# Comparison of Soil Properties Under Long-Term Rotation and Tillage

**Stacy M. Zuber, Gevan D. Behnke, Emerson D. Nafziger, María B. Villamil**
**Department of Crop Sciences, University of Illinois at Urbana-Champaign**
**smzuber@illinois.edu**

## BACKGROUND

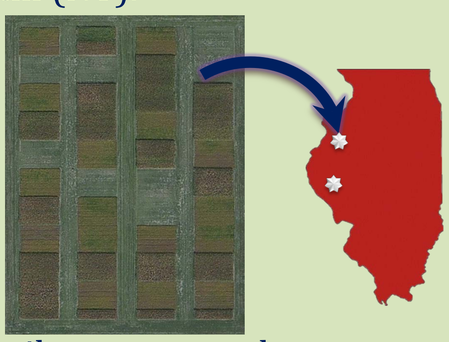
Recent increases in corn prices have led to a shift from multi-crop rotations to continuous corn throughout the Midwest U.S. Changes in tillage practices have also occurred as the monoculture becomes more common. It is vital to determine how tillage and rotations affect soil properties under long term use of these practices.

## OBJECTIVES

- To determine the effect of crop rotation and tillage on soil chemical and physical properties after 15 years management.
- To identify management practices that best maintain beneficial soil properties under long-term agricultural use.

## EXPERIMENTAL PROCEDURE

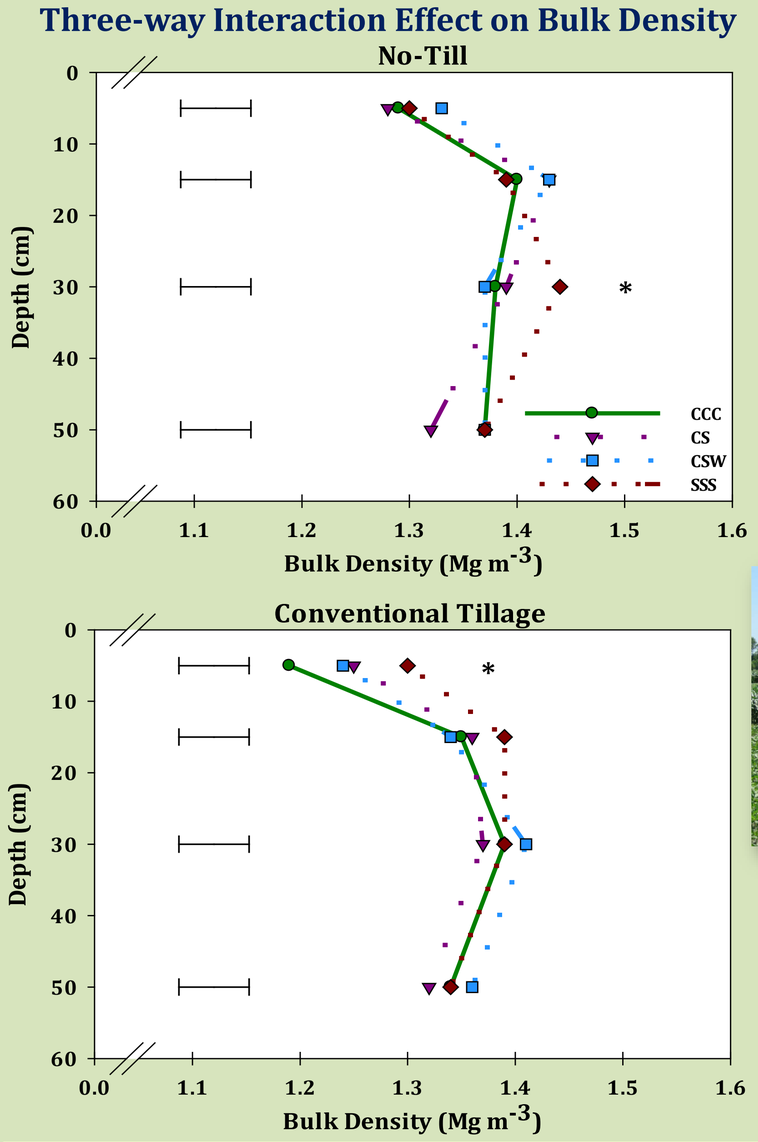
- Experimental plots were established in 1996 at two locations—near Monmouth, IL and near Perry, IL as a split-plot RCBD with four blocks. Whole plot treatments consisted of crop rotations of continuous corn (CCC), corn-soybean (CS), corn-soybean-wheat (CSW), and continuous soybean (SSS), with each present each year. Subplot treatments were chisel tillage (CT) and no-till (NT).



- Three soil cores per plot were sampled in May 2011 at Monmouth and May 2012 at Perry with only the corn phase sampled in CS and CSW rotations. Each core was cut to 0-10, 10-20, 20-40, and 40-60 cm. Bulk density (BD, Mg $m^{-3}$) was determined by the core method. Water aggregate stability (WAS, g $g^{-1}$) of 0-10 and 10-20 cm depths was measured using an Eijkelkamp wet sieving apparatus. Soil organic carbon (SOC, Mg $ha^{-1}$) and total nitrogen (TN, Mg $ha^{-1}$) were determined by dry combustion.
- Data was analyzed with Proc Mixed in SAS (ver 9.3, SAS Institute, 2012) with rotation, tillage, and depth as fixed and sites and blocks as random effects. Measurements at successive depths were analyzed using repeated measures. Treatment means were separated with an LSD ($\alpha$=0.10).

## RESULTS AND DISCUSSION

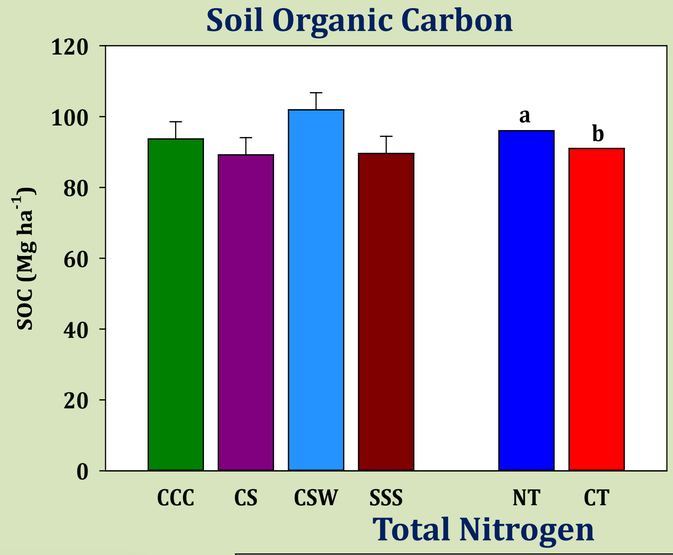
**Three-way Interaction Effect on Bulk Density**




- Under NT, BD for SSS was greater than the other rotations, but only at 20-40 cm.
- For CT, the only difference was at 0-10 cm, with the lowest BD for CCC and highest for SSS.
- Over 0-60 cm and averaged over all rotations, BD was greater for NT than CT.

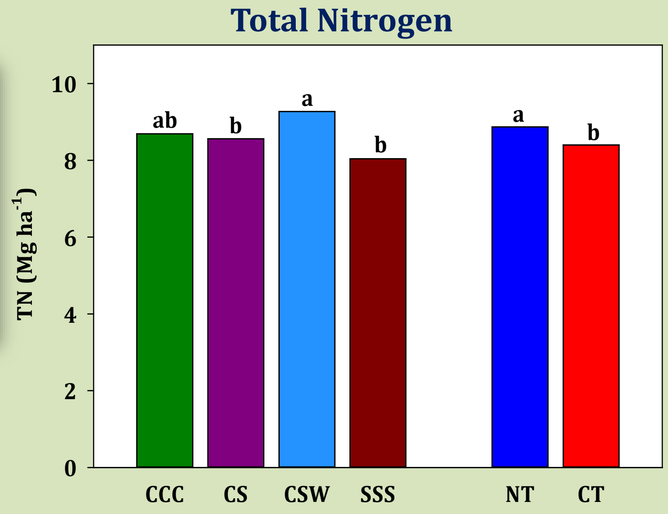
Corn residue for no-tillage (left) and chisel tillage (right) during March 2012

**Soil Organic Carbon**

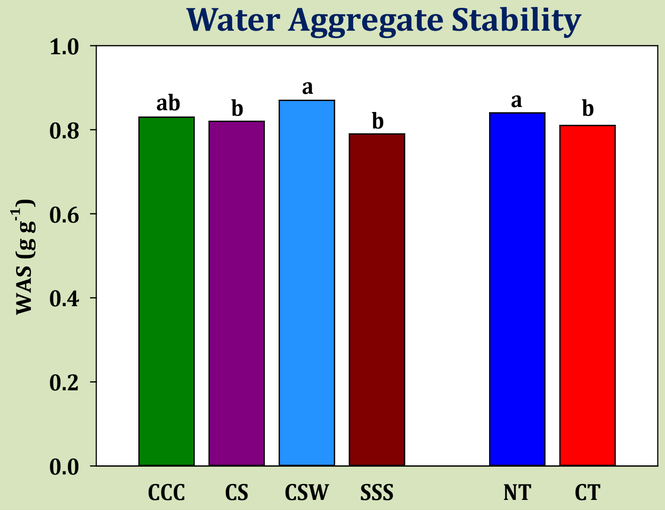



Soybean and corn plots during June 2012

**Total Nitrogen**




**Water Aggregate Stability**




- The greatest TN and WAS were found in CSW, and the lowest levels were in CS and SSS over 0-60 cm soil depth. While not significant, a similar trend among rotations is seen for SOC.
- For SOC, TN, and WAS, greater amounts were measured under NT compared to CT over 0-60 cm and all rotations.

## CONCLUSIONS AND RECOMMENDATIONS

- The interaction of rotation and tillage was significant only for BD. For the other properties, the effect of the rotation was alike for both tillage treatments.
- Although BD was greater under NT, the level was not high enough to impede root growth. Greater SOC, TN, and WAS were measured under NT, illustrating the benefit of no-till to soil quality.
- The crop rotations with the greatest residue production, CSW and CCC, produced the highest levels of WAS and TN. While not significant, the trend for SOC was the same as for WAS and TN.
- The addition of wheat to a CS rotation may be beneficial, but the CSW rotation affected the soil in the same way as the CCC monoculture. The rotations with more frequent soybean inclusion have less crop residue inputs to the soil leading to lower SOC, TN, and WAS.

## ACKNOWLEDGEMENTS

I would like to thank Dr. Villamil, Dr. Nafziger, Gevan Behnke, Rachel Welch, Juan Acuna, Ivan Dozier, Mollie Adams and the many undergraduate workers as well as the farm crews at Monmouth and Perry for all of their assistance.

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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

SUSTAINABLE CORN.ORG
CROPS, CLIMATE, CULTURE AND CHANGE

USDA
United States Department of Agriculture
National Institute of Food and Agriculture