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The Use of Cover Crops as Climate-Smart Management in Midwest Cropping Systems

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1. Introduction

The observed trends in the Midwestern United States of increasing rainfall variability will likely continue into the future. Events such as individual days of heavy rain as well as seasons of floods and droughts lead to increased soil erosion, decreased water quality and reduced corn and soybean yields. Winter cover crops offer the potential to buffer many of these impacts because they essentially double the time for a living plant to protect and improve the soil. However, at present, cover crops are infrequently utilized in the Midwest (representing 1-2% of row cropped land cover) in particular due to producer concerns over higher costs and management, limited time and winter growing conditions as well as the potential harm to corn yields. In order to expand their use, there is a need to quantify how cover crops impact Midwest cropping systems in the long term and to understand how to optimize the benefits of cover crops while minimizing their impacts on cash crops.

Objective: Improve estimates of long term cover crop impacts on soil dynamics and cash crop yields in the Midwest

3. Summary

Model performance is suitable for the complexity of this cropping system

•Model fit statistics for maize, soybean, winter rye growth, soil carbon (see 2A) as well as for soil water and temperature (data not shown) are acceptable.

Maize and soybean yield impacts after long term cover crop incorporation

•APSIM predicted only minor non-significant differences between maize and soybean yields with the future climate scenarios.

Soil quality effects of cover crops and future climate scenarios

•An average cover crop biomass of 1200 kg ha^{-1} $year^{-1}$ reduced erosion by 19-28%. Further, the cover crop treatment had topsoil carbon losses of 1.7% (0-4 % CI) compared to a loss of 7.4% in the no cover crop treatment (5-9% CI).

Spring sampling of rye cover crop biomass

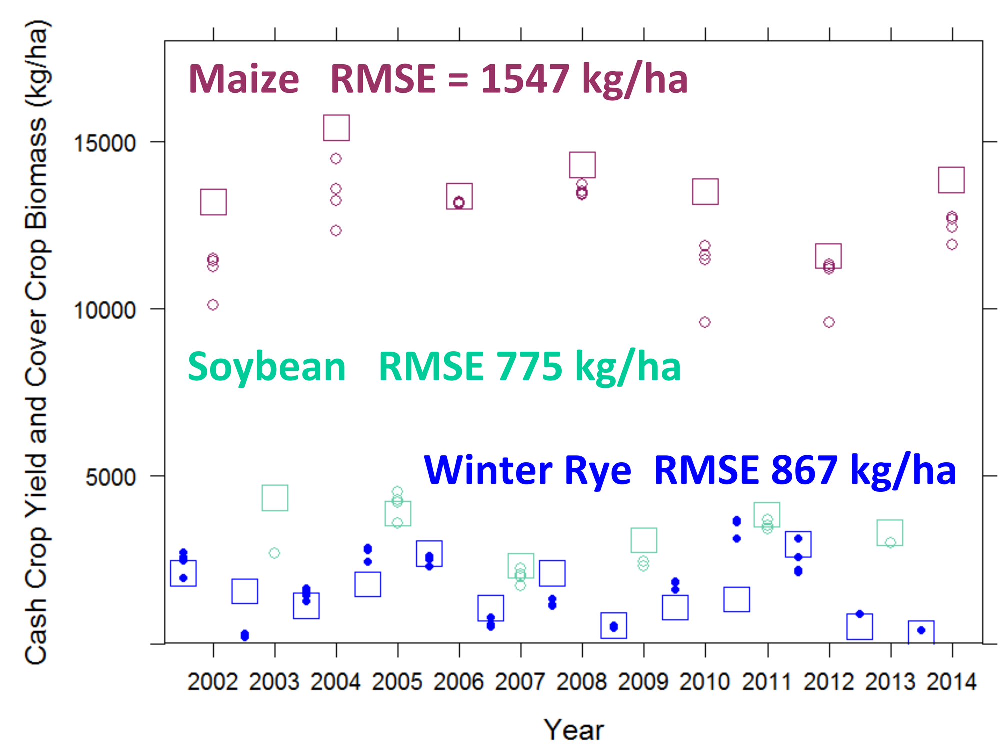
Aboveground biomass sampling of corn

Intact soil core sampling for water retention analysis and soil water parameters

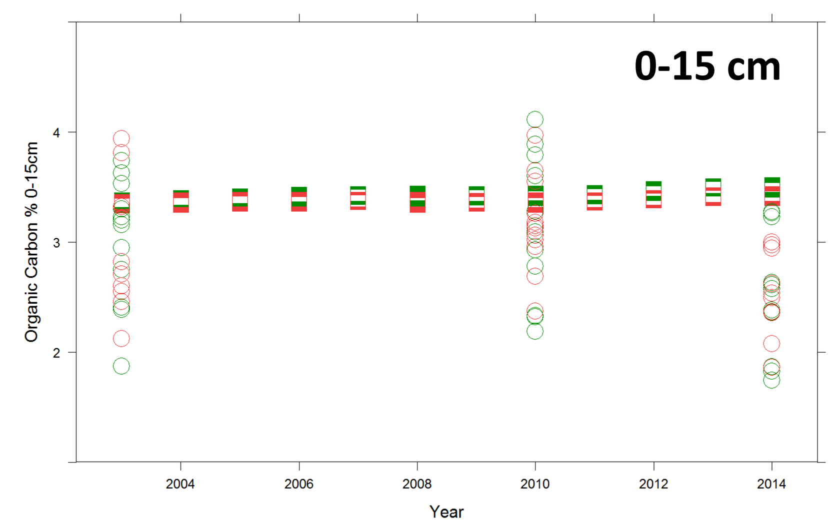
2A. Model Calibration and Testing

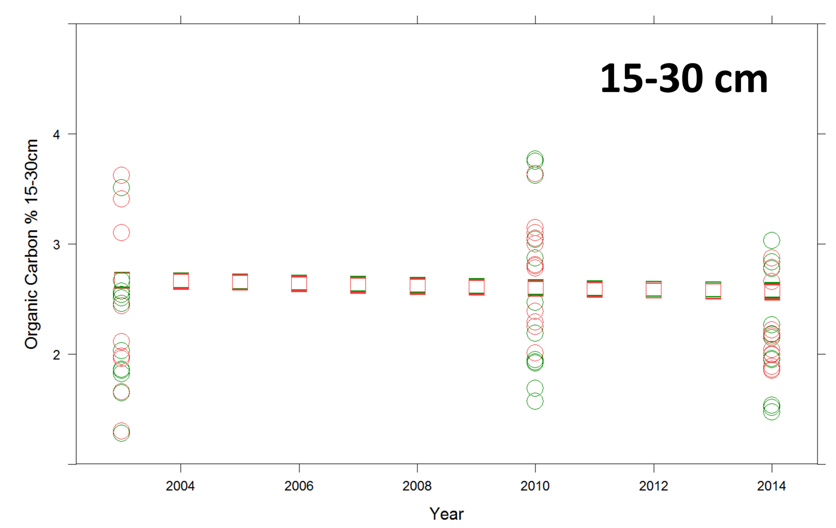
To establish our simulation, we utilized crop and soil data from a long term research site in Central Iowa managed with a winter rye cover crop for 15 years. We considered the period 2003-2008 for model calibration and 2009-2014 for model testing.

Model Testing



Simulated (squares) and observed (n=4, circles) data for the corn-soybean-winter rye rotation from 2002-2014.





Simulated (squares) and observed (circles) data for soil carbon. Field measurements from 2003, 2010 and 2014.

Crop Yields

Predictions do not show statistical differences between cover and no cover crop treatments, which matches field observations. Future weather increases crop yield variability.

No Cover Crop Trt

Cover Crop Trt

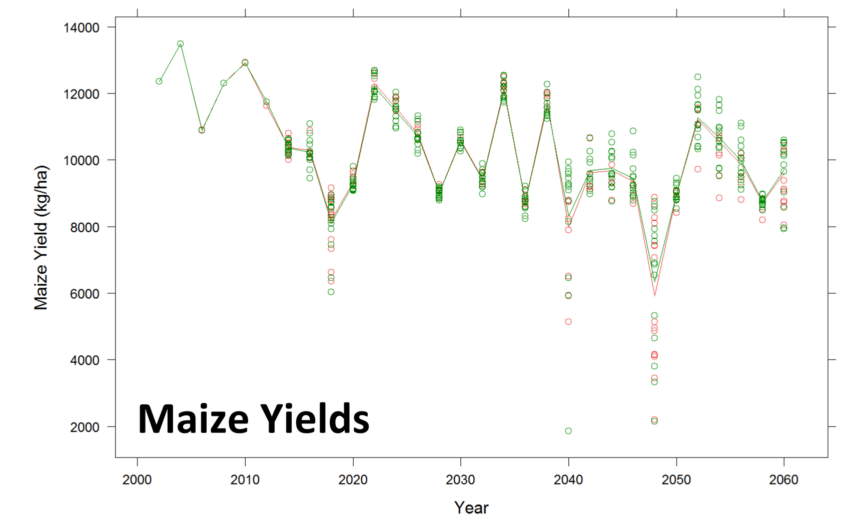
Soil Carbon

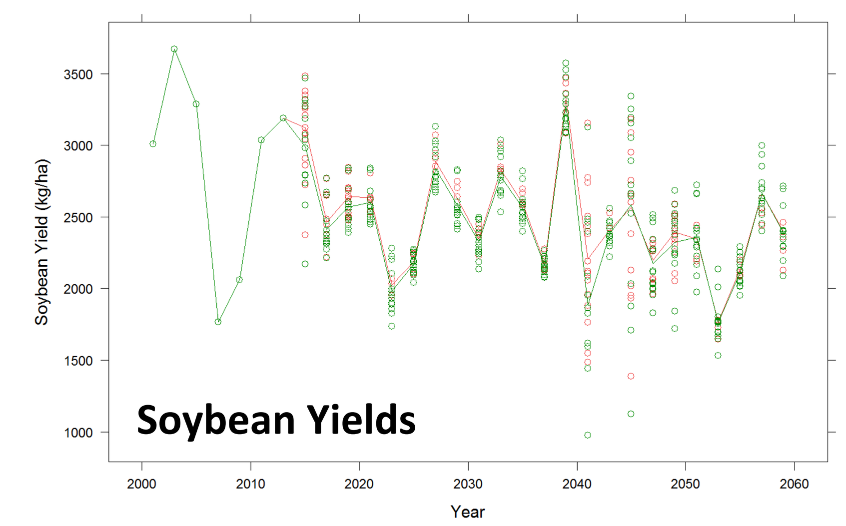
Soil carbon at both depths shows a decline over the 60 years of the simulation, more rapidly at the 15-30cm depths. At both depths, the cover crop treatment maintains higher carbon levels.

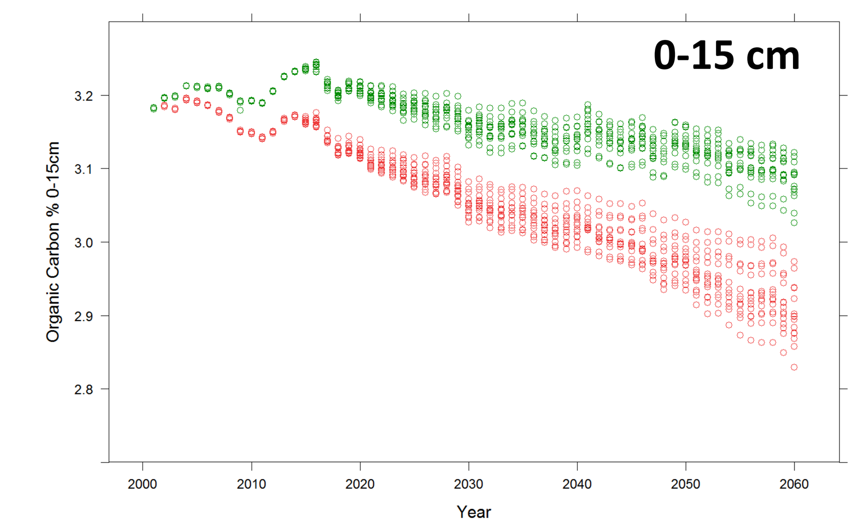
2B. Model Applications

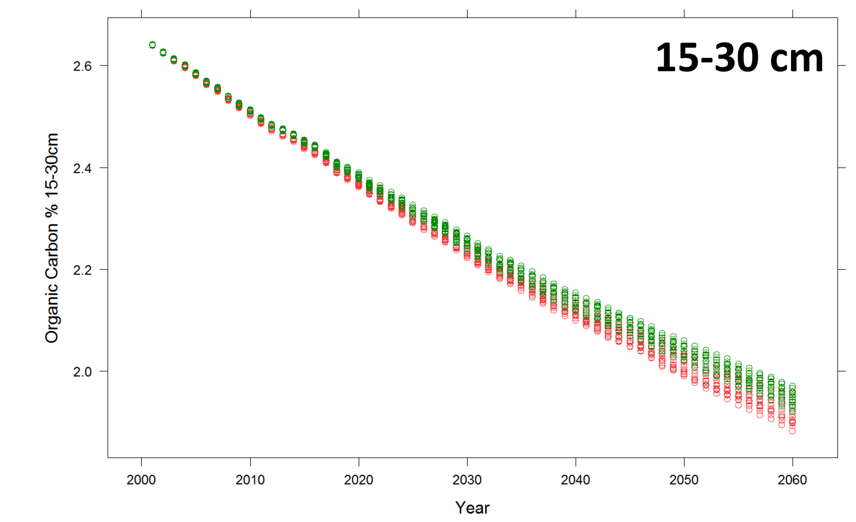
We generated future predictions using the methodology of the AgMIP Guide for Running Climate Scenario Generation Tools with R. We utilized 20 different CMIP5 GCM outputs with RCP4.5 and ran simulations through 2060.

Model Application









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