A partnership among Iowa State University; Lincoln University; Michigan State University; The Ohio State University; Purdue University; South Dakota State University; University of Illinois; University of Minnesota; University of Missouri; University of Wisconsin; USDA ARS – Columbus, Ohio; and USDA National Institute of Food and Agriculture (NIFA).

OBJECTIVES 1 & 2

Topic Area: Tillage System, Extended Rotations, Cover Crops, Nitrogen Sensing, Controlled Drainage, Greenhouse Gases, and Integrated Pest Management

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AS PER PROPOSAL: *Develop standardized methodologies for estimating C, N, and water footprints of corn production in the region and perform baseline monitoring in eight states to evaluate the impacts of a suite of crop management practices, including no-till, extended crop rotations, drainage water management, cover crops, and canopy N-sensors.*

SYNOPSIS: Management practices used in corn production systems influence carbon, nitrogen, and water processes in the soil. These processes can have a range of impacts on the greenhouse gas footprint and overall nitrogen, carbon, and water footprint of corn production and on the resilience of corn production systems to climate change. The research questions below attempt to capture what we believe to be the most important of these impacts. These questions will guide our joint efforts to study corn production in the context of climate change.

RQ 1. How do tillage management systems impact the greenhouse gas footprint of corn production systems?

Hypothesis: Reducing tillage will reduce the proportion of crop residue that is oxidized to CO_2, increase the proportion that ends up in soil organic matter, and reduce the greenhouse gas footprint of corn production.

RQ 2. How do extended rotations impact the greenhouse gas footprint of corn production systems?

Hypothesis 2a: Nitrous oxide emissions can be decreased and methane sinks can be enhanced by using extended crop rotations due to lower nitrogen fertilizer use in other crops in the rotation.
Hypothesis 2b: Soil organic carbon storage can be increased by using extended crop rotations due to longer growing seasons and greater rooting associated with perennial crops in the rotation.

RQ 3. How do winter cover crops impact the greenhouse gas footprint of corn production systems?

Hypothesis 3a: Winter cover crops will trap CO_2 from the air, increase organic carbon in soil, and reduce the greenhouse gas footprint of corn production systems.
Hypothesis 3b: Landscape position will influence the impact of winter cover crops on greenhouse gas footprint by influencing cover crop biomass and the proportion of this biomass that is ultimately oxidized back to CO_2.
Hypothesis 3c: Cover crops will reduce overall nitrate export to the stream, thus reducing off-site production of nitrous oxide.
Hypothesis 3d: Winter rye cover crop reduces corn nitrogen fertilization rate requirement over the long term, thus reducing the greenhouse gas footprint of corn production systems.

RQ 4. How does sensor-based nitrogen (N) fertilizer management impact the greenhouse gas footprint of corn production systems?

Hypothesis 4a: Sensor-based N fertilizer management can reduce total N fertilizer use while maintaining corn yields, thus reducing CO_2 release during fertilizer manufacture and reducing the greenhouse gas footprint of corn production systems.

Hypothesis 4b: Sensor-based N fertilizer management can reduce nitrous oxide emissions (and greenhouse gas footprint) by reducing the occurrence of N supply in excess of crop needs and by reducing the time window during which nitrous oxide can form.

RQ 5. How do cover cropping, tillage, and sensor-based N management interact in their impacts on the greenhouse gas footprint of corn production systems?

Hypothesis 5a: Cover cropping, tillage, and N management will interact in their effect on greenhouse gas footprint. Increased soil carbon from cover cropping and reduced tillage will increase soil moisture retention, increasing risk of nitrous oxide emissions and increasing the benefit due to sensor-based N management.

Hypothesis 5b: Greenhouse gas footprint effects and cost-benefit ratios will be different for these three approaches; understanding these differences can improve policy.

RQ 6. How does drainage impact the greenhouse gas footprint of corn production systems?

Hypothesis: Drainage compared to no drainage reduces nitrous oxide emissions, thus reducing the greenhouse gas footprint of corn production.

RQ 7. How does drainage water management impact the greenhouse gas footprint of corn production systems?

Hypothesis 7a: Drainage water management compared to conventional drainage will not differ relative to nitrous oxide emissions within the field.

Hypothesis 7b: Drainage water management compared to conventional drainage will reduce overall nitrate export to the stream, thus reducing off-site production of nitrous oxide.

RQ 8. How does sensor-based N management affect the resiliency of corn production to changing climate?

Hypothesis: Sensor-based nitrogen applications both avoid and compensate for nitrogen losses that occur with standard N management in wet years, increasing yield by more reliably supplying N.

RQ 9. How does tillage affect the resiliency of corn production to changing climate through alterations in carbon, nitrogen, and water in the soil?

Hypothesis: No-tillage compared to tillage improves soil quality by increasing soil carbon, soil aggregation, and soil water infiltration, thus reducing year-to-year variability in yield.

RQ 10. How do extended rotations affect resiliency of corn production through alterations in carbon, nitrogen, and water in the soil?

Hypothesis: Extended rotations will improve soil quality by increasing soil carbon, soil aggregation, and soil water infiltration, thus reducing year-to-year variability in yield.

RQ 11. How does drainage affect the resiliency of corn production through alterations in carbon, nitrogen, and water in the soil?

Hypothesis: Drainage compared to no drainage reduces yield variability, increases overall productivity, and improves the nitrogen and water use efficiency in corn-soybean productions systems.

RQ 12. How does drainage water management affect the resiliency of corn production through alterations in carbon, nitrogen, and water in the soil?

Hypothesis 12a: Drainage water management compared to conventional drainage reduces yield variability, increases overall productivity, and improves the nitrogen and water use efficiency in corn-soybean productions systems.
Hypothesis 12b: Drainage water management compared to conventional drainage will reduce overall nitrate export to the stream.
Hypothesis 12c: Drainage water management compared to conventional drainage will increase soil water storage.

RQ 13. How do winter cover crops affect the resiliency of corn production through alterations in carbon, nitrogen, and water in the soil?

Hypothesis 13a: Cover crops improve soil quality by increasing soil carbon, soil aggregation, and soil water infiltration, thus reducing year-to-year variability in yield.
Hypothesis 13b: Cover crops reduce nitrate leaching by taking up residual soil nitrate.
Hypothesis 13c: Cover crops conserve soil water, thus reducing year-to-year variability in yield.
Hypothesis 13d: Effect of cover crops on yield resiliency of corn production systems to weather stresses will vary as a function of diverse terrain.

RQ 14. Will corn and soybean diseases be affected by climate and management practices evaluated in the CS-Corn project?

Hypothesis 14a: Increased rain events will increase incidence and severity of foliar diseases of corn and soybean.
Hypothesis 14b: Management practices such as extended rotations, tillage and cover crops will affect foliar disease incidence and severity.
Hypothesis 14c: Extreme climate (i.e. drought or even temperature extremes) will cause higher incidence and severity of stalk rots or corn prior to harvest.

RQ 15. How do weeds affect greenhouse gas emission measurements? (Davis graduate student)

Hypothesis 15a: Effect of early season weed competition in corn and soybean will affect GHG emissions.
Hypothesis 15b: Dying weeds will affect GHG emission after post-emergence herbicide applications.

RQ 16. Will seed treatments help soybean production be more resilient to climatic fluctuations? (Zaworski)

Hypothesis 16a: L1940-A seed treatment will protect soybean seedlings against SDS.
Hypothesis 16b: L1940-A seed treatment efficacy will be affected soybean cyst nematode (SCN).
Hypothesis 16c: L1940-A seed treatment will help protect soybean seedlings against SCN.

RQ 17. Will production practices such as Drainage Water Management (DWM) and cover crops increase root rot diseases of soybean? (Han)

Hypothesis 17a: Fields with DWM tiling will have more root rot diseases.
Hypothesis 17b: Root rot severity will be affected by the moisture content of soils.
Hypothesis 17c: Root rot severity will be affected by the use of cover cropping strategies.

RQ 18. How does the cultural practice of cover cropping affect arthropods? (Dunbar)

Hypothesis: Pest pressure will decrease in the presence of the rye cover crop while beneficial arthropods will increase in diversity.

RQ 19. How does the cultural practice of crop rotation affect pests? (Dunbar)

Hypothesis: Incidence and severity of plant diseases will decreases with increasing number of crops rotated. Both rotation-resistant rootworm variants will be rare, but more variant north corn rootworms will be observed.

RQ 20. How does variation in climate across a broad geographical area affect pest management inputs and key pests? (Dunbar)

Hypothesis: Pest management inputs and key pests abundances at any one CSCAP site will be more similar to CSCAP sites located closer than those located further away. Pest management inputs will reflect local pest pressure.