# Research Insights from 2023

March 2024

## USDA-ARS Cropping System and Water Quality Research Unit

### Updates From the Most Recent Stakeholder Meeting

In our latest stakeholder meeting (August 2023), several key points were raised, highlighting the importance of enhancing our communication and collaboration efforts. Here's a summary of the key takeaways:

1. **More Frequent and Clearer Communication:** Stakeholders emphasized the need for more regular and transparent communication.

2. **Swift Dissemination of Results:** Stakeholders expressed the need to receive research results promptly. We acknowledge this and plan to speed up sharing outcomes, ensuring a quicker turnaround from research to dissemination.

3. **Holistic Approach to Research:** To enhance our research impact, stakeholders proposed a more integrated approach. This includes getting stakeholders more involved with formulating research ideas. Furthermore, research findings should not be limited to journal publications but should also be shared with growers and producers.

4. **Knowledge Sharing Across Groups and States:** Recognizing the value of shared knowledge, we aim to facilitate exchanges between groups and states. This includes showcasing synthesis work that we are participating in or are aware of that is happening concurrently in different locations.

5. **Improving Stakeholder Input:** We understand the importance of gathering diverse perspectives. To enhance stakeholder input, we plan to:
   - Attend more field days and technical committees.
   - Encourage stakeholders to bring questions they hear from the field, ensuring we address real-world concerns.

These points underscore our commitment to strengthening collaborations and improving the relevancy of science being conducted. By working more closely with stakeholders and adopting a more inclusive and communicative approach, we aim to elevate the impact of our research. To accomplish these goals, we are starting a semi-annual newsletter that highlights recent activities, findings, and opportunities for feedback.

# Comparison of Cropping Systems in 2023

As our research unit's name suggests, our primary focus is the evaluation of various cropping systems. To achieve this, we utilize our Centralia research site, including an 88-acre field and large replicated plots. The 88-acre field features a 4-year crop rotation, no-till, cover crops, and variable rate fertility.

Drought years like 2023 provide valuable data as we “stress” test the different cropping systems. Our initial assessment of the 88-acre field, planted with soybeans, showed signs of drought stress and other biotic stress (downy mildew and minor sudden death syndrome).

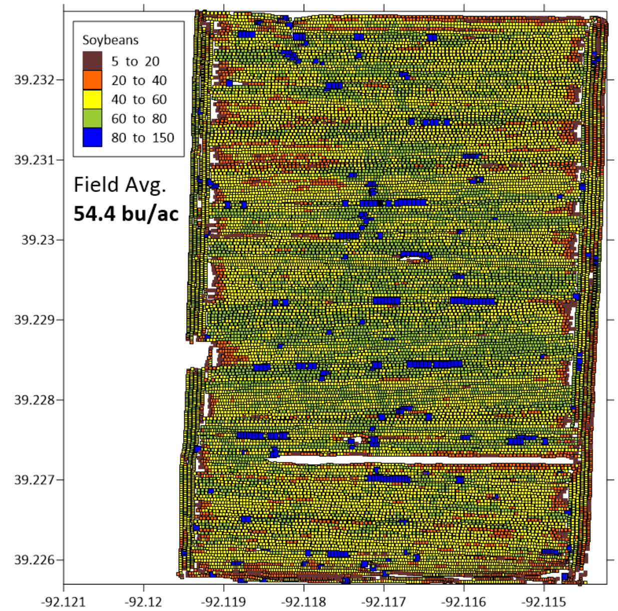



*Figure 1: 2023 soybean grain yields on the 88-acre “alternative” field. The majority of yields were between 40-80 bu/ac. Red areas yielded low. Blue areas yielded high.*

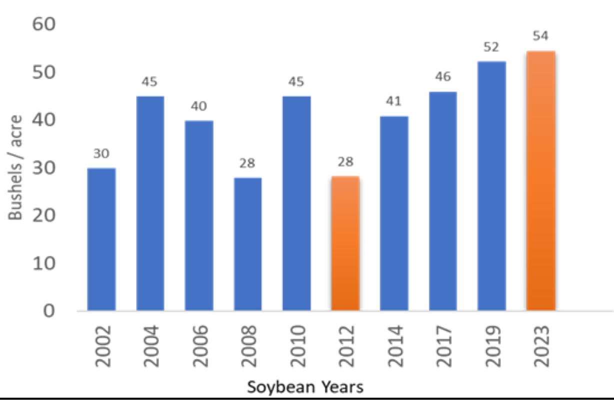



*Figure 2: The field average soybean yields from the 88-acre field. Orange bars indicate drought years.*

Given the limited moisture, we anticipated significantly reduced yields (Figure 1). Surprisingly, the 2023 yields were comparable to or even surpassed those of other years with better growing conditions (Figure 2). We attribute these better-than-expected yields to timely rainfall events and several management changes.

In 2020, we incorporated a perennial hay crop into the rotation (Figure 3) and updated our equipment. Notable equipment adjustments involve modernizing the planter with Precision Planting’s DeltaForce® (enhancing planting depth), Smartfirmers® (improving planter operations on a row-by-row basis), and Conceal® (better placement of starter fertilizer).

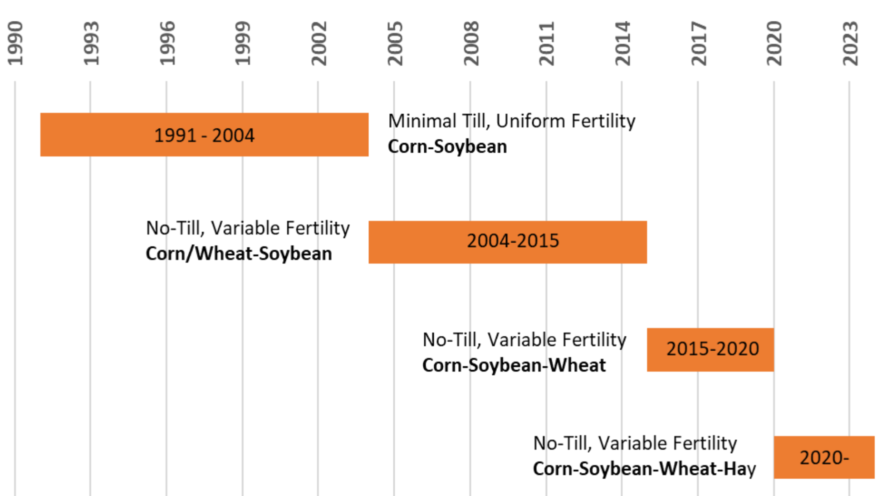



*Figure 3: Timeline of the management practices on the 88-acre field.*

## Comparison of Cropping Systems in 2023 Continued.

In addition to the 88-acre field, we are also comparing 10 different cropping systems using large, replicated plots. Below are some of the grain crop yields (6 out of 10 systems) we observed from this past year.

- In our alternative cropping systems with added cover crops, the lack of moisture in the fall/winter of 2022 resulted in low cover crop biomass. Even with less than desired cover crop growth, we observed less plant available water for crop emergence and early growth. This particularly affected the corn and grain sorghum stand uniformity which ultimately impacted the crop yields. In contrast neighboring fields without cover crops, we had improved stand and grain yields.
- Cover crops also impacted soybean stand uniformity but the crop was able to compensate with minimal yield loss.
- Over time we've seen that conservation practices—no-till, extended crop rotations, and adding cover crops— lead to increased yields and yield stability, especially on eroded landscape positions (Yost et al., 2016*). Last year was no different; the alternative system's soybeans (no-till, 4-year rotation, and cover crops) resulted in a 12 bushel/acre increase compared to a conventional system (corn-soybean rotation without cover crops).

| Cropping System | Rotation | 2023 Crop | 2023 Yield (bu/ac) | 2011-2022 Yields (same crop) |
|---|---|---|---|---|
| **Minimal Till** | Minimal-Till Corn – No-Till Soybean | Soybean | 41 | 46 |
| **No-Till** | No-Till Corn-Soybean + Switchgrass | Soybean | 38 | 45 |
| **Prevailing Practice** | Corn-Soybean + Cover Crops | Corn | 0* Failed crop replanted into Sorghum-Sudan | 141 |
| **Alternative 1** | No-Till Corn-Soybean-Wheat + Cover Crops | Corn | 109 | 142 |
| **Alternative 2** | No-Till Corn-Soybean-Wheat-Hay + Cover Crops | Soybean | 53 | 55 |
| **Alternative 3** | No-Till Grain sorghum-soybean-wheat + Cover Crops | Grain Sorghum | 18* Poor stand | - No previous grain Sorghum data |

* Yost, M.A., Kitchen, N.R., Sudduth, K.A., Sadler, E.J., Baffaut, C., Volkmann, M.R. and Drummond, S.T., 2016. Long-term impacts of cropping systems and landscape positions on claypan-soil grain crop production. *Agronomy Journal*, *108*(2), pp.713-725.

# Recent Journal Publications (August 2023 to February 2024)

Feng, A., Zhou, J., Vories, E.D., Sudduth, K.A. 2023. **Prediction of cotton yield based on soil texture, weather conditions and UAV imagery using deep learning**. Precision Agriculture. 25(1): 303-326. https://doi.org/10.1007/s11119-023-10069-x

The article discusses the use of deep learning to predict cotton yield at a field scale using soil, weather, soil electrical conductivity, and UAV imagery data. Overall, the findings suggest that **integrating soil, weather, and UAV imagery data with advanced data analytic methods has the potential to improve the performance in quantifying crop growth and yield at a field scale**. Results showed that a model trained with data from two years could accurately predict the cotton yield in a third year. This approach may be useful to researchers and to farmers who are interested in predicting cotton yield at a high spatial resolution.

Nguyen, A., Thompson, A.L., Sudduth, K.A., Vories, E.D. 2023. **Automatic management zone delineation for center pivot variable rate irrigation using field data**. Journal of the ASABE. 66(6): 1527-1545. https://doi.org/10.13031/ja.15528.

This study created software to automate the creation of variable rate irrigation plans for center pivot systems based on machine characteristics and mapped field data. The MOPivot software requires the user to input specific pivot system information and the desired water application plan. **The software can be used on all common types of center pivot VRI systems – those with individual sprinkler control, defined sprinkler zones, or system rotation speed changes**. The results from this study will help provide irrigation engineers with a new tool to optimize VRI prescriptions with respect to system operating characteristics.

Data logger and soil moisture sensors being installed at various topsoil depths in the 88-acre soybean field.

Schreiner-McGraw, A.P., Baffaut, C. 2023. **Quantifying links between topsoil depth, plant water use, and yield in a rainfed maize field in the U. S. Midwest**. Agricultural Water Management. 290. Article 108569. https://doi.org/10.1016/j.agwat.2023.108569

Soil erosion in the U.S. Corn Belt has led to fields with varying soil depths, posing challenges for farming, particularly in locations with shallow topsoil. This study investigated the impact of topsoil depth on plant water availability and yield, specifically in Claypan soils, testing the assumption that deeper topsoil leads to better yields. Measurements of soil water content, plant water use, and end-of-season biomass and yield for maize showed **deeper topsoil retains more water leading to increased plant water use, larger plants, and higher grain yield**. Understanding the relationship between topsoil depth, water use, and yield variability can help refining precision agriculture strategies to improve water holding capacity and crop yields, especially in regions of shallow topsoil.

# Recent Journal Publications (August 2023 to February 2024)

Schreiner-McGraw, A.P., Ransom, C.J., Veum, K.S., Wood, J.D., Sudduth, K.A., Abendroth, L.J. 2023. **Quantifying the impact of climate smart agricultural practices on soil carbon uptake relative to conventional management**. Agricultural and Forest Meteorology. 344. Article 109812. https://doi.org/10.1016/j.agrformet.2023.109812

Recent interest in climate-smart agriculture aims to sequester carbon in soil, yet verifying effectiveness of practices has been challenging. Traditional soil sampling fails to confirm atmospheric carbon capture. Our research compared carbon sequestration between fields employing alternative practices (no-till farming, cover crops, extended crop rotation) and conventional methods (tillage, corn-soybean rotation). Utilizing soil samples and eddy covariance technology, we confirmed that **alternative practices enhanced carbon sequestration, achieving the "4 per mil" target—mainly due to cover crops**. This underscores the importance of conservation farming in mitigating climate change and the effectiveness of new measurement technologies.

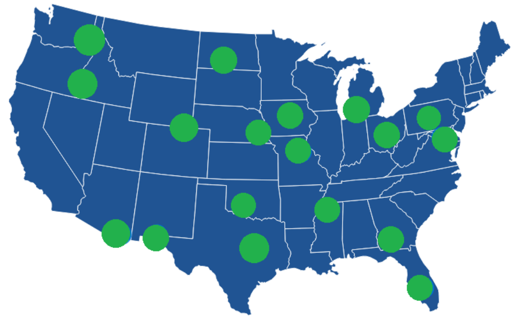
An eddy covariance tower used in this study to measure CO2 exchanges between the atmosphere, soil, and crop.

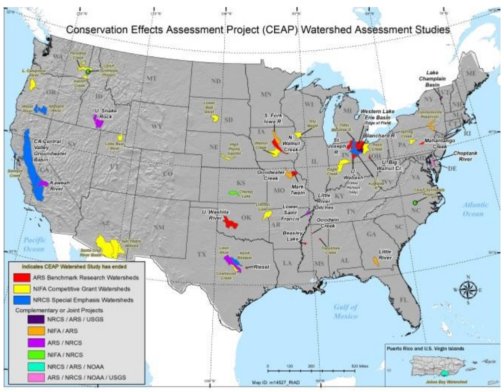
Paddock, K. J., Veum, K. S., Finke, D. L., Ericsson, A. C., & Hibbard, B. E. (2024). **Soil microbes from conservation agriculture systems reduce growth of Bt-resistant western corn rootworm larvae**. *Journal of Pest Science*, 1-13. DOI?

Western corn rootworm (WCR) is a costly pest for corn, causing over $2 billion in losses each year. Improving soil health can affect soil microbiomes, but we don't know much about how this impacts pest control. In our study, we found that the **soil microbiome from a long-term conservation system (a diverse corn-soybean-wheat rotation with cover crops and no-till) influenced WCR-corn interactions compared to the microbiome from a regular system (corn-soybean rotation with tillage and no cover crops).** The most common way to control WCR, using transgenic (Bt) corn, was equally effective with both soil microbiomes for susceptible insects. However, Bt-resistant insects were smaller when grown in the conservation system. **This suggests that conservation practices can benefit pest management by changing the soil microbiome.** As interest in soil health and conservation practices grows, this research will help farmers and advisers understand how their choices impact the sustainability and profitability of corn production.

## Links to Regional Collaborations and Research Efforts

**Long-Term Agroecosystem Research (LTAR)** is a growing research network comprising 18 established, long-term research sites focused on developing national strategies for more efficient agricultural production while improving the quality of the environment and the well-being of America's farming communities. Visit the website https://ltar.ars.usda.gov/ for links to ongoing efforts, recent publications, and collaborating locations.






**Conservation Effects Assessment Project (CEAP):** USDA's Conservation Effects Assessment Project (CEAP) is a multi-agency effort led by the Natural Resources Conservation Service (NRCS) to quantify the effects of conservation practices across the nation's working lands. Visit the website https://www.nrcs.usda.gov/ceap to find reports on trends in conservation practices and their outcomes.

## Vacancies

We have a few vacancies that are all in the pipeline to be filled (hopefully this year):

**Research Scientists**

- Agricultural Engineer/Soil Scientist/Hydrologist in Portageville, Missouri
- Agricultural Engineer/Data Scientist in Columbia, Missouri

**Support Scientist**

- Data Analysist/Geospatial Scientist in Columbia, Missouri

## Feedback

As we wrap up this edition, we want to hear from you! Your feedback is the cornerstone of our continuous improvement. Whether it's a question, a suggestion, or a comment, we're all ears. Please don't hesitate to reach out to us Ken.Sudduth@usda.gov. Your insights are invaluable in helping us serve you better and keeping our research relevant. Looking forward to hearing from you!

Warm Regards,

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