United States Department of Agriculture
Northeast Climate Hub

The University of Vermont

Evaluating Greenhouse Gas Emissions in Promising Tillage and Manure Application Practices at Borderview Farm

BY UNIVERSITY OF VERMONT | MAY 2017

HOW DO MANURE APPLICATION AND TILLAGE METHODS IMPACT GREENHOUSE GAS EMISSIONS?

A research team at UVM, led by Dr. Carol Adair and Dr. Heather Darby, is evaluating the benefits and drawbacks of four different tillage approaches (conventional, strip, vertical, and no till) and two different methods of manure application (broadcast and injection). The goal is to determine the practices best suited for reducing greenhouse gas emission, improving carbon storage and limiting nitrogen losses. The team measures carbon dioxide and nitrous oxide emissions from the treatments every two weeks or more frequently after events (large rainfall, manure application) using a measuring device called photoacoustic multigas monitor.

TYPES OF TILLAGE

CONVENTIONAL PLOW TILLAGE refers to deep tillage and disturbance of the entire field. **STRIP TILLAGE** cultivates a 4-6" strip of soil along both sides of a planted row and deeply tills the soil (8-10" in depth) where the crop is planted. **VERTICAL TILLAGE** lightly tills the top 2-3" of soil. **NO TILL** does not till, but uses metal coulters to cut the soil and plant seed into the slot, which is then closed by the planter.

MANURE APPLICATION

BROADCAST manure applications are sprayed across the surface of the soil, whereas the manure **INJECTION** method slices the soil open with a disc and injects liquid manure into the soil through the slot.

FARMERS CAN SIGNIFICANTLY HELP TO MITIGATE NITROUS OXIDE BY ADOPTING MANAGEMENT PRACTICES THAT IMPROVE THE EFFICIENCY OF NITROGEN USE FROM FERTILIZERS AND MANURE.

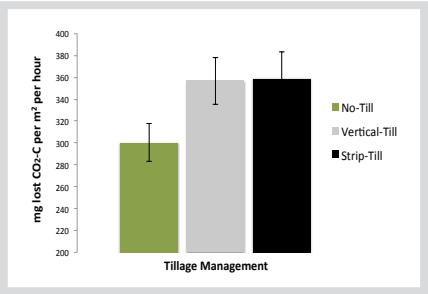
Soil and fertilizer management methods can significantly impact greenhouse gas emissions. Soil disturbance, such as tillage, breaks up soil aggregates and increases microbial respiration as the organic carbon in the soil becomes available to oxidation. This results in the release of carbon dioxide from soils during and after tillage. Microbial respiration also causes the nitrogen component of a fertilizer to be released as nitrous oxide if the soil environment becomes anaerobic. More than 50% of manure nitrogen may be lost through runoff and volatilization if it is not incorporated into the soil. In addition, the nitrogen component of fertilizers is prone to leaving the farm in water-soluble forms and contributes to algal blooms which deplete stream oxygen. However, tillage and fertilizer application methods vary widely between farms and regions and some management approaches release fewer GHGs and nutrient runoff streams than others.

IT'S IN THE INTEREST OF FARMERS AND COMMUNITIES TO KEEP NITROGEN AND SOIL CARBON ON FARMS AND IN THE SOIL FOR THE BENEFIT OF AGROECOSYSTEM PRODUCTIVITY, CLIMATE CHANGE MITIGATION AND WATERSHED HEALTH.

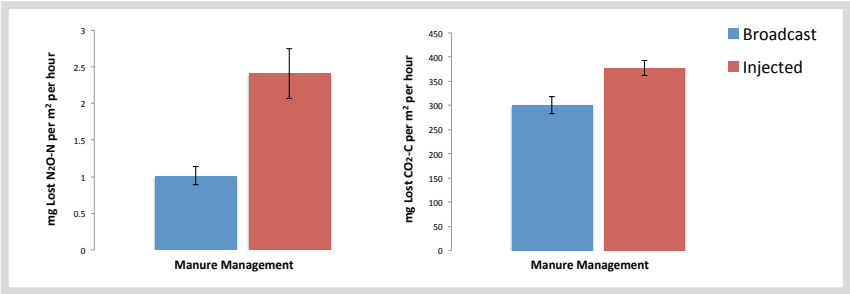
For many farmers, the goal is to keep nitrogen and carbon in the soil in a form that is available to plants and enhances soil health – not escaping into the surrounding air or water. This project brings together a global perspective of agricultural impacts on climate change with local, practical applications for farmers. Minimum and no-tillage practices have the potential to reduce farmer expenses and greenhouse gas emissions while increasing soil health, and initial data from this study support that. Promising manure application methods present tradeoffs between greenhouse gas mitigation and other benefits.

PRELIMINARY RESULTS: MANAGEMENT PRACTICES IMPACT GREENHOUSE GASSES AND NUTRIENT RETENTION

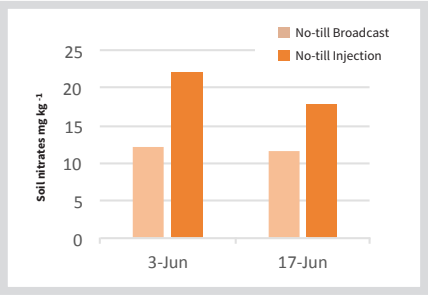
NO-TILL DECREASES CO2 EMISSIONS



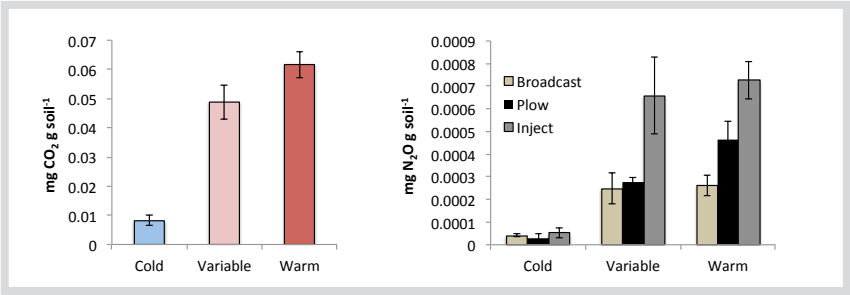
MANURE INJECTION INCREASES EMISSIONS



MANURE INJECTION INCREASES EARLY SEASON NITRATE RETENTION IN SOIL



MANURE INJECTION, WARMER WEATHER AND FREEZE-THAW CYCLES



1 Initial results indicate that manure injection presents a tradeoff between greenhouse gas emissions and other potential benefits. The method keeps more nitrogen on farm, reducing fertilizer applications and nitrogen flows into the watershed, but increases greenhouse gas emissions. The research team hopes that a method or combination of management strategies can be refined to retain these benefits, improve crop quality, mitigate greenhouse gas emissions, and increase carbon sequestration.

2 No-till management decreases carbon dioxide emissions and can be implemented without compromising crop yields.

3 The impact of increasing winter and early spring temperatures associated with climate change projections on carbon dioxide and nitrous oxide emissions was evaluated using soil cores from the field experiments. Soil cores were subjected to different temperatures conditions in the lab: frozen (-7C), thawed (5C), and alternating freeze/thaw. Preliminary data from these incubations indicates that the increases in variable spring temperatures and earlier soil thawing associated with climate change will likely increase carbon dioxide and nitrous oxide emissions from soil, and this will be exacerbated by manure injection.

THE RESEARCH TEAM IS CONDUCTING TRIALS TO FIND A MANAGEMENT STRATEGY THAT RETAINS THE BENEFITS OF MINT, AND REDUCES GREENHOUSE GAS EMISSIONS. THE STUDY IS IN ITS FIRST SEASON. COMPLETE RESULTS OF THE STUDY ARE EXPECTED IN 2017.

Initial agronomic data associated with this project can be found via **UVM EXTENSION'S NORTHWEST CROPS AND SOILS PROGRAM ANNUAL MINT TRIAL REPORT:** www.uvm.edu/extension/cropsoil/wp-content/uploads/2015-MINT-Report.pdf

For further information about greenhouse gas data collection **CONTACT UVM'S ADAIR LAB:** www.uvm.edu/rsenr/cadair

The mission of the **USDA NORTHEAST CLIMATE HUB** is to develop and deliver science-based knowledge and practical information for land managers and farmers to support their decision making related to climate impacts. We work in partnership with local, state, and federal governments, land grant institutions consultants, and private organizations reaching across twelve states from Maine to West Virginia and the District of Columbia.

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