) to identify the soil attributes and carbon storage in each treatment, but results are still being analyzed.

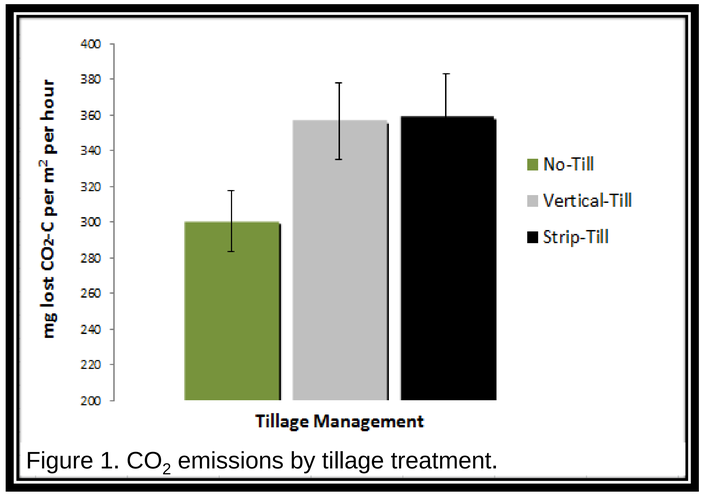


Figure 1. CO_2 emissions by tillage treatment.

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RESULTS:

Tillage practice did not impact N_2O emissions, but CO_2 emissions were lowest from the no till treatment (Fig 1). Emissions of CO_2 and N_2O were greater from manure injection than from broadcast manure application (Fig 2).

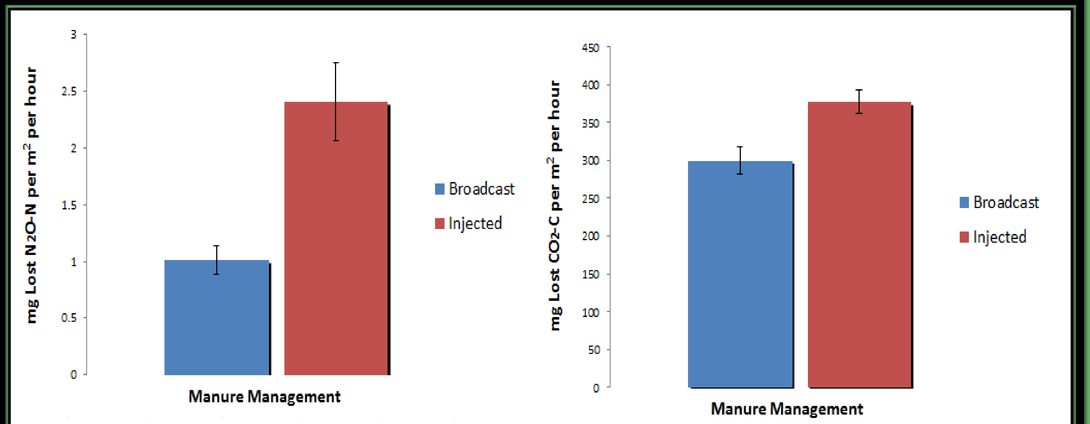

Figure 2. N_2O (left) and CO_2 (right) emissions by manure treatment.

CONCLUSIONS:

Manure injection likely puts more carbon/organic matter and nitrogen belowground in the soil where microbes can use it for energy (respiration) and conditions are more likely to be anoxic. With broadcast (no incorporation), much of the carbon and nitrogen may be lost as runoff in larger storms. Manure injection promotes anaerobic respiration (denitrification), therefore creates more N_2O. However, injecting the manure also increases aerobic respiration and CO_2 emissions by providing more carbon for microbes in belowground aerobic zones (with plenty of oxygen). While manure injection likely reduces runoff of carbon, nitrogen, and other nutrients, our research suggests that it increases emissions of both CO_2 and N_2O.

Both strip and vertical tillage disturb the soil, breaking up soil aggregates and making carbon more available for aerobic respiration and increasing CO_2 emissions. No till soils likely produce less CO_2 because the soil remains compact and soil carbon remains protected (unavailable) in aggregates. By disturbing the soil and burying surface residue, more soil particles are likely to detach from the soil surface and increase the potential for run off from agricultural fields. Reducing the amount and intensity of tillage can help build soil structure and reduce both soil erosion and CO_2 emissions.