Using COMET-Farm to Estimate Soil Greenhouse Gas Emissions from a Field Study under different Crop Rotations and Tillage Type in Illinois, USA

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INTRODUCTION

Agriculture contributes to greenhouse gas emissions of carbon dioxide, nitrous oxide, and methane. Agricultural greenhouse gas mitigation can be attained by implementing conservation soil management practices. Modeling tools such as COMET-Farm can support implementation of best management practices since it estimates emissions considering variation in soil and climatic conditions across farmlands.

OBJECTIVE

The objective of this project is to compare the greenhouse emissions estimates of COMET-Farm from crop rotations under different tillage regimes to those measured in a field study at the Northwestern Illinois Agricultural Research and Demonstration Center in Illinois, USA, conducted from 2012 to 2015.

MATERIALS and METHODS

COMET-Farm Modeling:

Historic Management (Pre-2000)

Pre-1980s: Lowland; non-irrigated;no conservation practices applied

1980-2000: Annual crops in rotation; non-irrigated; intensive tillage

Baseline Management 2000 to 2021

Continuous corn under intensive tillage; no irrigation; no liming; no burning of residues.

Management Treatment 2022 to 2031

Tillage and No-Tillage; no irrigation; no liming; no burning of residues.
- Continuous Corn
- Corn-Soybean rotation
- Corn-Soybean-Oats rotation

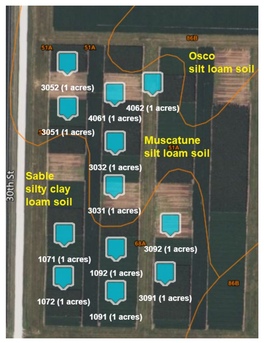
Historic management data is used to calculate changes in soil C stock. Baseline management is compared to management scenarios to assess their impact.

COMET-Farm Input Data: data of selected crop rotations and tillage type from the field study was used as input data. This included dates of planting, fertilization, tillage and harvest; average yield for each crop; and N fertilizer rates.

N fertilizer rates with urea ammonium nitrate for crops under till and no-till

Continuous Corn	Corn-Soybean	Corn-Soybean-Oats
Corn: 219.5 lbs/acre	**Corn**: 180.22 lbs/acre **Soybeans:** no fertilization	**Corn:** 180.22 lbs/acre **Oats**: 49.9 lbs/acre **Soybeans**: no fertilization

COMET-Farm Field Site and Plots: the location of the field site in COMET-Farm contains information on soil characteristics and climate conditions. Simulations of baselines and treatments were conducted on two of soils from the field study: Muscatune and Sable soils.

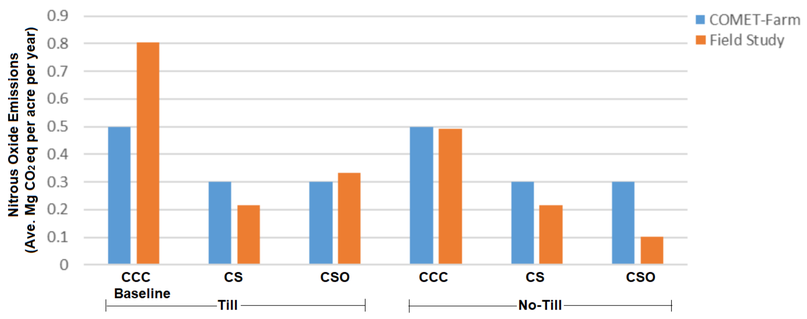


Muscatune silt loam	Sable silty clay loam
Baseline: Continuous Corn, Till	**Baseline:** Continuous corn -Till
Treatments: Corn-Soybean, Till Corn-Soybean-Oats, Till Continuous Corn, No-Till Corn-Soybean, No-Till Corn-Soybean-Oats, No-Till	**Treatments:** Corn-Soybean, Till Corn-Soybean-Oats, Till Continuous Corn, No-Till Corn-Soybean, No-Till Corn-Soybean-Oats, No-Till

*COMET-Farm reports both soils as silt loams, with Sable having higher % clay.

RESULTS

Nitrous Oxide Emissions:



CCC: continuous corn; CS: corn-soybean; CSO: corn-soybean-oats.

- N_2O emissions from both COMET-Farm and the field are higher for continuous corn under both till and no-till than other crops. This is likely due to corn in continuous corn plots received higher N fertilizer rates than the plots with crop rotations.
- COMET-Farm does not show a reduction in N_2O emission from till to no-till shown for continuous corn and the corn-soybean-oats rotation measured in the field.
- There was no effect of soil type on N_2O emissions.

COMET-Farm Average Net CO_2 Sequestration:

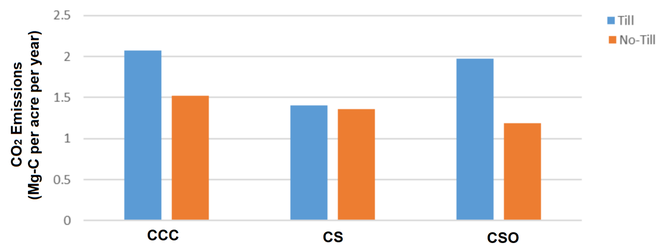
Crop Rotation	Till	No-Till
CCC	-0.2	-0.6
CS	-0.1	-0.6
CSO	-0.15	-0.65

CCC: continuous corn; CS: corn-soybean; CSO: corn-soybean-oats.

COMET-Farm reports net CO_2 sequestration as soil organic carbon (SOC) after allowing for CO_2 emissions from the soil. Negative values indicate an increase in SOC.

Shifting from a till to a no-till practice showed an increase in soil organic carbon (SOC). There was no effect of soil type on CO_2 sequestration as SOC.

Field CO_2 Emissions:



CCC: continuous corn; CS: corn-soybean; CSO: corn-soybean-oats.

Continuous corn and corn-soybean-oats rotations under till had the largest CO_2 emissions. Corn-soybean rotations under till and no-till had similar CO_2 emissions.

CONCLUSION and IMPLICATIONS

- COMET-Farm did not estimate the reduction in N2O emissions from till to no-till shown for continuous corn and the corn-soybean-oats rotation.
- Higher CO_2 sequestration estimates when shifting from till to no-till do not correspond to lower CO_2 emissions in all crops under no-till measured in the field.
- This study fills an important gap of comparing COMET-farm with field data, but further studies are needed to expand the evaluation to carbon measured from the long term field studies and those estimated by the tool.

References

1. COMET-Farm, USDA/NRCS/Colorado State University, https://comet-farm.com
2. Behnke, Gevan et al. 2018. Long-term crop rotation and tillage effects on soil greenhouse gas emissions and crop production in Illinois, USA. Agriculture, Ecosystems, and Environment [Internet]. [Cited 29 June 2022]. 261(62-70). Available from https://www.sciencedirect.com/science/article/pii/S0167880918301221

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