Protocol development for greenhouse gas analysis in corn systems with cover crops using current literature

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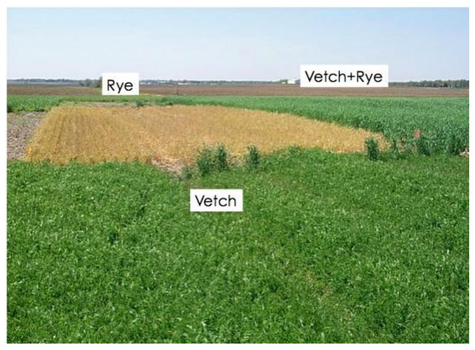
BACKGROUND

Cover crops are any grass, legume or small grain species grown during non-regular grain production periods that are intended to provide agronomic benefits such as protecting soil and reduce weed pressure. There are many well researched ecological benefits to incorporating cover crops into corn cropping systems, such as their potential to decrease soil erosion, reduce nitrate leaching and increase soil organic matter. Some of these benefits, however, may have unintended consequences for other elements of an agroecosystem given the coupling of nutrient cycles, notably C and N. Some field research does point toward an increase in nitrous oxide emissions in cropping systems where cover crops are present. This work, however, is limited and comes from various sites utilizing a range of cover crops and different measurement techniques. Further, the prior work uses various indices such as overall global warming potential, annual gas emissions totals or flux during particular periods of the year.

Through a literature review of corn systems with cover crops, our goal is to establish a best practice method for compiling data from a variety of sources. This will better provide us with an understanding of the mechanisms underlying gas flux from cover cropping systems. It will also help us establish modeling thresholds once field data from our project becomes available.



METHODS

The literature search began with utilizing a Web of Science and Google Scholar search with keywords “cover crops” and “emissions”

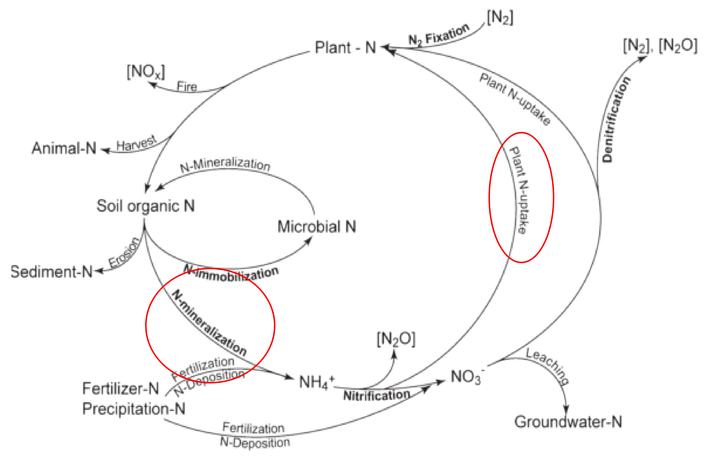
- Began with only corn systems but included some with alternate crops to compare potential trends
- Included model and field studies

PRELIMINARY RESULTS

Location	Cover Crop Variety	Cropping System	N_2O (kg $N*ha^{-1}*yr^{-1}$)	% N_2O Δ from experimental control	Global warming potential (kg CO_2-eq$*ha^{-1}*yr^{-1}$)	Citation
Brazil	grass	No-till maize	-0.074±0.056	-	-	Gomes et al. (2009)
Brazil	legume	No-till maize	0.805±0.072	-	-	Gomes et al. (2009)
Brazil	grass and legume	No-till maize	1.316±0.103	-	-	Gomes et al. (2009)
Brazil	legume	No-till maize	1.323±0.221	-	-	Gomes et al. (2009)
Brazil	legume	No-till maize	1.116 ±0.143	-	-	Gomes et al. (2009)
Michigan	grass	Corn-soybean with complete corn stover removal	0.23	-28%	-9450	Fronning et al. (2008)
California	legume	4 year rotation: tomato, safflower, corn, beans	1.70±.08	-23%	-2921±292	De Gryze et al. (2010)
California	legume	Standard till corn and tomato rotation	2.60±.10	-18%	9±192	De Gryze et al. (2010)
California	legume	Conservation till corn and tomato rotation	2.21±.18	-27%	-192±391	De Gryze et al. (2010)
California	grass and legume	Standard till cotton and tomato rotation	4.01±.10	17%	-675±147	De Gryze et al. (2010)
California	grass and legume	Conservation till cotton and tomato rotation	3.79±.10	16%	-969±147	De Gryze et al. (2010)
California*	legume	4 year rotation: tomato, safflower, corn, beans	0.6±0.3	-85%	-	De Gryze et al. (2010)
California*	grass and legume	Rotation of corn and tomato	3.0±0.1	-27%	-	De Gryze et al. (2010)
Denmark	legume	Conventional till with barley	3.86	146%	-	Peterson et. al (2011)
Denmark	legume	Direct drilling with barley	2.17	36%	-	Peterson et. al (2011)
Denmark	legume	Reduced till with barley	3.03	55%	-	Peterson et. al (2011)

*DAYCENT model simulation

Figure adopted from Robertson and Groffman (2006) illustrating the proposed stages of the nitrogen cycle where cover crops may lead to enhanced nitrous oxide emissions.



DISCUSSION

- Preliminary literature analysis points to the type of cover crop - legume versus grass - as playing a role in increasing nitrous oxide emissions. *Do sites include cover crops other than rye?*
- In both the California and Denmark studies, the largest decrease in greenhouse gases came from reduced tillage plus cover crops. *Are other treatments included with cover crops, such as tillage or extended rotations?*
- Not all studies included measurements for carbon dioxide (or soil carbon) and methane therefore overall global warming potential could not be accounted for. *Do field measurements include SOC, N_2O and CH_4?*
- Most of the literature tracks measurements monthly (or more frequently), providing an assessment of temporal trends in emissions. *How often are gas flux measurements taken?*
- The California experiment used historical site data for model validation. *How much prior information exists on emissions and management practices that could be utilized?*

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