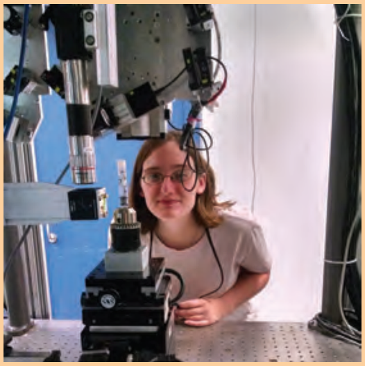
Climate & Corn CAP Next Generation Scientists

Poster Symposium

Oct 15, 2015

Washington, DC

INSIDE: poster titles and authors, and research summaries



project website:

SUSTAINABLE CORN.ORG

CROPS, CLIMATE, CULTURE AND CHANGE

The Climate and Corn-based Cropping Systems CAP (Climate & Corn CAP) is a USDA-NIFA supported program, Award No. 2011-68002-30190. It is a transdisciplinary partnership among 11 institutions creating new science and educational opportunities. The Climate & Corn CAP seeks to increase resilience and adaptability of Midwest agriculture to more volitile weather patterns by identifying farmer practices and policies that increase sustainability while meeting crop demand. (Pub. no. CSCAP-0187-2015)

USDA

United States Department of Agriculture

National Institute of Food and Agriculture

The Climate & Corn CAP at a Glance...

The Climate & Corn CAP (Coordinated Agricultural Project) began in 2011 thanks to a grant from the U.S. Department of Agriculture National Institute of Food and Agriculture, which was seeking to invest in sound science that helps producers adapt or transform their corn-based cropping systems to be more resilient and sustainable under changing weather patterns and more frequent and extreme weather events.

Field Trials, Analysis and Modeling

Project scientists are collecting and analyzing data from 35 sites in eight states in the Corn Belt, using standardized protocols and a centralized database. They also are measuring crop production, pests and carbon (C), nitrogen (N) and water footprints as they examine the effects of various crop management practices. They are using models to evaluate the impacts of the practices on C, N and water footprints for different climate and economic scenarios. The practices include no-till, extended and diverse crop rotation, drainage water management, cover crops and canopy N-sensors. Team members aim to develop a suite of practices for corn-based cropping systems that:

> Retain and enhance soil organic matter and nutrient and carbon stocks

> Reduce off-field nitrogen losses that contribute to greenhouse gas emissions and water pollution

> Better withstand droughts and floods

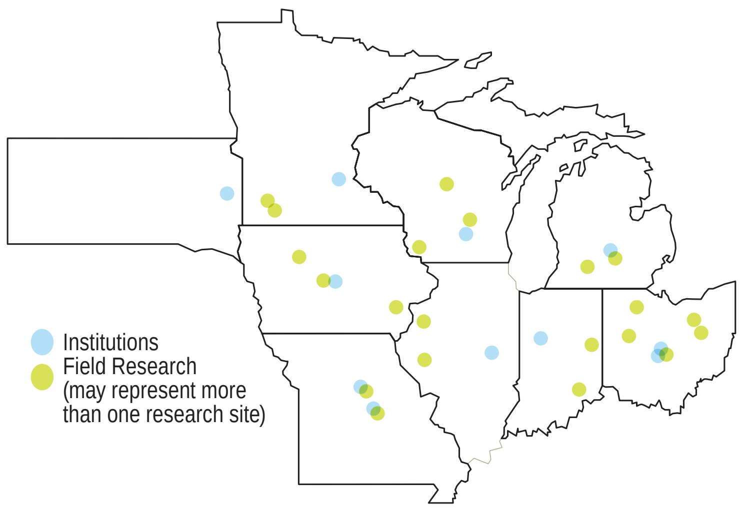
> Ensure productivity under different climate conditions

Social and Economic Research

The effectiveness of any adaption or mitigation action in Corn Belt agriculture depends on the degree to which the region's farmers are willing and able to act. Project social scientists are conducting social science research to assess farmers' understanding of climate change impacts and attitudes toward adaption and mitigative practices and strategies.

Extension and Education

Through our extension team, who work at land-grant universities, we work with farmers to connect our science to their on-farm decisions and to learn from each other. And through the education aspect of the project, we involve graduate students and train teachers to ensure learning and scientific investigation of climate change impacts on Corn Belt agriculture continues.



Management Practices

Corn-Soybean Rotation, Cereal Rye Cover Crop, Extended Crop Rotations, Organic Cropping System, Drainage Water Management, Nitrogen Fertilizer Management, Tillage Management, Landscape Position

project website:

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CROPS, CLIMATE, CULTURE AND CHANGE

CLIMATE & CORN CAP TEAM

> 46 principal investigators (PIs)

> 11 project partner PIs

> 57 research or technical staff

> 23 extension educators

> 20 postdoctoral associates

> 85 graduate students

> 22 advisory board members

(Numbers are cumulative)

Team members are associated with the following institutions:

> University of Illinois

> Iowa State University

> Lincoln University

> Michigan State University

> University of Minnesota

> University of Missouri

> The Ohio State University

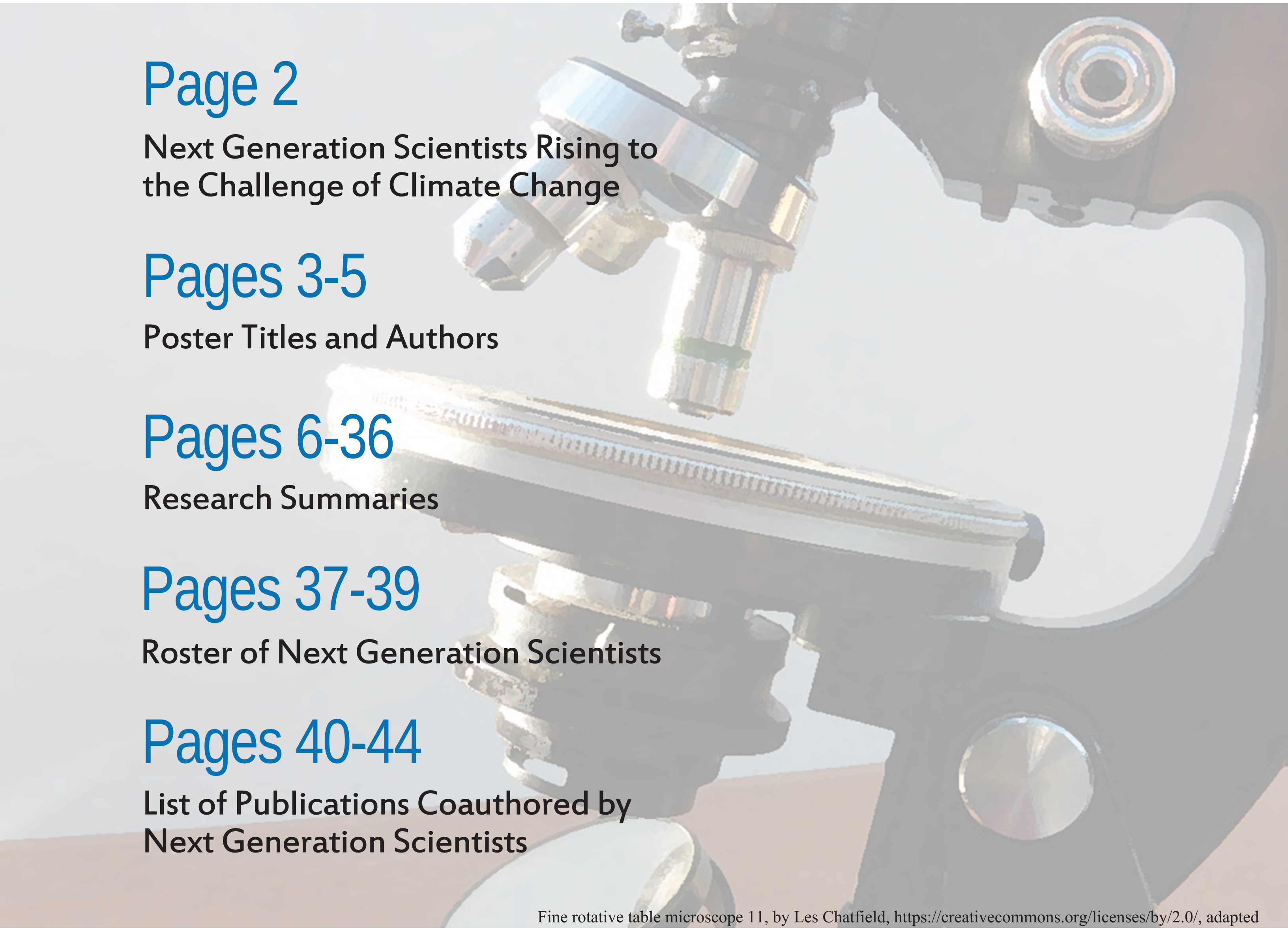
> Purdue University

> South Dakota State University

> University of Wisconsin

> USDA Agricultural Research Service, Columbus, Ohio

Contents



Fine rotative table microscope 11, by Les Chatfield, https://creativecommons.org/licenses/by/2.0/, adapted


1-10 Corn Field by Davis Staedtler CC 2.0

Next generation scientists rising to the challenge of climate change

Addressing the complexities of climate and cropping system resilience requires Climate & Corn CAP* next generation scientists to work hard to excel as scientists within their own discipline, as well as learn how to work collaboratively with scientists in other disciplines.

Each individual is housed within a land-grant University and must meet their institutional requirements as well as contribute to project goals. They progress in their comprehension and ability to participate in transdisciplinary work as they participate in the opportunities offered through the project, such as field and lab research, team meetings, science webinars, and sharing what they've learned with fellow team members through field demonstrations and poster presentations.

To-date, 132 undergraduate students, 85 graduate students (32% minority and 47% women) and 20 postdoctoral associates (75% minority and 10% women) have been involved with the Sustainable Corn team. This equates to a total of 3674 months of experience for this cohort. Our team's current contingent includes 39 graduate students and 7 postdoctoral next generation scientists. Next generation scientists have been highly engaged in the science of the team and extending that out by coauthoring journal articles. To-date, 66 journal articles have been coauthored by next generations which is an important success metric and will help them move into science based careers.

**USDA-NIFA Climate and Corn-based Cropping Systems Coordinated Agricultural Project*

Posters ~

Alphabetically by last name of presenting author

Effect of Tillage, Cover Crop and Crop Rotation on Soybean Yield and Grain Carbon Content

Shanta Acharya* *and Nsalambi Nkongolo*
Lincoln University, Jefferson City, MO

Simulating Long-term Impacts of Cover Crops and Climate Change on Crop Production and Environmental Outcomes in the Midwestern United States

Andrea Basche[1]*, *Fernando Miguez[1], Sotirios Archontoulis[1] and Thomas Kaspar[2]*
[1]Iowa State University, Ames, IA; [2]National Laboratory for Agriculture and the Environment, USDA-ARS, Ames, IA

Carbon Processes in the Presence of Cover Crop on Diverse Terrain

Jordan Beehler* *and Alexandra Kravchenko*
Michigan State University, East Lansing, MI

Climate Education Solutions for the U.S. Cornbelt

Kimberly Chapman[1]*, *Kristi Lekies[1], Richard Moore[1], Deana Hudgins[1], Todd Higgins[2], Nsalambi Nkongolo[2], Laura Frescoln[3], Colin McKellar[4], Morgan Schafbuch[3], Cody Troop[4], Dennis Todey[4], Wade Miller[3] and David Blockstein[5]*
[1]The Ohio State University, Columbus, OH; [2]Lincoln University, Jefferson City, MO; [3]Iowa State University, Ames, IA; [4]South Dakota State University, Brookings, SD; [5]National Council for Science and Environment

Quantifying the Impacts of a Cereal Rye Cover Crop on Soil Water Content and Temperature in Central Iowa

Kristina Craft*, *Matthew Helmers, Rebecca Roberts and Michael Castellano*
Iowa State University, Ames, IA

Preparing the Next Generation of Scientists: A Transdisciplinary Approach

Laura Di Giulio[1], *Kristi Lekies[1], David Blockstein[5], Wade Miller[3], Richard Moore[1], Nsalambi Nkongolo[2] and Dennis Todey[4]*
[1]The Ohio State University, Columbus, OH; [2]Lincoln University, Jefferson City, MO; [3]Iowa State University, Ames, IA; [4]South Dakota State University, Brookings, SD; [5]National Council for Science and Environment

Increased Risk of Insect Injury to Corn with Rye Cover

Mike Dunbar*, *Aaron Gassmann, and Matthew O'Neal*
Iowa State University, Ames, IA

Soil Quality as Affected by Cereal Rye under Corn-Soybean Rotation in the U.S. Corn Belt

Christopher Eidson* *and Rattan Lal*
The Ohio State University, Columbus, OH

Using a Cereal Rye (*Secale cereale* L.) Cover Crop to Mitigate Effects of Climatic Stresses on a Corn-Soybean (*Zea mays* L. – *Glycine max* L. *Merr.*) Rotation in Indiana

Trevor Frank*, **Joseph Rorick*** *and Eileen Kladivko*
Purdue University, West Lafayette, IN

(continued on next page)

Posters continued...

Dominant Worldviews in the U.S. Conventional **Agriculture and its Influence on Farmers'** Support for Climate Change Adaptation

Maaz Gardezi* *and J. Arbuckle*
Iowa State University, Ames, IA

Understanding Prediction Robustness of the Root Zone Water Quality Model (RZWQM)

Lei Gu[1]*, *Robert Anex*[1], *Michael Fienen*[2] *and Matthew Helmers*[3]
[1]*University of Wisconsin, Madison, WI;* [2]*Wisconsin Water Science Center, U.S. Geological Survey, Middleton, WI;* [3]*Iowa State University, Ames, IA*

Soil Management Practices: Influences on Soil Nutrients

Samuel Haruna[1,2]* *and Nsalambi Nkongolo*[1]
[1]*Lincoln University, Jefferson City, MO;* [2]*University of Missouri, Columbia, MO*

Midwest Specialty Crop Growers' Views on Climate Change Impacts

Anna L Johnson* *and Lois Wright Morton*
Iowa State University

Validation of DayCent Model on N_2O Emission from Crop Rotations in Wisconsin

Maciej Kazula*, *Joe Lauer and Thierno Diallo*
University of Wisconsin, Madison, WI

Assessing the Impacts of Agricultural Management Practices on Crop Yields and Nitrate-Nitrogen Concentrations from Subsurface Drainage in Iowa

Ainis Lagzdins*, *Matthew Helmers, Carl Pederson, Linda Schott, Xiaobo Zhou and Aaron Daigh*
Iowa State University, Ames, IA

Sustainable Corn Project Team Personnel, Meetings and Outputs: Facts and Figures

Suresh Lokhande*, *Lori Abendroth, Katie Schwaegler and Lois Wright Morton*
Iowa State University, Ames, IA

Corn Yield Response to Winter Cover Crops: A Meta-Analysis Update

Guillermo Marcillo* *and Fernando E. Miguez*
Iowa State University, Ames, IA

Relationship between Soil Pore Space Indices and Greenhouse Gases Fluxes in a Corn-Soybean Field at Freeman Farm, Missouri

Dinesh Panday* *and Nsalambi Nkongolo*
Lincoln University, Jefferson City, MO

Root and Shoot Biomass and Nutrient Composition in a Winter Rye Cover Crop

Swetabh Patel*, *John E. Sawyer, John P. Lundvall and Jeena I. Hall*
Iowa State University, Ames, IA

Use of Computed Microtomography to Investigate the Microstructure of Soil Aggregates

Michelle Quigley[1]*, *Alexandra Kravchenko*[1] *and Mark Rivers*[2]
[1]*Michigan State University, East Lansing, MI;* [2]*University of Chicago, Chicago, IL*

Comparison between Gas Chromatograph and Photo Acoustic Methods for Measuring CO_2 and N_2O Emissions in Corn-Soybean Field

Dipti Rai* *and Nsalambi Nkongolo*
Lincoln University, Jefferson City, MO

Spring Timing and Method of Cereal Rye Termination Influence Soil Nitrate

Rebecca Roberts*, *Michael Castellano, Matthew Helmers, Kristina Craft and Carl Pederson*
Iowa State University, Ames, IA

Soil Health as an Integrative Concept: Farmer Adaptation to Climate Change and On-Farm Resiliency

Gabrielle Roesch-McNally*, *J. Gordon Arbuckle and John Tyndall*
Iowa State University, Ames, IA

Drainage Water Management Effect on Water Table Recession Rate

Samaneh Saadat*, *Jane R. Frankenberger, Laura C. Bowling and Kyle Brooks*
Purdue University, West Lafayette, IN

Effects of Drainage on Crop Yield, Soil Water Content, Drainage Volume, Nitrate Loss, and Planting Date in Southeastern Iowa

Linda Schott*, *Carl Pederson and Matthew Helmers*
Iowa State University, Ames, IA

Persistent Effect of Management on Soil Organic Matter Composition from Whole to Within Macroaggregate Scale, Evidence from 13C-NMR, FTIR and X-ray Tomography

Ehsan Toosi[1]*, *Kusay Wheib[1] Michelle Quigley[1], Jingdong Mao[2], Sasha Karvchenko[1]*
[1]Michigan State University, East Lansing, MI; [2]Old Dominion University, Norfolk, VA

Changes in Water Balance in the Corn Belt over the Past 30 Years

Cody Troop[1]*, *Dennis Todey[2] and William Capehart[1]*
[1]South Dakota School of Mines and Technology, Rapid City, SD; [2]South Dakota State University, Brookings, SD

Quantifying the Impacts of Tillage on Cover Crop Growth, Nitrogen Uptake, Soil Moisture, and Soil Temperature

Emily Waring*, *Linda Schott, Ainis Lagzdins, Carl Pederson and Matt Helmers*
Iowa State University, Ames, IA

The Past Matters: Communicating Climate Science for Agricultural Decision Support

Adam Wilke* *and Lois Wright Morton*
Iowa State University, Ames, IA

Comparison of Soil Properties under Long-Term Crop Rotation and Tillage

Stacy Zuber*, *Gevan Behnke, Emerson Nafziger and Maria Villamil*
University of Illinois, Urbana, IL




Shanta Acharya, Lincoln University - Missouri

My research

The objective of my research was to assess the effect of four years of tillage/no-till, rotation and cover cropping on the yield of soybean.

Why I'm doing the research

Worldwide, soybean is an important and inexpensive source of protein for humans and livestock. The U.S. accounts for 35 percent of global soybean production, of which more than 85 percent is produced in the north central region known as the Corn Belt. But soybean, like all row crops, has environmental impacts. There are also concerns that a changing climate may reduce soybean yields and worsen its environmental impacts. Conservation tillage, cover cropping and crop rotation have been proposed as effective climate adaption strategies for soybean, as well as a way to reduce its environmental impacts. They also improve soil quality by increasing soil carbon, soil aggregation, and soil water infiltration, and thus show promise to reduce year-to-year variability in yield. My research seeks to show how these practices affect yield and, thus, provide farmers information for making decisions on their farm.

How my research is conducted

The study was conducted in a 10-acre field plot at Lincoln University's Freeman farm. Twenty four plots of soybean plants were laid out in a randomized complete block design with 8 practices and 3 replications. Practices were: conventional tillage and no tillage; cover crop and no cover crop; and continuous soybean and soybean/corn rotation. I compared yields of each plot annually, from 2011 – 2014.

Notable findings

In the first three years of research, soil management practices did not significantly affect corn and soybean yields.

By the fourth year:

- soybean yield significantly benefited by the interaction of no-till and continuous soybean

Since crop management systems take longer time to stabilize soil physical and chemical characteristics, more research should be done over a longer period of time to understand the long-term effects of these practices.




Andrea Basche, Iowa State University

My research

I am exploring whether winter rye cover crops, which keep soil covered in the winter and early spring when corn and soybeans are not growing, can be managed in a way that their weather-buffering benefits outweigh their costs. In addition, I want to know if winter rye cover crops can be used to reduce nitrous oxide—a powerful greenhouse gas—in corn-soybean cropping systems.

Why I'm doing the research

Climate projections for the Midwest tell us we should expect more heat extremes, heavy downpours, flooding and droughts in the future. Winter cover crops have the potential to improve soil health and make corn-soybean systems more sustainable and resilient in response to the effects of climate change. But adding cover crops to a corn-soybean system is expensive and can include costs for seeds, pest management, equipment rental and adjustments, herbicides for terminating the crop in the spring, and potential yield loss in the cash crops. Findings from my research can help farmers compare some of the short- and long-term costs and benefits of adding cover crops to their specific cropping system.

How my research is conducted

I am using computer models to explore, over time and given expected climate trends, the impacts of winter cover crops on soil health, soil erosion, soil water dynamics, crop yields and nitrous oxide emissions, in a corn-soybean cropping system. I am also utilizing data that has been collected for fifteen years on cover crop/no cover crop comparison plots to test the accuracy of our computer simulation model.

Notable findings

Under anticipated changes in climate, use of a winter rye cover crop:

- decreased soil erosion by 11 to 29 percent
- reduced soil carbon decline
- did not significantly reduce cash crop yields

Winter cover crops have the potential to store water for use throughout the cash-crop growing season, as demonstrated by higher soil water levels found deeper in the soil profile in plots that had included a winter rye cover.

A meta-analysis of twenty-six cover crop studies found that cover crops may increase nitrous oxide emissions directly measured from the soil surface, but when measured over longer periods of time the increase is minimal.

Jordan Beehler, Michigan State University

My research

I want to determine if different topographies in crop fields - summit, slope, and depressions - and the presence of cover crop influence soil carbon. I hope to find that we can increase soil carbon in corn-soybean cropping systems.

Why I'm doing the research

Carbon is the building block of life. In soil, it makes crops and gardens grow and thrive. When soil has sufficient carbon, plants grow larger and more vigorously, are better able to resist pests and disease, and tolerate drought better—soaking up water and releasing it when needed. Carbon is most commonly accumulated in soil through plants, as they decompose. In addition, carbon moves from the atmosphere to plants and from plants to the atmosphere in the form of carbon dioxide (CO_2), which is a greenhouse gas. By measuring and assessing inputs and outputs of carbon in a corn and soybean cropping system, we can understand how much carbon the soil is able to store and then take action to increase the amount of soil carbon.

How my research is conducted

I am collecting and recording data from two field sites in Michigan, where I am collecting soil samples, to measure carbon, and taking CO_2 emissions measurements from the soil at various times during the year and at three topographical positions: summit, slope and depression. Additionally, I am using data collected over the past five years to compare soil carbon values at our field sites.

Notable findings

Soil carbon data from 2013 suggests nutrient poor, sandy soil has the potential to store more carbon, in the presence of a cover crop.

The input of carbon as cover crop biomass is dependent on weather conditions in early spring which affect cover crop growth. In 2014 for example, cover crop was stunted because of excessive rain and subsequent flooding of the research field.

At one site in Michigan, cover crops increase CO_2 emissions on summit positions.




Kimberly Chapman, The Ohio State University

My research

My research involved evaluating programs developed by the Corn CAP's Education and Outreach Team. Programs included a webinar series, climate camp workshops, and a graduate level course at The Ohio State University's Stone Laboratory. The audiences for these programs included team members, in-service science and agriculture teachers, and graduate students. Programs were evaluated for effectiveness in raising awareness and increasing understanding of key agricultural and environmental issues.

Why I'm doing the research

Evaluating educational programs provides insights into what aspects of the programs worked well and what aspects need to be further developed or discarded. This allows for continual improvement and modification of educational programs to fit the needs of participants as well as the ability to stay attuned to ever-changing issues and methods. There is a need for professional development and continuing education for teachers and students working in the field. As such, it is important to ensure these educational opportunities are having the intended outcomes. Conducting evaluations of these programs provides the feedback needed to continue to improve participant experience and program objectives.

How my research is conducted

I developed evaluations to match the content and activities for each program. Participants were asked to fill out evaluation forms upon completion of the webinar series, climate camps, and Stone Laboratory course. I then analyzed the results to measure knowledge gained, satisfaction with the program, ways in which the information would be used after the completion of the program as well as activities that were particularly useful to the participants.

Notable findings

Overall, participants found the programs to be an engaging and worthwhile learning experience.

The webinar series was an effective method for communicating ideas and information, and could be adapted to address other topics or issues to diverse audiences.

87 percent of teachers who participated in the summer climate programs intend to share what they learned with their colleagues, while 93 percent intend to incorporate what they learned into their classroom and/or other educational settings.

Evaluation data from the climate programs and graduate course at Stone Lab show an increase in participant knowledge in areas of climate change, agriculture, soil, water resources and wildlife.

Kristina Craft, Iowa State University

My research

Through field studies and computer modeling I am quantifying effects of two agricultural best management practices (BMPs) on agricultural systems in Iowa, including 1) the use of a cereal rye winter cover crop and its related effects on soil temperature and moisture, and 2) impacts that drainage water management techniques, such as shallow drainage and controlled drainage, will have with future climate conditions.

Why I'm doing the research

In Iowa, subsurface drainage systems—a kind of underground plumbing—are important for crop production on poorly-drained agricultural lands in Iowa, however, they also send nitrate to downstream surface waters, ultimately making it to the Gulf of Mexico and contributing to a condition called "hypoxia," a depletion of dissolved oxygen needed to support aquatic life. In controlled and shallow drainage systems, it has been found that the amount of water and nitrate leaving a field can be better controlled and sometimes reduced, however more needs to be known about how these systems will work with changing climate conditions.

Additionally, the use of a cereal rye cover crop is an effective tool for reducing the left-over soil nitrate in fields and eliminating some soil erosion, however less is known about the how a cover crop will alter soil temperature and moisture content.

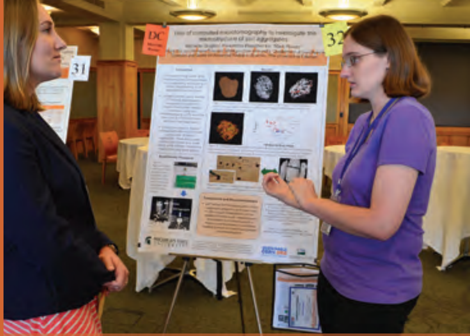
How my research is conducted

At a cover crop field study in Central Iowa, I am measuring the effects of cover crops on soil moisture and temperature within a corn-soybean system. At a drainage field study in Southeast Iowa, measurements of drainage volume and nitrate loss have been taken from corn-soybean systems with subsurface drainage. I am applying a systems model, The Root Zone Water Quality Model (RZWQM), to simulate the impacts of drainage that have been measured in these field studies. With successful simulations, the model will ultimately be run using climate projections to draw conclusions of the future impact of drainage on the sustainability of agricultural systems.

Notable findings

There is strong evidence that RZWQM is capable of simulating conventional, shallow, and controlled drainage with various climates and agronomic systems. Additional model testing is being done to minimize simulation error with field-collected data and apply model parameters to future climate predictions.

Cover crops generally reduce the daily fluctuation of soil temperature and increase the soil water storage within the top 30 centimeters of soil in Central Iowa, however statistical analysis is still being completed.



Laura Di Giulio, The Ohio State University

My research

I am new to the Corn CAP and to The Ohio State University. My research interests revolve around sustainable agriculture, climate change, and food systems around the world. I will be assisting with the evaluation of educational activities of the Corn CAP. In addition, I will be summarizing overall project findings for dissemination to researchers, Extension and outreach specialists and educational planners.

Why I'm doing the research

An important aspect of the Corn CAP is preparing graduate students—the next generation of scientists—as transdisciplinary researchers and scholars. Project leaders and graduate students developed a "roadmap" that would guide and document graduate student activities such as participation in professional meetings and webinars, professional presentations, and publications. Conducting evaluations of these programs provides the feedback needed to continue to improve graduate students' experiences and learning opportunities.

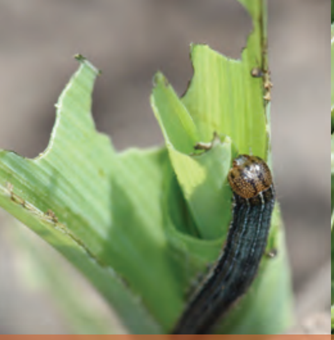
It is important to publicize findings to wider audiences who can benefit from the lessons learned and develop similar educational activities in other regions of the country.

How my research is conducted

I am currently reviewing evaluation materials and working in collaboration with project faculty, staff, and graduate students to develop several journal articles on key findings. Additionally, I am preparing a survey, to be completed by past and present students and postdoctoral associates, in order to learn more about their experiences, accomplishments and ways that their involvement with the project has contributed to their professional development.

Notable findings

Webinars and the graduate level course held at The Ohio State University Stone Laboratory have been beneficial for participants and have raised awareness and understanding of key issues related to climate and agriculture. To date, 132 undergraduate students, 85 graduate students, and 20 postdoctoral associates have been involved with the Corn CAP. Sixty-six journal articles have been published by graduate students and postdoctoral associates as lead or co-authors.




Mike Dunbar, Iowa State University

My research

I measured how two crop management strategies, the addition of a rye-cover crop and the use of extended rotations, interact with key pest and beneficial arthropod populations.

Why I'm doing the research

Pest management is an important component of corn-based cropping systems, as pests, including insects, have the potential to significantly reduce crop yields. Increasing diversity within agroecosystems, such as the addition of a cover crop or the addition of another crop to a rotation scheme, is theorized to reduce pest pressure. Diverse agroecosystems compliment Integrative Pest Management (IPM), which combines multiple management strategies, including chemical pesticides and crop rotations, with knowledge of pest ecology to manage pest pressure in an economically and environmentally viable way. Therefore, increased diversity within both agroecosystems and IPM strategies should help maintain the efficacy of pest management tools against the evolution of pest resistance (Insect Resistance Management).

How my research is conducted

To test how the addition of a rye-cover crop and extended rotations affected beneficial arthropod abundance and diversity, I sampled arthropod communities on university research farms in four Midwest states. To test how a rye-cover crop and extended rotations affect key pest species, I measured pest populations on commercial fields throughout Iowa.

Notable findings

- Predatory arthropods were captured in significantly greater densities in research plots that included a rye-cover crop, which supports the theory that increasing crop diversity can support greater abundance of natural enemies
- Crop rotations increased weed-seed predator densities
- True armyworm abundance and corresponding corn injury were both significantly greater in cornfields planted into a rye-cover crop compared to cornfields without a cover crop
- Fields with a history of crop rotation were at less risk from western corn rootworm injury compared to fields planted in continuous corn




Christopher Eidson, The Ohio State University

My research
I am investigating the contribution of winter rye cover crops, in no-till corn-soybean rotations, to enhance physical and chemical properties of soil. Additionally, I am integrating some of the soil property enhancements from cover crops into a soil quality index, which is under development and which is aimed at quantifying the capacity of different soils to grow crops.

Why I'm doing the research
Cover crops—crops grown to provide ground cover during the time when cash crops are not growing—have been shown to provide several cropping system benefits, including reduced soil erosion. However, cover crops increase costs for labor, seeding in the fall and terminating in the spring, but do not directly increase cash crop yields. These costs, with no direct and immediate benefit to yield make it difficult for farmers to adopt the practice of cover cropping. Current estimates suggest that cover crops are being included on only 8-14 percent of corn-soybean acres in the U.S. Corn Belt. My research will show that though cover crops may not directly improve grain yields they can be used to enhance soil properties and overall soil quality, and thus provide long-term benefits that help to build resiliency into corn-soybean systems in the U.S. Corn Belt.

How my research was conducted
I used a regional database, created by our Corn CAP team members, to look for differences in soil physical and chemical properties attributable to the inclusion of winter rye cover crops in no-till corn-soybean systems. Sites in Michigan, Indiana, and Iowa were selected based on differences in both local climate (temperature and precipitation) and soil types. Measured soil properties were then integrated, using an assessment framework, into a unit less score representing overall soil quality.

Notable findings
Long-term inclusion of winter rye cover crops in a corn-soybean rotation combined with no-till management can increase soil organic carbon (SOC) concentrations of sandy loam soils.

Enhancement of soil physical and chemical properties through the inclusion winter rye cover crops, particularly the SOC pool, can lead to quantifiable increases in overall soil quality.

Corn and soybean grain yields were unaffected by the inclusion of winter rye cover crop throughout the 4-year duration of this study.




Trevor Frank, Purdue University

My research

My research explores the effects of cover crops (crops grown to provide ground cover during the time when cash crops are not growing) on cash crop yields and soil properties such as soil stability and nitrogen cycling over a four-year period, in a corn-soybean rotation.

Why I'm doing the research

As greater weather variability occurs in the Midwest, such as increased temperatures and precipitation events, cover crops have the potential to improve soil health and make corn-soybean systems more sustainable and resilient in response.

How my research is conducted

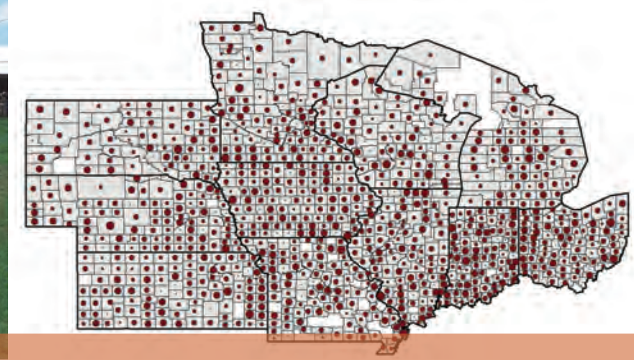
From years 2011 through 2014, corn and soybeans were grown in rotation, with cover crop treatments (rye vs. no rye). I measured and studied the growth of a cereal rye cover crop, rye nitrogen uptake and release, soil aggregate stability, soil organic carbon and total nitrogen, soil fertility, cash crop growth and yields, and corn grain and stover nitrogen concentrations.

Notable findings

When rye was grown longer in the spring before soybean planting, greater growth and nitrogen uptake was achieved. Greater growth can lead to increased soil organic matter, which, as it breaks down, creates fertile soil.

Lower soil nitrogen concentrations were found when cereal rye was actively growing as compared to the no cover crop. This indicates less potential for nitrogen loss from the soil when cereal rye is actively growing.

Cash crop growth and yields were generally unaffected by cover crop treatment during this four-year study, indicating that a rye cover crop is not detrimental to cash crop yields. This occurred both with the drought conditions in 2011 and 2012, and the less variable weather patterns in 2013 and 2014. We hypothesize that with additional years of cover crop growth, cash crop yields may increase as compared to the no cover crop control.



Maaz Gardezi, Iowa State University

My research

My research is exploring how Midwestern corn/soybean farmers' abstract faith in human ingenuity influences their use and support of farming practices that can ensure long-term sustainability of their farm.

Why I'm doing the research

In an increasingly globalizing society, people are ever more reliant on abstract or expert systems for managing risks. This is especially relevant with regards to large-scale hazards from which people cannot easily withdraw, e.g. nuclear warfare or where people have to make decisions under conditions of uncertainty, such as climate change.

People's trust in expert systems has been characterized as an abstract faith in human ingenuity. Within this paradigm, people believe that continual improvements in science and technology will ultimately provide remedies to many current and future hazards.

This research can help extension educators to develop outreach programs that are sensitive to farmers' views about the ability of science and technology to solve climate change-related issues. Such programs can provide Corn Belt farmers' with a balanced view about the limitations and possibilities of science and technology for solving climate change-related issues.

How my research is conducted

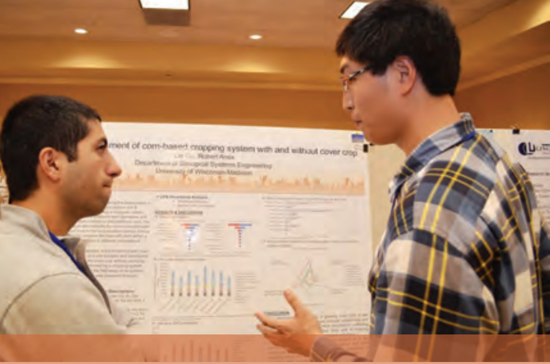
I am applying a statistical model to a survey of ~5000 corn/soybean farmers across 11 Midwestern states. My survey respondents (farmers) are from a geographical region that is responsible for more than one-third of the global corn supply and represent nearly 65 percent of all corn acres and 55 percent of soybean acres in the U.S.

Notable findings

Higher faith in human ingenuity is associated with higher levels of self-confidence in technical capacity to adapt.

Higher self-confidence in technical capacity to adapt is associated with lower levels of climate-related risk perception.

Higher faith in human ingenuity is related to lower levels of support for climate change adaptation.



Lei Gu, University of Wisconsin-Madison

My research

My research investigates the benefits and impacts of a winter rye cover crop on energy consumption, soil loss, greenhouse gas emissions, nitrate leaching and crop productivity.

Why I'm doing the research

When measured by economic value, total acres, and tons harvested, corn is the most important crop produced in the United States. But corn, like all row crops, has environmental impacts. There are also concerns that a changing climate may reduce corn yield and worsen its environmental impacts. Planting winter cover crops has been proposed as an effective climate adaptation strategy for corn, as well as a way to reduce its environmental impacts. Assessing the lifecycle costs and benefits of cover crops will improve our understanding of the economic and environmental trade-offs. The findings will also inform farm managers and policymakers about management options to increase the sustainability of corn production in a changing climate.

How my research is conducted

I am comparing field data on plots of corn and soybeans with cover crops to plots with no cover crops, in research fields in Iowa, Indiana and Missouri. I am also using future climate models to investigate how fields with and without winter cover crops might perform under changing climate conditions.

Notable findings

- Cover crops reduced soil erosion
- Cover crops reduced nitrate leaching; the amount of reduction depended on site specific weather and soil conditions
- Cover crops did not cause reductions in cash crop yields under current conditions nor under future climate scenarios
- Nitrogen fertilizer is the largest contributor to life cycle energy use and global warming potential




Samuel Haruna, Lincoln University - Missouri

My research

The focus of my research is on understanding the influence, both positive and in some cases negative, of tillage, cover crop and crop rotation on soil nutrients in a corn-soybean cropping system.

Why I'm doing the research

The global human population is expected to reach 9 billion in 2050. By that time, it has been projected that the current agricultural production needs to increase by about 70 percent to maintain the current food availability. Since plants need nutrients from the soil for growth, maintaining and improving soil nutrients are essential to combating food shortage. Tillage can improve soil nutrient availability initially, but can lead to rapid nutrient depletion over time. If cover crops, like rye, are killed and returned to the soil, they have the potential to improve nutrient availability in the soil. My research findings can help farmers make decisions about farm management practices, to avoid harmful practices and improve crop yields.

How my research is conducted

This research was conducted over a three year period; from 2011 to 2013. I took soil samples, in each year, from research plots that included tillage, cover crop and crop rotation managements. These soil samples were taken from the surface of the soil down to a depth of 24 inches (60 cm) and analyzed in the laboratory. The results were computed using statistical methods.

Notable findings

During the first year, soil nitrate was 40 percent greater when the soil was tilled compared with no tillage. This can improve crop productivity. However, soil nitrate moves with water in the soil and, when not taken up by plants, can quickly leach into underground water and eventually into streams and rivers.

During the second year of the study, cereal rye reduced soil calcium and magnesium by five percent and 8 percent respectively. By taking up these nutrients, loss is reduced; these nutrients can be returned to the soil when cover crop residues are incorporated into the soil for the subsequent cash crop.

During the third year, potassium was greatest with a combination of cover crop and soybean/corn rotation. This can reduce the out of pocket cost of potassium fertilization in subsequent years.

Anna Johnson, Iowa State University

My research

My research is a preliminary investigation into what specialty crop growers (fruit, vegetable, floriculture and nursery) perceive to be their biggest climate change challenges.

Why I'm doing the research

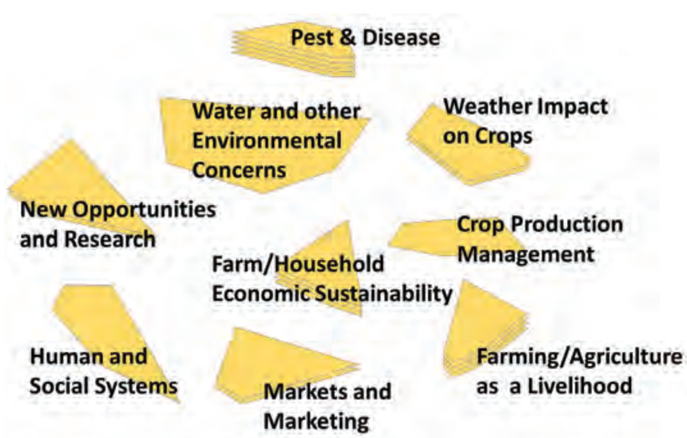
In 2012, fruit growers in Michigan experienced early warming followed by late spring frosts which decimated the fruit crops that year. This unusual weather may become more frequent; little is known about the possible impacts of climate change to Midwest specialty crops. Findings will be used to focus future research and inform individuals developing a region-wide plan of work for the Midwest Climate Hub.

How my research is conducted

Researchers and specialty crop industry leaders from Michigan and Ohio gathered in Toledo, Ohio, in October 2014 to discuss the impacts of climate change on the Midwest specialty crop industry. We asked participants to brainstorm a list of anticipated climate challenges. They came up with 85 statements. Then we asked them to rank the importance of the statements and group them into clusters based on their similarities. Participants were then asked to reach out to their grower contacts in the industry and invite them to participate by also ranking and clustering the statements. I compiled responses from 19 growers and gauged which statements and which topic clusters were of greatest concern. Cluster names were chosen subjectively by the researchers.

Notable findings

The number of layers in each cluster represents the grand mean of the importance ratings that participants assigned to the statements in the cluster. The clusters with the highest grand means, and therefore of the most importance to participants, were Pest and Disease, Farm Economic Sustainability, and Farming as a Livelihood.



Maciej Kazula, University of Wisconsin-Madison

My research

The main objective of my research is to investigate whether the addition of more crops into a crop rotation cycle will reduce nitrous oxide emissions. Nitrous oxide is a greenhouse gas.

Why I'm doing the research

Although nitrous oxide accounts for a relatively small proportion of total U.S. greenhouse gas emissions, approximately 2/3 of nitrous oxide emissions come from the agricultural sector, mainly through nitrogen fertilizer applications. Corn has a high demand for nitrogen and, in the Midwest, using a continuous corn rotation is a dominant practice. Therefore, rotating corn with other cash crops, which require less or no nitrogen applications, has the potential to reduce agriculture's overall nitrous oxide emissions, while still providing farm income.

How my research is conducted

I was able to collect data on three long-term rotation experiments in Wisconsin. I compared greenhouse gases emissions of continuous corn with corn-soybean and corn-soybean-wheat rotations. Using this field data I was able to calibrate and validate a biogeochemical modeling program (DAYCENT) to simulate future rotation behaviors in terms of nitrous oxide emission and crop yield responses under different climate change scenarios.

My research also included the study of changes in soil physical properties among rotations and the emissions of two other major greenhouse gases, carbon dioxide and methane.

Notable findings

- A corn-soybean rotation or the corn-soybean-wheat rotation can reduce nitrous oxide emissions
- Nitrous oxide emissions can be mitigated by improved weather prediction and application methods that increase nitrogen use efficiency, such as split-applications of nitrogen and nitrogen-stabilizers
- Current field measurements of nitrous oxide emissions are in agreement with the emissions predicted by a computer modeling program (DAYCENT) which is commonly used in research

Ainis Lagzdins, Iowa State University

My research

Subsurface drainage systems—a kind of "plumbing" installed under farm fields—remove excess water from agricultural land. I am investigating how agricultural management practices such as tillage methods, nitrogen application timing and a winter cereal rye cover affects crop yields and nitrate-nitrogen concentrations in water discharging from a tile drained agricultural field in Iowa.

Why I'm doing the research

In Iowa, subsurface drainage systems are important for crop production on poorly-drained agricultural lands. Subsurface drainage outlets drain not only water, but also nutrients that move with water, such as nitrate, into nearby streams and ditches. The waters and nitrate from these ditches and streams can eventually make their way to rivers and as far downstream as the Gulf of Mexico, causing a condition called "hypoxia," a depletion of dissolved oxygen needed to support aquatic life.

The practices I am researching have been recommended as part of the Iowa Nutrient Reduction Strategy to reduce nitrogen loss for agricultural soils to downstream waters. Findings from my research can be used by farmers to evaluate these practices for their operation, as a part of their nutrient-reduction strategy.

How my research is conducted

My research is being conducted at the Gilmore City Drainage Research and Demonstration site located in Pocahontas County, Iowa, from 2011 to present, on 40 experimental plots with a corn-soybean rotation. The practices we're studying are no-till/tillage, various nitrogen application times, and a winter cereal rye cover crop. I am comparing subsurface drain flow measurements, nitrate concentrations leaving the drainage outlets, and crop yield measurements to quantify the effects of practices.

Notable findings

Winter cereal rye cover crop and no-till practices showed the potential to reduce nitrate-nitrogen concentrations in subsurface drainage.

Fertilizer application timing had little impact on nitrate-nitrogen concentrations in drainage water, during the corn phase.

During the soybean phase, nitrate-nitrogen concentrations were lower in drainage water when nitrogen application for the previous corn crop was done in the fall, rather than the spring.

The treatments with the highest corn yields during 2011-2014 were observed for the spring and fall nitrogen application with conventional tillage, as compared to no-till.

Suresh Lokhande, Iowa State University

My research

As a postdoctoral associate in project management with the Corn CAP, I want to know what project management strategies help participants make progress towards their goals and what strategies aid the project's overall success. For example, I want to know if there is any relationship between project accomplishments and attendance in project meetings. To this end, I am measuring participant involvement and accomplishments and identifying trends.

Why I'm doing the research

Traditionally, research has been conducted by scientists in distinct, departmentally-based specialties, with little collaboration outside specialties. Conducting research in collaboration with large numbers of scientists from diverse disciplines is a new phenomenon in agricultural research. Little is known about managing success for large, multidisciplinary research projects, such as the Corn CAP, which has 160+ team members from 11 institutions and from a number of diverse disciplines, e.g., agronomy, economics, climatology, rural sociology, plant pathology, etc.

My current research findings provide the quantitative data needed to assess relationships between team members' involvement and project outcomes. Additional efforts are needed to complete a study of how to manage these types of projects for success.

How my research is conducted

I studied quantifiable participation and achievement data, collected from March 1, 2011 through July 31, 2015, for example: number of meetings attended by participants, number of refereed journal articles, conference and extension presentations delivered, media pieces, etc. I plotted the results by date (funding year).

Notable findings

Preliminary analysis of these data reveals a number of trends associated with activity level of the team and productivity.

- The number of meetings increased over time to meet project goals, integrate multi-disciplinary efforts in meaningful ways, and complete milestones and tasks for each year.
- A substantial increase in total outputs occurred over time with 63 outputs in Y1 increasing to 309 in Y2, to 322 in Y3 and 455 in Y4. (Y = year)
- We found that the number of team co-authored papers that integrated disciplinary sciences and/or education and extension increased with time, with the greatest increases occurring in Y4 and Y5.




Guillermo Marcillo, Iowa State University

My research
As an agronomist in the modelling component of our project, I am investigating how cover crops influence corn productivity. I am also studying the critical periods of winter rye development in response to changing climate conditions.

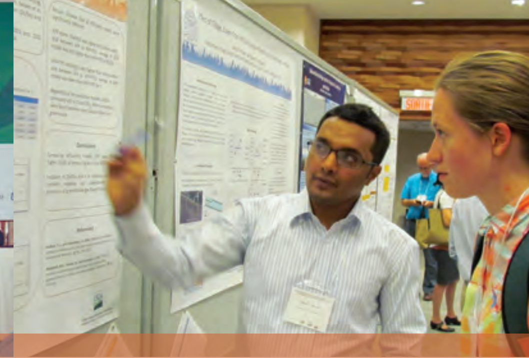
Why I'm doing the research
Despite the undeniable contribution of cover crops to promoting sustainability in our cropping systems, widespread adoption of the practice still faces many challenges. For example, many farmers see cover crops as a risky investment that brings potential competition for soil resources to their cash crops, leading to eventual reductions in yields and diminished profitability in their operations. My research will help to clarify unfounded perceptions, or even reinforce anecdotal evidence on the farm, about the field practices that minimize the risks of planting a cover crop under challenging conditions. My research will also add to what is known about agronomic practices that suit the growing conditions of the Midwest and maximize the expected benefits of a cover crop system.

How my research is conducted
I look at past records of cover crop performance in the U.S. and apply statistical methods to identify agronomic practices in minimal conflict with corn productivity. The practices may relate to the cover crop species utilized and/or the differences in weather conditions for a region. In addition, I track down the times at which winter rye germinates and reaches new stages through its development in the field. I later pair this information with weather information to improve the accuracy of our prediction cropping models.

Notable findings
Cover crops promote or maintain corn yields. Depending on the species utilized, the last 10 years of cover crop data in the US show that corn following a cover crop has neutral to six percent gains in yield.

To optimize the benefits of cover crops with minimal impact to corn yields, farmers need to explore and determine optimum cover crop management practices for their fields and crop rotations. These include but are not limited to knowing when to plant and terminate the cover crop, the characteristics of the species of cover crop they are planting, and when and how much nitrogen to apply.





Dinesh Panday, Lincoln University - Missouri

My research

My research explores the effects of tillage, cover crop and corn-soybean rotations on soil pore space indices and its relationship to greenhouse gas (GHGs) emissions/consumption in soil, specifically carbon dioxide (CO_2) and nitrous oxide (N_2O).

Why I'm doing the research

Climate change-related threats to agriculture are leading to increasingly urgent calls for farmers to adopt agricultural practices that contribute to the mitigation of climate change and to the resilience and sustainability of Midwest agriculture. Several farm management practices have been proposed as ways to do this. Many researchers are focusing on how these management practices improve soil quality and resilience, e.g., soil's capacity to hold moisture and release it as needed. I want to know if the same practices that make cropping systems more productive and resilient can also be used to manage GHG emissions from soil and consumption/storage in soil in farm fields.

How my research is conducted

I collected soil samples from 2011-2014, on a Lincoln University research farm, on 48 plots with various practices, including tillage/no-tillage, cover crop/no cover crop and corn-soybean rotation/soybean-corn rotation/continuous corn/continuous soybean. Using the soil samples and 5 diffusivity models, I computed two indices of soil pore space and structure: gas diffusion coefficient and pore tortuosity factor. CO_2 and N_2O flows were also measured in the samples.

Notable findings

The combination of tillage, cover crop and crop rotation made greenhouse gas movement easier in surface layer than deeper one, suggesting that adopting these practices could increase soil consumption of GHGs.

Soil pore space and structure improved more when tillage with cover crop, and tillage with crop rotations were combined than any individual treatment, for all models from 2012-14.

Increases in soil pore space indices showed increases in carbon and nitrogen flows. Thus the inclusion of soil pore space indices in predictive models will certainly improve our understanding of the dynamics of greenhouse gas fluxes (emissions and consumption).




Swetabh Patel, Iowa State University

My research

To further understand winter cereal rye cover crop's nitrogen uptake and effectiveness for scavenging and recycling nitrogen, I studied the amount of root/shoot biomass production and nitrogen and carbon partitioning at time of rye termination.

Why I'm doing the research

Nitrogen loss from applied fertilizer can be a significant economic loss in corn production systems as well as an environmental quality issue if nitrate moves to surface or ground water. Cover crops are plants that are primarily grown to cover and provide protection to the soil when no cash crop is growing in the field. The Iowa Nutrient Reduction Strategy science assessment has identified winter cereal rye as a cover crop that can significantly reduce nitrogen and phosphorus losses (31% nitrate-N and 29% P reduction) from corn-soybean cropping system.

However, previous studies have shown that there might be a potential yield loss in corn when it is grown following a rye cover crop. This yield loss in corn may be attributed to the changes in soil dynamics due to the cover crop. Understanding how cover crops affect soil can lead to finding crop management solutions to eliminate or minimize yield loss.

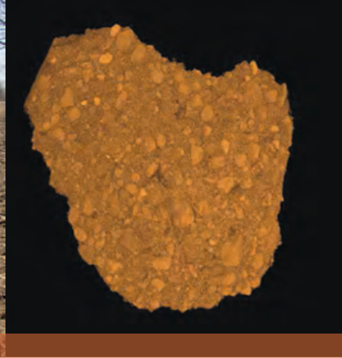
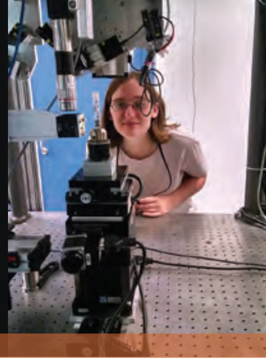
How my research is conducted

The study was conducted at an Iowa State University research site on fields with a corn-soybean rotation system grown with a winter cereal rye cover crop. I installed two root ingrowth tubes per plot between rye rows shortly after the rye was seeded in fall after corn and soybean harvest. The ingrowth tubes and above-ground shoot biomass samples were collected the following spring, just before the rye was chemically terminated. I then analyzed root and shoot biomass for total carbon and total nitrogen.

Notable findings

The largest fraction of total nitrogen uptake (~85%) and carbon assimilation (~70%) by the rye cover crop was contained in its aboveground biomass which suggests that rye cover crop's potential to recycle nitrogen and sequester carbon in soil depends mainly on shoot (above ground) growth.

The carbon/nitrogen ratio of the rye root material was high enough to likely cause nitrogen immobilization (make it not available for uptake by the next crop).

Michelle Quigley, Michigan State University

My research

I investigate the microstructure of soil aggregates. Specifically, I am interested in seeing how adding a rye winter cover crop changes the soil aggregate.

Why I'm doing the research

Soil aggregates are groups of soil particles that bind to each other more strongly than to adjacent particles. The spaces between the aggregates provide pore space for retention and exchange of air and water. Soil aggregates are the building blocks of the soil like an atom is the building block of matter. Like an atom, the soil aggregate is a slight mystery because of its small scale. Many of the processes that occur within it are vital to soil health and agricultural sustainability. They are hinted at, but not fully known, such as carbon retention. By increasing our understanding of the small scale processes within soil aggregates that affect carbon storage, we should be able to, in the future, better advise farmers on management practices that would be most beneficial to their soil.

How my research is conducted

Computed microtomography (uCT) is one way to look at this small scale. Similar to how a medical CT scan can help a doctor unobtrusively look at a patient, uCT allows me to look at soil aggregates in a non-invasive way. Pores, roots, and other intact organic material can be identified in uCT images.

In order to better understand the processes taking place in soil aggregates, I use uCT imaging to get 3D aggregate images and then identify roots and pores within them. I can then use these aggregates in more traditional measurements like total carbon to look at carbon protection at the aggregate scale.

Notable findings

It has been found that total carbon is associated with the lower image values. This means we can use the image values to roughly "track" how carbon is distributed around pores. This information can be used in future studies to assess how adding a rye winter cover crop affects a soil aggregate.




Dipti Rai, Lincoln University of Missouri

My research

I am comparing two methods of measuring carbon dioxide and nitrous oxide emissions from corn and soybean fields, to determine the best suitable method for accurate measurements.

Why I'm doing the research

Over the last few decades, scientists have predicted an increase in the temperatures of the atmosphere and oceans mainly due to the emissions of greenhouse gases (GHGs) such as water vapor, carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4). Nine percent of total U.S. greenhouse gas emissions are attributed to agriculture. In order to know how land use changes and soil management practices may serve to reduce those emissions, accurate and practical measuring methods must be developed and tested.

How my research is conducted

Gas Chromatography (GC) is widely used, but it is manual and time consuming. Photo Acoustic Gas Analyzer (PAS) is a new option for accurate, in-situ and continuous measurement of GHGs, but its results need to be compared with other methods. I am taking measurements of GHGs fluxes (fluctuations) from corn and soybean fields using PAS and GC to compare their accuracy and efficiency. I am also utilizing the data from the previous years, where these two different methods were used.

Notable findings

Even though they show good agreement for measuring of soil CO_2 and N_2O fluxes, there exists some discrepancy between PAS and GC measurements. The reason for discrepancy is not clear yet and further studies are needed.

Both the measurement methods show various advantages and disadvantages. Based on ease of operation and time efficiency, PAS method is helpful but is highly sensitive and selective for gas detection. The study is still continuing and will give more results.



Rebecca Roberts, Iowa State University

My research

Cover crops are grown to retain soil and nutrients during periods of time when the soil is typically fallow. In the upper Midwest, crop systems are typically fallow from fall to spring. In these systems, cold-tolerant cover crops such as cereal rye are planted in the early fall and usually terminated with herbicides in the spring. In corn-soybean crop systems with a cereal rye cover crop, I studied the effects of herbicide type and termination date on soil nitrate levels.

Why I'm doing the research

Nitrate is a critical nutrient for crop production, but in excess can impair water quality. It is found naturally in the soil, but is also included in fertilizer or manure that is added to the soil to improve crop yields. In Iowa, warm weather and rain in late fall and early spring when corn or soybeans are not vigorously growing lead to nitrate loss to waterways. Indeed, fallow fields rather than nitrogen fertilizer inputs are the main cause of nitrate loss to waterways. Cereal rye, a cold-tolerant cover crop, can reduce nitrate loss during these times because it is growing and using nitrate when corn or soybeans are not growing or using nitrate.

Farmers can choose from a variety of herbicides and times at which to terminate a cover crop. However, herbicide type and termination timing may affect soil nitrate loss, as well as cash crop yield. Information from my research can be used by farmers to optimize cover crop management.

How my research is conducted

I monitored soil nitrate concentrations by sampling the soil weekly. I also collected rye shoot biomass and allowed it to decompose in the field, sampling it throughout the growing season to see how nitrogen is taken up and released from cereal rye.

Notable findings

A well-established rye cover crop significantly reduced soil nitrate concentrations from the fall through late spring, which is the time of year when most soil nitrate loss occurs.

In one year of the two-year study, herbicide type affected the release of nitrogen from the terminated cover crop residue.

Terminating the cover crop at a later date significantly decreased soil nitrate.

The rye cover crop did not affect cash crop yields.



Gabrielle Roesch-McNally, Iowa State University

My Research

As a social scientist with the Corn CAP, I am conducting social science research to examine factors that influence farmers' adoption and sustained use of agricultural practices on their farms, which are known conservation practices and/or are practices which have the potential to contribute to the mitigation of climate change and to the resilience and sustainability of Midwest agriculture.

Why I'm doing the research

Climate change-related threats to agriculture are leading to increasingly urgent calls for farmers to adopt agricultural practices that contribute to the mitigation of climate change and to the resilience and sustainability of Midwest agriculture. The effectiveness of any adaption or mitigation action in Corn Belt agriculture depends on the degree to which the region's farmers are willing and able to act. If professionals, such as Extension specialists and policy analysts, are to assist farmers in this endeavor, they need to know the factors that influence farmers' adoption and sustained use of these practices.

How my research was conducted

I used social science methods to analyze survey data collected from nearly 5,000 farmers across nine states in the Corn Belt. Additionally, I designed the research protocol and managed a team of extension educators in order to collect qualitative data from in-depth interviews with nearly 160 farmers across the Midwest.

Notable findings

Sixty-six percent of farmers believe climate change is happening and forty-one percent of them think that this is at least in part due to human activity.

Farmers who believe climate change is happening are more concerned about impacts and have been found to be supportive of both adaptation and mitigation actions.

Instructional, research and policy efforts focused on improving soil health have the potential to engage farmers in adaptive and mitigative actions, regardless of their beliefs about climate change.

Some actions farmers are taking in response to increased weather variability have negative impacts to soil and water conservation. Efforts need to be made to better understand the potential for maladaptive responses among farmers.





Joseph Rorick, Purdue University

My research

I am researching how cover crops (crops grown to provide ground cover during the time when cash crops are not growing) and no-tillage affect soil physical and chemical properties over time, as well as the effects of cover crops on yield in a corn-soybean rotation.

Why I'm doing the research

Long-term sustainability of soil is a critical component of maintaining and increasing crop yields in spite of extreme weather events. Cover crops and no-tillage are two possible management practices that may increase resiliency to climate stresses by lowering soil bulk density, increasing water infiltration rates, resisting erosion by increasing soil aggregation, and increasing water-holding capacity.

How my research is conducted

A field site was established in 2011 and was split into four blocks of four treatments each with corn and soybean alternating yearly with cereal rye or a no cereal rye control following each cash crop. I have taken soil measurements over time, including aggregation, infiltration, bulk density, water retention, soil nitrate and ammonium, and total soil nitrogen and carbon.

Notable findings

Soil aggregation is a measure of the soil's ability to resist destructive forces such as erosion. When the study began in 2011, there were no differences in soil aggregation between the cover crop and no cover crop treatments. In 2013, after only two years of overwinter cover crops there was a significant difference between average aggregate size. In 2015, after four years of a winter cover crop of cereal rye, soil aggregation increased greatly when compared to the no cover crop control treatments.

We hypothesize that water infiltration rates will be greater with cover crop vs. no cover crop due to the increased soil stability and the cereal rye root growth, but data are still being analyzed.

Samaneh Saadat, Purdue University

My research

As an environmental and water resources engineer, I am exploring hydrological and environmental effects and best management practices of controlled drainage on farm fields in the Corn Belt. Controlled drainage is a water management practice, which uses underground control structures to manage the water table level.

Why I'm doing the research

Climate change poses a potential threat to Midwestern agriculture due to higher intensity and less frequent rainfall events, as well as hotter and dryer conditions. Controlled drainage has the potential to contribute to climate change mitigation and adaptation. It can be used to hold water in the field, reducing nitrate loss, and give farmers control over water levels in the field during planting and growing seasons. However, controlled drainage may reduce the flow rate to the drainage pipe, and thus increase the time needed for the water table level to fall. Farmers want to know how to best manage this so it does not negatively affect crop yield or their ability to get out in the field to plant and harvest.

How my research is conducted

I analyzed observed data collected from Davis Purdue Agricultural Farm Center located in Indiana to investigate if controlled drainage lengthens the time needed for the water table to fall after a rainfall event.

Notable findings

- Analysis of water table recession rates indicated that controlled drainage has a statistically significant effect on the rate of water table fall. Controlled drainage decreased the average recession rate of water table between 37.6 percent and 54.3 percent.
- This means that the time it takes the water table to fall below 60 cm is between 26 to 38 hours longer when drainage is being controlled.
- Changing the operation strategy of drainage from controlled to free-draining before storm events would reduce the amount of time that water table is at a detrimental level for either crop growth or trafficability. However this change during the rainfall events would probably have some disadvantages, like nitrate loss from the field. Whether the benefits of this change outweighs the cost depends on the sensitivity of the crop and the probability of a severe storm.

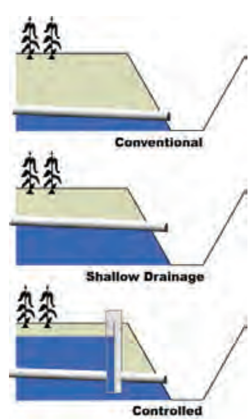
Linda Schott, Iowa State University

My research
Subsurface drainage systems—a kind of "plumbing" installed under farm fields—remove excess water from agricultural land. I am investigating how two different subsurface drainage water management options impact drainage water volume, nitrate lost to subsurface drainage outlets, water table depth, and crop yields.

Why I'm doing the research
In Iowa, subsurface drainage systems are important for crop production on poorly-drained agricultural lands. Subsurface drainage outlets drain not only water, but also nutrients that move with water, such as nitrate, into nearby streams and ditches. The waters and nitrate from these ditches and streams can eventually make their way to rivers and as far downstream as the Gulf of Mexico, causing a condition called "hypoxia," a depletion of dissolved oxygen needed to support aquatic life. Drainage water management, such as shallow and controlled drainage, has been recommended as part of the Iowa Nutrient Reduction Strategy to reduce nitrogen loss from agricultural soils to downstream waters.

How my research is conducted
I analyzed 8 years of data collected at the Iowa State Southeast Research Farm near Crawfordsville, Iowa. I also collected temperature and moisture data for three years. At the site are fields with two drainage water management types and a field with subsurface drainage pipes placed as they conventionally are in a field. (See illustrations below.) In addition, there is a field with no subsurface drainage tile system at all. Equal amounts of nitrogen are applied on each field annually. On each of these, I compared these measurements: total amount of water leaving drainage outlets, nitrate concentrations leaving the drainage outlets, soil temperature, the volume of water in the soil, and changes in water table depth and crop yields.

Notable findings
- Drainage water management reduced water volume and nitrate loss when compared to conventional drainage. Controlled drainage reduced drainage by 45 percent and nitrate loss by 49 percent. Shallow drainage reduced drainage by 51 percent and nitrate loss by 42 percent.
- The two drainage water management types tested did not reduce soybean yields.
- Shallow drainage, as a management type, did not reduce corn yields. Controlled drainage did reduce corn yields in wet years. However, this outcome could change if the control structure is used to more actively manage the water table after large rain events during the growing season, to more rapidly reduce the water table. More research is needed.





Ehsan Toosi, Michigan State University

My research

I investigate how interactions of cropping practices in the Midwest (tillage, crop rotation, crop residue, cover crops) control processes that occur in small-scale and are responsible for buildup or loss of soil organic matter and production of greenhouse gases from soil.

Why I'm doing the research

It is well-known that soil management practices, such as tillage, incorporation of crop residue, crop rotation, and including a cover crop, affect soil functions such as long-term soil productivity and production of greenhouse gases (GHGS) from soil. However, soil functions with broad impacts are rooted in fine scale processes. Examples of fine scale processes are soil porosity (tillage-induced compaction), molecular composition of crop residue, microbial composition of soil, etc. These processes determine critical soil functions such as retention (vs. loss) of nutrients and organic matter, capacity of soil to restore carbon from atmosphere and intensity of greenhouse gas emissions from soil. Recent technological advances now enable us to interpret/predict response of soil to shifts in management practices and under changing climate scenarios. Findings from my research can help farmers make decisions about what practices to adopt to make their cropping systems more resilient and productive in the long-term, and what practices could help reduce greenhouse gas emissions.

How my research is conducted

I study soils that have been under long-term contrasting management systems, i.e. conventional vs. no-till/reduced tillage, and cover cropping. I combine isotopic, spectroscopic and imaging techniques to measure changes in amount and chemistry of organic matter and production of GHGs in the soil of these management systems.

Notable findings

Compared to conventional tillage, soil aggregates in no-till and cover cropping systems have a very diverse pore structure. This pore structure can increase protection of soil organic matter against decomposing microorganisms. This partially explains the buildup of soil organic matter after long-term establishment of less intensive management systems.

In the short term (days) loss of native soil organic matter is less when corn (compared to soybean) residue is returned to the soil after harvest. However, this depends on soil porosity. The loss of soil organic matter is greater in soils with lower porosity (i.e. compacted soil due tillage). I am currently conducting research to assess if the pattern changes in extended periods of time (i.e. months).




Cody Troop, South Dakota University

My research

I am exploring how cropping changes affect feedback to climate and how the water balance— the flow of water in and out of a system—is changing in the Corn Belt over time.

Why I'm doing the research

Water vapor is an important greenhouse gas—it can trap heat. The higher the concentration of water vapor in the atmosphere, the more heat that can be trapped.

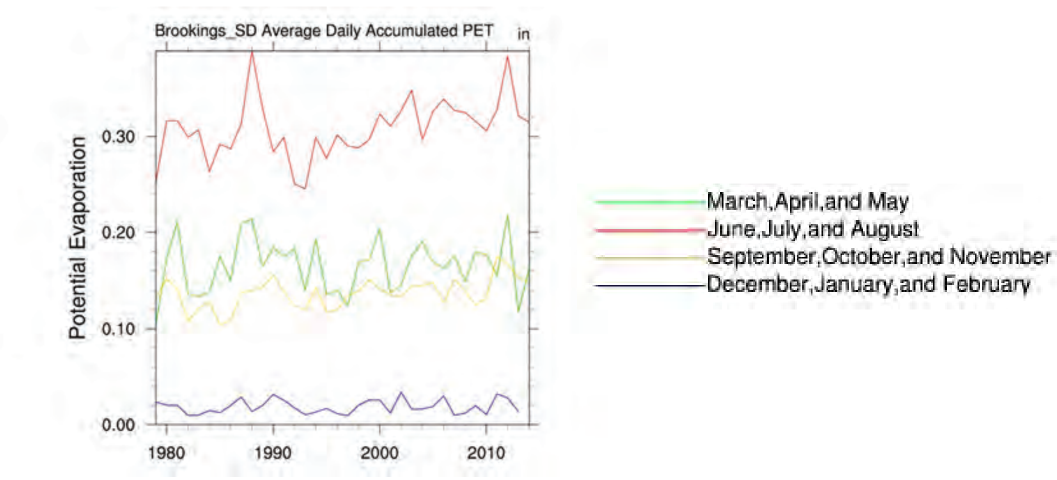
There has been a large shift in parts of eastern South Dakota from grassland to cropland (especially corn). Understanding how these land use changes are changing the water balance, and may therefore affect the climate, will help scientists better predict future changes in the climate-agriculture system.

How my research is conducted

I am using the North American Land Data Assimilation System (NLDAS) dataset. NLDAS uses past satellite- and ground-based observations to model many atmospheric variables over North America. This allows me to get measurements in places where they are not taken, or at times they are not taken. I am looking at this output (36 years of data) from as many perspectives as I can to understand changes in the amount of potential evapotranspiration (PET) and when it occurs during the year.

Notable findings

Preliminary analysis has shown an increase in potential evapotranspiration (PET) during the summer months in the northern plains, from 1979 to 2014.






Emily Waring, Iowa State University

My research

My research investigates the impacts of a winter rye cover crop on soil moisture and temperature.

Why I'm doing the research

In Iowa, subsurface drainage systems are important for crop production on poorly-drained agricultural lands. Subsurface drainage outlets drain not only water, but also nutrients that move with water, such as nitrate, into nearby streams and ditches. Nitrate in excess is harmful to human and aquatic health. In fact, the waters and nitrate from these ditches and streams can eventually make their way to rivers and as far downstream as the Gulf of Mexico, causing a condition called "hypoxia," a depletion of dissolved oxygen needed to support aquatic life.

Most nitrates are lost in the spring because that is when Iowa gets the most rain and agricultural soils are often bare. Cover crops—crops that cover the soil when no cash crop is growing—can reduce nitrate loss and, over time, improve soil health and the soil's water holding capacity. However, cover crops increase costs for labor, seeding in the fall and terminating in the spring; increase pest management and can potentially reduce cash crop yields. These costs and potential losses make it difficult for farmers to adopt the practice of cover cropping. Therefore, it's important to learn how the negative impacts of cover crops can be reduced.

My colleagues and I want to know how cover crops affect yield. We hypothesized that negative yield impacts from cover crops may be due to increased soil moisture and decreased soil temperature, which would result in later than normal planting dates for cash crops.

How my research is conducted

To measure soil moisture and temperature, we installed moisture sensors at 5 different depths on corn and soybean plots in a field in Northwest Iowa. Plots had different treatments: 1) no till and no cover crop; 2) conventional tillage and no cover crop; and 3) no till with a cereal rye cover crop. We then compared the moisture and temperatures of the treatments at various times, over a 4 year period.

Notable findings

We found that most of the time, when cover crops affected temperature and moisture, they made them drier and warmer. This demonstrated that cover crops actually facilitate earlier planting of cash crops, rather than later.



Adam Wilke, Iowa State University

My research
My sociological research involves advancing communication and application of climate and agricultural science for land use decision making, educational curriculum, and science-based policy. I use social science methods such as interviews and surveys to assess how farmers, scientists, or other agricultural stakeholders think about climate and agricultural science.

Why I'm doing the research
Social factors such as beliefs, values, and perceptions of risk can influence willingness to accept and utilize scientific recommendations. My research seeks to uncover potential social barriers and facilitators that influence how climate science is perceived and used for agricultural and land use management. This helps us understand why (or why not) various farm practices and techniques are adopted and what impacts they may have on water, carbon, and nitrogen cycling on different landscape scales.

How my research is conducted
I designed a research protocol that involved conducting surveys and interviews with extension and state climatologists in the North Central Region in 2012. The research questions were aimed at understanding how to best communicate climate science to agricultural audiences. Results of the climatologist study provided information to develop qualitative data analyses tools for 159 farmer interviews across the region, as well as survey questions for the 2015 Iowa Farm and Rural Life Poll.

Notable findings
Beliefs about climate significantly vary between stakeholder groups, such as scientists, extension educators, crop advisors, and farmers.

Some extension educators (24.7 percent), crop advisors (22.4 percent) and farmers (31 percent) believe there is not sufficient evidence to know with certainty whether climate change is occurring or not.

Climate science information is better received by agricultural audiences when communicated in terms of benefits to climate risk management, as opposed to harms of climate change.




Stacy Zuber, University of Illinois

My research
My research focuses on the effects of long-term crop rotation and tillage practices on soil quality.

Why I'm doing the research
Recently, changing corn prices have influenced the acreage of corn planted following corn rather than as a crop rotation. Crop rotation also influences the choice of tillage practice. These management practice decisions may have important implications for soil quality. I want to identify management practices that best maintain beneficial soil properties under long-term use.

How my research is conducted
I took soil samples at two Illinois experimental plots 15 years after establishment. These plots included four different crop rotations—continuous corn, corn-soybean, corn-soybean-wheat, and continuous soybean with both conventional tillage and no-tillage for each rotation. To assess soil quality, I analyzed the soil samples to determine many different soil properties including both physical and chemical properties.

Notable findings
No-tillage:

- After 15 years, the use of no tillage was beneficial to soil quality compared to conventional tillage. Increased soil organic carbon, total nitrogen and aggregate stability were found under no-till over the top 60 cm. These properties, especially soil organic carbon, are important indicators of soil quality.

Crop rotation:

- Crop rotations that produce greater crop residues, such as continuous corn and corn-soybean-wheat, led to greater total nitrogen and aggregate stability. Measurements of soil organic carbon were not significantly different among rotations, although the trend was the same as for total nitrogen and aggregate stability.
- The use of an extended rotation by incorporating wheat as a third crop into the corn-soybean rotation may be beneficial, however, the use of continuous corn was similarly favorable.
- Differences among crop rotations were the same regardless of tillage practice.

Roster – Climate & Corn CAP Next Generation Scientists

Postdoctoral Research Associates

Landon Bunderson, Agronomy, Iowa State University (2013-15)

Aaron Daigh, Agricultural and Biosystems Engineering, Iowa State University (2013)

Benjamin Dumont, Geological Sciences, Michigan State University

Javed Iqbal, Agronomy, Iowa State University

Sandeep Kumar, School of Environment and Natural Resources, The Ohio State University (2011-12)

Ainis Lagzdins, Agricultural and Biosystems Engineering, Iowa State University

Ruiqiang Liu, School of Environment & Natural Resources, The Ohio State University

Suresh Lokhande, Sociology, Iowa State University

Atanu Mukherjee, School of Environment and Natural Resources, The Ohio State University (2013-15)

Toru Nakajima, School of Environment and Natural Resources, The Ohio State University (2012-14)

Magdalena Necpalova, Biological Systems Engineering, University of Wisconsin (2013-14)

Wakene Negassa Chewaka, Plant, Soil and Microbial Sciences, Michigan State University (2011-14)

Vincent Obade, School of Environment and Natural Resources, The Ohio State University (2012-15)

Ioannis Panagopoulos, Center for Agricultural and Rural Development, Iowa State University (2012-13)

Jose Pantoja, Agronomy, Iowa State University (2011-13)

Rashid Rafique, Biological Systems Engineering, University of Wisconsin (2011-12)

Raj Shrestha, School of Environment and Natural Resources, The Ohio State University

Ehsan Toosi, Plant, Soil and Microbial Sciences, Michigan State University

Adriana Valcu-Lisman, Economics, Iowa State University (2013-15)

Yongjie Yi, Center for Agricultural and Rural Development, Iowa State University (2013-15)

Ph.D. Students

Grazieli Araldi da Silva, Plant Pathology & Microbiology, Iowa State University

Jenette Ashtekar, Agronomy, Purdue University (2011-14)

Andrea Basche, Agronomy, Iowa State University (2011-15)

Chun-mei Chiu, Agronomy, Purdue University (2013)

Shashi Dhungel, Biological Systems Engineering, University of Wisconsin (2011-13)

Mike Dunbar, Entomology, Iowa State University

Trenton Ellis, Agricultural and Biosystems Engineering, South Dakota State University (2012)

Jessica Fry, Plant, Soil and Microbial Sciences, Michigan State University

Syed Maaz Gardezi, Sociology, Iowa State University

Maria Gonzalez-Ramirez, Economics, Iowa State University (2011-15)

Lei Gu, Biological Systems Engineering, University of Wisconsin

(continued on next page)

Roster continued...

Samuel Haruna, Agriculture and Environmental Science, Lincoln University and University of Missouri

Jonathan Hobbs, Sociology, Iowa State University (2012-13)

Maciej Kazula, Agronomy, University of Wisconsin

Moslem Ladoni, Plant, Soil and Microbial Sciences, Michigan State University (2011-15)

Scott Lee, Agronomy, Iowa State University

Adam Loy, Sociology, Iowa State University (2012-13)

Guillermo Marcillo, Agronomy, Iowa State University

Andrew McCubbins, Agriculture Education, Iowa State University (2013-14)

Jean McGuire, Sociology, Iowa State University (2011-14)

Juan Munoz, Plant, Soil and Microbial Sciences, Michigan State University (2011-14)

Ryan Nagelkirk, Geological Sciences, Michigan State University (2013-15)

Lindsay Pease, School of Environment and Natural Resources, The Ohio State University

Michelle Quigley, Plant, Soil and Microbial Sciences, Michigan State University

Gabrielle Roesch-McNally, Natural Resources Ecology and Management, Iowa State University

Erin Seldat Kline, Agricultural and Biosystems Engineering, South Dakota State University (2012)

Samane Saadat, Agricultural and Biological Engineering, Purdue University

Aditi Sengupta, School of Environment and Natural Resources, The Ohio State University (2013-15)

Matthew Shultz, Agricultural Education and Studies, Iowa State University (2012-13)

Timothy Sklenar, Agronomy, Iowa State University

Emma Snyder, School of Environment and Natural Resources, The Ohio State University

Maninder Walia, School of Environment and Natural Resources, The Ohio State University (2013-15)

Adam Wilke, Sociology, Iowa State University

Lu Zhang, Bioproducts and Biosystems Engineering, University of Minnesota

Stacy Zuber, Crop Sciences, University of Illinois

M.S. Students

Shanta Acharya, Agriculture and Environmental Science, Lincoln University

Hasan Ali, Agriculture and Environmental Science, Lincoln University (2013-15)

Rebecca Bailey, Agronomy, University of Wisconsin (2012-15)

Afolasade Balogum, Lincoln University

Jordan Beehler, Plant, Soil and Microbial Sciences, Michigan State University

Marci Bird, School of Environment & Natural Resources, The Ohio State University (2012-13)

Kyle Brooks, Agricultural and Biological Engineering, Purdue University (2011-13)

Brittany Campbell, School of Environment and Natural Resources, The Ohio State University (2011-12)

Jason Cavadini, Agronomy, Purdue University (2011-13)

Kim Chapman, School of Environment & Natural Resources, The Ohio State University

Kristina Craft, Agricultural and Biosystems Engineering, Iowa State University

Ariele Daniel, Agronomy, Iowa State University (2014-15)

Omar de Kok-Mercado, Agronomy, Iowa State University (2013-14)
Laura Di Giulio, The Ohio State University

Christopher Eidson, School of Environment and Natural Resources, The Ohio State University (2013-15)

Trevor Frank, Agronomy, Purdue University (2013-15)

Laura Frescoln, Sociology, Iowa State University (2013-15)

Ryan Goeken, Agricultural and Biosystems Engineering, Iowa State University (2011-13)

Gang Han, Plant Pathology and Microbiology, Iowa State University (2012-14)

Kaylissa Halter, Agronomy, Purdue University (2011-13)

Caroline Hughes, Agricultural and Biological Engineering, Purdue University

Anna Johnson, Sociology, Iowa State University

Reed Johnson, School of Environment and Natural Resources, The Ohio State University

Natalie Jozik, Biological Systems Engineering, University of Wisconsin

Renan Kobayashi Leonel, Plant Pathology and Microbiology, Iowa State University

Guy Bou Lahdou, Agricultural and Biological Engineering, Purdue University (2013-14)

Ao Li, Biological Systems Engineering, University of Wisconsin (2011-13)

Scott Mayhew, School of Environment and Natural Resources, The Ohio State University (2014)

Brandon Mebruer, Agriculture & Environmental Science, Lincoln University (2011-12)

David Mitchell, Agronomy, Iowa State University (2010-12)

Dinesh Panday, Agriculture and Environmental Science, Lincoln University (2013-15)

Swetabh Patel, Agronomy, Iowa State University

Richard Price, Plant, Soil and Microbial Sciences, Michigan State University

Dipti Rai, Agriculture and Environmental Science, Lincoln University

Rebecca Roberts, Agronomy, Iowa State University

Joseph Rorick, Agronomy, Purdue University

Stephanie Sale, Agriculture and Environmental Science, Lincoln University (2011-13)

Linda Schott, Agricultural and Biosystems Engineering, Iowa State University

Mandira Sharma, Agriculture and Environmental Science, Lincoln University

Cody Troop, Atmospheric and Environmental Sciences, South Dakota School of Mines and Technology

Emily Waring, Agricultural and Biosystems Engineering, Iowa State University

Jason Williams, Agriculture and Environmental Science, Lincoln University (2011-13)

Edward Zaworski, Plant Pathology and Microbiology, Iowa State University (2012-14)

Note: Adam Wilke, Lei Gu, Stacy Zuber and Samuel Haruna have dual degrees (Current PhD and past MS). Likewise, Jose Pantoja and Adriana Valcu-Lisman worked as postdoctoral associate and were also PhD students with the project. These individuals are only listed once, however.

Publications

The following publications were authored or co-authored by Climate & Corn CAP graduate students and/or postdoctoral associates. The list is alphabetical by last name of the first authors.

Arbuckle, J., L.W. Morton and J. Hobbs. 2015. Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, climate change beliefs, and perceived risk. Environment & Behavior. 47:205-234. http://dx.doi.org/10.1177/0013916513503832

Arbuckle, J.G., J. Hobbs, A. Loy, L.W. Morton, L. Prokopy and J. Tyndall. 2014. Understanding farmer perspectives on climate change to inform engagement strategies for adaptation and mitigation. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):505-516. http://dx.doi.org/10.2489/jswc.69.6.505

Arbuckle, J.G., L.W. Morton and J. Hobbs. 2013. Farmer beliefs and concerns about climate change and attitudes toward adaptation and mitigation: Evidence from Iowa. Climatic Change. 118:551-563. http://dx.doi.org/10.1007/s10584-013-0700-0

Arbuckle, J.G., L.S. Prokopy, T. Haigh, J. Hobbs, T. Knoot, C. Knutson, A. Loy, A.S. Mase, J. McGuire, L.W. Morton, J. Tyndall and M. Widhalm. 2013. Climate change beliefs, concerns, and attitudes toward adaptation and mitigation among farmers in the Midwestern United States. Climatic Change Letters. 117:943-950. http://dx.doi.org/10.1007/s10584-013-0707-6

Bailey, R.R., T.R. Butts, J.G. Lauer, C.A.M. Laboski, C.J. Kucharik and V.M. Davis. 2015. Effect of weed management strategy and row width on nitrous oxide (N_2O) emissions from soybean. Weed Science. http://dx.doi.org/10.1614/WS-D-15-00010.1

Basche, A., F. Miguez, T. Kasper and M. Castellano. 2014. Do cover crops increase or decrease nitrous oxide emissions in agroecosystems? A meta-analysis. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):471-482. http://dx.doi.org/10.2489/jswc.69.6.471

Basche, A.D., G.E. Roesch-McNally, L.A. Pease, C.D. Eidson, G. Bou Lahdou, M.W. Dunbar, T.J. Frank, L. Frescoln, L. Gu, R. Nagelkirk, J. Pantoja and A.K. Wilke. 2014. Challenges and opportunities in transdisciplinary science: The experience of next generation scientists in an agriculture and climate research collaboration. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):176A-179A. http://dx.doi.org/10.2489/jswc.69.6.176A

Campbell, B., L. Chen, C. Dygert and W. Dick. 2014. Tillage and crop rotation impacts on greenhouse gas fluxes from two long-term agronomic experimental sites in Ohio. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):543-552. http://dx.doi.org/10.2489/jswc.69.6.543

Daigh, A.L., M.J. Helmers, E. Kladivko, X. Zhou, R. Goeken, J. Cavadini, D. Barker and J. Sawyer. 2014. Soil water during the drought of 2012 as affected by rye cover crop in fields in Iowa and Indiana. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):564-573. http://dx.doi.org/10.2489/jswc.69.6.564

Frescoln, L. and J. Arbuckle. 2015. Changes in perceptions of transdisciplinary science over time. Futures. 73:136-150. http://dx.doi.org/10.1016/j.futures.2015.08.008

Goeken, R., X. Zhou and M. Helmers. 2015. Comparison of timing and volume of subsurface drainage under perennial forage and row crops in a tile-drained field in Iowa. Transaction of American Society of Agriculture and Biological Engineering. (doi not assigned yet)

Gonzalez-Ramirez, J., C.L. Kling and A. Valcu. 2012. An overview of carbon offsets from agriculture. Annual Review of Resource Economics. 4:145-184. http://dx.doi.org/10.1146/annurev-resource-083110-120016

Haruna, S.I. and N.V. Nkongolo. 2015. Effects of tillage, rotation and cover crop on the physical properties of a silt-loam soil. International Agrophysics. 29(2):137-154. http://dx.doi.org/10.1515/intag-2015-0030

Haruna, S.I. and N.V. Nkongolo. 2014. Spatial and fractal characterization of soil chemical properties and nutrients across depths in a clay-loam soil. Communications in Soil Science and Plant Analysis. 45(17):2305-2318. http://dx.doi.org/10.1080/00103624.2014.932371

Haruna, S.I. and N.V. Nkongolo. 2013. Variability of soil physical properties in a clay-loam soil and its implication on soil management practices. ISRN Soil Science. 2013:1-8. http://dx.doi.org/10.1155/2013/418586

Herzmann, D.E., L.J. Abendroth and L.D Bunderson. 2014. Data management approach to multidisciplinary agricultural research and syntheses. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):180A-185A. http://dx.doi.org/10.2489/jswc.69.6.180A

Iqbal, J., D. Mitchell, F. Miguez, J. Sawyer, J. Pantoja, D. Barker and M.J. Castellano. 2015. Does nitrogen fertilizer rate to corn affect N_2O emissions from the rotated soybean crop?. Journal of Environmental Quality. 44:711-719. http://dx.doi.org/10.2134/jeq2014.09.0378

Iqbal, J., M.J. Helmers, X.B. Zhou, T.B. Parkin and M. Castellano. 2014. Denitrification and N_2O emissions in annual croplands, perennial grass buffers and restored perennial grasslands. Soil Science Society of America Journal. 79(1):239-250. http://dx.doi.org/10.2136/sssaj2014.05.0221

Iqbal J., M.J. Castellano and T.B. Parkin. 2013. Evaluation of photoacoustic spectroscopy for simultaneous measurement of N_2O and CO_2 gas concentrations and fluxes at the soil surface. Global Change Biology. 19(1):327-336. http://dx.doi.org/10.1111/gcb.12021

Iqbal, J., T.B. Parkin and M. Castellano. 2013. Accuracy and precision of no instrument is guaranteed: A reply to Rosenstock et al. Global Change Biology. 20(5):1362-1365. http://dx.doi.org/10.1111/gcb.12446.

Jha, M.K., P.W. Gassman and Y. Panagopoulos. 2013. Regional changes in nitrate loadings in the Upper Mississippi River Basin under predicted mid-century climate. Regional Environmental Change. 15:449-460. http://dx.doi.org/10.1007/s10113-013-0539-y

Kling, C.L., Y. Panagopoulos, A. Valcu, P.W. Gassman, S. Rabotyagov, T. Campbell, M. White, J.G. Arnold, R. Srinivasan, M.K. Jha, J. Richardson, G. Turner and N. Rabalais. 2014. LUMINATE: linking agricultural land use, local water quality and Gulf of Mexico hypoxia. European Journal of Agricultural Economics. 41(3):431-459. http://dx.doi.org/10.1093/erae/jbu009

Kling, C.L. and A. Valcu. 2013. State level efforts to regulate agricultural sources of water quality impairment. Choices. 28(3):1-4. http://www.choicesmagazine.org/choices-magazine/theme-articles/innovations-in-nonpoint-source-pollution-policy/state-level-efforts-to-regulate-agricultural-sources-of-water-quality-impairment

Kravchenko, A.N., B. Hildebrandt, T.L. Marsh, W.C.Negassa, A.K. Guber and M.L. Rivers. 2014. Intra-aggregate pore structure influences phylogenetic composition of bacterial community in macroaggregates. Soil Science Society of America Journal. 78:1924-1939. http://dx.doi.org/10.2136/sssaj2014.07.0308

Kravchenko, A.N., W. Negassa, A.K. Guber and S. Schimidt. 2014. New approach to measure soil particulate organic matter in intact samples using X-ray computed micro-tomography. Soil Science Society of America Journal. 78:1177-1185. http://dx.doi.org/10.2136/sssaj2014.01.0039

(continued on next page)

Publications continued...

Kumar S., T. Nakajima, E.G. Mbonimpa, S. Gautam, U.R. Somireddy, A. Kadono, R. Lal, R. Chintala, R. Rafique and N Fausey. 2014. Long-term tillage and drainage influences on soil organic carbon dynamics, aggregate stability, and corn yield. Soil Science and Plant Nutrition. 60(1):108-118. http://dx.doi.org/10.1080/00380768.2013.878643

Kumar, S., T. Nakajima, A. Kadono, R. Lal and N. Fausey. 2014. Long-term tillage and drainage influences on greenhouse gas fluxes from a poorly-drained soil of central Ohio. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):553-563. http://dx.doi.org/10.2489/jswc.69.6.553

Kumar, S., A. Kadono, R. Lal and W. Dick. 2012. Long-term no-till impacts on organic carbon and properties of two contrasting soils and corn yields in Ohio. Soil Science Society of America Journal. 76(5):1798-1809. http://dx.doi.org/10.2136/sssaj2012.0055

Kumar, S., A. Kadono, R. Lal and W. Dick. 2012. Long-term tillage and crop rotations for 47-49 years influences hydrological properties of two soils in Ohio. Soil Science Society of America Journal. 76(6):2195-2207. http://dx.doi.org/10.2136/sssaj2012.0098

Ladoni, M., A. Basir and A.N. Kravchenko. 2015. Which soil carbon characteristic is the best for assessing management differences? View from statistical power perspective. Soil Science Society of America Journal. 79:848-857. http://dx.doi.org/10.2136/sssaj2014.10.0426

McGuire, J., L.W. Morton and A. Cast. 2013. Reconstructing the good farmer identity: shifts in farmer identities and farm management practices to improve water quality. Agriculture and Human Values. 30:57-69. http://dx.doi.org/10.1007/s10460-012-9381-y

Mitchell, D.C., M.J. Helmers, T.B. Parkin, X.B. Zhou and M.J. Castellano. 2014. Comparing nitrate sink strength in perennial filter strips at toeslope of cropland watersheds. Journal of Environmental Quality. 44(1):191-199. http://dx.doi.org/10.2134/jeq2014.05.0201

Mitchell D.C., M.J. Castellano, J.E. Sawyer and J.L. Pantoja. 2013. Cover crop effects on nitrous oxide emissions: Role of mineralizable carbon. Soil Science Society of America Journal. 77:1765-1773. http://dx.doi.org/10.2136/sssaj2013.02.0074

Morton, L.W., J. Hobbs, J. Arbuckle and A. Loy. 2015. Upper midwest climate variations: Farmer responses to excess water risks. Journal Environmental Quality. 44(3):810-822. http://dx.doi.org/10.2134/jeq2014.08.0352

Morton, L.W., J. Hobbs and J.G. Arbuckle. 2013. Shifts in farmer uncertainty over time about sustainable farming practices and modern farming reliance on commercial fertilizers, insecticides and herbicides. Journal of Soil and Water Conservation. 68(1):1-12. http://dx.doi.org/10.2489/jswc.68.1.1

Mukherjee, A. and R. Lal. 2015. Tillage effects on quality of organic and mineral soils under on-farm conditions in Ohio. Environmental Earth Science. 74:1815-1822. http://dx.doi.org/10.1007/s12665-015-4189-x

Mukherjee, A. and R. Lal. 2015. Short-term effects of cover cropping on quality of a Typic Argiaquolls in central Ohio. Catena. 131:125-129. http://dx.doi.org/10.1016/j.catena.2015.02.025

Mukherjee, A. and R. Lal. 2014. Comparison of soil quality index using three methods. PLOS ONE. 9(8):1-15. http://dx.doi.org/10.1371/journal.pone.0105981

Munoz, J.D., J. Steibel, S. Snapp and A.N. Kravchenko. 2014. Cover crop effect on corn growth and yield as influenced by topography. Agriculture, Ecosystem & Environment. 189:229-239. http://dx.doi.org/10.1016/j.agee.2014.03.045

Munoz-Robayo, J.D. and A.N. Kravchenko. 2012. Deriving the optimal scale for relating topographical attributes and cover crop plant biomass. Geomorphology. 179:197-207. http://dx.doi.org/10.1016/j.geomorph.2012.08.011

Nakajima, T., R. Lal and S. Jiang. 2015. Soil quality index of crosby silt loam in central Ohio. Soil and Tillage Research. 146(B):323-328. http://dx.doi.org/10.1016/j.still.2014.10.001

Nakajima, T. and R. Lal. 2015. Comparison of greenhouse gas emissions monitored with a photoacoustic infrared spectroscopy multi-gas monitor and a gas chromatograph from a Crosby silt loam. Carbon Management. http://dx.doi.org/10.1080/17583004.2015.1080473.

Nakajima, T. and R. Lal. 2014. Tillage and drainage management effect on soil gas diffusivity. Soil and Tillage Research. 135:71-78. http://dx.doi.org/10.1016/j.still.2013.09.003

Necpálová, M., R.P. Anex, M.N. Fienen, S.J. Del Grosso, M.J. Castellano and J.E. Sawyer. 2014. Understanding the DayCent model: calibration, sensitivity, and identifiability through inverse modeling. Environmental Modeling & Software. 66:110-130. http://dx.doi.org/10.1016/j.envsoft.2014.12.011

Necpálová, M., R.P. Anex, A.N. Kravchenko, L.J. Abendroth, S.J. Del Grosso, W.A. Dick, M.J. Helmers, D. Herzmann, J.G. Lauer, E.D. Nafziger, J.E. Sawyer, P.C. Scharf, J.S.Strock and M.B. Villamil. 2014. What does it take to detect a change in soil carbon stock? A regional comparison of minimum detectable difference and experiment duration in the North-Central United States. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):517-531. http://dx.doi.org/10.2489/jswc.69.6.517

Negassa, W., A.K. Guber, A.N. Kravchenko, T.L. Marsh, B. Hildebrandt and M.L. Rivers. 2015. Properties of soil pore space regulate pathways of plant residue decomposition and community structure of associated bacteria. PLOS ONE. 10(4):1-22. http://dx.doi.org/10.1371/journal.pone.0123999

Negassa, W., R. Price, A. Basir, S.S. Snap and A.N. Kravchenko. 2015. Cover crop and tillage system effects on soil CO_2 and N_2O fluxes at contrasting topographic positions. Soil and Tillage Research. 154:64-74 http://dx.doi.org/10.1016/j.still.2015.06.015

Obade, V. and R. Lal. 2014. Soil quality evaluation under different land management practices. Environmental Earth Sciences. 72:4531-4549. http://dx.doi.org/10.1007/s12665-014-3353-z

Obade, V. and R. Lal. 2014. Using meta-analyses to assess pedo-variability under different land uses and soil management in central Ohio, USA. Geoderma. 232-234:56-68. http://dx.doi.org/10.1016/j.geoderma.2014.04.030

Obade, V., R. Lal and R. Moore. 2014. Assessing the accuracy of soil and water quality characterization using remote sensing. Water Resources Management. 28(14):5091-5109. http://dx.doi.org/10.1007/s11269-014-0796-7

Panagopoulos, Y., P.W. Gassman, R.W. Arritt, D.E. Herzmann, T.D. Campbell, A. Valcu, M.K. Jha, C.L. Kling, R. Srinivasan, M. White and J.G. Arnold. 2015. Impacts of climate change on hydrology, water quality and crop productivity in the Ohio-Tennessee River Basin. International Journal of Agricultural and Biological Engineering. 8(3):36-53. https://ijabe.org/index.php/ijabe/article/view/1497/pdf_1

Panagopoulos, Y., P.W. Gassman, R. Arritt, D.E. Herzmann, T. Campbell, M.K. Jha, C.L. Kling, R. Srinivasan, M. White and J.G. Arnold. 2014. Surface water quality and cropping systems sustainability under a changing climate in the Upper Mississippi River Basin. Journal of Soil and Water Conservation, Special Issue for Climate and Agriculture. 69(6):483-494. http://dx.doi.org/10.2489/jswc.69.6.483

Panday, D. and N.V. Nkongolo. 2015. Soil water potential control of the relationship between moisture and greenhouse gases fluxes in corn-soybean field. Climate. 3(3):689-696. http://dx.doi.org/10.3390/cli3030689

(continued on next page)

Publications continued...

Pantoja, J.L., K.P. Woli, J.E. Sawyer and D.W. Barker. 2015. Corn nitrogen fertilization requirement and corn soybean productivity with a rye cover crop. Soil Science Society of America Journal. http://dx.doi.org/10.2136/sssaj2015.02.0084

Prokopy, L., L. Morton, J. Arbuckle, A. Mase and A. Wilke. 2014. Agricultural stakeholder views on climate change: Implications for conducting research and outreach. Bulletin of the American Meteorological Society (BAMS). 96(2):81-90. http://dx.doi.org/10.1175/BAMS-D-13-00172.1

Prokopy, L.S., T. Haigh, A.S. Mase, J. Angel, C. Hart, C. Knutson, M.C. Lemos, Y. Lo, J. McGuire, L.W. Morton, J. Perron, D. Todey and M. Widhalm. 2013. Agricultural advisors: A receptive audience for weather and climate information?. Weather, Climate, and Society. 5:162-167. http://dx.doi.org/10.1175/WCAS-D-12-00036.1

Rabotyagov, S., T. Campbell, M. White, J. Arnold, J. Atwood, L. Norfleet, C. Kling, P. Gassman, A. Valcu, J. Richardson, G. Turner and N. Rabalais. 2014. Cost-effective targeting of conservation investments to reduce the northern Gulf of Mexico hypoxic zone. Proceedings of the National Academy of Sciences. 111(52):18530-18535. http://dx.doi.org/10.1073/pnas.1405837111.

Rabotyagov, S., A. Valcu, C.L. Kling, P.W. Gassman, N.N. Rabalais and R.E. Turner. 2014. The economics of dead zones: causes, impacts, policy challenges, and a model of the Gulf of Mexico Hypoxic Zone. Review of Environmental Economics and Policy. 8(1):58-79. http://dx.doi.org/10.1093/reep/ret024

Rabotyagov, S.S., A. Valcua, C.L. Kling, T. Campbell, P.W. Gassman and M. Jha. 2014. An improved reverse auction for addressing water quality in agricultural watersheds using coupled simulation-optimization models. Frontiers of Economics in China. 9(1):25-51. http://journal.hep.com.cn/fec/EN/10.3868/s060-003-014-0003-1

Rabatyagor, S., A. Valcu and C. Kling. 2013. Reversing property rights: practice-based approaches for controlling agricultural nonpoint-source water pollution when emissions aggregate nonlinearly. American Journal of Agricultural Economics. 96(2):397-419. http://dx.doi.org/10.1093/ajae/aat094

Rafique, R., M.N. Fienen, T.B. Parkin and R.P. Anex. 2013. Nitrous oxide emissions from cropland: A procedure for calibrating the DAYCENT biogeochemical model using inverse modeling. Water, Air, & Soil Pollution. 224(1677):1-15. http://dx.doi.org/10.1007/s11270-013-1677-z

Sengupta, A. and W.A. Dick. 2015. Bacterial community diversity in soil under two tillage practices as determined by pyrosequencing. Microbial Ecology. http://dx.doi.org/10.1007/s00248-015-0609-4.

Tyndall, J.C. and G. Roesch. 2014. A standardized approach to the financial analysis of structural water quality BMPs. Journal of Extension. 52:3 http://www.joe.org/joe/2014june/a10.php

Wilke, A.K. and L.W. Morton. 2015. Climatologists' patterns of conveying climate science to the agricultural community. Agriculture and Human Values. 32:99-110. http://dx.doi.org/10.1007/s10460-014-9531-5

Wilke, A.K. and L.W. Morton. 2015. Communicating climate science: Components for engaging the agricultural audiences. Science Communication. 37(3):371-395. http://dx.doi.org/10.1177/1075547015581927

Zuber, S.M., G.D. Behnke, E.D. Nafziger and M.B. Villamil. 2015. Crop rotation and tillage effects on soil physical and chemical properties in Illinois. Agronomy Journal. 107(3):1-8. http://dx.doi.org/10.2134/agronj14.0465

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