Trial Type: Cover Crop
Growing Season: 2017-2023

Project Objective: The objective of this project is to quantify the effects of cover crops on soybean and corn yields as well as their effect on soil health measurements as defined by the NRCS CEMA 216 protocol.

Project Insights:

1. First years with a cover crop saw large variability in cash crop yield response.
2. Variability in yield responses decreased by 33.8% in corn and 84.3% in soybeans from the first year to the seventh year of establishment.
3. Increased cover crop growth may negatively impact cash crop yield.
4. Significant changes in soil health measurements were not detected in 2022 or 2023.

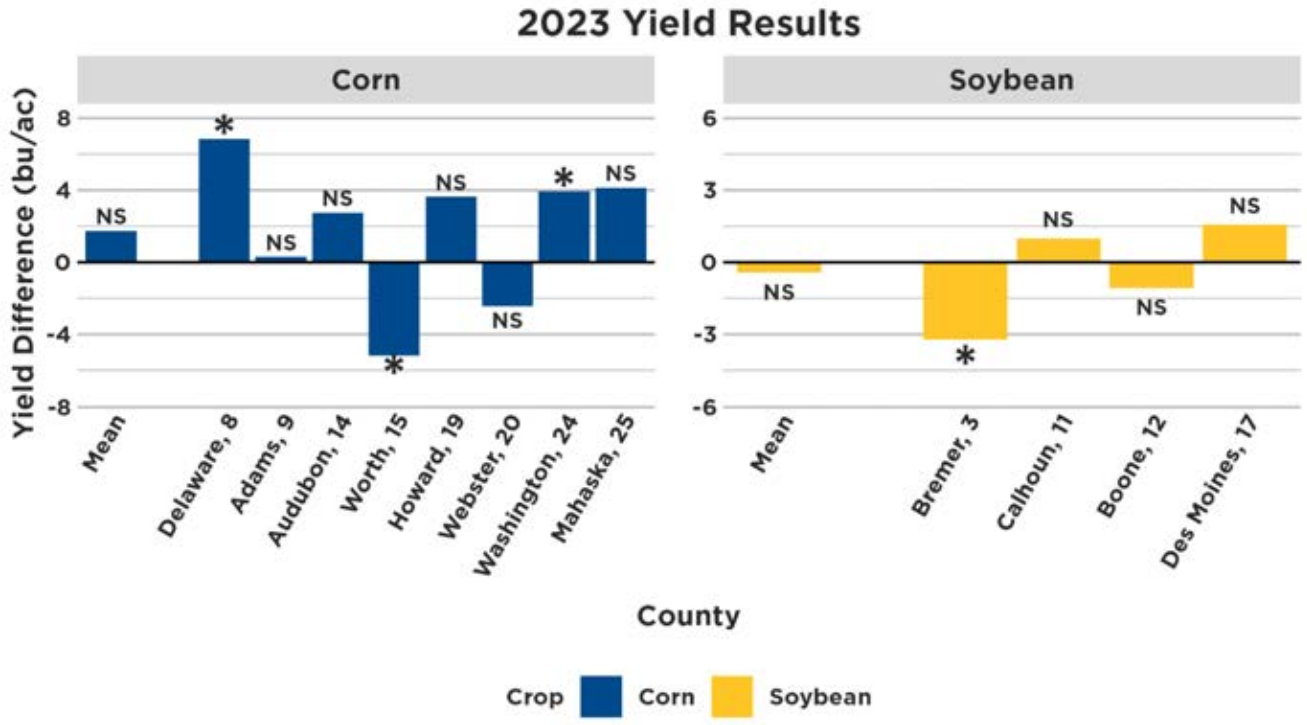

*Figure 1 The X-axis is the county and Site ID for each site, and the Y-axis is the yield difference. A negative value indicates a yield loss in the cover crop treatment. * Indicates statistically significant yield differences, NS indicates a statistically insignificant yield difference.*

2023 Project Discussion

The multi-year cover crop project has been ongoing with initial sites established between 2014 and 2019. In 2023, soybean sites were in years 7 to 8 of the project, while the corn locations varied from years 5 to 8. Yield response to the cover crop was variable in 2023. Differences between the cover crop and untreated strips are shown in Figure 1, ranging from -5.2 to +6.9 bu/ac on corn (average +1.8 bu/ac) and -3.2 to +1.6 bu/ac on soybean (average -0.4 bu/ac). Twelve sites were reported (locations shown in Figure 2), with four sites showing a significant response to the use of a cover crop. Note that while Site 25 did have a +4.2 bu/ac response, this was not significant due to variability in responses across the field.

Figure 2 Site locations in 2023

Drought conditions impacted most of Iowa, with rainfall ranging from 2 to 10 inches below the 20-year average. April-August rainfall totals at the trial locations are reported in Table 1. Due to the reduced rainfall, nearly all the sites produced average or below average yields within the trial areas compared to the last year in which the same cash crop was grown (Figure 3).

Corn

	April - August Rainfall (inches)	
	2023	20-year Avg
Site 8*	16.14	23.91
Site 9	19.3	22.16
Site 14	17.46	22.1
Site 15*	13.56	23.93
Site 19	16.76	25.2
Site 20	14.39	21.18
Site 24*	11.96	20.27
Site 25	11.55	21.79

Soybean

	April - August Rainfall (inches)	
	2023	20-year Avg
Site 3*	13.69	23.64
Site 11	16.06	19.63
Site 12	16.92	20.53
Site 17	18.17	20.33

*Table 1 April-August rainfall totals in 2023 and the 20-year average at each location. Sites with a significant yield response marked with *.*

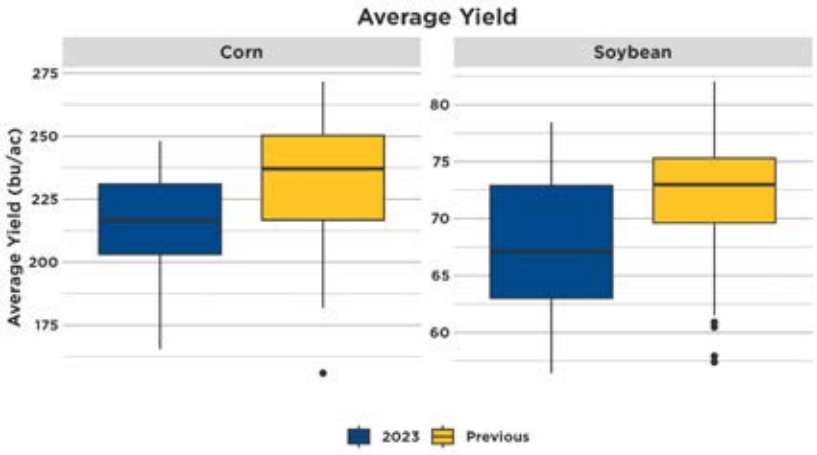

Figure 3 Average 2023 yield from all sites compared to the average yield at the same sites previously planted to the same cash crop and treatment.

At Site 3 (Figure 4), soybeans had a significant yield reduction in strips with cover crops. Discussions with the farmer and agronomist led us to conclude that early season competition resulted in delayed early growth in the soybean. The soybeans were planted on May 17 into actively growing cereal rye, which was not terminated until the post application in June. Following termination, the cereal rye residue remained and further impacted the growing conditions within those strips. Given the early competition and delayed growth, the soybeans in these strips did not catch up to those planted into the uncovered areas (Figure 4).

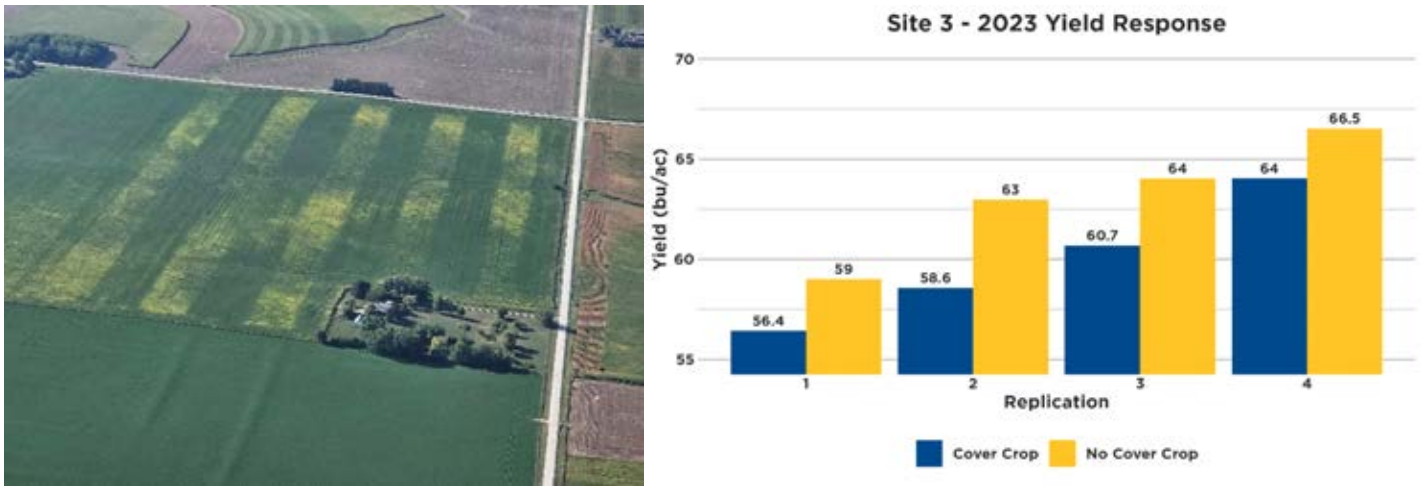

Figure 4 (Left) Aerial image of Site 3 in Bremer County, submitted by trial participant taken on 9/3/2023. Dark green strips where cover crops were established.
(Right) 2023 yield results for Site 3.

Overall Project Discussion

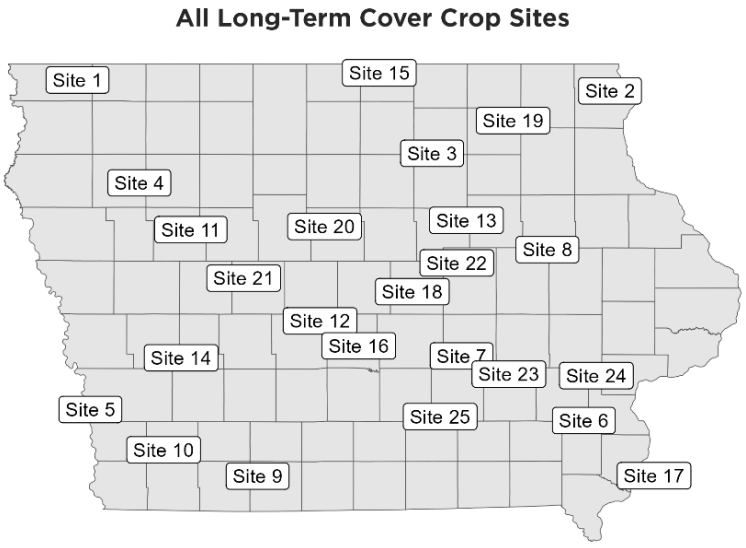

Figure 5 All multi-year cover crop site locations that have participated in the project.

As noted previously, the active sites in 2023 began between 2014 and 2019 and are included in a larger dataset that includes 13 additional sites that compared cover crop and no-cover crop treatments but are no longer active. All locations that have participated in this project are shown in Figure 5. During the first year

of the project, both corn and soybeans resulted in a significant yield difference with the use of a cover crop. Following the first year, corn showed a significant yield difference in the second and sixth years, while soybean saw a significant yield difference during the seventh year (Figure 6). Across all 117 site years, there was no significant difference in yield for either soybean or corn. Soybean averaged 62.4 and 63.2 bu/ac with a cover crop and no-cover crop treatment, respectively (49 site years), while corn averaged 223.6 and 225.1 bu/ac with a cover crop and no-cover crop treatment, respectively (68 site years). While there was no significant difference in yield across all site years, the variability in yield response was reduced in both corn and soybeans as fields remained enrolled in the project. The standard deviation, or amount of variation within the data, changed from 5.9 to 3.9 bu/ac in corn and 5.3 to 0.8 bu/ac in soybeans from years 1 to 7. As farmers participated in the trial for more years, the yield range decreased, as shown in Figure 6 by the decreased width of the box plots from left to right. This reduction in variability suggests yield stability over time, resulting from learning to work with cover crops and any beneficial changes to the field or farming operation.

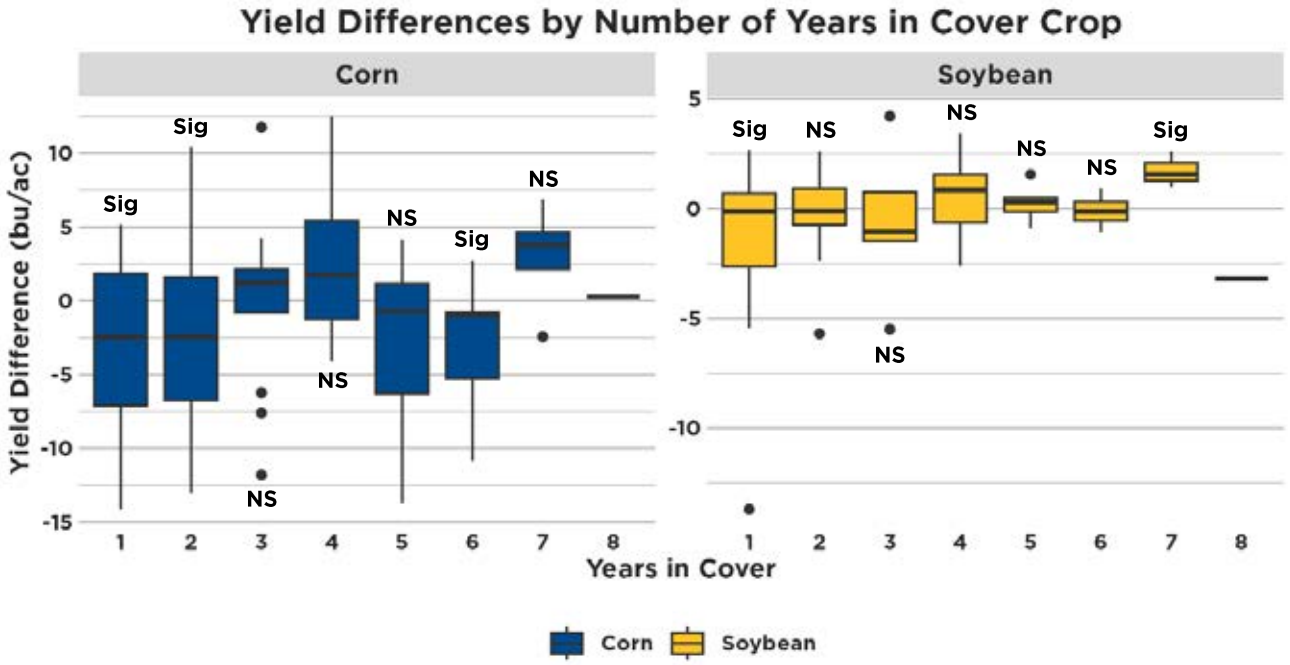

Figure 6 Yield difference between cover crop and no cover crop treatments by years involved in the study. A negative value indicates a yield loss in the cover crop treatment. Year 8 in both corn and soybeans had a single site, resulting in the absence of the observed variability. Sig Indicates statistically significant yield differences, NS indicates a statistically insignificant yield difference.

Soil Health Test Results

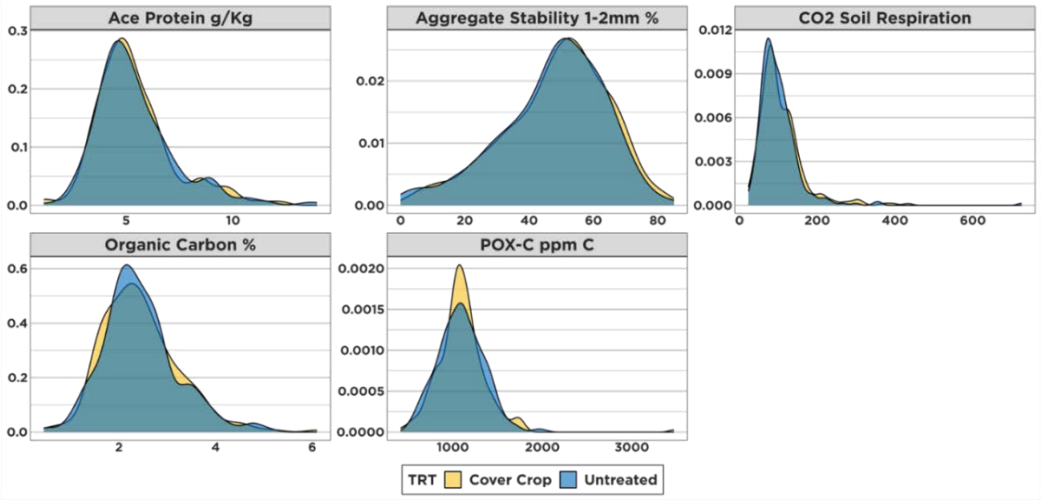

Figure 7 CEMA 216 measurements distributions are shown. Minimal differences in soil health measurements were observed across all locations.

In 2022 and 2023, ISA took soil health samples (0-6 inch depth) at all active sites using the NRCS CEMA 216 protocol. Across both years we saw no statistical difference in any measurements between treatments, shown in Figure 7. All trials compared cover crops to no-till, which may have limited the ability to detect a difference. Previous research has indicated that there is a smaller difference in soil health measurements when comparing soil that has been treated with cover crops in no-till systems as compared to a conventional tillage system.

Cover Crop Establishment

Figure 8 Cover crop establishment can be variable. Three unique sites ranging from minimum (left) to maximum (right) cover crop biomass.

All previous sites were seeded to a single species of cereal rye in the fall. With variability in planting methods and fall and spring weather, there were varying levels of cover crop establishment at each location and year (Figure 8). From left to right in Figure 8, estimated biomass per acre was 1,500, 2,300, and 8,100 lbs/ac which resulted in yield responses of +2.4 (corn), +0.6 (soybean), and -9.3 (corn) bu/ac respectively. Satellite imagery was used to look at each site and year to check quality and growth using NDVI (normalized difference vegetation index). Using this, we found that one of the leading indicators of yield loss potential was how well the cover crop established in the spring. As more ground coverage and growth is observed, there is a negative correlation to yield.