Does Tillage Depth of Cover Crops and Manure Control Nitrous Oxide Emissions?

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Introduction

Nitrous oxide (N_2O) is a greenhouse gas with 298 times more Global Warming Potential than carbon dioxide (US EPA 2015) . In ag soils, most N_2O emissions are produced via denitrification. Denitrification occurs in soils with anaerobic conditions and excess nitrate. N_2O is difficult to measure and emissions are highly variable. Tillage depth of cover crops and manure can be a key control of N_2O emission.

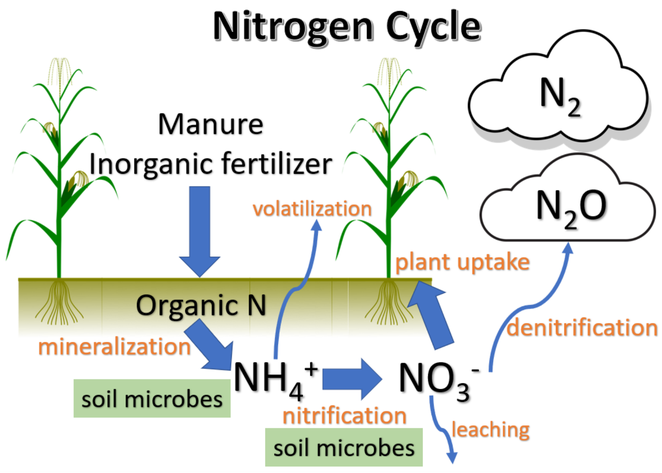

Figure 1: Denitrification produces N_2O as microbes utilize the oxygen from NO_3-

Results

The positive correlation of increasing tillage depth and increasing N_2O emission was consistent over all simulations.

Increased distribution of organic matter in soil layers also increased N_2O.

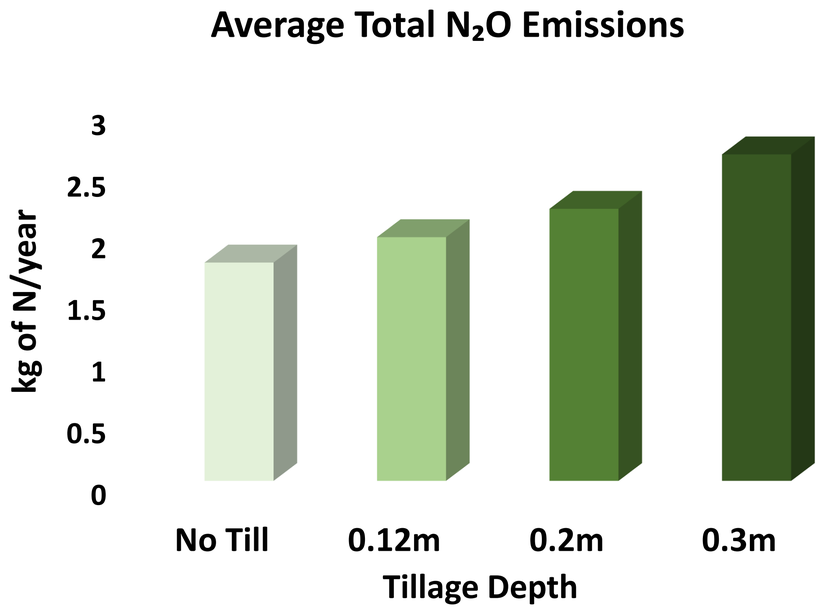

Figure 4: Average annual N_2O emissions at varying tillage depths

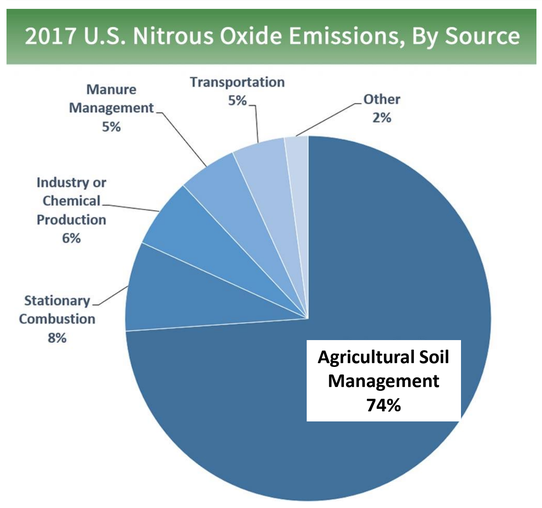

Figure 2: Distribution of N_2O emissions by source showing agriculture as the primary emitter (US EPA 2015).

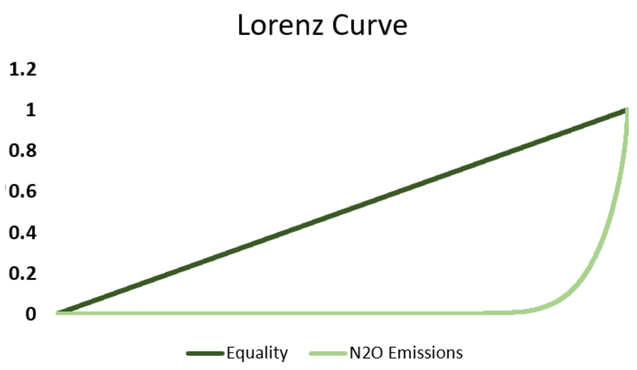

Figure 3: Lorenz curve using N_2O results from Cycles to show extreme variability of emissions

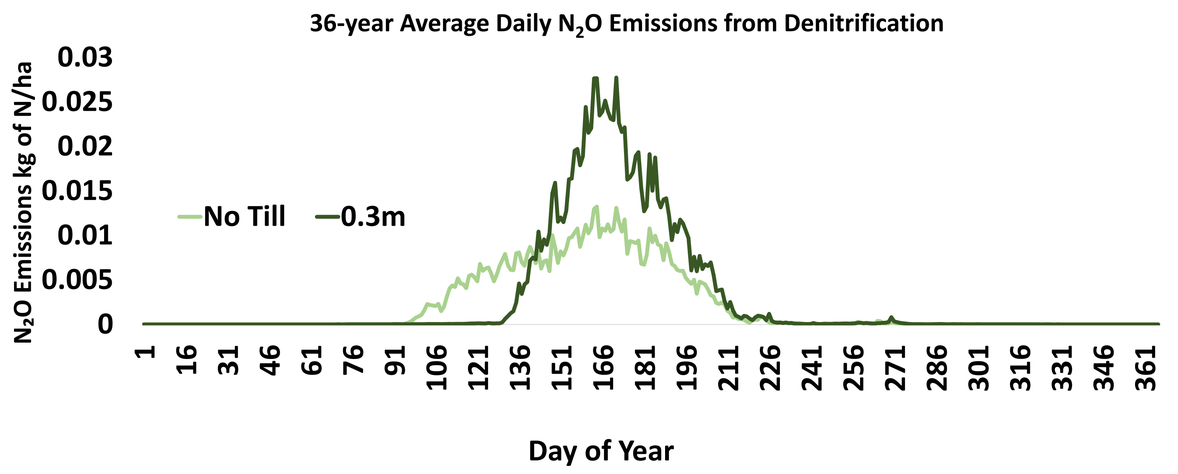

Figure 5: Average daily denitrification emissions of N_2O

Hypothesis: Increasing tillage depth of manure and leguminous cover crops increases nitrous oxide emissions.

Methods

- Conduct a literature review of agronomic nitrous oxide emissions
- Use the Cycles agroecosystems model (Kemanian & Stöckle 2010) to simulate agronomic practices and generate outputs of N_2O at Rock Springs, PA, during 1980 -2016
- Tested no till, 0.12 m, 0.2 m, and 0.3 m tillage depths of crimson clover with manure
- Tested simulation with 21,300 and 46,000 kg manure/ha in addition to synthetic N
- Analyzed crop yield and N_2O outputs from Cycles simulations in Excel

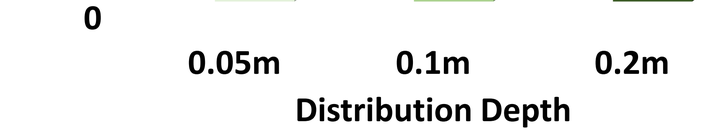

Figure 6: Average annual N_2O emissions at varying distribution of Crimson Clover and manure

Crimson Clover cover crop in the field as in the Cycles simulations

Plowing in the field as in the Cycles simulations to bury cover crop and manure

Conclusion

- Deeper tillage results in higher N_2O emissions; likely a result of increased moisture and lower-oxygen conditions and increased microbial access for denitrification in deeper soil layers
- **19% change** in emissions from conventional to no-till practices
- Supports Drawdown solutions of nutrient management, conservation and regenerative agriculture as reduced tillage and no-till maintain yield and improve nitrogen utilization
- Models are not perfect, and field test is necessary to further validate the results

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References:

- Kemanian, A. R., & Stöckle, C. O. (2010). C-Farm: A simple model to evaluate the carbon balance of soil profiles. *European Journal of Agronomy*, *32*(1), 22–29. https://doi.org/10.1016/j.eja.2009.08.003
- US EPA, O. (2015, December 23). Overview of Greenhouse Gases [Overviews and Factsheets]. Retrieved July 16, 2019, from https://www.epa.gov/ghgemissions/overview-greenhouse-gases