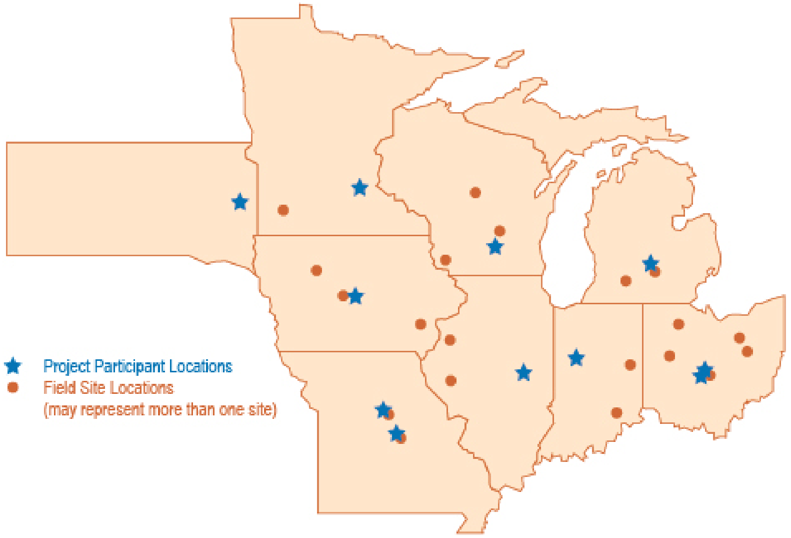
Cropping Systems Coordinated Agricultural Project (CSCAP):
Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems

ORGANIC RESEARCH

BUILDING MIDWEST AGRICULTURE RESILIENCE

The CSCAP is a transdisciplinary team seeking to increase the capacity of corn-soybean cropping systems to:
1) **Retain more soil carbon** resulting in improved soil quality and sustainability,
2) **Limit the loss of nitrogen** during seasonal peaks observed within Midwestern systems that have naturally rich soils and fertilizer applications,
3) **Stabilize soil and nutrients** during periods of saturated and flooded conditions while improving water availability and efficiency for crop use during moisture stress conditions,
4) **Build system resilience** by integrating productivity and environmental goals through field, farm, watershed and landscape level management in the face of changing climate, and
5) **Transfer knowledge and findings** through science-driven, experiential learning opportunities to equip and educate farmers and teachers.

A partnership among 11 institutions: Iowa State University, Lincoln University, Michigan State University, The Ohio State University, Purdue University, South Dakota State University, University of Illinois, University of Minnesota, University of Missouri, University of Wisconsin, USDA Agricultural Research Service – Columbus, Ohio.



The team is investigating complex carbon, nitrogen, and water cycles to increase the efficiency and productivity of corn-based cropping systems while simultaneously decreasing the environmental footprint under extreme and variable long-term weather conditions.

An integrated approach is utilized across 35 research locations (*see map*) to capture crop and environmental responses under a suite of management practices including: corn-soybean rotation, cover crops within a corn-soybean rotation, extended crop rotations, organic cropping system, drainage water management, nitrogen fertilizer management, tillage management, and landscape position. A set of local, regional, and national scale models utilize the field research data to examine current and predicted implications of the various practices on C, N, and water under different climate conditions. Farmer social and economic behaviors and responses are additionally researched related to changing climate, including farmer perceptions of impacts to their production systems.

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

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ORGANIC RESEARCH : BIG PICTURE

Two-thirds of organic corn grain production occurs within a nine state region in the central US. Research investigating the sustainability of these systems, specifically the water, carbon and nitrogen footprints, is necessary to identify the strengths of these systems and weaknesses. Climate patterns in the central US are expected to become increasingly variable with changes in rainfall intensity, seasonality and available moisture. The economic and social importance of corn makes it a top priority for determining the effects of increasing climate variability on crop production and water requirements. Two CSCAP research hubs exist that are examining these questions, in Coshocton, OH and Lamberton, MN with a paired set of organic experiments designed **to quantify water use across the individual components, crops (corn, soybean, wheat and cover crops) and weeds, as well as the whole system.**

Crop rotation diversification is the most powerful tool that farmers have to reduce economic risk, disrupt pest cycles, increase soil resilience, and improve water quality. Diverse crop rotations have the potential to increase soil organic carbon (SOC) retention and sequestration thereby mitigating the impacts of climate change. Additional potential co-benefits of mitigating climate change through managing soil carbon include increased water and nutrient holding capacity, and improved water use efficiency (WUE) and nutrient use efficiency.

OUTCOMES

- Receive $95,000 for research from organic industry to-date to support and expand research efforts in OH and MN.
- Building dataset regarding water use in organic systems with similar data collected in OH and MN for west-east synthesis.
- Building dataset of overall footprint of conventional and organic systems performance for sustainability metrics.

RESEARCH FUNDED BY:

ORGANIC VALLEY

FARMERS ADVOCATING FOR ORGANICS

Sustainable Food Trade Association
organic leaders for sustainability

Annie's

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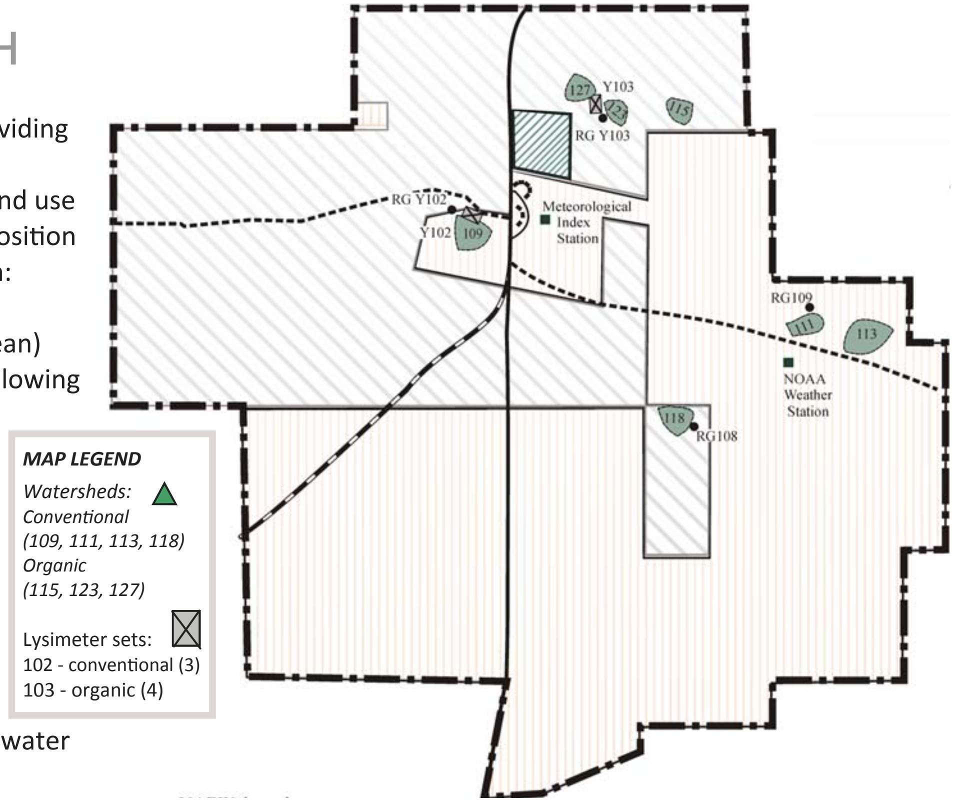
OHIO ORGANIC RESEARCH

Efforts are focused on determining and quantifying the role of cover crops in providing weed control in organic grain production systems. This involves a 3 year rotation and use of annual cover crops that differ in composition based on the ensuing crop in the rotation:

- Radish and rye (following corn)
- Radish and cowpeas (following soybean)
- Radish, cowpeas, and sunn hemp (following wheat)

Data gathered includes:

- Agronomic and soil data as per CSCAP protocols
- Flume to quantify runoff
- Lysimeters measure runoff and percolate
- Weather data
- Soil moisture sensors to monitor soil water profile



2013 ORGANIC RESEARCH ACCOMPLISHMENTS AND RESULTS:

Weeds flourished during the summer drought in 2012 overtaking all the crops. Weed biomass was sampled and the C and N content was determined. Crop failure ensued and the biomass was baled and removed to allow planting of additional cover crops to create a surface mat of residue and also generate allelopathic effects to inhibit weed dominance. Wet conditions following planting in 2013 also exacerbated the weed problem by preventing timely cultivation in the corn phase.

Watershed-Level Research

Lysimeter

Water Capture Facility

MINNESOTA ORGANIC RESEARCH

Data gathered from all research sites include:

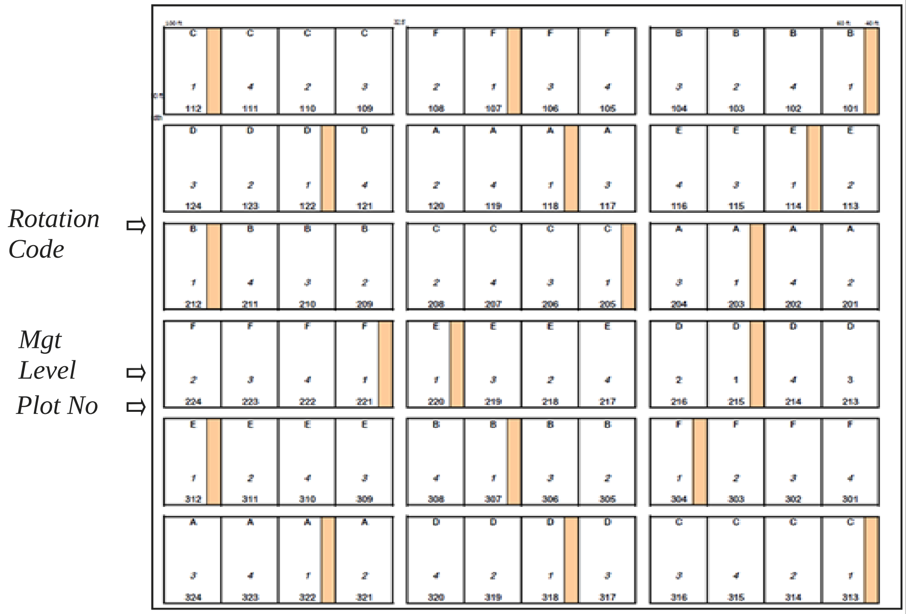
- Agronomic and soil data as per CSCAP protocols
- Weather data
- Soil moisture sensors to monitor soil water profile

In Minnesota, comparisons include a two-year conventional rotation of corn following soybean, a four-year conventional and a four-year organic rotation of corn, soybean, oat-alfalfa, alfalfa, a three year organic rotation of corn, soybean, wheat-red clover and a perennial native grass *(see map)*.

Variable Input Crop Management Study (VICMS)

Mgt Levels 1– Min(2B), 2=Lower Purchased Inputs(LB), 3=Higher Purchased Inputs(HEI),4=Organic(OI)

Rotations: A,B,C,D=4 years, E & F= 2year



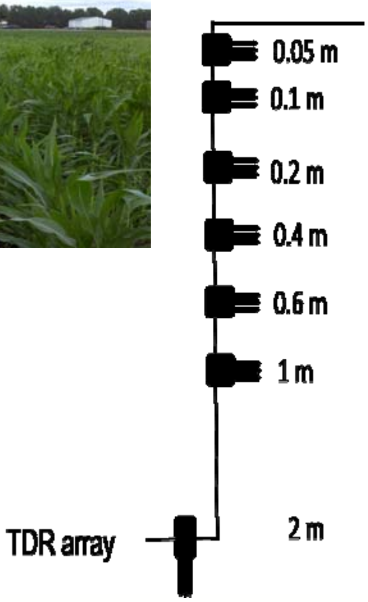
40ft wide prairie strips in the eastern portion of MN(1) plots

PLOT SIZE:0.4132 ac (100x180)

Soil Moisture Data Equipment

Solar powered data logger

Soil Moisture Probe



Weather Stations

VICMS Research Plots

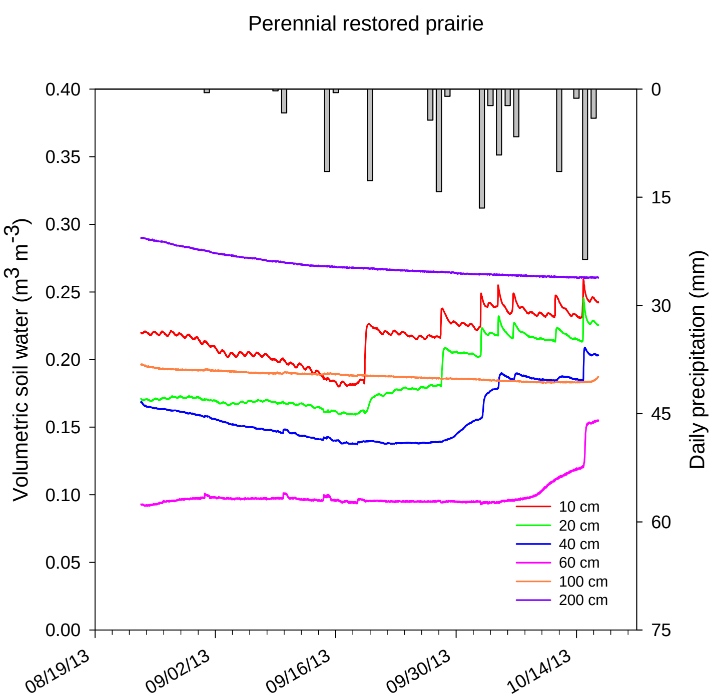
MINNESOTA 2013 RESEARCH ACCOMPLISHMENTS AND RESULTS:

Water is an important factor in crop production. The approximate seasonal water requirements for corn, soybean and small grains are similar and range between 500-800 mm, 450-700 mm and 450-650 mm, respectively, for optimum yield depending on variety, and crop and water management. The seasonal water requirements for alfalfa are considerably greater and range between 800-1600 mm. Prevailing weather conditions, available water in the soil, crop species, and growth stage influence crop water use.

Table 1. Partial seasonal soil water balance components for restored prairie, organic and conventional crop rotations from 0-200 cm soil depth (August 24-October 15, 2013).

Component (mm)	Organic 4-yr rotation				Conventional 4-yr rotation				Conventional 2-yr rotation		Perennial Restored Prairie
Rainfall	130				130				130		130
	Corn	Soybean	Oat/ Alf.	Alfalfa	Corn	Soybean	Oat/ Alf.	Alfalfa	Corn	Soybean	Prairie
Change in soil water storage (DS)	-21	-38	-29	-45	-44	-28	-35	-28	-29	-21	-34
Total rotation DS	*-133*				*-135*				*-50*		*-34*

The partial seasonal soil water balance for change in soil water storage is shown in Table 1, for cropping systems and crops within cropping systems. The totals for 2013 between the extended 4-year rotations are not significantly different. The change in soil water storage for corn in the 4-year conventional system was significantly more negative than for either the 4-year organic system or the 2-year conventional system. The change in soil water storage for alfalfa in the 4-year organic system was significantly more negative than for the 4-year conventional system. Yield information for all crops was not available at the time of this report so no estimates of crop water productivity were calculated. It is expected that differences in soil water storage and expected yield differences among cropping systems will result in differences in crop water productivity. Crop water productivity is the quotient of crop yield and crop water use efficiency (CWUE) where crop yield is the dividend and CWUE is the divisor.



Changes in volumetric soil water content by depth for the perennial restored prairie are shown in Figure 1. This data shows the hourly change in soil water content for the soil profile to 2 m. The data indicate that during 2013, changes in soil water content were dynamic above 1 m in response to precipitation events and water use by the grasses and forbs in the prairie. Data from this project will be shared with stakeholders during annual meetings beginning in 2014.