Corn-Soybean-Wheat/Soybean vs. Conventional Corn-Soybean

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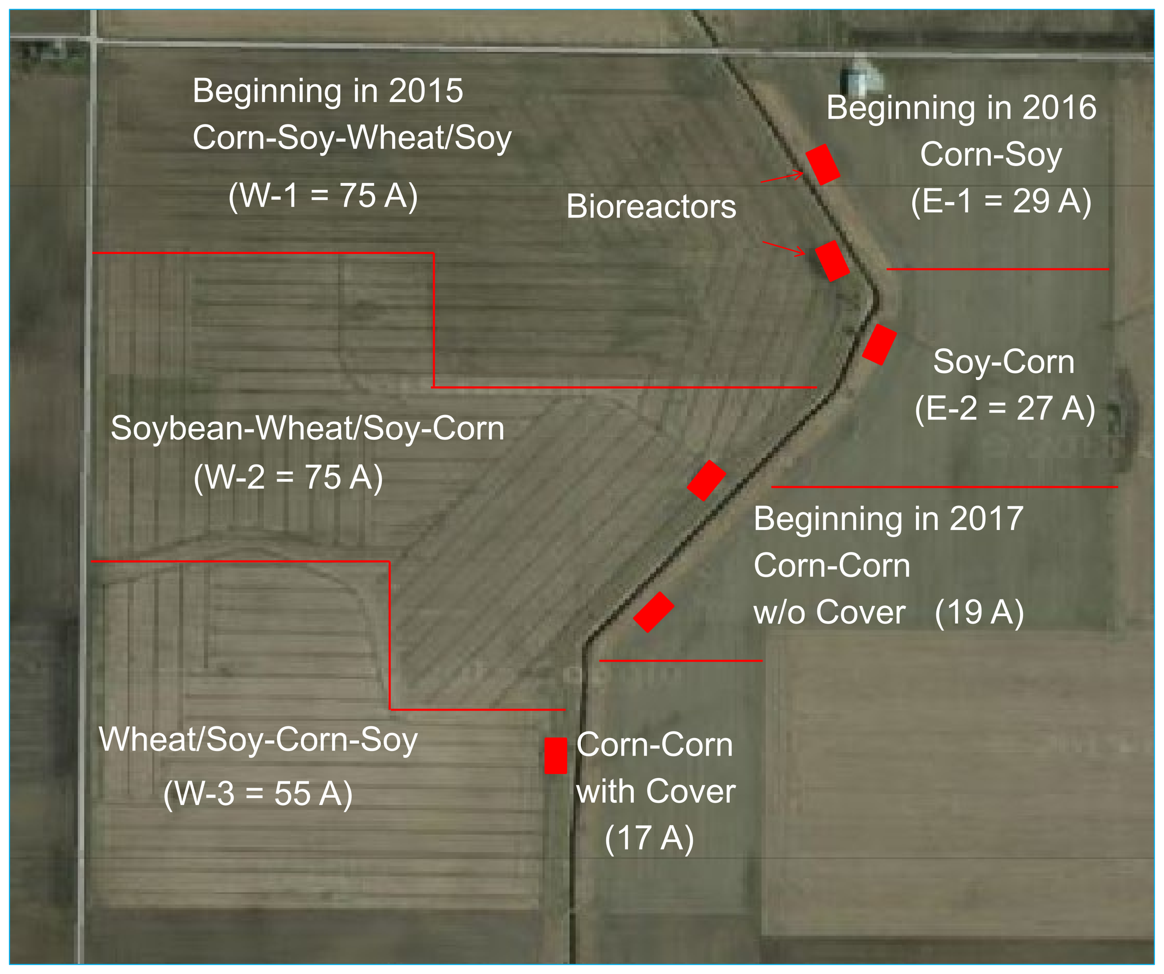
NREC Study-Piatt County



Field Design and Cropping Systems

This working farm owned by Eric Miller in Piatt County, IL compares 4 cropping systems including: corn-soybean-wheat/double-crop soybean with cereal rye after corn vs. conventionally managed corn-soybean vs. continuous corn with and without cereal rye (with 6 woodchip bioreactors monitored as well).

In C-S-W, corn was strip-tilled and received a total of 180 lbs of N/A (2x2 starter and side-dress). Winter wheat was no-tilled and received a total of 122 lbs of N/A (DAP in the fall and split N in the spring). Soybean was no-tilled and received no fertilizer N. Cereal rye was grown after corn. Following winter wheat harvest, radish and turnip was grown in 2015 and red clover/cereal rye in 2016 whereas soybean was double cropped after wheat from 2017 to the present.

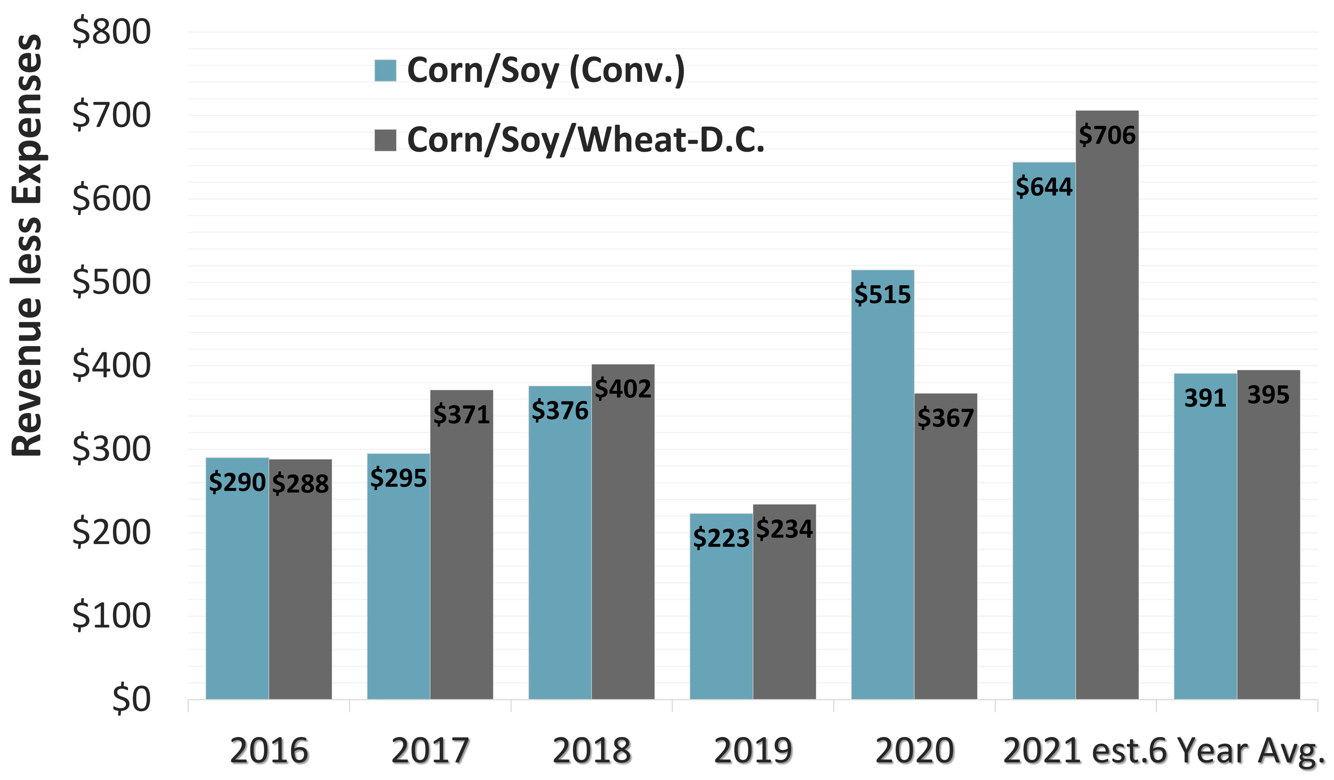
In C-S, full width tillage is performed. Corn received a total of 180 lbs of N/A (2x2 starter and side-dress) in 2026 and 2017. From 2018 to the present fall N fertilizer was applied at approximately 70% of the total 180 lbs/of N/A (with starter and side-dress for the remainder).

Table showing cropping sequence by field for crop yields and flow weighted mean nitrate concentrations of tiles from 2015 through 2021.

Fields	2015	2016	2017	2018	2019	2020	2021
	C-S-W						
W-1	Corn	Soy	Wheat/Soy	Corn	Soy	Wheat/Soy	Corn
Yield (bu/A)	253	75	98/55	265	75	92/20	241
Tile NO_3 (ppm)	7.7	2.2	2.2	4.7	1.9	4.5	8.7
W-2	Soy	Wheat	Corn	Soy	Wheat/Soy	Corn	Soy
Yield (bu/A)	83	101	259	97	102/25	231	84
Tile NO_3 (ppm)	3.8	2.3	7.5	6.7	8.2	6.4	9.1
W-3	Wheat	Corn	Soy	Wheat/Soy	Prevent	Soy	Wheat/Soy
Yield (bu/A)	77	206	80	88/52	-	71	106/53
Tile NO_3 (ppm)	7.3	0.8	1.2	8.7	7.0	1.5	2.1
	C-S						
E-1		Corn	Soy	Corn	Soy	Corn	Soy
Yield (bu/A)		219	79	271	83	217	80
Tile NO_3 (ppm)		7.2	5.0	9.4	7.8	8.9	5.5
E-2		Soy	Corn	Soy	Corn	Soy	Corn
Yield (bu/A)		86	242	86	221	80	228
Tile NO_3 (ppm)		7.0	7.3	5.8	12.1	5.1	11.6

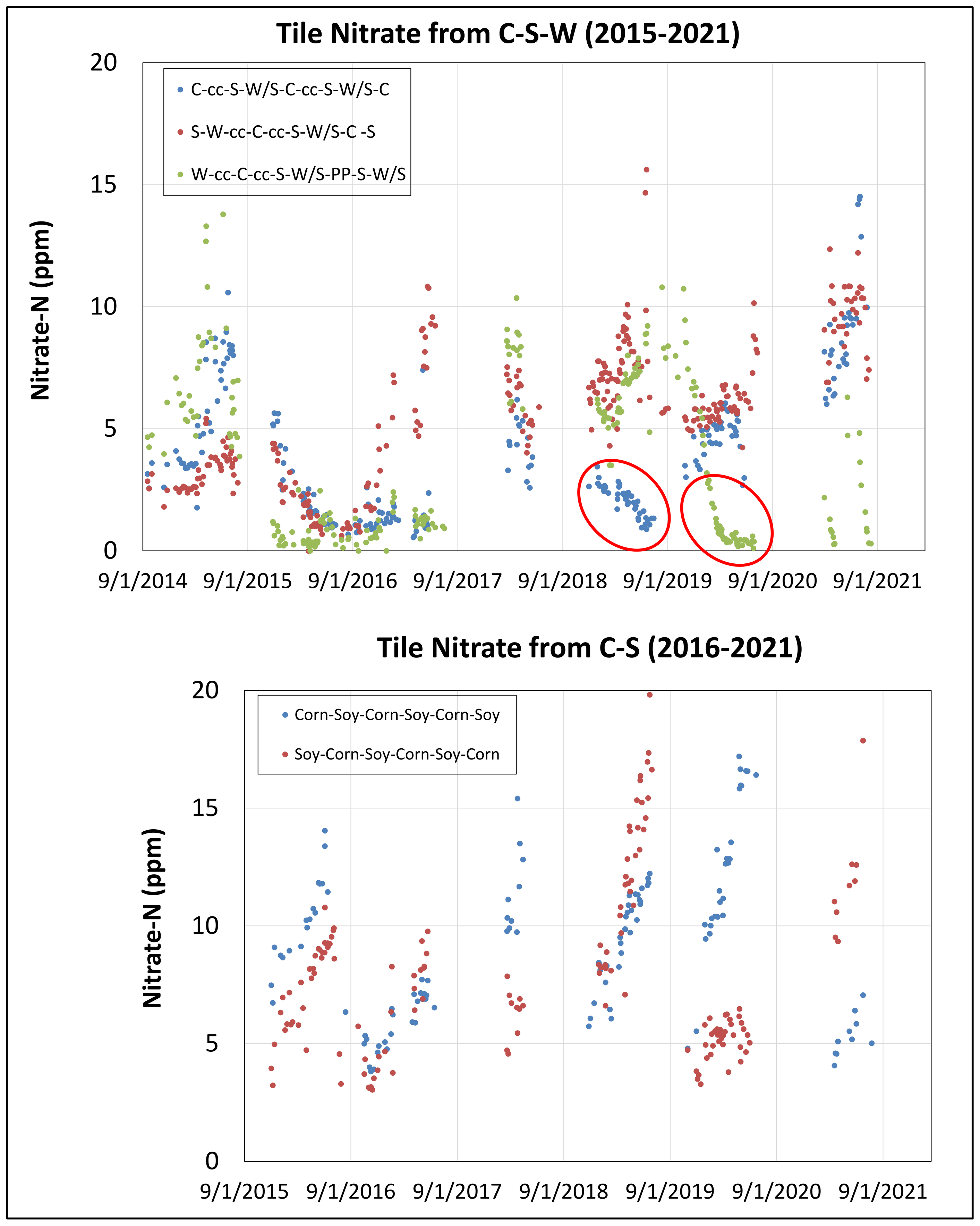
Crop yields have been excellent at this farm during the past 7 years. Corn and soybean yields have been comparable between C-S-W and C-S. Wheat double crop soybean has greatly added to the overall productivity of the system as well as helped make C-S-W with cereal rye economically competitive with conventional C-S.

Economic Evaluation



Economic evaluation of C-S-W with double crop soybean after wheat and cereal rye after corn vs. conventionally managed C-S.

Tile Nitrate from C-S-W vs. C-S



Tile nitrate in C-S-W from 2015-2021 and C-S from 2016-2021.

In C-S-W, cereal rye after corn greatly reduced tile nitrate during the soybean phase of the rotation, especially in 2019 and 2020 when soybean was planted green into standing cereal rye (Red ovals on top graph). Cold months of April in 2018 and 2020 limit cereal rye growth and its positive impact on tile nitrate.

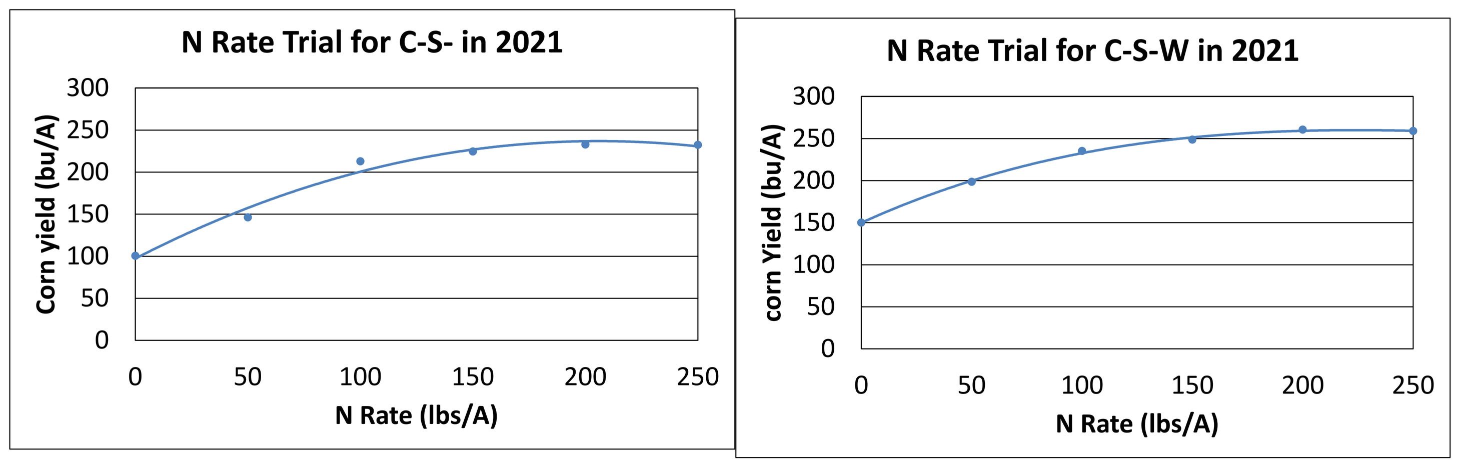
In C-S, the corn phase of the rotation lost the most nitrate (bottom graph) every year. Fall N application in the past four years has created greater separation of tile nitrate between the phases.

Based on average annual flow weighted mean tile nitrate concentrations from 2017-2021, we find that C-S-W/S reduced tile nitrate by 33% with removal rates greater than 40% in years 2017, 2019, and 2020 compared with C-S.

N Rate Trials

We have established an N rate trial in the corn phases of the C-S-W and the C-S rotations every year. Fertilizer N rates are 0, 50, 100, 150, 200, and 250 lbs/A.

Photo of the N rates trials in C-S-W in the foreground and you can just barely see the N rate trial in C-S in the distance.



Fertilizer N rate trial corn yield curves and EONR (yellow triangle) for C-S (left) and C-S-W (right) in 2021.

The economic optimum N rates (EONR) in 2021 were very similar between the two N rate trials (178 lbs/A for C-S and 180 lbs/A for C-S-W); however, optimum yield was 25 bu/A greater in C-S-W than C-S (258 bu/A vs. 233 bu/A). **It is interesting to note that the 0 lb/A rate and the 50 lb/A rate produced 50 bu/A more in C-S-W than in C-S.**

Table of corn yield and stalk nitrate by N rate in both C-S and C-S-W in 2021.

2021	C-S	C-S	C-S-W	C-S-W
N Rate	Corn Yield	Stalk Nitrate	Corn Yield	Stalk Nitrate
lbs/A	bu/A	ppm	bu/A	ppm
0	100.5	70	150.1	70
50	146.2	40	198.6	30
100	212.9	50	235.1	40
150	224.6	260	248.7	440
200	232.9	1470	260.6	2150
250	232.5	4970	258.9	6600

Stalk nitrate can be used as a proxy for plant N availability as concentrations >450 ppm indicate N sufficiency and >2000 ppm are considered excessive. We found greater stalk nitrate at the two highest N rates in C-S-W than in C-S.

Overall, the combination of greater corn yields at the low end of the N rate trial along with greater stalk nitrate at the high N rates indicate there is more plant available N in C-S-W than C-S.

Summary

- This research demonstrates proof of concept that we can greatly reduce tile nitrate loads by coupling the carbon and N cycles through a more diverse rotation and the use of cover crops.
- In addition, this study documents the quick response time of tile nitrate to management and suggests long lag times are not an issue.

Acknowledgements

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