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CROPS, CLIMATE, CULTURE AND CHANGE

The **Climate and Corn-based Cropping Systems CAP (CSCAP)** is a transdisciplinary team creating new science and educational opportunities. The CSCAP team seeks to develop a suite of practices that heighten system capacity to: 1) retain and enhance soil organic matter nutrient and carbon stocks, 2) reduce off-field nitrogen losses that contribute to greenhouse gas emissions and water pollution, 3) better withstand droughts and floods, and 4) ensure productivity under different climatic conditions.

TOP 10 YEAR TWO ACCOMPLISHMENTS

1. **Two years of carbon, nitrogen, and water data collected across the CSCAP research network.** Researchers completed baseline and Year Two measurements on corn-based cropping systems, including collecting agronomic, soil, and water data across 35 field research sites in 8 Midwestern states.
2. **Centralized database constructed to functionally increase data sharing and analyses.** Entry and import features of the team's centralized database were created to allow team members to efficiently enter data, share data and access data for analyses.
3. **Climate and agricultural models calibrated and integrated.** Crop, soil, water, and systems models—including DAYCENT, SALUS, DNDC, SWAT, EPIC, and VIC—were calibrated and integrated to enable research that can capture and address the complexity and geographic scale of corn-based systems' environmental footprint.
4. **Survey of 5000 farmers from 22 watersheds representing 60 percent of US corn production.** Results show that 66 percent of farmers in the region believe that climate change is occurring, 31 percent are uncertain, and four percent do not believe it is happening. Farmers who believe it is occurring *and* due to human activity (41 percent) expressed higher levels of concern about potential impacts and were more likely to support adaptation and mitigation activities than those who attribute climate change primarily to natural causes, are uncertain about its existence, or do not believe it is occurring. For more details, see: http://www.sustainablecorn.org/videos.html#Arbuckle.
5. **20 Land Grant University (LGU) Extension Educators enrolled 92 farmer cooperators.** Across ten LGU's, extension educators formed farmer working groups to discuss long-term weather shifts and related management decisions. Educators received climate training and prepared materials for farmers on topics such as the recent drought and past flooding events.
6. **Teachers and high school students engaged in experiential learning and applications of science.** Twenty-six individuals participated in two interactive summer camps where they learned from CSCAP scientists about climate science, agricultural production, and global challenges related to natural resources and climate.
7. **Next generation scientists created a roadmap for becoming disciplinary and transdisciplinary scholars.** The project's 35 graduate students created a roadmap defining their disciplinary and transdisciplinary project expectations and opportunities. While learning their disciplinary science, graduate students gave presentations and created posters for the annual meeting, participated in monthly working groups, and served on project committees.
8. **Leveraged financial resources to accomplish more.** Scientists reached out to key partners and leveraged the USDA investment to acquire an additional $1.02 million for project activities in year two.
9. **370 Presentations, fact sheets, newsletters, videos and refereed journal articles produced.** Team members communicated agronomic, soil, water, and greenhouse gas information to farmers, agribusiness, and scientists. Many of the communication pieces can be found on the CSCAP website: www.sustainablecorn.org.
10. **Team members learned more about each other's disciplinary science to build collaboration and capacity as a transdisciplinary project.** Working groups, printed materials and a series of speed science presentations were employed to build working knowledge and identify points of connectivity across the CSCAP's six objectives and 140 members.

CSCAP is a regional collaboration supported by USDA-NIFA Award No. 2011-68002-30190, "Cropping Systems Coordinated Agricultural Project (CAP): Climate Change, Mitigation, and Adaptation in Corn-based Cropping Systems." The 11 institutions comprising the project team include: University of Illinois; Iowa State University; Lincoln University; Michigan State University; University of Minnesota; University of Missouri; The Ohio State University; Purdue University; South Dakota State University; University of Wisconsin; and USDA-ARS Columbus, Ohio.
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USDA United States Department of Agriculture National Institute of Food and Agriculture

Balancing Carbon, Nitrogen and Water

Agriculture faces unmatched challenges to maximize the efficient use of inputs, reduce its environmental footprint, and increase crop productivity. CSCAP scientists are working to better understand the complex interactions among our changing climate; crop management practices; and carbon, nitrogen and water footprints, to identify adaption and mitigation strategies for farmers and policy makers.

What we know…

- Agriculture covers 40-50% of the Earth's land surface; it affects and is affected by greenhouse gas levels.
- Increases in greenhouse gases (GHG) such as CO_2 (carbon dioxide) and N_2O (nitrous oxide) warm the earth's surface and impact rainfall, snow cover, humidity, winds, and regional temperatures.
- Increased CO_2 is expanding habitable zones for invasive species. Higher temperatures and increased moisture contribute to accelerated growth of plant pathogens and insect populations.
- Nitrogen fertilizer efficiency—the fraction of applied nitrogen that is absorbed and used by the plant—is influenced by moisture and temperature.
- During rains and snow melts, nitrogen that has not been absorbed by plants can be lost off-field in the form of nitrates, which move through subsurface tiles and other subsurface flow paths into nearby streams and eventually into rivers. Nitrates from Midwestern crop fields are a major cause of the hypoxic zone in the Gulf of Mexico—a large region of water that has very low oxygen concentrations and therefore cannot support aquatic life.
- High crop yields coupled with the efficient use of nitrogen fertilizer achieve the lowest GHG emissions per unit of yield.
- Management practices that build soil organic matter can help to maintain long term productivity of soils.

CSCAP cooperator farmers attend a Michigan State University Extension Field Day.

Field with/without a cover crop. Photo by Tom Kaspar

Seeking to know more…

There is still much scientists do not know about the complex interactions among our changing climate and agricultural systems. Some of the questions CSCAP scientists seek to answer as a result of this project are:

- How do changes in drainage water management alter yield variability and nitrogen and water use efficiency? To what extent can drainage water management increase soil water storage and reduce overall nitrate export to streams?
- How do cover crops increase soil carbon, soil aggregation and soil water infiltration and affect year-to-year variability in yield? To what extent can cover crops reduce nitrate leaching by taking up residual soil nitrate? What is the effect of cover crops on yield in different corn production systems under varying weather stresses and diverse terrains?
- How do tillage management systems, winter cover crops, extended rotations, and drainage systems impact the GHG footprint of corn production systems? How does sensor-based nitrogen (N) fertilizer management impact the GHG footprint?
- How do changes in weather patterns and potential changes in agronomic and soil management (such as cover crops, water drainage management, extended crop rotations, reduced tillage) influence pest cycles?
- What are the life-cycle environmental and resource impacts and trade-offs of alternative corn management systems under projected future climate scenarios?
- What is the least-cost placement of cover crops and drainage management to achieve nutrient reduction goals in individual watersheds in the Upper Mississippi River Basin and the entire Basin? How does the optimal placement and cost change when crop prices increase?
- In what ways do farmers perceive climate change as a threat to their livelihoods and how do their perceptions influence their willingness to be supportive of or adopt adaptation strategies?

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