2021 Final Report Summary Sheet

Grantee Information

Project Title: Integrating livestock grazing into the western Illinois corn-soybean cropping system to enhance farm profitability and reduce nutrient loss

Institution: Western Illinois University

Primary Investigator: Mark Bernards (co-PI's – Joel Gruver, Graciela Andrango, Roger Viadero, Keela Trennepohl)

NREC Project # 2021-5-734109-84

Is your project on target from an IMPLEMENTATION standpoint? ☒ Yes ☐ No

If you answered "no" please explain:

We are behind our target date for the farmer survey, but will send that out in the first quarter of 2022, pending IRB approval.

Is your project on target from a BUDGET standpoint? ☐ Yes ☒ No

If you answered "no" please explain:

We have not expended as many funds as anticipated. One faculty member did not use his summer salary funds. We were delayed starting the grad student until several months after the grant began.

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:

1) John Nichols, the graduate student who helped initiate the project, had to withdraw from school because of health issues. Dr. Viadero has assigned another student from his lab to lead the water quality collection activities.
2) Heavy deer grazing and a slowness on our part in getting fences built between plots delayed cattle grazing in the spring, and consequently delayed cash crop planting. This had a profoundly negative impact on cash crop yield. We are in the process of having a deer fence built around the farm to protect the research
3) In year one of the study we planted only 2 of the 3 acres of Kernza due to seed shortage. We established the third plot with Kernza seed harvested from the farm in 2021.

Have you reached any conclusions related to this project that you would like to highlight? ☒ Yes ☐ No

If you answered "yes" please explain:

Please see detailed report.

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 held a field day on September 17, 2021. It was attended by approximately 20 individuals. Each PI presented the work they are conducting on their portion of the project. We intend to have a much larger field day in August/September 2022. We will also work in Spring 2022 to develop a website that would allow the public to track the activities of the project.

Please write a detailed summary report that includes: Details of each objective and the progress made towards its competition, planned research activities for 2022, major accomplishments, any preliminary findings or data relevant to the project, relevant budgeting, and any publications or outreach accomplished from the research. Please ***include a one page summary with relevant data tables or graphs and pictures related to the project that you would like included in the NREC end of the year report.***

Experimental management and cropping history

Sixteen experimental plots (120 x 340 feet) were laid out at WIU's Kerr Agronomy Farm in September 2020 (Figure 1). In the center of each plot is a drainage tile lateral buried approximately 4 feet that was installed in June 2017. At the outflow end of each plot is an AgriDrain Inline Water Level Control Structure that was used to access drainage water and collect samples. Drainage tiles (60-foot spacing) are located at the outside edge of each plot. (Water quality samples are not being collected from the border drainage tiles.) The soils in the research plot area are mapped as Rozetta and Keomah silt loams. With the exception of tillage in the Spring of 2018 to level the soil surface where tile lines were laid, the field had been managed using no-tillage farming techniques during the previous 20 years. Baseline soil samples were collected in early December 2020.

(8-1) CS SOY	(8-2) CC CORN f/b Winter cover crop	(8-3) CC RYE f/b Summer cover crop	(8-4) PC KERNZA	(9-1) CC SOY f/b RYE	(9-2) CS CORN	(9-3) CC RYE f/b Summer cover crop	(9-4) PC Triticale Inter-seeded w/ Red Clover	N
(6-1) CC SOY f/b RYE	(6-2) CC CORN f/b Winter cover crop	(6-3) CS SOY	(6-4) CS CORN	(7-1) PC KERNZA	(7-2) CC SOY f/b RYE	(7-3) CC CORN f/b Winter cover crop	(7-4) CS CORN	

Figure 1. Experiment layout and 2021 crop. CS = corn-soybean rotation applying standard management practices, CC = continuous cover (corn-soy-small grain rotation with cover crops planted between corn-soy and small grain-corn), PC = perennial crop cover. Plot 9-4 was planted to Kernza on September 30, 2021.

Two of the three planned Kernza plots were planted in early October 2020. Cereal rye was planted in all cover crop and small grain plots, and triticale was planted in the third Kernza plot, also in early October 2020. Red clover was frost-seeded into the triticale plot in March 2021 so there would be continuous living plant cover after triticale grain harvest. The rye cover crop attracted white-tailed deer feeding throughout the winter, and there was little forage available in mid-April. Corn and soybean in the control treatment were planted May 6, 2021. Semi-permanent fences were built between each plot in early May to facilitate rotational grazing. Approximately 30 cow-calf pairs grazed the cover crop treatments in

high-intensity, short rotation subplots of each main plot during the period of May 20-27. The rye cover crop was at heading at the time of grazing. After cover crop grazing was completed the remaining vegetation was terminated using glyphosate, and corn and soybean were planted June 4 and 5 in the grazed plots. Rye (small grain treatment) and triticale grain were harvested July 14 and a multi-species warm-season cover crop was drilled in immediately after harvest. Kernza was harvested in late August. The red clover and the summer annual cover crops were grazed in mid-September by pregnant cows. Kernza was planted into the third perennial cover plot in late September, and rye cover crops and rye for grain were planted following corn and soybean harvest in late September/early October.

Objective 1 – Measure the influence of high-density, short duration grazing of cover crop mixtures in a corn-soybean system or a perennial grain crop on nutrient loss through subsurface drainage tiles (compared to a typical corn-soybean production system.

Water samples were collected at sixteen drains from March 19, 2021, through October 29, 2021. During the growing season, samples were collected every two weeks for pH, specific conductance, nitrate, and orthophosphate. Water pH averaged 7.04 and ranged from 6.10 to 8.03 across the sixteen wells. There were no statistically significant differences in pH across the sixteen drains. The average specific conductance was 529 uS/cm and ranged from 114 to 1,124 uS/cm across the sixteen drains. Based on the range of the data and the number of observations made (n = 221), there were no statistically significant relationships between specific conductance and other experimental variables.

Average nitrate and orthophosphate concentrations for each replicate experimental treatment are presented in Table 1. The lowest average nitrate concentration was observed for the CC-SMALL GRAIN / SUMMER COVER (cover crop-small grain/ summer cover) treatment. This concentration was 29% lower than the average nitrate concentration for all experimental treatments. It is notable that the average nitrate concentrations of the Kernza treatment and the corn and soybean treatments that did not include a cover crop component were greater than the average. This trend will be monitored in future production seasons.

Table 1. Average nutrient concentrations for each experimental treatment.

Experimental Treatment	**NO_3, mg/L**	**PO_4, mg/L**
CC-CORN F/B RYE+	25.88	1.27
CC-SMALL GRAIN / SUMMER COVER	19.28	1.48
CC-SOY F/B SMALL GRAIN	24.27	1.05
CS-CORN	35.92	1.39
CS-SOY	28.26	1.49
KERNZA	29.24	1.15
Mean	**27.14**	**1.30**

The lowest average orthophosphate concentration was observed for the CC-SOY F/B SMALL GRAIN (cover crop-soy beans followed by small grain) treatment. This concentration was 19% lower than the average orthophosphate concentration for all experimental treatments.

Among the corn treatments, the average nitrate concentration for the treatment that included a cover crop was 28% lower than the treatment that lacked a cover crop. Similarly, the average nitrate concentration for the soybean treatment with a cover crop was 14% lower than the treatment that lacked a cover crop. Similar observations were made when assessing the impacts of a cover crop on average orthophosphate concentrations, where the inclusion of a cover crop yielded a 30% lower concentration for soybean treatments. A 9% reduction in the average orthophosphate concentration was observed when a cover crop was applied to corn treatments. From these preliminary data, the inclusion on a cover crop appears to have a practical impact on reducing nitrate and orthophosphate concentrations. This observation will be monitored and further quantified in subsequent growing seasons.

Objective 2. Document economic costs and benefits of incorporating diverse cover crop mixtures and cattle grazing within a Midwestern corn-soybean system or potential perennial grain system.

We have not yet calculated all costs and returns associated with cropping and grazing in 2021, but will do so in January 2022.

Objective 3. Determine socio-economic factors that may affect producers' adoption of grazing and cover crops in corn-soybean cropping systems.

A preliminary survey was developed and presented at the Field Day in September 2021. Based on feedback from field day participants a revised survey has been developed and will be submitted to Western Illinois University's Institutional Review Board for approval and will be sent to a list of cattle producers in the first quarter of 2022.

Objective 4. Quantify crop and cover crop productivity and soil health parameters for three distinct cropping systems.

Weather conditions were dry on the research farm in the second half of the summer (Figure 2). This, coupled with sub-optimal planting conditions (wet and compacted soil) had a negative effect on the corn and soybean yield when they were planted after the cover crops were terminated (Figure 3). The later-planted soybean plants were also preferred by deer and were grazed more heavily than the early May planted soybeans. The cattle consumed approximately 30% of the available forage and trampled approximately 70% (Figure 4). In 2022 grazing will take place in early May to increase palatability and % consumption. The late summer grazing was successful, although biomass was limited due to little precipitation in July and August. Baseline soil parameters by foot to a depth of three feet are reported in Table 2.

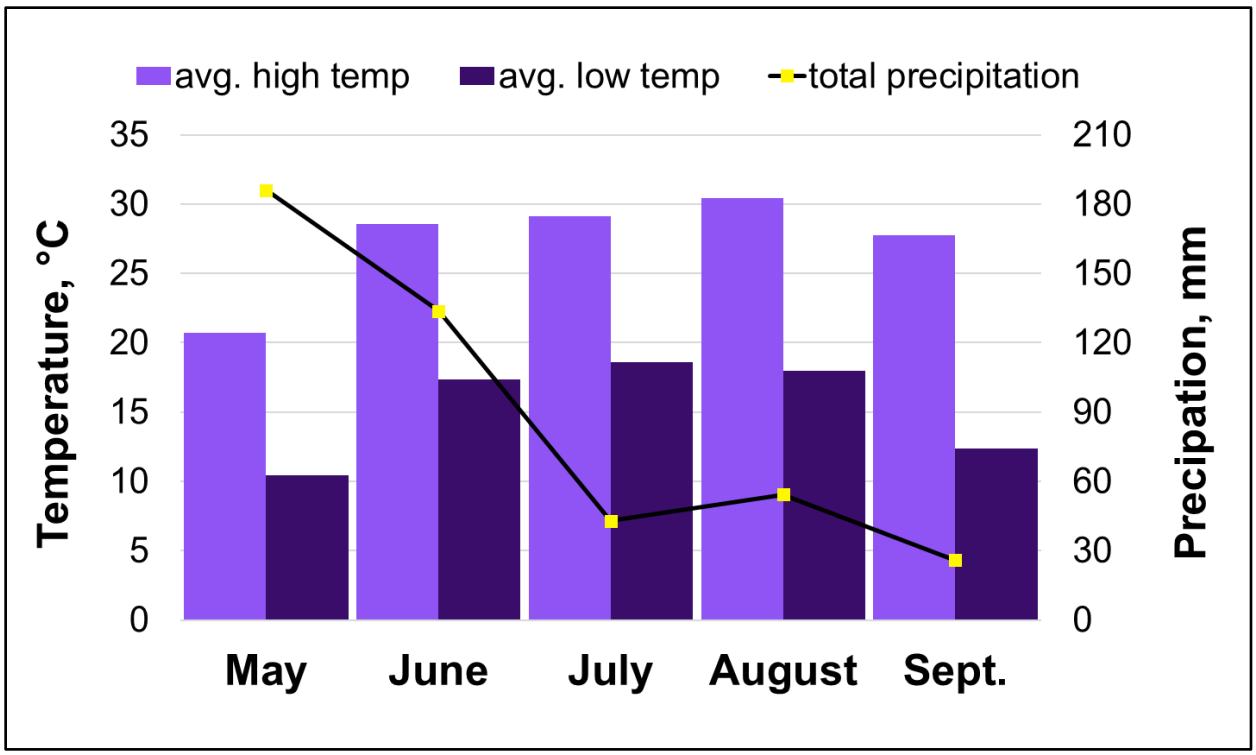

Figure 2. Average daily minimum and maximum temperatures and total rainfall for May-September 2021.

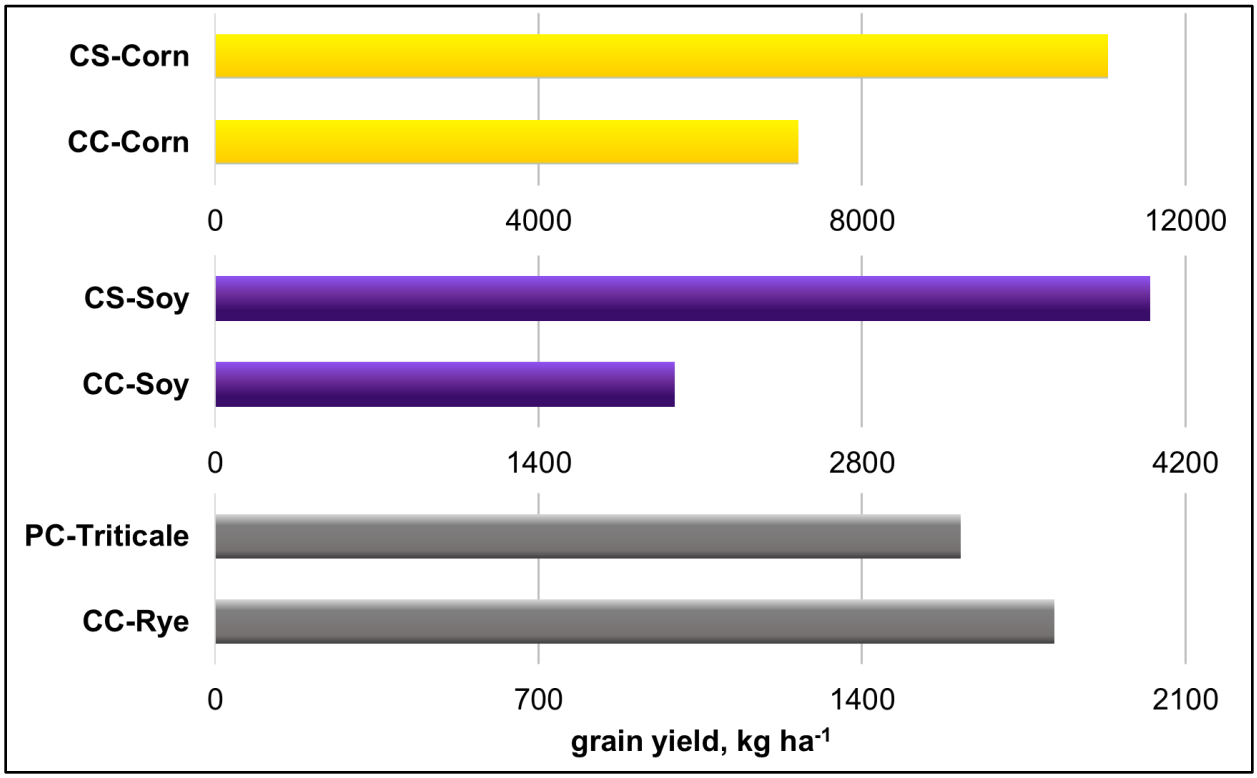

Figure 3. Grain yield as affected by cropping system. PC-Triticale was inter-seeded with red clover which was grazed in the fall.

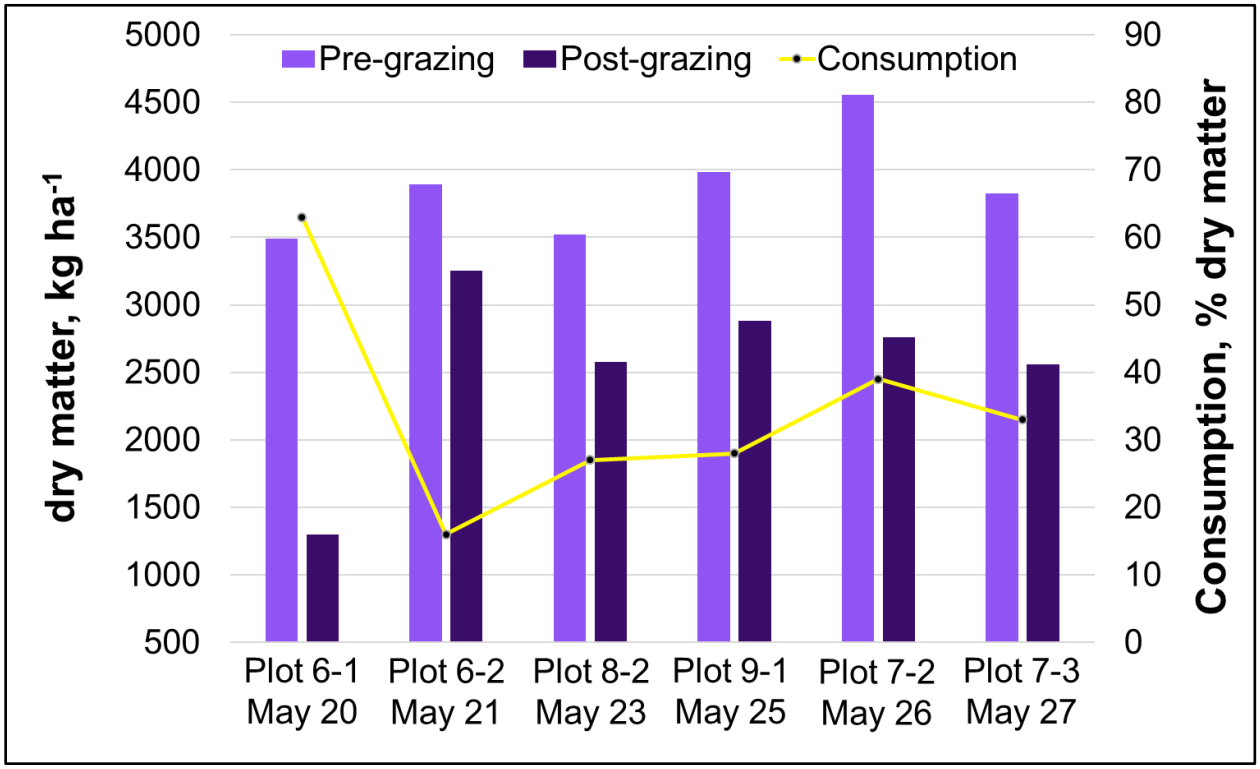

Figure 4. Dry matter of cereal rye cover crop before and after grazing by cattle, and percent of dry matter consumed.

Table 2. Soil test results from deep core baseline samples collected in December 2020.

Rotation	Depth	OM	P1	K	Mg	Ca	pH	CEC
	--cm--	%	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}		meq 100 g^{-1}
CC	0-30	1.8	21	125	269	2362	7.0	15
	30-60	1.2	15	179	681	2534	5.7	25
	60-90	1.0	17	200	1006	2614	5.6	30
CS	0-12"	1.5	22	130	188	2078	7.0	12
	12-24"	1.2	12	165	623	2554	5.9	23
	24-36"	1.1	13	174	968	2548	5.8	27
PC	0-12"	2.0	23	110	248	2692	7.2	16
	12-24"	0.9	12	147	646	2626	6.2	22
	24-36"	1.1	15	177	968	2665	5.8	28