2019 Final Report Summary Sheet

Grantee Information

Project Title: Precision nitrogen management for improving farm profitability and water quality in southern Illinois

Institution: Southern Illinois University Carbondale

Primary Investigator: Amir Sadeghpour, Joshua McGrath. Karl Williard, Jon Schoonover

NREC Project #

Is your project on target from an IMPLEMENTATION standpoint? ☒ **Yes** ☐ **No**
If you answered "no" please explain:

Is your project on target from a BUDGET standpoint? ☒ **Yes** ☐ **No**
If you answered "no" please explain:

Based on what you know today, will you meet the objectives of your project on-time and on-budget? ☐ **Yes** ☐ **No**
If you answered "no" please explain:

Have you encountered any issues related to this project? ☒ **Yes** ☐ **No**
If you answered "yes" please explain:

We had difficulty accessing software from companies including AgLeader, Topcorn, Yara, Pioneer, and Monsanto. We are hoping that as the project gains traction within the ag community we will have leverage bring the companies to the table. We would be able to run model based N recommendation systems ex post facto.
I tried to purchase OptRX sensor (AgLeader) using my startup package but it was more expensive than I thought. The rest of objectives are achievable as planned.

Have you reached any conclusions related to this project that you would like to highlight? ☐ **Yes** ☐ **No**
If you answered "yes" please explain:

Heavy rainfall in the spring caused a delay in planting corn in Illinois. The sites we chose for this project are large scale and thus, finding them was an issue. When we flagged the Carbondale site (ARC) it was under water and stayed that way until June making it difficult to soil sample and spray herbicides. We planted plots June 12th and 13th at BRC and ARC, respectively. The ARC site was sprayed later due to wet soil conditions. The site in Belleville (BRC) was better drained and allowed us to soil sample on time and apply herbicide right after planting. Overall, the yields obtained at ARC site was not useful due to waterlogged issues and issues with spraying due to standing water. The third site, located in Logan County Kentucky, was planted and sidedressed on time due to drier conditions in that area.

Have you completed any outreach activities related this project? Or do you have any activities planned? ☒ **Yes** ☐ **No**

If you answered "yes" please explain and provide details for any upcoming outreach:

We have presented our trial in many outreach meetings including the latest NREC Investment Insight Live in Champaign IL.

Outreach (Extension Talks):

February 13, 2020. IL NREC Investment Insight Live. Champaign, IL.
February 7, 2020. KY-TN Grain Day. Russellville, KY.
January 29, 2020 Kentucky Ag Expo. Owensboro, KY
December 5, 2020. Illinois Ag Masters CCA. Springfield, IL
December 3, 2020. Kentucky-Indiana Kentuckiana CCA School. French Lick, IN.
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Project Summary

Variable rate nitrogen management in corn presents growers with the opportunity to increase profit margin and nitrogen use efficiency, while decreasing environmental nitrogen losses. Currently, Illinois farmers do not have access to a regionally specific sensor-based algorithm for variable rate nitrogen management used with tools like GreenSeeker™ sensors. This project seeks to generate an algorithm for Illinois farmers, as well as provide them with improved conventional nitrogen recommendations. In addition, we will evaluate the precision and accuracy of existing commercially and publicly available nitrogen recommendation systems to help farmers make informed decisions regarding nitrogen management. Overall this project supports the goals of the Illinois Nutrient Reduction Loss Strategy.

Table 1. Early season, sidedress, and total season N rates at Logan County Site.

	At planting nitrogen rate			
	----------lb-N/a----------			
	18.5	37.0	55.5	74.0
V8 Trt No	Sidedress nitrogen rate			
	----------lb-N/a----------			
1	42	42	42	42
2	68	68	68	68
3	95	95	95	95
4	121	121	121	121
5	148	148	148	148
6	174	174	174	174
7	201	201	201	201
8	227	227	227	227
9	254	254	254	254
V8 Trt No	Total final rate			
	----------lb-N/a----------			
1	60	79	97	116
2	87	105	124	142
3	113	132	150	169
4	140	158	177	195
5	166	185	203	222
6	193	211	230	248
7	219	238	256	275
8	246	264	283	301
9	272	291	309	328

Table 2. Early season, sidedress, and total season N rates at BRC Site. Each plot contained two subplots, one with the assigned sidedress rate and one without any sidedress.

	At planting nitrogen rate			
	----------lb-N/a----------			
	0.0	18.5	37.0	74.0
V8 Trt No	Sidedress nitrogen rate			
	----------lb-N/a----------			
1	43	43	43	43
2	75	75	75	75
3	106	106	106	106
4	138	138	138	138
5	169	169	169	169
6	200	200	200	200
7	232	232	232	232
8	263	263	263	263
V8 Trt No	Total final rate			
	----------lb-N/a----------			
1	43	62	80	117
2	75	93	112	149
3	106	125	143	180
4	138	156	175	212
5	169	188	206	243
6	200	219	237	274
7	232	250	269	306
8	263	282	300	337

In spring 2019, we established N rate trials at three sites, two in Illinois (Carbondale, ARC; Belleville, BRC) and one in cooperation with a local farmer in Logan County, Kentucky (Figure 1). Two of the sites (ARC and BRC) included upfront rates ranging from 0 to 314 lbs /acre of N. Inclusion of high N rates at ARC and BRC offers us the opportunity to compare upfront-only to split applied N while developing a sensor-based algorithm. The upfront rates at the Logan County site only went up to 74 lbs/acre and were designed to evaluate split-applied N. This study uses a unique experimental design that includes check plots nested as subplots within each main plot (Figure 2). Table 1 shows the assigned starter (four) and sidedress (nine) rates for the Logan County site, which resulted in 36 final N rates. Each plot contained four subplots with a factorial combination of the assigned starter and sidedress rates. Resulting in subplots with starter + sidedress, starter without sidedress, sidedress

Table 3. The ARC site included high early season nitrogen plots. Each plot received a high at planting rate. Each of these plots was split in two and the subplots received either no sidedress or 263 lb/a nitrogen at sidedress.

High at planting nitrogen rate				
----------lb-N/a----------				
111	167	204	259	315
Sidedress nitrogen rate				
263/0	263/0	263/0	263/0	263/0
Total final rate				
----------lb-N/a----------				
374/111	430/167	467/204	522/259	578/315

without starter, and no sidedress or starter. This arrangement resulted in each block of plots in Logan County having 144 subplots. The ARC and BRC sites were designed to compare early season only to split-applied nitrogen. Space was limited at BRC so each main plot only had two split plots, one with the assigned sidedress rate and one without sidedress. Table 2 shows the lower early season rates used at BRC, each of which was included in a crossed factorial with eight sidedress rates, resulting in 32 split-applied N plots. Table 3 shows the five high early season N rates, each of which had sidedress split plots receiving either 263 lb/acre N or no sidedress. The ARC site was set up similarly to the BRC site, except due to more space it included nine sidedress rates divided equally from 43 to 263 lb/a N instead.

In addition to the three NREC-funded sites, data from two other trials with slightly different experimental designs will be used in sensor-based algorithm development and verification. The two additional trials included one at BRC with upfront application of six rates ranging from 0 to 250 lbs/acre N and one at ARC with ten treatments including upfront-only, sidedressed only, and split-applied N, with and without cover crop wheat preceding the corn. The cover crop N rate trial includes a wheat cover crop terminated early, late, and a no cover crop. There were ten N treatments included for each cover crop treatment, six N rates at sidedress, three upfront-only N rates, and one split-applied treatment with 50 lbs/acre N as starter plus 150 lbs/acre N sidedressed (Figure 3).

Figure 1. Corn shortly after emergence at precision N trials at BRC (left) and Logan County (middle) sites and sidedressing the site at Logan County site (right) in 2019.

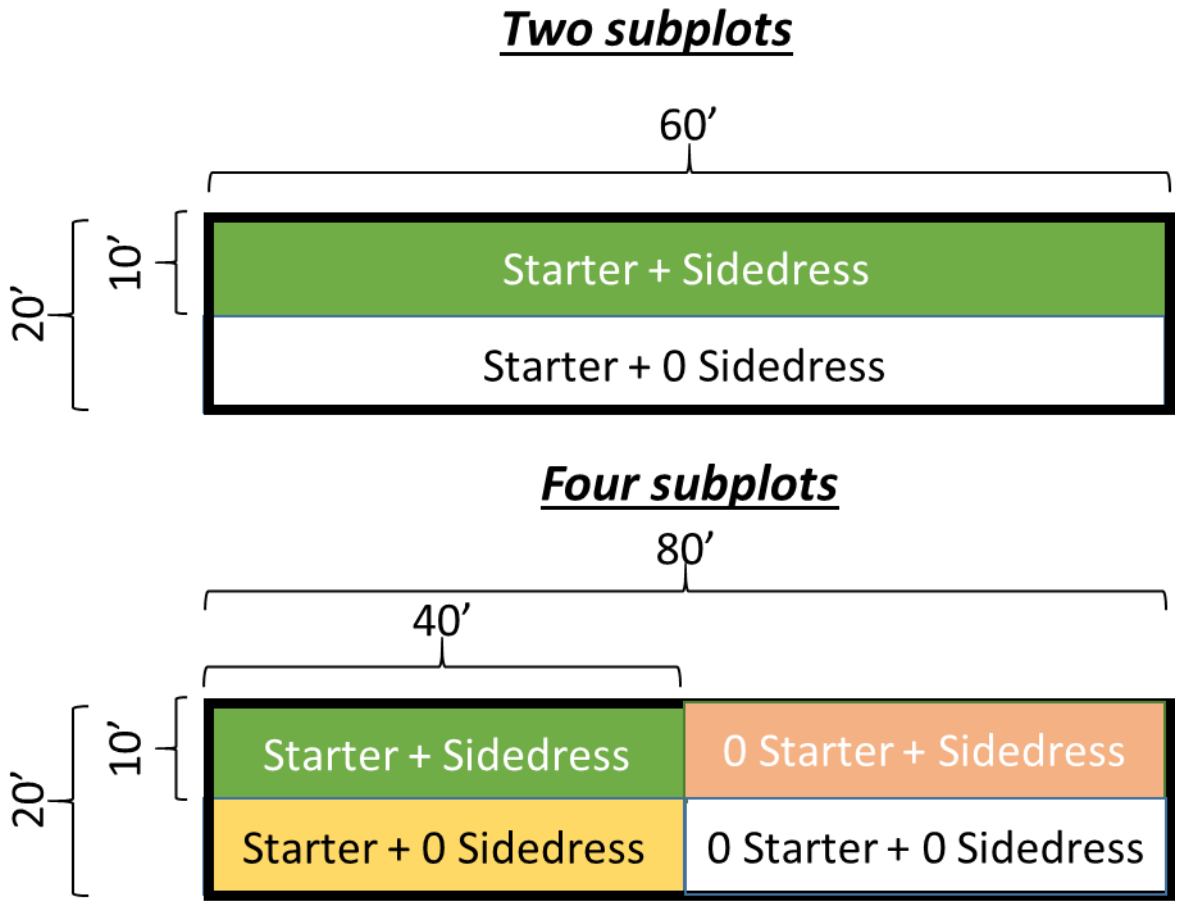
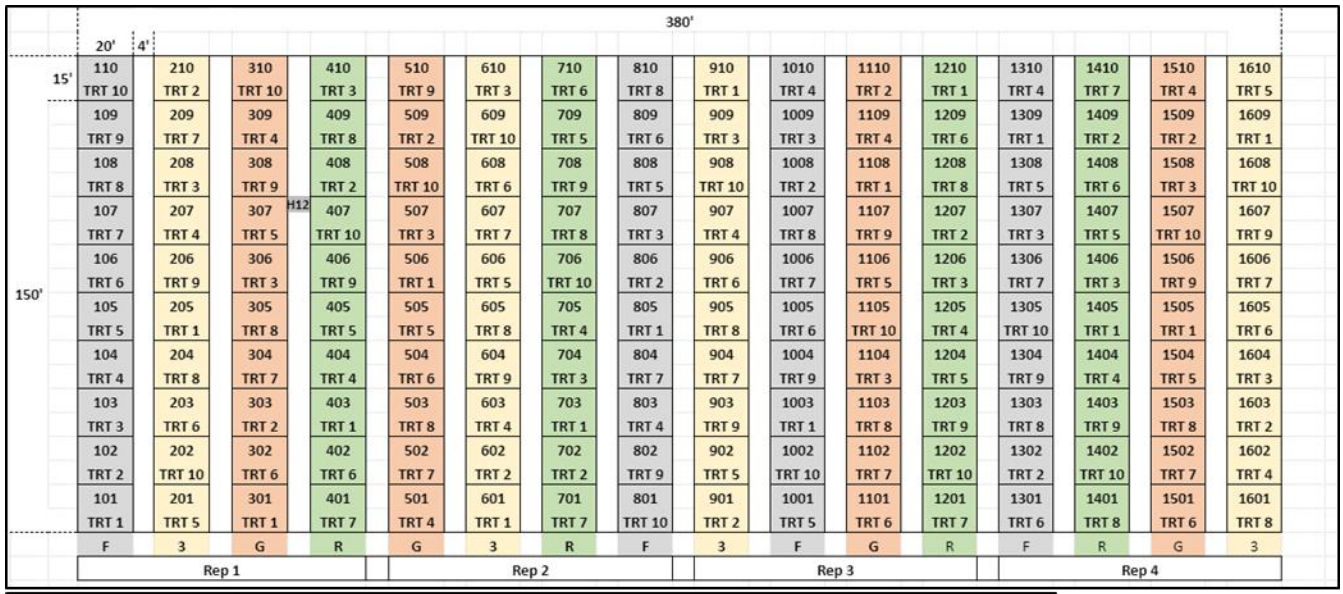


Figure 2. The ARC and BRC sites used the two-subplot design. The Logan County site used the four-subplot design. The factorial treatments were randomly assigned to the subplot location.



Cover Crop Treatment	TRT #	Nitrogen Rate	
		At Plant	Sidedress (V4-V6)
Fallow	TRT 1	0 lbs N/A	0 lbs N/A
Kill 3 Wk before Planting	TRT 2	0 lbs N/A	50 lbs N/acre UAN
Planting Green	TRT 3	0 lbs N/A	100 lbs N/acre UAN
Residue Removal	TRT 4	0 lbs N/A	150 lbs N/acre UAN
	TRT 5	0 lbs N/A	200 lbs N/acre UAN
	TRT 6	0 lbs N/A	250 lbs N/acre UAN
	TRT 7	150 lbs N/acre UAN	0 lbs N/A
	TRT 8	100 lbs N/acre UAN	50 lbs N/acre UAN
	TRT 9	50 lbs N/acre UAN	100 lbs N/acre UAN
	TRT 10	50 lbs N/acre UAN	150 lbs N/acre UAN

Figure 3. Map for 2019 cover crop X N rate trial at ARC.

Preliminary Results

In all trials in IL and KY (with or without cover crops), the economic nitrogen rate ranged from 99 to 330 lbs N/acre and optimum economic yield ranged from 128 to 342 bu/acre indicating huge variability in N requirement for reaching to optimum economic yield within just one year. These data indicate a need to move towards mechanistic N management approaches to improve site-specific N management practices (Figure 4).

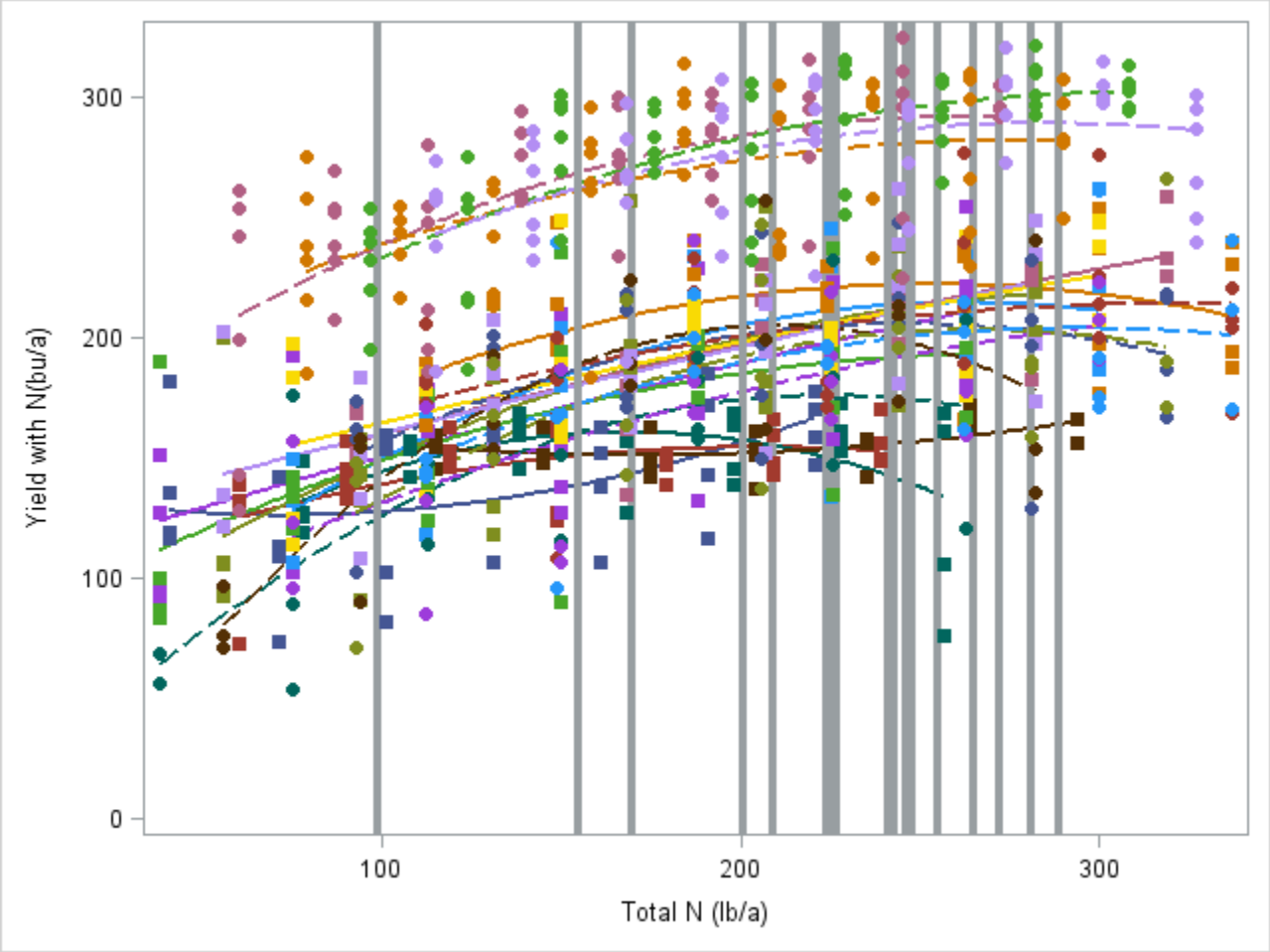


Figure 4. Economic Optimum N rate and optimum corn grain yield in multiple sites in IL and KY with and without cover crops.

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January 9, 2019 ServiTech Professional Development Conference. Kearney, NE

Presentations at Scientific Meetings:

Sadeghpour, A., Weidhuner, A.W. Kumar, P., Singh, G., Lange, R. Cover crop terminate date influences cover crop decomposition rates and corn N requirements in southern Illinois. ASA-CSSA-SSSA Annual Meeting, San Antonio, TX. November 10-13, 2019.

Journal Articles:

Weidhuner, A., R. Keshavarz Afshar, Y. Luo, M. Battaglia, A. Sadeghpour. 2019. Sample grinding size affects nitrogen and carbon estimate of a wheat cover crop. Agronomy Journal (Online First Look). doi: 10.2134/agronj2019.03.0164