PROJECT SUMMARY

Instructions:
The summary is limited to 250 words. The names and affiliated organizations of all Project Directors/Principal Investigators (PD/PI) should be listed in addition to the title of the project. The summary should be a self-contained, specific description of the activity to be undertaken and should focus on: overall project goal(s) and supporting objectives; plans to accomplish project goal(s); and relevance of the project to the goals of the program. The importance of a concise, informative Project Summary cannot be overemphasized.

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

PD: Wright Morton, Lois	**Institution:** Iowa State University
CO-PD: Lal, Rattan	**Institution:** The Ohio State University
CO-PD: Lauer, Joseph G.	**Institution:** University of Wisconsin
CO-PD: Kladivko, Eileen J.	**Institution:** Purdue University
CO-PD: Scharf, Peter C.	**Institution:** University of Missouri
CO-PD: Arritt, Raymond W.	**Institution:** Iowa State University
CO-PD: Nkongolo, Nsalambi V.	**Institution:** Lincoln University (Missouri)
CO-PD: Moore, Richard H.	**Institution:** The Ohio State University
CO-PD: Arbuckle, J. Gordon	**Institution:** Iowa State University
CO-PD: Anex, Robert P.	**Institution:** University of Wisconsin
CO-PD: Castellano, Michael J.	**Institution:** Iowa State University
CO-PD: Fausey, Norman R.	**Institution:** USDA-ARS, Columbus, OH
CO-PD: Helmers, Matthew J.	**Institution:** Iowa State University
CO-PD: Kravchenko, Alexandra N.	**Institution:** Michigan State University
CO-PD: Nafziger, Emerson D.	**Institution:** University of Illinois
CO-PD: Sawyer, John E.	**Institution:** Iowa State University
CO-PD: Strock, Jeffrey S.	**Institution:** University of Minnesota
CO-PD: Todey, Dennis P.	**Institution:** South Dakota State University
CO-PD: Mueller, Daren S.	**Institution:** Iowa State University

The Climate and Corn-based Cropping Systems Coordinated Agricultural Project (CSCAP) is entering Y5 with goals to: 1) complete sampling measurements at 35 field sites and enter all data (biophysical and social economic) into the database; 2) accelerate synthesis and modeling of primary and secondary data and publish findings in scientific outlets; 3) increase across-disciplinary integration and knowledge exchanges of data and findings to address more complex human-natural system research questions; 4) develop recommendations and extend scientific findings to extension educators, farmers, policymakers, agricultural sector, and science educators; and, 5) complete the graduate education of 47 project students and guide them into the next phases of their careers. Our work is about understanding systems, specifically the carbon, nitrogen, water and human-social systems that underpin the management and resilience of corn-soybean production to climate change. To accomplish a high level of multi-disciplinary and stakeholder integration our transdisciplinary team will intensify efforts to connect our disciplinary knowledge, theories and data in ways that allow us to answer difficult system-based science questions. To date, CSCAP has leveraged over $5.3 million through institutional support, partnerships, and other organizations. In the final year of the project, the team will work to ensure future science and outreach programming are poised to build on what the project has learned by strengthening existing while also building out new partnerships to leverage and transfer the work of the team such as standardized protocols, research and management databases, internal website, and inter-transdisciplinary networks of value to future proposals and projects.

USDA-NIFA Award No. 2011-38002-30190

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

Program Area Code and Priority: A3101 Regional Approaches to Climate Change
Cropping Systems: cereal production systems (corn)

USDA-NIFA Award No. 2011-68002-30190
USDA Award Date: March 1, 2011
Project Director: Dr. Lois Wright Morton, Iowa State University

Year 5 Continuation Application Submitted Dec. 16, 2014
Reporting CSCAP efforts for the period of Oct. 1, 2013 to Oct. 31, 2014. This captures all work since last reported to USDA-NIFA in the Y4 continuation proposal.

Field 8. Project Narrative

Field 8. A-1. Overview: Team POW for Year 5

The Climate and Corn-based Cropping Systems Coordinated Agricultural Project (CSCAP) is entering Y5 with goals to: 1) complete sampling measurements at 35 field sites and enter all data (biophysical and social economic) into the database; 2) accelerate synthesis and modeling of primary and secondary data and publish findings in scientific outlets; 3) increase across-disciplinary integration and knowledge exchanges of data and findings to address more complex human-natural system research questions; 4) develop recommendations and extend scientific findings to extension educators, farmers, policymakers, agricultural sector, and science educators with whom the team is working; and, 5) complete the graduate education of 47 project students and guide them into the next phases of their careers. In this last year of the project, the team will

work to ensure future science and outreach programming are poised to build on what the project has learned by strengthening existing while also building out new partnerships to leverage and transfer the work of the team such as standardized protocols, research and management databases, internal website, field experiments, and inter-transdisciplinary networks of value to future proposals and projects. Many Advisory Board members are highly engaged with the team and are working with the team to plan for sustaining the project legacy.

The team is working within and across six Objectives to accomplish these goals:

1. Develop standardized methodologies and perform baseline monitoring of carbon, nitrogen and water footprints at agricultural test sites across the Midwest.
2. Evaluate how crop management practices impact carbon, nitrogen and water footprints at test sites.
3. Apply models to research data and climate scenarios to identify impacts and outcomes that could affect the sustainability and economic vitality of corn-based cropping systems.
4. Gain knowledge of farmer beliefs and concerns about climate change, attitudes toward adaptive and mitigative strategies and practices, and decision support needs to inform the development of outreach that supports long-term sustainability of crop production.
5. Promote extension, outreach and stakeholder learning and participation across all aspects of the program.
6. Train the next generation of scientists, develop science education curricula and promote learning opportunities for high school teachers.

Cross-disciplinary integration and knowledge exchanges of data and analyses to accelerate synthesis and integration plans in this final project year are first presented followed by Objective-specific Y5 plans of work (POW), Y4 outputs, Y4 outcomes/impacts, milestones and deliverables, broad impacts, student training, and concluding statements.

Team POW for Year 5 – *CROSS-DISCIPLINARY INTEGRATION AND KNOWLEDGE EXCHANGES*

Although the milestones are organized around a set of project objectives, our work is about understanding systems—specifically the carbon, nitrogen, water and human-social systems that underpin the management of corn-soybean production systems and their interactive responses to variable climate and weather conditions. This requires a high level of multi-disciplinary and stakeholder integration through project management and systematic efforts by our transdisciplinary team to purposefully connect our disciplinary knowledge, theories and data in ways that allow us to answer some of the difficult science questions associated with managing corn-based cropping systems. Across-team Y5 integration goals are to: 1) accelerate synthesis and modeling of primary and secondary data and publish findings in scientific outlets; 2) increase across-disciplinary integration and knowledge exchanges of data and findings to address more complex human-natural system research questions; and, 3) develop recommendations and move scientific findings to applications for use by extension educators, farmers, policymakers, other groups in the agricultural sector, as well as science educators.

To accomplish the Y5 project goals we will continue the successful processes from past years that are bearing fruit and push forward to complete collection of all primary data (biophysical and social economic) with intent to finalize the project database; intensify cross-disciplinary

efforts to conduct primary and regional analyses, synthesis, and modeling; and publish the science of the team for scientific and non-scientific audiences.

Y5 whole-team POW tasks are:

a) Complete the project database. Objectives 1-4 tasked with collecting, cleaning and preparing project primary data for analysis will actively interface with the database team to assure all data are in the database by end of Y5;
b) Identify point persons for Objectives and field treatment workgroups to accelerate integration of disciplinary knowledge, theories, data and findings within Objectives and across the team so as to push multi-disciplinary integration and to facilitate across team knowledge exchanges;
c) Strengthen integration by utilizing whole team monthly/bimonthly meetings to present preliminary findings and plans for writing papers, to identify integration and cross-cutting themes, and to organize integrated synthesis-writing workgroups;
d) Increase virtual and face-to-face time for integrated team clusters to accelerate exchange of theories, propose and test hypotheses, analyze and synthesize data, and publish science findings;
e) Expand involvement of project extension educators into existing and new integrated team clusters to create more active feedback loops between research, extension, and education so that scientific findings have strong farmer applicability;
f) Develop products for non-scientific audiences by communicating key scientific findings to extension and education so these science outputs become inputs that extension and education teams can use with their target audiences;
g) Synthesize regional recommendations specific to experimental treatments (cover crops, drainage management, tillage, extended rotations, and N management, organic water use efficiency);
h) Publish regional recommendations via methods that target extension educators, agricultural advisors and intermediaries, farm media, science teachers, and project website visitors; and,
i) Develop workgroups and work closely with the CSCAP Advisory Board to explore mechanisms and partnerships to leverage and transfer the work of the team post-project (e.g., Midwest Climate Hub, North Central Region Experiment Station directors, NA Climate Smart Agriculture, industry-university-ARS consortia).

Field 8. A-2. Team POW for Year 5 – *OBJECTIVES 1 & 2 SPECIFIC*

The Y5 plan of work for Objectives 1 & 2 focuses on building upon prior years collaborative work within topic subgroups (cover crops, drainage water management, organic systems, tillage management, nitrogen management, extended rotations, and integrated pest management), the final year collection of field research data across the 35 CSCAP research network sites, transmittal of data into the central database, integration meetings with Objective 3-6 members, and preparation of regional publications synthesizing data across the CSCAP network.

This POW will be accomplished specifically by:

a) Continuing to virtually meet within subgroups monthly as well as face-to-face meetings (in addition to the annual meeting) to review and synthesize data across research sites;

b) Complete research experiments and gather final year of data from field measurements, laboratory analysis, and perform quality control of data for entry into the central database; c) Working with database team to assure all individual research site data and supporting metadata are entered, questions addressed, and ready for use as a complete dataset;
d) Expanding soybean-based research through additional funding from the United Soybean Board, funds allocated for increased data collection of carbon and nitrogen data (Oct. 2014-Oct. 2015);
d) Examining Y1-Y5 data across sites to identify emerging management practices, weather conditions, and soil properties that appear to be particularly influential on greenhouse gas emissions, agronomic productivity, soil quality and health, pest pressures, and overall carbon, nitrogen, and water footprints of these cropping systems;
e) Completing the Soil Quality Index (SQI) model based on Y1-Y5 field data. Evaluate how well this assesses soil quality and associated incremental gains or losses.
f) Extending findings and knowledge outward from the field and laboratory to farmers associated with the project through Obj. 5 members; and,
g) Produce innovative publications that synthesize across the region, add to the literature and translate regional differences; this will be a function of working across disciplines in Obj. 1 & 2, Obj. 3, Obj. 4, and Obj. 5.

Field 8. A-3. Team POW for Year 5 – *OBJECTIVE 3 SPECIFIC*

The Y5 plan of work for Obj. 3 includes ongoing synthesis and modeling of CSCAP data gathered during Y1-Y4, continued collaborative work among subgroups, improved functionality and support of the central database, and integrating socioeconomic and climate data into datasets for modeling and analysis.

This POW will be accomplished specifically by:

a) Continuing to meet virtually on a monthly basis within Obj. 3 and to hold face-to-face meetings;
b) Completing the database's export functionality to allow the working groups to easily access field data and assisting team members with data compilation to speed synthesis and publication efforts;
c) Evaluating the long-term implications on crop productivity and soil and water quality of cover crops using APSIM calibrated with Y1-4 cover crop data;
d) Connecting landscape water transport and quality modeling efforts with socioeconomic data from the HUC6 hydrologic units (Obj 4 data);
e) Continuing economic modeling to examine implications of conservation practices on cost and necessary economic incentives to meet nutrient reduction goals across the upper Mississippi;
f) Continuing to test SALUS model performance with field scale data to verify accurate prediction of grain yield under future climate for suite of management options;
g) Continuing to develop life cycle assessment (LCA) models using site data to evaluate management practices at all sites and to identify trade-offs across the range of life cycle impact categories;
h) Continuing to integrate climate model projections into the team's modeling in order to evaluate the response of management practices to future climate projections, such as those for mid-century (ca. 2050);

i) Meeting with modelers participating in the USDA-sponsored Usable to Useful (U2U) project to explore opportunities for collaboration and research synergies; and,
j) Providing extension educators (Obj. 5) with knowledge and tools to identify and adapt local crop management practices that have the potential to reduce climate variability impacts.

Field 8. A-4. Team POW for Year 5 – *OBJECTIVE 4 SPECIFIC*

The Y5 plan of work for Obj. 4 centers on continued (1) analysis of the quantitative and qualitative data that were collected in Y1-3, and (2) dissemination of that information, especially through the CSCAP Obj. 5 extension network. The close partnership with USDA U2U (Useful to Useable) project will continue with analyses and publications from the Obj. 4 shared database. Analysis and reporting will lead to improved understanding of farmer perspectives on climate change and adaptive and mitigative action; dissemination of that information to inform the work of scientists, natural resource and agricultural professionals, and policy makers; strengthening the transdisciplinary linkages with other project Objectives; and, continuation of learning partnerships with extension educators and farmers in nine Corn Belt states.

This POW will be accomplished specifically by:

a) Formalization and structuring of the interview transcript database from in-depth interviews of 159 farmers;
b) Analysis of in-depth interviews, synthesis and publications;
c) Analysis of data, synthesis and publications from the Y2 random sample survey of 4,778 Corn Belt farmers from 22 HUC6 watersheds spanning 11 states including joint work with USDA U2U (Useful to Useable) project and a second Farmer Statistical Atlas;
d) Finalizing quantitative and qualitative data for submission to the project database by end of Y5, preparation of codebooks for future use of data, assurance of quality control and confidentiality including removal of any identifying data; and,
e) Continue development of outreach strategies and materials through partnerships with extension educators and farmers with fact sheets on Statistical Atlas currently in progress.

Field 8. A-5. Team POW for Year 5 – *OBJECTIVE 5 SPECIFIC*

The Y5 plan of work for Obj. 5 includes continuing work with farmer groups, one-on-one discussions with farmers' about their production systems, state-specific field days and crop management meetings to convey science findings and recommendations to assist in establishing practices for adaptation to climate change and facilitated discussions on weather variability and agriculture. As part of the accelerated integration goal of Y5, extension educators have been asked to become more actively involved in output development themselves and to integrate with project work clusters to provide feedback to the development of regional recommendations to farmers and interpretation of findings for non-scientific audiences.

This POW will be accomplished specifically by:

a) Working with project farmers to build knowledge and evaluate implementation of practices through demonstrations that are similar to CSCAP experiments;
b) Continuing to encourage farmer groups to try performance-based environmental management and risk assessment tools like the Nutrient Tracking Tool, and pilot test USDA U2U project decision support tools to assess individual farmer fields or watershed level that can be compared to Obj. 2 findings;

c) Continuing to increase knowledge of project extension educators regarding climate and weather impacts on agriculture through meetings and discussions with team members and farmers;
d) Expanding involvement of extension educators into existing and new integrated team clusters for more active feedback loops between research, extension, and education to ensure scientific findings have strong farmer applicability;
e) Developing publications and products for farmer audiences working closely with Obj 1 & 2 researchers, a designer and editor to prepare a variety of products including dynamic media (e.g. YouTube videos, Twitter and AgriClimate blog content (agriclimateconnection.org), fact sheets, etc.);
f) Planning of topic-specific field days and meetings for extension educators, agency and industry stakeholders, and farmers; and,
f) Conduct a second assessment of farmers early in Year 5 to compare to the baseline assessment from Y1/2 to measure change in perceptions and behaviors.

Field 8. A-6. Team POW for Year 5 – *OBJECTIVE 6 SPECIFIC*

The Y5 plan of work for Obj. 6 is shaped around five key areas: (1) translate the science on climate change and agriculture (from this project and others) into educational materials for targeted stakeholder groups, (2) awaken and inspire the next generations of scientists and agricultural professionals to "do" agricultural science, (3) synergize and catalyze impacts and accomplish more than the sum of outcomes from Objectives 1-5, (4) integrate and cycle educational outcomes generated by the respective Objectives back to transform the project, and (5) target the dissemination of the science, research, processes, results, and implications to priority audiences of the project: graduate students, undergraduate students, and high school science and agriculture teachers.

This POW will be accomplished specifically by:

a) Facilitating knowledge of team science theory (i.e. transdisciplinary) so graduate students on the project can become contributing scientists in their own disciplines and effective members of interdisciplinary teams;
b) Fall 2015 graduate student meeting in Washington DC for students to present their research and learn about career opportunities in government post-graduation;
c) Coaching project graduate students in preparing post-graduation resumes, job presentations, and career opportunities;
d) Promoting knowledge about climate change science and climate literacy via NCSE CAMEL virtual site which targets secondary teachers;
e) Developing products for CAMEL website for science teachers and non-scientific audiences based on project outputs of key scientific findings;
f) Engaging science and agricultural education teachers in learning opportunities to understand how land surfaces processes and cropping systems impact climate and are impacted by climate change using local and regional agriculture examples and experiences; and,
g) Promoting linkages and synergy with national and international organizations that promote a scientific discourse on climate change.

Field 8. B-1. Team Outcomes/Impacts for Y4

Overview of Outcomes To-Date

As the project enters Y5, the final year of our project, there are a number of high profile outcomes and impacts which just recently became visible but were grounded in Y1-Y3 POWs. The Resilient Agriculture National Conference held August 5-7, 2014 in Ames, Iowa drew 189 people including producers, farm leaders and agricultural organizations and was streamed to 70 registered remote attendees. CSCAP Advisory Board members were highly engaged in the conference planning, providing supplemental financial support, and moderating sessions. This national conference showcased: 1) many project science findings to-date; 2) engagement of project farmers in the applications of the science; 3) strong partnerships built with the 25x'25 Alliance and the USDA U2U project (pilot testing of farmer decision support tools); and, 4) project team engagement with knowledge exchanges among disciplines and stakeholders to address weather and climate challenges associated with corn-based cropping system management. Post-conference evaluation (Appendix H) indicated that the focus on attaining resilience through region-specific adaptation approaches and the proactive planning necessary to address short-term and long-term implications of climate change resonated with farmers and crop consultants. A 48-page color magazine (Appendix G) was published for the national conference with the farmer audience in mind; it highlights project findings and was awarded an Extension Education Materials Award of Excellence from the American Society of Agronomy. A project-wide effort was the publication of key research in the Journal of Soil and Water Conservation (JSWC) November-December 2014 issue on Climate and Agriculture at http://www.jswconline.org/. Two years in the making, 14 of the 20 articles were authored all or in part by CSCAP researchers and graduate students (Appendix J).

The publication of the team research in the 2014 JSWC special issue and 34 other journals in Y4 demonstrate the increased capacity of the team to synthesize and model our data and publish project findings (Appendix C). One outcome from the training of undergraduate and graduate students has been the publication of 19 journal articles that they have authored/co-authored to-date. This is an important metric of success as these students graduate and move into science-based careers. Students continue to learn how to be scientists from their major professors and other project scientists. The systems science focus and cross-disciplinary opportunities to learn continues to attract talented young people into the team, and to agricultural-based sciences.

The team's publication guidelines (Appendix F) for how research data and findings are published (including recognizing USDA funding sources) have been used extensively in the preparation, submission, and publication of project findings. Collaborative research clusters and subgroups have worked more effectively together in Y4 on a cross-disciplinary and regional basis to analyze data and increase development of joint publication as result of increased understanding of diverse disciplinary perspectives and stronger trust relationships. Members of the CSCAP have increased their comfort in communicating across disciplines and actively exchanging knowledge and generating new ideas to guide hypothesis testing and interpretation of findings. The comprehensive research directive (initiated in Y2; see Appendix E) which provides the foundational disciplinary and multidisciplinary research questions and hypotheses is being revised in preparation for Y5 synthesis, modeling, and publication.

Field 8. B-2. Team Outcomes/Impacts – *OBJECTIVE 1 & 2 SPECIFIC*

Y4 outcomes include:

a) Continuation of the team's research network of 35 sites that is being leveraged for additional funds and research beyond the original scope of CSCAP and is used to drive scientific and lay publications;
b) Continued development of graduate student capacity in conducting field research and a knowledge of protocol methods and collection of data beyond their specific discipline. Many new students (primarily M.S.) began this past year so significant time was spent on this component;
c) Working groups were formed with many of them highly functioning and well prepared to undertake the synthesis and analysis of data across time and space. This is helping to build expertise and capacity among members, especially graduate students, to understand these practices on a larger scale;
d) Greater appreciation for the modeling and synthesis ability of Obj 3 personnel based on working group discussions and products;
e) Sharing of findings to the entire team to aid comprehension and knowledge of C, N, and water responses to the treatments being investigated; and
f) Dissemination of research through papers in journals, presentations, and the media to build scientific knowledge of the capacity these treatments having for adaptation and mitigation.

Field 8. B-3. Team Outcomes/Impacts – *OBJECTIVE 3 SPECIFIC*

Y4 outcomes include:

a) Interactions with the central database and data owners in use of primary data, interpretation, and co-authorship;
b) Supporting and continuing to build consistency among Obj. 1 & 2 members in their familiarity and ease of data entry with an overall high level of comfort and ability attained. Data reviews summarizing data entered/missing for each subcontract were conducted and this further built the relationships between the Objectives;
c) Continued development of graduate student capacity in data synthesis and modeling with connections to field research that go beyond their specific discipline;
d) The Obj. 3 team has been building collaborations with other Objective teams as well as among the modeling teams. For example, SALUS and DAYCENT are being used in tandem with SALUS predicting impacts of climate variability on corn yield and these yield changes allowing for more accurate predictions of soil N_2O emissions;
e) Dissemination of research through papers in refereed journals, presentations, and the media to build scientific knowledge of the effectiveness of these treatments in providing climate adaptation and mitigation; and,
f) Continuing to build partnerships beyond the CSCAP to connect with data sources and model developers (see external groups in Appendix C). In Y4, partnerships with Drs. Izaurralde and Williams (EPIC), Dr. Fienan (parameter estimation expert from the USGS), Dr. Parkin (nitrous oxide expert from the ARS), members of the soil carbon modeling community (Drs. Del Grosso and Paustian), Dr. Tornquist (EPIC and DAYCENT), and Drs. Chaubey and Raj at Purdue University (regarding CenUSA modeling efforts of biofuels).

Field 8. B-4. Team Outcomes/Impacts – *OBJECTIVE 4 SPECIFIC*

Y4 outcomes include:

a) Publication of the "Farmer Perspectives on Agriculture and Weather Variability in the Corn Belt: A Statistical Atlas" (Appendix I) presenting data from the survey of 4,778 farmers across 11 states and 22 HUC6 watersheds in tabular and map form. This major product of a dynamic partnership with the Purdue-led USDA grant "Useful to Usable" (U2U) and the National Agricultural Statistics Service (NASS) was downloaded 11,399 times in 2014,
b) Dissemination of findings to key stakeholders and policy makers with several presentations to USDA administrators in the OSEC, NRCS, ARS, and FSA offices; these helped to guide language used by the Secretary of Agriculture in discussing climate change and framing the newly developing Climate Hubs. The scientific process and methods used in the survey have informed other farmer surveys throughout the US,
c) Establishment of transdisciplinary research and extension partnerships across the CSCAP Objectives and incorporation of farmer survey data and in-person interview qualitative data to guide and interpret Obj 3 watershed modeling efforts, and
d) Increased capacity among extension educators to translate climate and agriculture science to farmers by focusing on key adaptive strategies and concerns revealed through survey and interviews.

Field 8. B-5. Team Outcomes/Impacts - *OBJECTIVE 5 SPECIFIC*

Y4 outcomes include:

a) Extension educators in all CSCAP states incorporated climate and agriculture presentations, information, and discussions into their existing extension programming efforts (Appendix C) and reached over 7000 farmers, crop consultants, and other extension educators,
b) Cover crops continue to be a popular topic as well as water quality and drainage. Several extension educators have been able to step in with needed information and expertise because of their knowledge through and experience with the CSCAP,
c) Garnering widespread support in the team's efforts to programmatically strengthen the Land Grant University's focus on climate education for agriculture represents a significant shift relative to past efforts. Educators in IN and MI have conducted extension in-service this past year to address this need. Also, during the extension summer meeting, the extension educators formed 5 key working groups (see Outputs category for details) focused on specific information delivery and messaging around topics they felt would be well received by clientele. This focused messaging is important in building capacity institutionally and increasing the focus on resilience and sustainability in extension programming across the region, and
d) Partnership with the U2U project continued with promotion of U2U tools facilitated by CSCAP extension educators in extension presentations, newsletters, one-on-one conversations, and at the national conference.

Field 8. B-6. Team Outcomes/Impacts - *OBJECTIVE 6 SPECIFIC*

Y4 outcomes include:

a) Graduate student involvement in research, extension and education efforts of the team are helping to shape them into the next generation of climate and agricultural scientists and educators. Currently, we have 47 graduate students (Appendix D). Many new graduate students recently joined the team and are being trained by individual PI's. Additional students are not expected to join the team in Y5 due to funding and time necessary to complete their degrees. The graduate student cohort has contributed significantly to building their own identity and connectivity, often being a resource for one another.
b) Graduate students are highly engaged in team activities and presenting their work to external audiences. There was high student participation at the national conference with 71% of the team posters presented by graduate students. Students also are actively attending and presenting at professional society meetings (see Presentations in Appendix C).
c) The web-based graduate seminar titled "The Science behind Climate Change" highlighted three external and three internal faculty members as an opportunity for the students to learn about various sciences as they relate to climate change. Participants expressed positive attitudes about the webinar series and increased understanding of disciplines and application of research to real-world system challenges.
d) Iowa State University (ISU) hosted a weeklong CSCAP climate camp for science and agriculture teachers (see Outputs). Two other affiliated camps were hosted at University of Minnesota via an Obj. 1 & 2 PI, with CSCAP research being used in programming. At ISU, participants completed a questionnaire post-camp (Appendix K) and using a Likert-type scale, participants indicated a greater understanding of climate change (CC) and scientific methods to study CC, impacts of CC on agriculture, and how farmers can adapt to CC and reduce impact on CC. The evaluations were extremely positive and showed a significant shift in perceptions and ability/willingness to incorporate into curriculum. Example comments include: "Incredible!!! Thanks USDA!!!", "(I'm) more interested incorporating these concepts into my curriculum instead of avoiding them!", and "Definitely would recommend to any science/ag teacher…. primarily because of the critical importance of this topic and the need to communicate the unbiased facts to students in a non-political context. Teachers need to be prepared to respond scientifically to student questions/comments about the greenhouse effect, climate change, etc."
e) The appointment of our third graduate student representative to the Leadership Team continues two-way communication between the graduate students and the leadership team to ensure an environment conducive to student learning and growth.

Field 8. C-1. Team Outputs for Y4

In Years 1-3, we have had annual (internal) team meetings but this year we hosted a three-day national conference in Ames, IA. There were 189 individuals registered in-person and 70 online including farmers, scientists, industry, etc. In addition, 4 times during the year, Objective based working sessions occurred in-person to advance papers, outputs, and strategic plans. The groups included: cover crop working group, drainage water management working group, Obj. 3, and Obj. 5.

The team website (www.sustainablecorn.org) has seen an increase in traffic; site usage statistics from Oct. 2013 through Sept. 2014 include 14,175 site visits (53% increase from last year), 7,161 unique visitors (74% increase), 36,602 page views (37% increase). The most visited pages include the AgriClimate Connection blog, field research, and farmer perspectives about agriculture and weather variability.

Efforts to increase communications in Y4 with key external target audiences include the following:

- Ongoing blogposts made weekly on current topics through partnership with U2U.
- A 48-page magazine was created containing 21 illustrated articles by our team members (Appendix G). It highlighted the science behind climate resilience strategies for corn-based cropping systems and featured some of the team's research findings to-date. A total of 320 print copies have been distributed to-date to farmers and crop advisors. The magazine continues to be available electronically on our public website.
- A video entitled, Views from the Field: Farmers on Changing Weather Patterns, was collaboratively created by the team's videography student intern and extension educators. It debuted at the conference and is available at youtube.com/sustainablecorn.
- News releases were sent out to highlight the statistical atlas by Obj. 4 and to tie the team's work in with nationally covered topics such as the release of the Third National Climate Assessment.
- The 2014 national conference for Corn Belt farmers, crop advisors and CSCAP team members was promoted via news releases to ~400 local and national farm press, team website, blog, Twitter, postcards, ag and crop newsletters at partner universities, and outreach to corn and soybean farmer organizations through our relationships and our co-host 25x'25 Alliance. The CSCAP project and the science of crop resilience were carried in popular press publications such as Wallace's Farmer, Successful Farming Magazine and the Farm Bureau Spokesman. All conference products are available at www.sustainablecorn.org, including the magazine, conference sessions on video, Sec. Vilsack's comments on video, and posters.

Field 8. C-2. Team Outputs - *OBJECTIVE 1 & 2 SPECIFIC*

The Obj. 1 & 2 teams have several subgroups and these groups meet once per month during non-field season to discuss processing and synthesis of data and writing of papers. Many members are on multiple teams so they attend numerous virtual meetings per month. The working groups include drainage water management, cover crops, organic cropping systems (possible through leveraged funding), greenhouse gas, tillage, nitrogen, and extended rotations; the last two meet informally on an ad-hoc basis due to limited research sites and personnel involved. These groups are working on papers regarding regional variation and applicability of management practices and cross-disciplinary papers such as greenhouse gas emission from artificially drained soils. Multidisciplinary presentations are also occurring such as one encompassing IPM and farmer perceptions.

Standardized protocols, developed in Year 1 for the CSCAP researchers to use as standard methods, have been published in the JSWC 2014 special issue (see below and Appendix J) and provide a mechanism for further integration into proposals and research by CSCAP and non-CSCAP individuals.

Team members continue to collect field research data, including agronomic, soil, pest, greenhouse gas, and water data, with only Y5 data remaining. Much of the data is in the research database and PI's along with the data team are working hard to ensure team members keep up in getting remaining data entered. The entry of management information (metadata) and research data is a substantial output for these Objectives and represents hours and hours of hard work by data collectors as well as the database team. Our aggressive approach in uploading data is a major output to-date and allows for more rapid dissemination and use by other team members.

In Y4, Obj. 1 & 2 personnel were highly productive in communicating their science and produced a total of 214 outputs and reached 12687 individuals in-person (Appendix C; see PIs: Castellano, Cruse, Dick, Fausey, Frankenberger, Gassmann, Helmers, Kladivko, Kravchenko, Lal, Lauer, Mueller, Nafziger, Nkongolo, O'Neal, Sawyer, Scharf, Strock, and Villamil). Outputs for Y4 include: referred journals (23), fact sheet (2), MS Thesis (3), proposals (6), book chapter (1), extension publications (9), conference presentations (79), extension presentations (51), external partnership (1), blog (2), popular press (26), University press (1) and radio/TV spot (1), videos (4), and news release (5). Combined with Y1, Y2 & Y3 output data, this result in a total of 502 outputs to-date and 26177 individuals reached in-person.

Some papers to highlight from Y4 include:

- Munoz, J.D., J. Steibel, S. Snapp and A.N. Kravchenko. 2013. Cover crop effect on corn growth and yield as influenced by topography. Agric. Ecosyst. Environ. 189:229-239. [Impact Factor: 2.86]
- Mukherjee, A. and R. Lal. 2014. Comparison of soil quality index using three methods. PLOS ONE. 9(8):1-15. [Impact Factor: 3.53]
- Kladivko, E.J., M.J. Helmers, L.J. Abendroth, D. Herzmann, R. Lal, M. Castellano, D.S. Mueller, J.E. Sawyer, R.P. Anex, R.W. Arritt, B. Basso, J.V. Bonta, L. Bowling, R.M. Cruse, N.R. Fausey, J. Frankenberger, P. Gassman, A.J. Gassmann, C.L. Kling, A. Kravchenko, J.G. Lauer, F.E. Miguez, E.D. Nafziger, N. Nkongolo, M. O'Neal, L.B. Owens, P. Owens, P. Scharf, M.J. Shipitalo, J.S. Strock and M.B. Villamil. 2014. Standardized research protocols enable transdisciplinary research of climate variation impacts in corn production systems. J. Soil Water Conserv., Sp. Issue for Climate and Agriculture. 69(6):532-542. [Impact Factor: 1.72]

Field 8. C-3. Team Outputs - *OBJECTIVE 3 SPECIFIC*

The modeling and synthesis team meet monthly to present and discuss ongoing analysis results, enhance model integration and expand collaborative analysis efforts. Several Obj. 3 members also participate regularly in the Obj. 1 & 2 working group meetings to build cross-communication and interpretation of field data to ensure syntheses are framed properly from an agricultural perspective. This also provides insight to Obj. 1 & 2 personnel regarding the performance or management practices in other locations and under future climate.

In Y4, central database priorities were on data curation, frequent communication with site individuals, addressing inconsistencies between baseline metadata and actual reported field data, building the export beta-function for agronomic and soils data, and supporting working groups in data acquisition and plotting.

Obj. 3 members balance their modeling and synthesis efforts between regional current analyses of the data and predictive analysis based on future climate scenarios. Life cycle models investigating tillage management, nitrogen management, and inclusion of a cover crop were completed. Two manuscripts were published detailing the use of parameter estimation techniques to calibrate the DAYCENT model; this showed the predictive accuracy of the model is dramatically improved if it is calibrated using more physical measurements (such as soil temperature in addition to N2O emissions and crop yield). A new algorithm was constructed for SALUS to account for increased soil carbon sequestration through improved residue management practices; this helps quantify impact of climate change on crop yield. Several models (SALUS, DAYCENT, and CENTURY) were evaluated in terms of their congruency under future climate scenarios. Additional effort was put into assessing and reporting the completeness of climate model projections (i.e., GCM prediction) for use in all Obj. 3 models.

In collaboration with Obj. 4 the future best management practice (BMP) scenarios have been defined and incorporated in SWAT simulations for the Upper Mississippi and Ohio basins. Specific focus is on farmers' plans to incorporate certain conservation practices in the future such as no-till, cover crops, in-field structural practices, and tile drainage. Progress on estimating benefit and cost functions for different conservation practices has been made and this will be important for policy related to water and air quality.

In Y4, Obj. 3 personnel were highly productive in communicating their science and produced a total of 88 outputs and reached 5820 individuals in-person (Appendix C; see PIs: Abendroth, Anex, Arritt, Basso, Bowling, Gassman, Herzmann, Kling, Miguez, and Owens). Outputs for Y4 include: referred journals (22), white paper (1), MS Thesis (2), PhD dissertation (2), proposals (3), book chapter (2), extension publications (1), conference presentations (36), extension presentations (1), partnerships with external groups (9), blog (1), videos (7), and news release (1). Combined with Y1, Y2 & Y3 output data, this results in a total of 206 outputs to-date and 10698 individuals reached in-person.

Some papers to highlight from Y4 include:

- Rabotyagov, S., A. Valcu, and 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. Rev Environ Econ Policy. 8(1):58-79. [Impact Factor: 3.34]
- 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. J. Soil Water Conserv., Sp. Issue for Climate and Agriculture. 69(6):483-494. [Impact Factor: 1.72]
- M. Necpálová, 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. J. Soil Water Conserv., Sp. Issue for Climate and Agriculture. 69(6):517-531. [Impact Factor: 1.72]

Field 8. C-4. Team Outputs - *OBJECTIVE 4 SPECIFIC*

The social-economic research team met regularly to discuss ongoing data analysis and manuscript and report writing. The publication of "Farmer Perspectives on Agriculture and Weather Variability in the Corn Belt: A Statistical Atlas" (as discussed earlier in Outcomes/Impacts; see Appendix I) allowed for rapid dissemination and use of survey data by extension educators, scientists, and policymakers by releasing processed data at the regional and watershed levels. Available at sustainablecorn.org, it was downloaded 11,399 times between Jan. 29 to Dec. 3, 2014. The team also finished transcription of 159 farmer interviews conducted by project extension educators, constructed a coding framework, and began data analysis.

In Y4, Obj 4 personnel were highly productive in communicating their science and produced a total of 48 outputs and reached 1278 individuals in-person (Appendix C; see PIs: Arbuckle, Tyndall, and Wright Morton). Outputs for Y4 include: refereed journals (15), statistical atlas (1), fact sheets (2), PhD dissertation (1), extension publications (4), conference presentations (12), extension presentations (3), popular press media (9), and videos (2). Combined with Y1, Y2 & Y3 output data, this results in a total of 158 outputs to-date and 4070 individuals reached in-person.

Some papers to highlight from Y4 include:

- Prokopy, L., L. Morton, J. Arbuckle, A. Mase and A. Wilke. 2014. Agricultural stakeholder views on climate change: Implications for conducting research and outreach. Bull. Am. Meteorol. Soc. . [Impact Factor: 6.12]
- Arbuckle, J.G., J. Hobbs, A. Loy, L.W. Morton, L. Prokopy and J. Tyndall. 2014. Understanding farmer perspectives on climate change: Toward effective communication strategies for adaptation and mitigation in the corn belt. J. Soil Water Conserv., Sp. Issue for Climate and Agriculture . 69(6):505-516. [Impact Factor: 1.72]
- Morton, L.W. 2014. Achieving water security in agriculture the human factor. Agron. J. 106:1-4. [Impact Factor: 1.51]
- Arbuckle, J., L.W. Morton and J. Hobbs. 2013. Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, climate change beliefs, and perceived risk. Environ Behav. X:1-30. [Impact Factor: 1.28]
- Wilke, A.K. and L.W. Morton. 2015. Climatologists' patterns of conveying climate science to the agricultural community. Agr. Hum Values. [Impact Factor: 1.36]

Field 8. C-5. Team Outputs - *OBJECTIVE 5 SPECIFIC*

Extension educators have over 155 farmer leaders and group members for their state-based farmer groups with several collecting farm management data to help build understanding of system management and areas to hone in messaging. For example, producers have commented that dealing with climate extremes include seed slot erosion from high rainfall events, timeliness of planting, and weed pressure shifts. This data will help to inform models and synthesis of findings as it relates to variability in farm management and risk. Many partner farmers also put up Sustainable Corn signs in their fields to promote their involvement with the team. Several extension educators also have on-farm demonstrations or research that they have sought out or received from grants; this is helping to get the practices out.

The extension team virtually meets monthly to advance working group activities. Objective 5 met for a two day in-person meeting at DeForest, WI in June 2014. The purpose was to transition towards a more cohesive and strategic group focused on producing outputs in 5 key message areas determined including water management, nitrogen management, extended rotations, climate messages, and soil health. Michael Dahlstrom, Communications Professor at Iowa State University, was brought in specifically to educate in messaging and translating complex messages. He led a half-day workshop and discussion.

As research findings are becoming more prolific, the programming and information used by extension educators becomes more CSCAP centric. For example, Minnesota had a field day with 130 attendees comprised entirely of CSCAP presentations and materials. The focus was on water quality and it served as a strong example of numerous disciplines (individuals and material provided from Obj. 1 & 2, 4, and 5). Overall, the extension team has presented in numerous local and regional settings with most presentations themed around cover crops, soil health, crop productivity, and weather variability (see Appendix C for presentation titles and location). Extension educators were highly involved in the team's national conference by bringing partner farmers and presenting during several sessions.

In Y4, Obj. 5 personnel produced a total of 139 outputs and reached 7353 individuals in-person (see Appendix C for Extension Educators, PIs: Ingels and Todey). Outputs for Y4 include: promotional report (1), proposal written by Dennis Todey (1), extension publications (1), conference presentations (6), extension presentations (87), websites (2), blog entry (14), popular press (12), university press (13), radio/TV spot (1), and video (1). The Twitter account has been built out this year with a substantial following now; this type of social media will help reach another subset of the population. Combined with Y1, Y2 & Y3 output data, this resulted in a total of 295 outputs to-date and 11276 individuals reached in-person.

Field 8. C-6. Team Outputs - *OBJECTIVE 6 SPECIFIC*

Undergraduate interns (n=10) at Iowa State University and The Ohio State University were engaged in team research with their mentors and presenting their findings. For example, one student worked with Obj. 4 on a soil health subproject by conducting a literature review, initial data analysis, and presentation of research at the team's national conference. Undergraduate research assistants (n=41) across CSCAP institutions were also involved in research such as in-field data collection and conducting of lab procedures. A total of 51 undergraduate students were involved in the CSCAP in Y4.

Iowa State University hosted a weeklong CSCAP climate camp in June for 17 science and agriculture teachers from 4 states (82% rural; 18% urban). The camp integrated a variety of hands on activities, field trips, and topic presentations based on relevant climate science and CSCAP research. A Stone Lab Course at The Ohio State University was also held during the summer for graduate students (10 participants) and focused on transdisciplinary aspects of sustainability and climate.

The Y4 web-based graduate spring seminar titled "The Science behind Climate Change" highlighted three external and three internal faculty members. The weekly average attendance was 20 graduate students and staff; participants rated the webinars highly.

A partnership and subcontract were established with the National Council for Science and the Environment (NCSE). This partnership was formed at the beginning of this reporting period with coordination and planning occurring for developing educational materials and transfer of CSCAP factsheets and videos to the Climate Adaptation Mitigation E-Learning (CAMEL) website and for NCSE to host a graduate webinar series in Fall 2014. The web-based graduate course "Climate Change: Causes, Consequences and Solutions" was led by Arnold Bloom from the University of California Davis (www.climatechangecourse.org) with CSCAP faculty serving as facilitators. A total of 24 graduate students participated in the seven webinars and web-based discussions and assignments related to climate change and agriculture.

Graduate students participated in a "Next Generation Scientist" dinner at the national conference along with the "Next Generation Farmers" in attendance to allow for mutual learning and network building.

In Y4, Obj. 6 personnel produced a total of 32 outputs and reached 1311 individuals in-person (see Appendix C; PIs: Lekies, Miller, Moore, Nkongolo, Todey). Outputs for Y4 include: evaluation report (3), proposal written (3), book (1), book chapter (3), conference presentations (5), extension presentations (2), summer camp or course (2), graduate student webinar presentations (13), and blog entry (1). Combined with Y1, Y2 & Y3 output data, this results in a total of 71 outputs to-date and 3225 individuals reached in-person.

Field 8. D. Team Milestones and Deliverables

The team milestones for Year 4 and Year 5 are attached in Appendix B and sorted by Objective. At this time, all Year 4 milestones are completed, although some have shifted in terms of focus or scale as the team continues to build out in many areas well beyond these milestones. Year 1-3 milestones are not included here but can be found in the team's previous reports submitted to USDA-NIFA.

The team deliverables (outputs) for Year 4 are attached in Appendix C and sorted by Objective; deliverables for previous years can be found in previous reports. The team has been productive again with a total of 60 refereed journals, 5 project reports or promotional pieces, 5 white papers, 5 MS thesis, 3 PhD dissertations, 13 proposals, 7 books or book chapter, 26 extension publications, 152 conference presentations, 149 extension presentations, 13 education webinars, 1 education camp, 4 websites, and 10 partnerships with external groups 23 blog entries, 97 popular press pieces (such as Corn and Soybean Digest and Successful Farming), 28 University press, 7 radio and TV spots, 27 videos, and 9 news releases. Team members have also identified planned publications and various types of deliverables in Year 5; these are not shown in the Appendix due to space.

Field 8. E. Broad Impacts

The project has had broad scientific impacts with the development of standardized protocols for measuring C, N, and water in corn-based cropping systems. It has also built extensive partnerships with the 25x'25 Alliance, North American Climate Smart Agriculture, USDA U2U project and Midwest Climate Hub; impacts that ensure the project findings, publications and products are widely shared in scientific and non-scientific communities. The project has also established professional networks that will have future impacts on the development of new proposals, increased collaboration across-region and state, extension programming around

climate, weather, and agriculture, and overall increased robustness in larger scale research and dissemination of findings. The legacy of the networks our 47 graduate students have begun is just beginning to be realized by the students themselves as they seek post-graduate careers, prepare manuscripts for publication, and explore applications of their science with extension and agricultural stakeholders.

The team has leveraged additional funding; the USDA-NIFA substantial investment in this project now comprises 67% of the whole team budget. More importantly, additional funding demonstrates the partnerships team members have built to further accomplish the ambitious goals of the project. To-date (Y1-Y4), a total of $5,328,900 has been leveraged. This consists of $1,965,000 in institutional support, $837,047 from the United Soybean Board, $667,000 in connection with the USDA grant "Precipitation Intensity Over Central US", $507,070 from the Iowa Department of Agriculture and Land Stewardship, $413,224 from an NREC Grant, $300,000 from the Iowa Soybean Association, $162,206 from the MN Corn Growers Association, $141,680 from an NOAA-SARP Grant, $95,000 from the Biological Agricultural Partners to support organic-focused research, $51,762 from the USDA-NRCS, $51,400 for Survey Funding from NRCS/Purdue Ag/ISU CALS, $44,096 from a SARE grant, $39,571 in connection with the Leopold Center, $28,844 from a USDA Hatch Grant, and $25,000 from the Great Plains Climate Hub. Additionally, team members have submitted proposals for leveraged funds that were not selected for funding but may be resubmitted in the future; to-date (Y1-Y4) a total of 28 proposals have been submitted by team members.

Field 8. F. Training

The CSCAP team includes a diverse set of expertise and specialties across the faculty, postdoctoral researchers, topic-based specialists/technical staff, graduate students, and undergraduate students. Appendix D includes the team personnel listing with individuals sorted by their supervising PI. The CSCAP team is also actively engaged in helping train students within STEM disciplines. To-date, a total of 103 undergraduate students, 83 graduate students, and 18 postdoctoral researchers are members of this team; this equates to a total of 2708 months for this cohort of next generation scientists involved with the CSCAP. Our team's current Y4 contingent includes 46 graduate students and 10 post-doctoral scientists. Over the past three and a half years, our team has included a total of 83 graduate students (30% minority and 46% women) and 18 post-doctoral scientists (72% minority and 17% women). Many of these individuals have produced various items listed within the Deliverables section as denoted by the author list.

Gabrielle Roesch-McNally, elected graduate student representative for Y4 and member of the Leadership Team, is working to connect graduate students to the opportunities within the CSCAP graduate student body and facilitate transdisciplinary engagement as possible. Graduate students continue to do outstanding work and are active, contributing members of the team as well as represent our team in professional meetings and USDA functions such as the Project Director meeting in Jan. 2014 where Andrea Basche (Iowa State University) and Lindsay Pease (The Ohio State University) attended and were part of the graduate student breakout and Gabrielle Roesch-McNally (Iowa State University) and Chris Eidson (The Ohio State University) were invited to attend the PINEMAP summer meeting and participate in the graduate student discussions. At our 2014 national conference, graduate student posters were part of a competition with the top 3 awarded for excellence: 1st: Maciej Kazula (University of Wisconsin),

2nd: Linda Geiger (Iowa State University), and 3rd: Lindsay (Kilpatrick) Pease (The Ohio State University). A cohort of our graduate students also authored a paper for the special issue of the JSWC highlighting what their experience has been in this project. Graduate students have been involved in the successful publication of 19 journal articles which they have authored/co-authored to-date.

Field 8. G. Concluding Statement

In conclusion, as the project moves into its final year (Y5), this transdisciplinary team of 154 scientists, technical specialists and staff, extension educators, graduate students and post-doctoral researchers has achieved several high-impact accomplishments. Some accomplishments are recent, many more are expected in Y5, and others will only become evident post-project. The team has become widely known for not only the development of new scientific methods and findings, but also for their project structure and management which has integrated cross-disciplinary sciences and stakeholder knowledge to generate new knowledge. Specifically, to date we have: 1) established standardized sampling protocols that are foundational to effectively integrate regional primary field data for synthesis and predictive modeling; 2) created a shared database to better detect changes in soil and water, and document the impact of future climate on crops and begun to identify patterns of soil properties and greenhouse gas production associated with specific cropping practices; 3) calibrated, validated, and applied biophysical models to show the impact of management practices and future climate on a regional scales using CSCAP field trial data; 4) built an extensive cross-disciplinary network that provides capacity to address future natural-human system research questions; 5) trained next generation scientists in disciplinary and transdisciplinary science including applications to stakeholders; 6) developed research and project management databases which are serving as models for other projects and institutions; 7) translated social science findings in ways that engage policy makers, extension and farmers in the research of the project to create knowledge exchanges and willingness to try new practices; and, 8) built capacity of secondary science teachers to incorporate agriculture and climate in classroom programming.

The Integration column (Appendix A) in our logic model represents both team values and the key outcomes from the activities and outputs of the project. The 2014 JSWC Climate and Agriculture special issue papers authored by team scientists and graduate students well illustrates the culmination of achieving many of the project milestones. Leveraged dollars and personnel resources totaling over $5.3 million to-date enable the project to increase the depth of work and build greater connections (see Broad Impacts for sources of leveraged dollars).

The team is well positioned and excited as we look to continuing our work in Y5. All co-PI's met in Chicago in November 2014 to discuss progress to-date and plans for Y5 to ensure completion of key goals and deliverables. The Advisory Board is eager to support this strategic plan as we move into Y5 and beyond. A clear plan with action items were developed out of this to provide exceptional clarity and reinforce our shared goals in publishing our science and extending this outward. The national conference, co-hosted with 25x'25, was a significant step in collaborative efforts among key farmer leaders, farm organizations, academia, and the general public. The team is actively working to strengthen and build on these collaborations to ensure that climate and agriculture remains a priority and capacity is built across the sectors as it relates to corn-based cropping systems.