Summarizing Horse Creek Test Plot Yield and Bulk Density Data

CORN

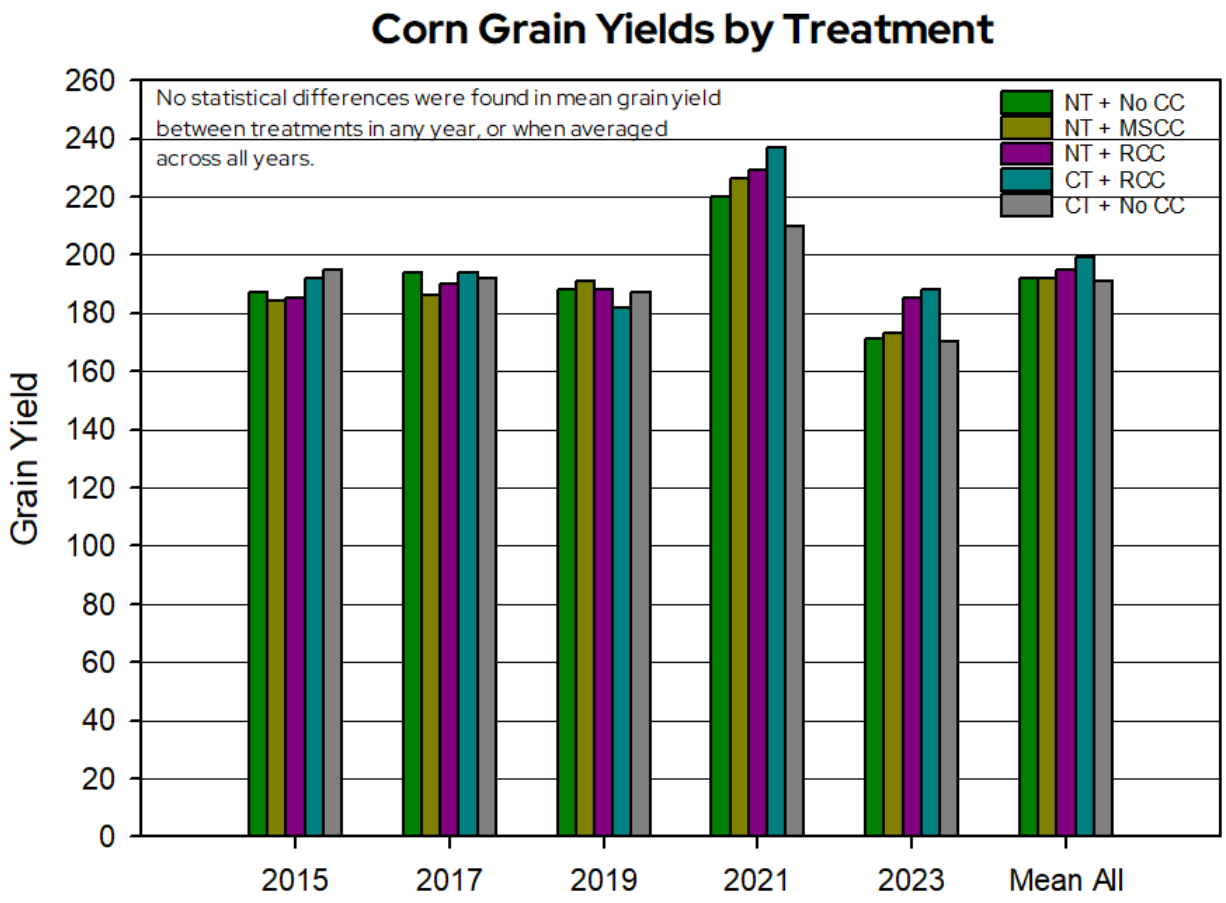

Figure 1. Corn grain yields by treatment, observing within-year and across years (mean all) differences.

- There were no significant differences in corn yield between treatments within any specific year or when averaged across all study years. Growing season year was more influential on grain yield than treatments.
- Numerically, when averaged across all study years, treatments with cereal rye cover crops results in the highest yield (Purple and blue bars within the "Mean All" section).
- Additionally in 2023, although not statistically significant, reduced grain yield was observed in CT+NoCC compared to NT+NoCC, NT+MSC, NT+RCC, and CT+RCC by 10, 16, 19, and 27 bu/ac, respectively.

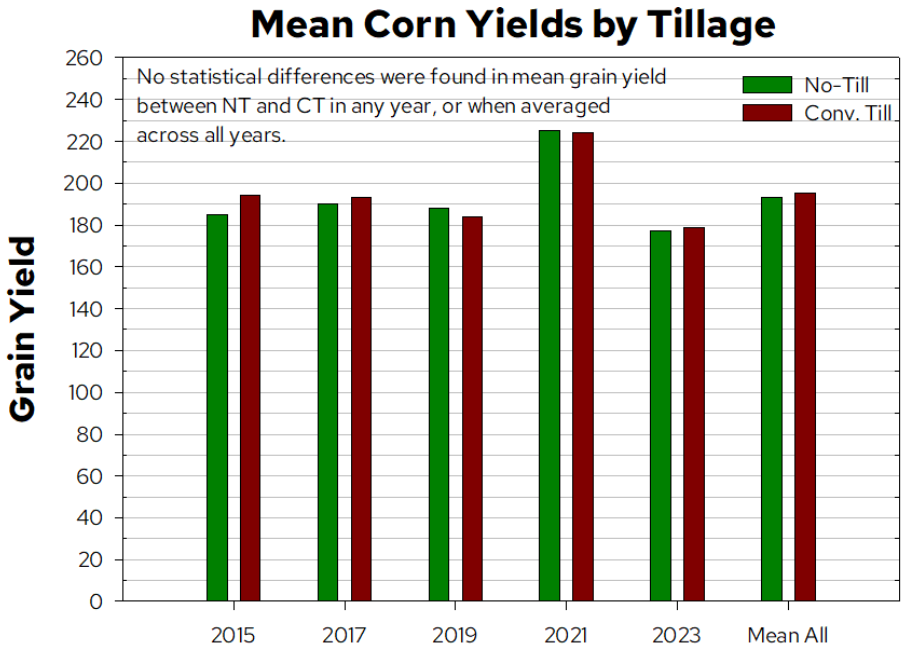

Figure 2. Mean corn yields by tillage (no-till vs conventional tillage). Here, corn yield was aggregated by tillage, regardless of cover crop or no-cover crop.

- There were no differences in corn yield when evaluating between no-till vs tillage.
- Interestingly, yet not surprisingly, we see slightly lower (not significantly) grain yields in NT compared to CT in the first 2 corn-years of the trial (2015 and 2017), but then from 2019-2023, yields are numerically identical (188v184 in 2015, 225v224 in 2021, and 177v179 in 2023; NTvCT).
    - This demonstrates the slight "yield lag" when transitioning from CT to NT, but this data suggests the "lag" is negligible and likely will be more than paid for by not tilling.
    - IF Yield is the same in NT as in CT, AND we don't have the expense + time invested in conducting tillage, we are winning economically.
    - Dane, we really should put pen to paper on some economics of tillage operations in your region so we can determine the $$$ saved by going to NT on this demonstration plot.

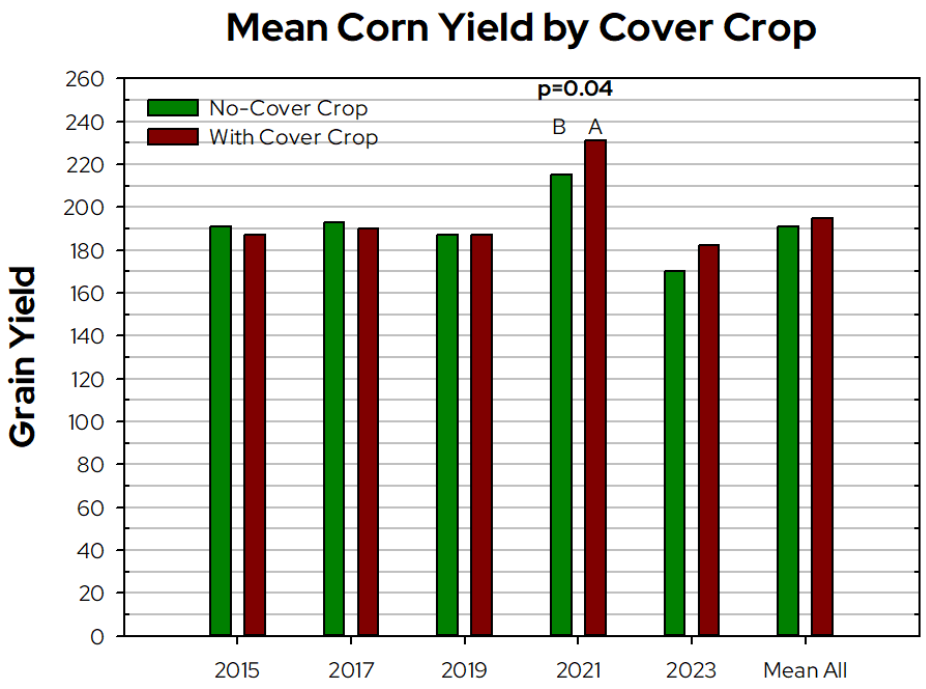

Figure 3. Mean corn yields by cover crop (CC vs no-CC). Here, corn yield was aggregated by cover crop, regardless of tillage or no-tillage. Corn yield from cereal rye and multi-species CC were aggregated together for this analysis.

- In 2021, corn yields where there was a cover crop were greater than where there was not a cover crop (Figure 3). Averaged across all years, however, there were no significant differences between CC and no-CC. Numerically, corn yield was greater following CC than no-CC when averaged across years.
    - This is interesting because you will notice that in 2015 and 2017, yields were numerically greater in no-CC than in CC. In 2019, they are numerically the same, and then in 2021 and 2023 we see corn yields increasing a bit when following CC.
    - We are maintaining yield by using covers as compared to not using covers; however, there is no significant yield increase yet either.
    - It would be interesting to keep these plots going another cycle or 2 (1-2 more corn and bean years) to see if the red bars continue to go up or at least stick with the green bars… This could help us identify "how long" it takes for CC systems to result in greater corn yields than in no CC systems.
- Being that there are no yield advantages being observed (yet) with CC, we do have to account for the economic inputs of managing the CC. How much "loss" money-wise is occurring by using the covers in the short term?

- When combined with the transition to NT, however, where we are saving the tillage expenses, I would be interested to see if the money saved there would over compensate for the "lost" money on managing covers here.
    - Also, keep in mind, soil erosion reduction and all of the other soil health/function benefits the covers and NT are providing us that are not so easy to quantify from a monetary standpoint.

Year	Treatment 1 (NT+NoCC)	Treatment 2 (NT+MSCC)	Treatment 3 (NT+RCC)	Treatment 4 (CT+RCC)	Treatment 5 (CT+NoCC)	P > F
2015	187	184	185	192	195	0.73
2017	194	186	190	194	192	0.73
2019	188B	191	188	182	187	0.42
2021	220	226	229	237	210	0.25
2023	171	173	185	188	170	0.51
Mean-All	192	192	195	199	191	0.81
Year	**NT**	**CT**	**p>F Till**	**No-CC**	**CC**	**p>F CC**
2015	185	194	0.15	191	187	0.47
2017	190	193	0.46	193	190	0.50
2019	188	184	0.12	187	187	0.88
2021	225	224	0.87	215b	231a	***0.04***
2023	177	179	0.80	170	182	0.15
Mean-All	193	195	0.75	191	195	0.39

Table 1. Mean corn grain yields by year and 1. Treatment (Magenta section of table, evaluating treatment averages within a study year); 2. Tillage vs no-tillage (Green section of table, evaluating average yields between NT and CT); and 3. Cover crop vs no-cover crop (blue section, evaluating average yields between noCC and CC). Different lowercase letters within a row of a section (e.g. blue) indicate statistical differences in yield between treatments.

SOYBEAN

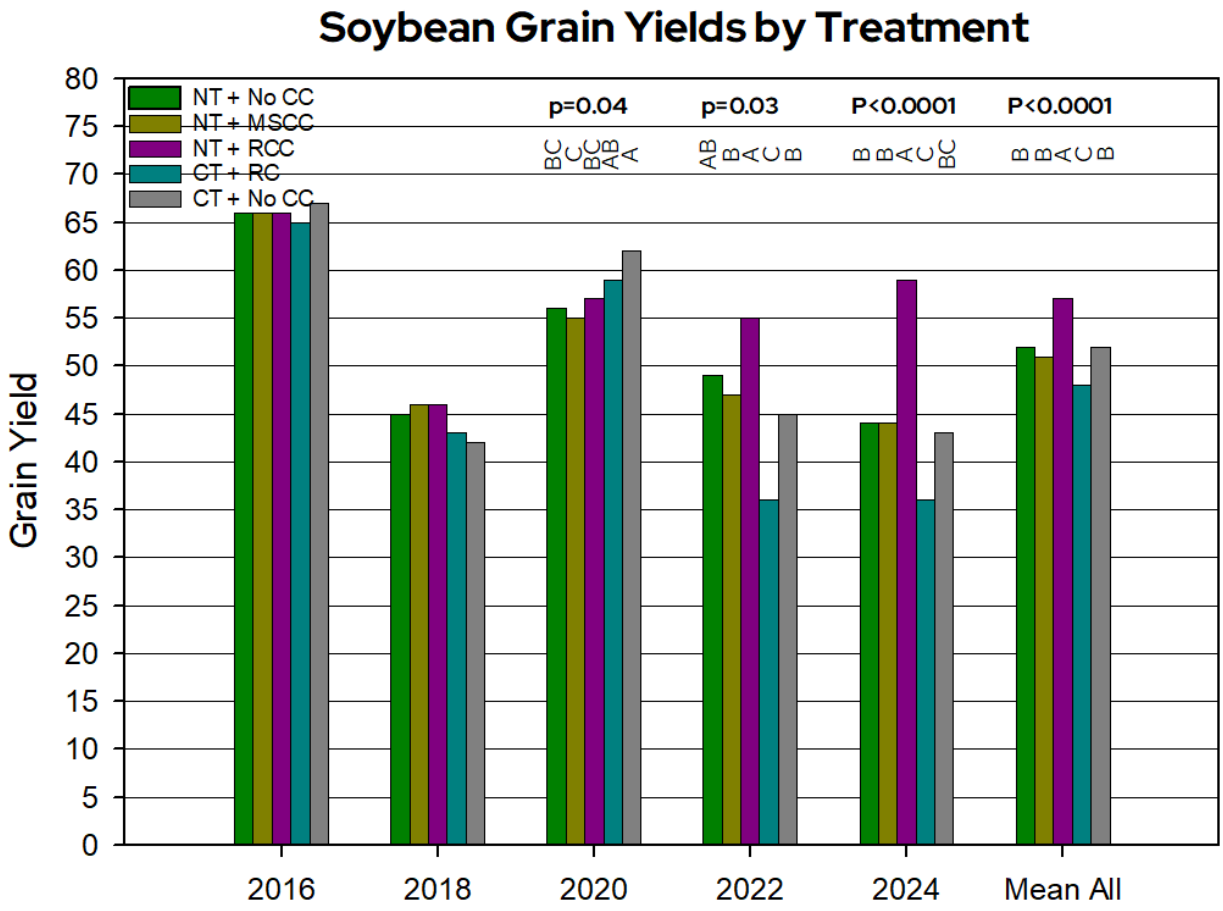

Figure 4. Soybean grain yields by treatment, observing within-year and across years (mean all) differences. [p values < 0.10 indicate statistical significance; different uppercase letters above bars within a "year" indicate significant differences in soybean yield.

- Significant differences in soybean yield were not observed until the 2020 growing season.
    - In 2020, CT+noCC had the highest yield, followed by CT+RCC > NT+RCC > NT+noCC > NT+MSCC.
    - In 2022, 2024, and when average across all sites, NT+RCC resulted in the highest yields.
        - In 2022, NT+RCC was significantly greater than both CT treatments and the NT+MSC treatment.

        - In 2024 and when averaged across all years, NT+RCC was significantly greater than all other treatments.
    - In 2022, 2024, and when averaged across all sites, CT+RCC resulted in lower yields than all other treatments.

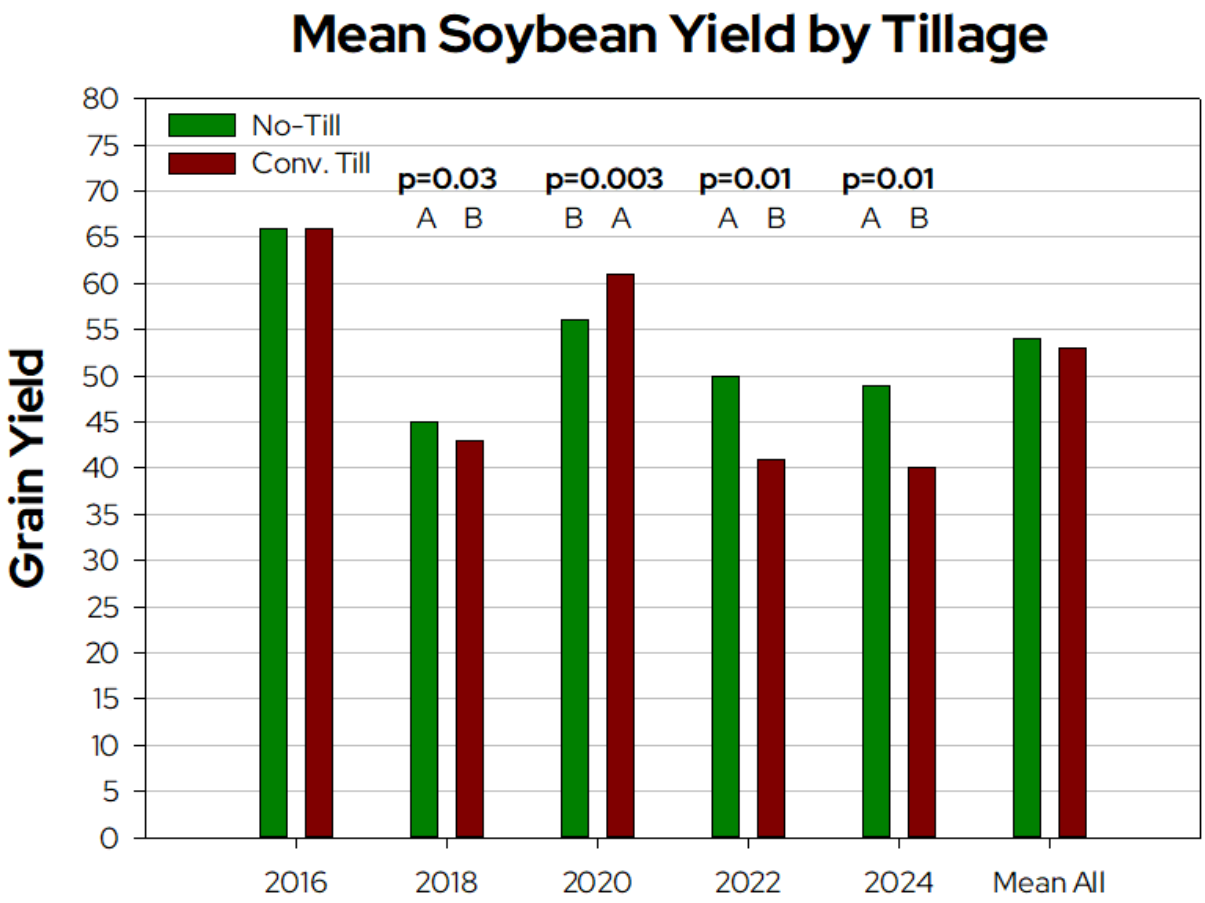

Figure 5. Mean soybean yields by tillage (no-till vs conventional tillage). Here, soybean yield was aggregated by tillage, regardless of cover crop or no-cover crop.

- We see a fight for top yields between NT and CT in 2018 and 2020 where the trend shifts back and forth.
- Starting in 2022, no-till bean yields were significantly greater than CT beans.
- Averaged across all sites, although not statistically significant, NT yields were numerically greater than CT yields.
    - My interpretation is that like in the corn x tillage data above (Figure 2), it took a couple of years for the system to equilibrate before we see the consistency in greater yields under NT compared to CT. Would be interesting to see another year or 2 of bean data to see if the higher yields is the new normal in NT over CT.

- Again, similar to the corn data, there is no yield penalty (in-fact a slight yield benefit) to going NT. The $$$ analysis would be very interesting here.

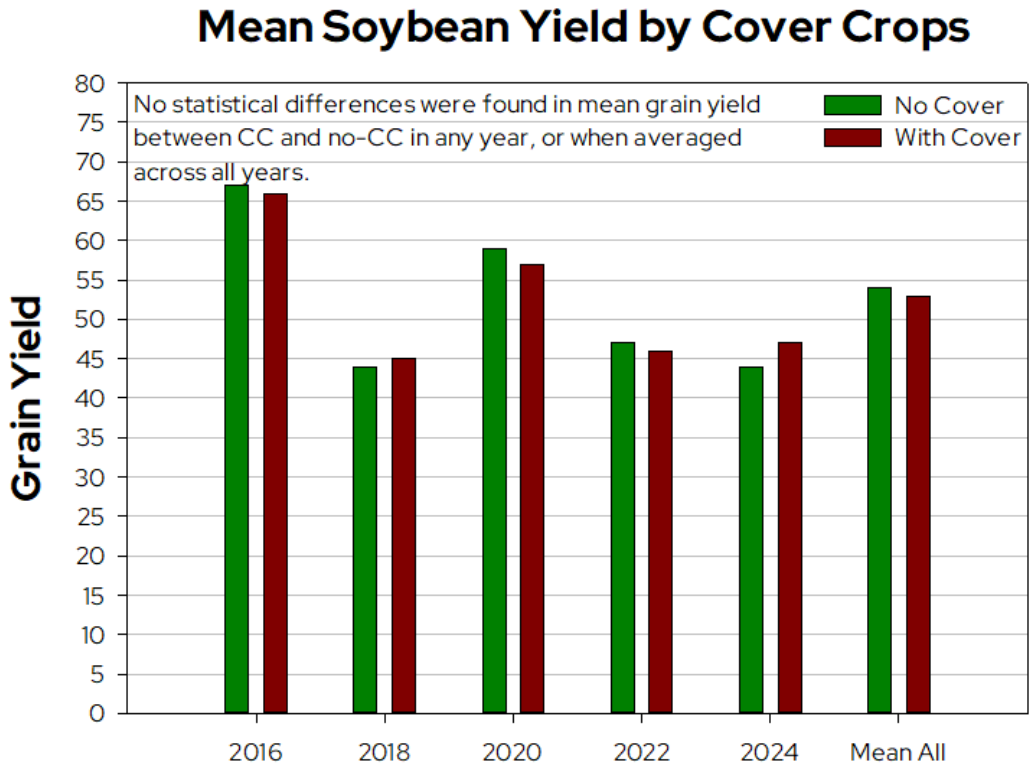

Figure 6. Mean soybean yields by cover crop (CC vs no-CC). Here, soybean yield was aggregated by cover crop, regardless of tillage or no-tillage. Soybean yield from cereal rye and multi-species CC were aggregated together for this analysis.

- Soybean yields were not effected by cover crops alone.
- As seen in Figure 4 and 5, especially starting in 2022 and 2024, stacking NT with cover crops is where we see the largest yield benefits.

Year	Treatment 1 (NT+NoCC)	Treatment 2 (NT+MSCC)	Treatment 3 (NT+RCC)	Treatment 4 (CT+RCC)	Treatment 5 (CT+NoCC)	P > F
2016	66	66	66	65	67	0.60
2018	45	46	46	43	42	0.43
2020	56bc	55c	57bc	59ab	62a	**0.04**
2022	49ab	47b	55a	36c	45b	**0.03**
2024	44b	44b	59a	36c	43bc	**<0.0001**
Mean-All	52b	51b	57a	48c	52b	**<0.0001**
Year	**NT**	**CT**	**p>F Till**	**No-CC**	**CC**	**p>F CC**
2016	66	66	0.48	67	66	0.29
2018	45a	43b	**0.03**	44	45	0.32
2020	56b	61a	**0.003**	59	57	0.29
2022	50a	41b	**0.01**	47	46	0.83
2024	49a	40b	**0.01**	44	47	0.36
Mean-All	54	53	0.46	54	53	0.85

Table 2. Mean soybean grain yields by year and 1. Treatment (Magenta section of table, evaluating treatment averages within a study year); 2. Tillage vs no-tillage (Green section of table, evaluating average yields between NT and CT); and 3. Cover crop vs no-cover crop (blue section, evaluating average yields between noCC and CC). Different lowercase letters within a row of a section (e.g. magenta) indicate statistical differences in yield between treatments.

BULK DENSITY

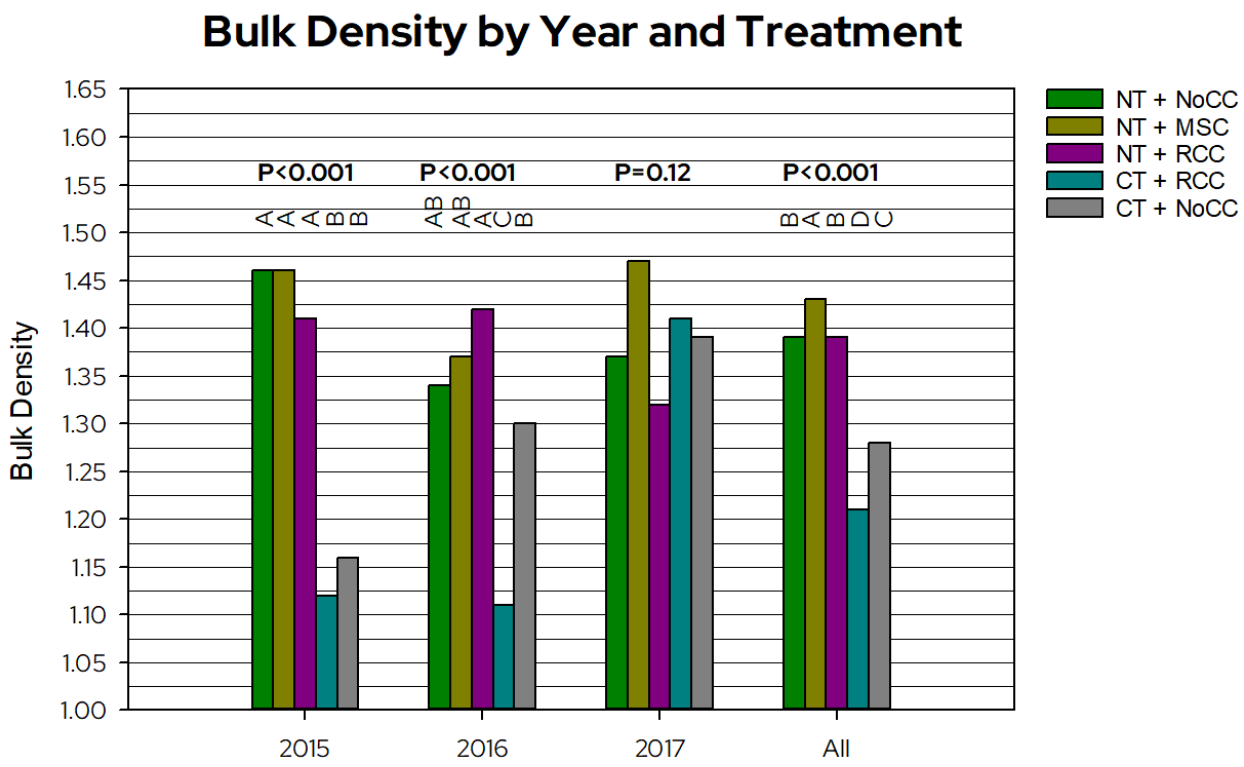

Figure 7. Soil bulk density by treatment, observing within-year and across years (mean all) differences. [p values < 0.10 indicate statistical significance; different uppercase letters above bars within a "year" indicate significant differences in soybean yield.

- In 2015, NT treatments had greater BD than CT plots.
- In 2016, NT treatments had greater BD than CT plots. Interestingly, BD in NT+NoCC and NT+MSC were not different than in CT+NoCC (although numerically they were….) CT+RCC had the lowest BD by quite a bit.
- On the average, NT resulted in higher BD than CT which is probably not surprising.

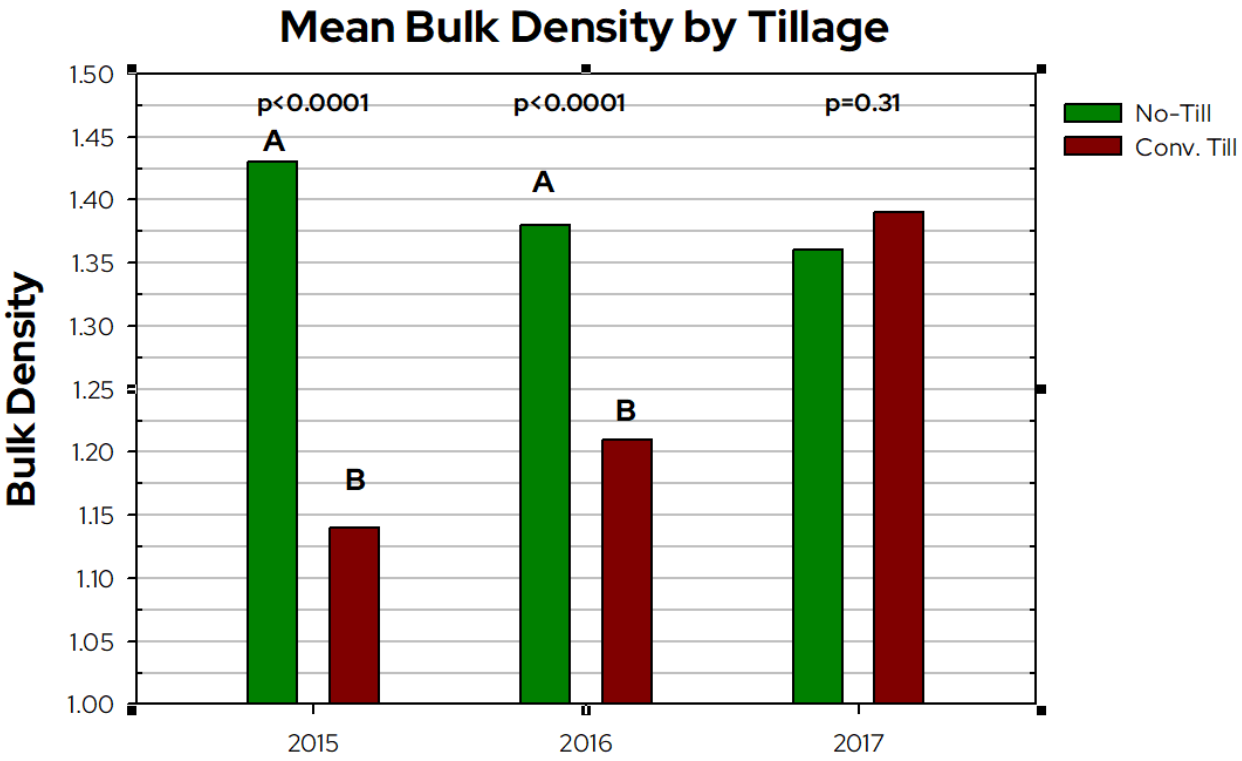

Figure 8. Mean bulk density by tillage (no-till vs conventional tillage). Here, BD was aggregated by tillage, regardless of cover crop or no-cover crop.

- In the first 2 years, tillage resulted in lower BD, but not in 2017
    - Might be interesting to pull BD samples again now to see what the comparison looks like 7 years later…

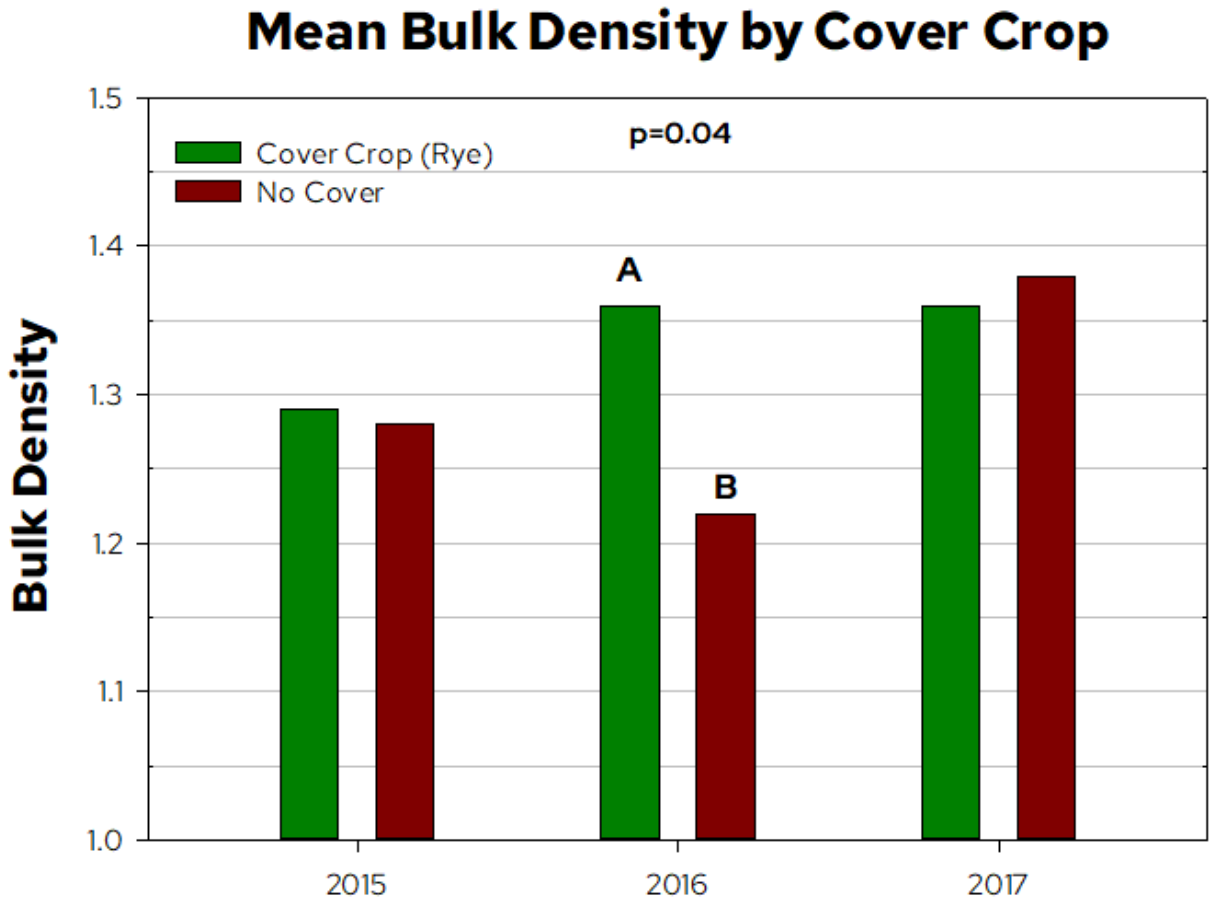

Figure 9. Mean bulk density by cover crop (CC vs no-CC). Here, BD was aggregated by cover crop, regardless of tillage or no-tillage. BD from cereal rye and multi-species CC were aggregated together for this analysis.

- Not much to see here, I think the effect of tillage is going to drive BD much more than CC in the first couple years of the study/transition.
- Again, would be interesting to pull BD samples again to see if/how things have changed 7 years later…

PUTTING IT ALL TOGETHER, SO FAR

- Corn: There was a 2-corn year yield drag (numerical, not statistical) when transitioning from CT to NT and no CC to RCC. After which, yields in NT and with covers is the same or slightly higher than CT and no CC. Largely, corn yields were not affected by adopting no-till and/or cover crop use. Thus, improvements to soil health and function can be made while not sacrificing yield. **Profitability is likely**

the same between CT+NoCC and NT+RCC, if not slightly higher for NT+RCC, because of the elimination of tillage costs when stacking the practices together. Combine the monetary savings of tillage elimination with indirect profits of improved soil conservation and this sounds like a winning system in your environment!

- Soybean: During the first 2-3 years of beans after transitioning to NT, we observed mixed results when compared to CT (1 year yields were equal, 1 year NT>CT, 1 year CT>NT. The last 2 years of beans, and averaged across the entire study, we saw a significant benefit to adopting NT and cereal rye covers as compared to CT and no CC. The story is very similar to that of corn, where eliminating tillage costs will result in greater profit in NT systems that are also using rye covers. In fact, because we did see a slight agronomic advantage of the NT+RCC in the last 2 years of the study and on the average across all years, there is likely a fair profit to be made after 2 years of beans by switching to NT+winter rye.
- Bulk Density: To no ones surprise, soils are a bit more compacted following the early transition to NT from CT. As samples haven't been taken in a number of years, it would likely be worthwhile to pull an extensive round of samples again to see how things might have "settled" after all of these years of NT and CC.3

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