Corn rotation effect on greenhouse gases emission from Wisconsin soils

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Introduction

Agriculture plays a significant role in the global flux of three major greenhouse gasses (GHG - CO_2, N_2O and CH_4), which when trapped in the atmosphere warms the surface of the Earth via infrared radiation (1,2). A large amount of these gas fluxes are thought to be derived from soil through crop intensification (2). Improved management practices like reduced tillage, controlled fertilization (3) or extended crop rotation (4) are of particular interest because they have a high potential to mitigate gas emissions. To interpret emission intensity of GHG's it is very important to monitor the weather and soil property changes like bulk density or water retention. **Our objective** was to measure GHG emissions from extended corn rotations at the Arlington, Lancaster and Marshfield Research Stations, which we have been monitoring since the end of March 2012. A second objective was to measure water retention curves of the same rotations at two different depths. Sufficient time has passed since plot establishment in 2000 to allow these extended crop rotation experiments to equilibrate differences within treatments and soil depths.

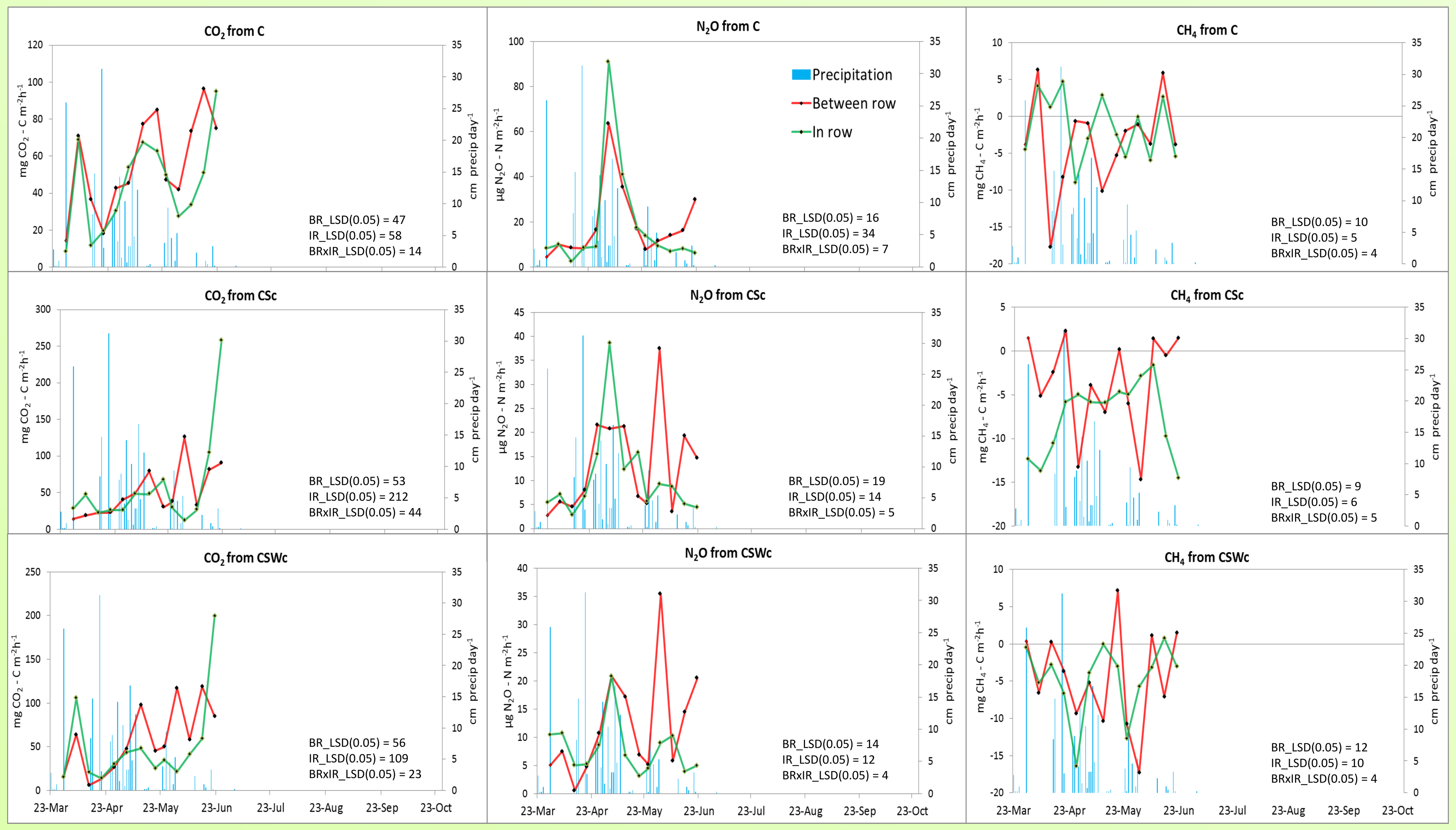
GHG - Materials and Methods

Locations, Rep, Data collection			Treatments	Placement	Data collection	Analysis
Arlington Marshfield Lancaster	3 3 2	Weekly Biweekly Biweekly	1. Continuous corn (C) 2. Corn-soybeans (Cs) 3. corn-Soybeans (cS) 4. Corn-soybeans-wheat (Csw) 5. corn-Soybeans-wheat (cSw) 6. corn-soybeans-Wheat (csW) *Capital letters = current crop*	In each treatment, chambers were placed: IR- in row, BR-between row, Giving a total of 12 chambers per rep.	CO_2, N_2O , and CH_4 fluxes were estimated using in situ closed-cover flux chambers permanently installed in all plots. Gas fluxes were measured at four-20 minute sampling intervals. Samples are taken from gas traps by inserting a 30 mL syringe into the rubber septa from where 20 mL was used to flush a vented 5 mL glass vial and remaining 10 ml was placed in the glass vial, giving the vial a gas overpressure.	The experimental design was a randomized complete block in a split-plot arrangement, with two or three replications. Whole plot factors were rotation treatment, and the split plot factor was the chamber placement. Analysis of variance for the factors location, treatment, chamber placement, and replications as blocks was performed using the PROC MIXED procedure of SAS (SAS Inst., 2008).

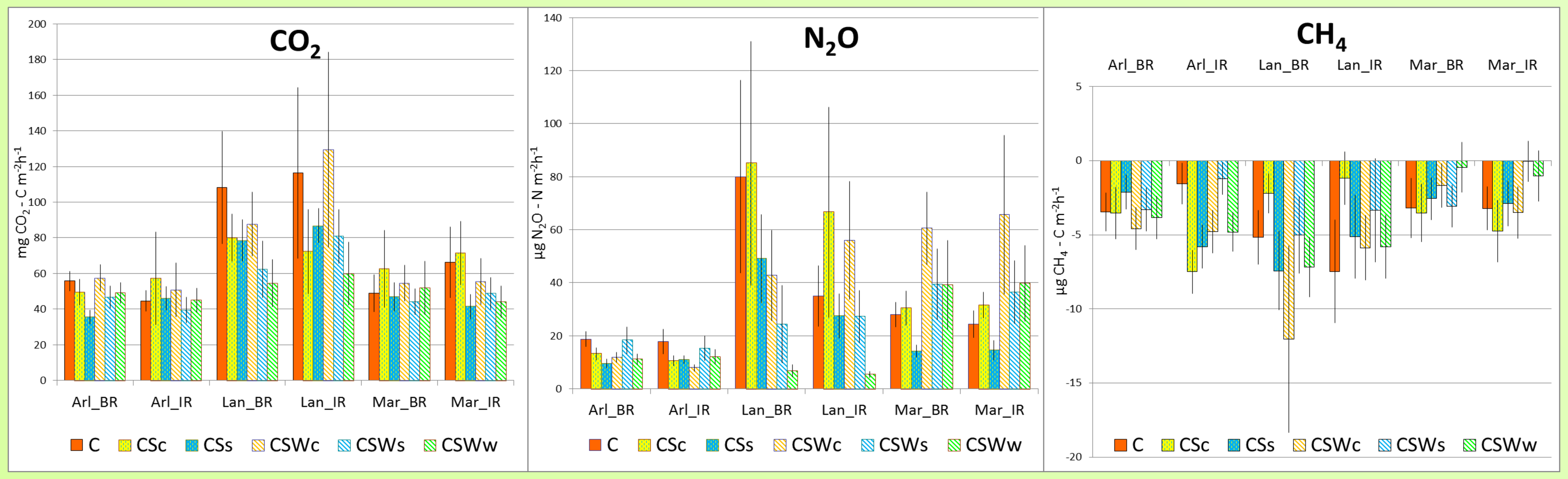
Water Retention - Materials and Methods

Treatments	Data collection	Analysis
1. C 2. CS 3. CSW	For water retention, in 2011, 3 soil core samples were collected from each treatment at two depths: 0-10 cm 10-20 cm	A pressure plate water-release apparatus was used to measure water release for a suction range of 0 to -15 bar (here, we present up to -0.33 bar). PROC GLM regression procedures of SAS (SAS Inst., 2008) was used in comparing slopes and intercepts.

GHG fluxes at Arlington based on first 13 samplings days. Data shows only corn treatments.



Averaged GHG fluxes across sampling dates. Data shows comparisons between locations and chamber placement.



Measuring GHG fluxes.

GHG Preliminary Results

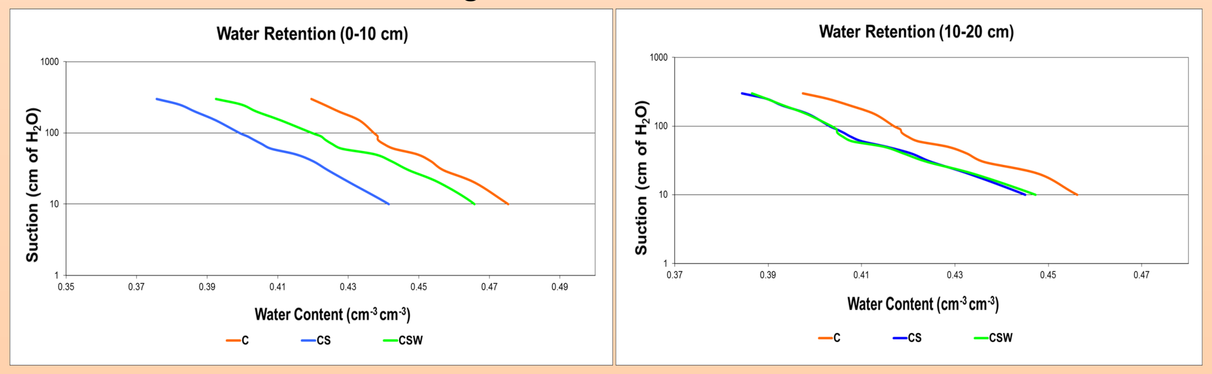
At Lancaster, chambers placed between rows emitted 36 and 33% more CO_2, 75 and 35% more N_2O and captured 49 and 64% more CH_4 than Arlington and Marshfield, respectively.

Chambers placed in-row at Lancaster emitted 41 and 37% more CO_2, 69 and 13% more N_2O and captured 2% and 41% more CH_4 than Arlington and Marshfield, respectively. Arlington noticeably contributed the least N_2O, which might be explained with unusually dry weather conditions.

Generally, across locations and chamber placement, the rotation treatments cS, cSw and csW, compared to continuous corn, emitted to the environment less CO_2 by 34, 27 and 29%, and less N_2O by 38, 25 and 48%, respectively.

Pressure plate apparatus.

Water retention curves at Arlington.



Water Retention Preliminary Results

The results show that water retention at two soil depths were different among rotations (P=0.0259) and the slopes, at both depths, were the same (P>0.05).

At the first depth all treatments were different from each other (P<0.05). Greater organic mater increases water retention (5); which may explain why high biomass production in no-tilled continuous corn had the greatest water retention compare to other rotations, and CSW rotation had greater than CS.

At the second depth continuous corn had significantly greater (P<0.05) water retention; however, there was no significant differences between CS and CSW (P>0.05).

Corn-soybean-wheat rotation study at Arlington Research Station.

Future steps

This research is ongoing and these data will be compared with data from literature and other CSCAP projects to:

- Calculate total annual C fluxes via CO_2 and CH_4 and N via N_2O
- Estimate spatial variability of GHGs, by monitoring weather, soil quality, and other agronomic indicators
- Confirm our primary hypothesis that GHG emissions can be decreased and carbon retention and sequestration increased by using extended crop rotations
- Develop best-management recommendations for minimizing GHG's emissions from corn-based systems

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This research is part of a regional collaborative project supported by the USDA-NIFA, Award No. 2011-68002-30190: Cropping Systems Coordinated Agricultural Project: Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems. Project Web site: sustainablecorn.org