Enhancing Profitability of Soybean Production and Soil Health through Livestock Integration

Objectives/Summary:

The objective of this study is to enhance the profitability of soybean production and soil health through livestock integration. The focus of this project is on winter rye cover crop management practices involving dual season (fall and spring) grazing. Soil health (physical, chemical, and biological properties), soybean production, livestock production, and economic effects will all be evaluated

Project Update

Completed Work:

On July 1, 2022 a masters level graduate student, Josh Wianecki started a graduate research assistantship associated with this research project. Josh received his B.S. in Animal Science with a Crop & Soil Science Minor, making him a great fit for this integrated project.

In August research plots were established at the two research locations at the Central Grasslands Research Extension Center (CGREC) near Streeter and the Carrington Research Extension Center (CREC). Treatments include 1) dual grazing (fall and spring grazing) winter rye, 2) spring grazing winter rye, 3) non-grazed winter rye, and 4) no rye. Each treatment was replicated three times at both location for a total of six replications. Streeter and Carrington locations were both seeded on September 8, 2022. Seeding took place later than planned due to delayed harvest of the proceeding cash crop. Following seeding baseline soil samples were collected for each treatment at both locations.

Soil chemical property samples were collected at 0-6 inch and 6–12 inch depths using a 15-inch step probe. Each depth was sampled at 4 different locations within the plot before being combined and a subsample collected. The samples were stored on ice and sent to Agvise laboratories in Northwood, ND. Soil chemical property tests include soil total carbon (C), total organic carbon (SOC), soil inorganic carbon (SIC), carbon:nitrogen ratio, pH, phosphorous (P) Olsen test, potassium (K), nitrogen, carbonates by pressure calcimeter, and organic matter (OM) by loss on ignition.

Soil physical properties are evaluated via bulk density, soil aggregate stability and water infiltration. Bulk density was sampled with a soil core sampler with hammer attachment at depths of 0-3cm and 5-8cm. Each depth was collected at 4 different locations within the plot. The soil samples are then dried, and bulk density is calculated from the volume of the cylinder. Soil aggregate stability was collected at a depth of 6 inches with a tiling spade and sent to Agvise laboratories. Water infiltration rate was measured via Cornel sprinkle infiltrometer.

Soil biological properties were sampled via a 15-inch step probe at 6-inch depth and frozen. These samples will be processed for arbuscular mycorrhizal fungi (AMF) hyphal length via microscopy and microbial biomass carbon (MBC) via chloroform fumigation.

Prior to grazing forage biomass was determined by clipping three $0.25m^2$ frames in each plot and carrying capacity was estimated. Samples were dried and weighed to determine dry matter

content and forage biomass. Following the fall grazing period, forage utilization was determined by clipping three 0.25 m^2 frames of the fall + spring and no graze plots after the grazing period of the respective location. Samples were dried and weighed to determine forage biomass. Utilization was determined by dividing the grazed plot biomass by ungrazed plot biomass. Forage nutrient analysis samples were taken from the dried pre-graze samples and submitted for analysis of neutral detergent fiber (NDF), acid detergent fiber (ADF), net energy (NE), and in vitro dry matter digestibility (IVDMD).

Cattle performance was evaluated by 2-day weights taken before and after grazing. Streeter turned out 4 head of bred heifers averaging 987 pounds per fall treatment for 5 days and Carrington turned out 5 head of bred heifers averaging 1,195 pounds per fall graze treatment for 3 days.

Preliminary Results:

Almost immediately following winter rye seeding at Streeter and Carrington both locations experienced abnormally dry conditions which extended into a moderate drought. These conditions likely delayed germination and lowered stand biomass production. Rye stands in Carrington were inconsistent but generally yielded higher compared to the stands in Streeter. Soil type and field management variation between location and may influence forage production as well. Forage utilization followed a similar trend between locations, with Streeter having lower utilization than Carrington. This is likely due to the amount of residue remaining from the previous crop at the Streeter location, which provided additional forage for grazing animals and increased the grazing period. Due to low biomass production both locations had short grazing periods of five days in Streeter and three days in Carrington.

Location	Treatment	Forage Production (lbs/ac)	Estimated Carrying Capacity (AUMs)	Grazing Utilization	Days Grazed	Average Animal Gain (lbs)
Streeter	Fall + Spring	156.1	0.34	0%	5	-13.75
Streeter	Spring	119.0		-	0	-
Streeter	No Graze	100.8		-	0	-
Carrington	Fall + Spring	197.9	0.32	46.7%	3	-14.12
Carrington	Spring	259.5		-	0	-
Carrington	No Graze	208.47		-	0	-

Table 1. Forage production (lbs/ac), carrying capacity, grazing utilization, treatment period (days grazed) and animal gain in fall 2022

As a result of the shortened grazing period, animal performance was only measured in gains because a longer period of time is needed to observe change in backfat. Heifers grazing at both locations lost weight over the grazing period with heifers losing an average of 13.75 pounds at Streeter and 14.2 pounds at Carrington.

Baseline soil samples are pending results from Agvise for aggregate stability and soil chemical properties. Forage nutrient analysis, soil MBC, AMF hyphal length, bulk density and water infiltration are also pending results.

Work to be Completed:

In the spring, estimates of field cover will be made in twelve 0.25-m2 quadrats per experimental treatment as a measure of erosion protection. At this time forage samples will also be clipped to determine yield and estimate carrying capacity for the fall + spring and spring grazing treatments. Forage quality will be evaluated for both fall + spring and spring grazing treatments. Grazing cattle will be evaluated for performance based on weight change and visual body condition score.

Following the grazing period soil samples will be collected to determine impacts of the treatments to the soil physical, chemical and biological parameters sampled in the baseline assessment.

Upon completion of the soil sampling soybeans will be seeded. Soybean production will be evaluated through stand counts and yield data during harvest. Weed species and density will be recorded for each plot, as well as any other physiological responses to treatments (such as plant height, maturity, seed quality, or NDVI).

Economic analysis will be conducted to evaluate the cost and/or revenue advantages of the winter rye management practices against a baseline system to determine if these strategies pay off based on livestock and/or soybean production advantages.

The project team is preparing to share results to date at meetings this winter. Project results will be shared with Extension agents at an in-service training this spring, and with farmers and ranchers at summer field days.