Forage Production, Livestock Performance, Soil Nutrients and Cost Comparison for Cover Crops Using a Livestock/Cropping Integrated System

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Summary

The 2020 drought had a dramatic negative impact on cover crop forage production. Due to low production, hay production and the grazing stocking rate were affected negatively, creating a year when both were not economical options, compared with traditional alternatives. However, both grazing use treatments added nitrogen and organic matter to the soil profile after one season of grazing.

This project will be repeated in 2021 to assess a longer-term economic impact as well as assess soil health benefits, physical and chemical. The final year of the study will assess the impacts of integrated grazing cover crops on farmland and its impact on a cash crop in 2022.

Introduction

Cover crops have gained popularity as a practice implemented by producers across the U.S. According to the U.S. Department of Agriculture's Census of Agriculture, 15.4 million acres were planted to cover crops in 2017, up 50% from the 10.3 million acres in 2012 (UDSA 2019; USDA, 2014).

North Dakota is no exception to this trend, with producers incorporating cover crops to improve soil health and increase crop production (USDA, 2019; Conservation Technology Information Center [CTIC], 2017). Despite the ecological benefits of incorporating cover crops into a system, the economic benefits may not be realized if livestock are not incorporated into the system (Costa et al., 2014; Franzluebber and Stuedemann, 2015).

The benefits of integrated crop and livestock systems (ICLS) include enhanced nutrient cycling as well as reduced inputs and livestock feeding costs. Livestock management decisions, such as stocking rates, stock density and utilization, have the potential to impact the environmental and economic sustainability of ICLS.

The majority of research evaluating ICLS has been conducted in regions characterized by humid climates, and little information is available to producers in the northern Great Plains to help make these management decisions. This producer-led demonstration project will aid in the development of best management practices for managing grazing livestock in ICLS to enhance soil health, livestock production, crop production and economic sustainability.

Our study objective is to determine the impact of an ICLS using two years of grazed winter cereal followed by grazed cover crop with two different stocking rates followed by a cash grain crop on soil health, livestock performance and economic return.

Study Area

This study was conducted on the Central Grasslands Research Extension Center (CGREC) in 2020. Experimental plots at the CGREC were on gravelly sandy loam soils (USDA-Natural Resources Conservation Service, 2020). Precipitation was below normal (May and June) prior to seeding the cover crop and below normal while the cover crop grew in July 2020 (Table 1). The average temperature was 3 F cooler than the long-term average in May and above average from June through August (Table 1).

Table 1. Precipitation and average temperature during the study period May through September at the Central Grasslands Research Extension Center near Streeter, N.D., in 2020 (North Dakota Agricultural Weather Network, 2020).

Month	Precipitation (inches)	Percent of Normal	Average Temperature (°F)	Departure from Average (°F)
May	1.81	74	51	-3
June	1.35	39	67	4
July	2.13	67	71	2
August	2.73	118	69	1
September	0.31	15	57	-1
Total	**8.33**	**63**		

Procedures

- Four treatments – grazing at two stocking rates (50% use and 70% use), haying and non-use – were tested on a nine-way cover crop mixture seeded after a winter cereal crop that was grazed from May 11-June 8 (see Winter Cereal Crop article, Sedivec et al.).
- The study design is a randomized block design, with a split plot design imposed on the non-use treatment, creating an even split for the non-use and hayed treatment.
- The nine-way cover crop mixture was seeded on nine 10-acre fields on June 13, 2020, with each treatment replicated three times.
- The nine-way cover crop mixture included forage oats (18 pounds/acre), sorghum sudangrass (3 pounds/acre), German millet (2 pounds/acre), sunflowers (1.5 pounds/acre), forage radish (1 pound/acre), kale (0.75 pound/acre), hybrid turnip (0.75 pound/acre), brown flax (2 pounds/acre) and forage peas (10 pounds/acre).
- We analyzed for significance using a general linear model in SAS (SAS version 9.4; SAS Inst. Inc., Cary, N.C.). Means were separated using the post hoc test Duncan's Multiple Range Test (Duncan, 1955).
- All fields have been in no-till for 14 years or more. No fertilizer was applied and all fields were sprayed with 1 quart of glyphosate + 1 ounce of Sharpen/acre to kill the winter cereal and any volunteer yellow foxtail (*Setaria pumila*) prior to seeding.
- Each field was grazed with yearling pregnant heifers from Aug. 25 through Sept. 22, 2020.
- All fields were clipped using six 0.25 meter^2 frames spread evenly across each field (54 frames total) on Aug. 21, 2020, to determine forage production and stocking rate.
- The stocking rate for the 50% and 75% use treatments was 0.87 heifer per acre. The fields with the 50% degree of use had a higher average forage production at 1,854 pounds/acre versus the 75% degree of use, having an average of 1,380 pounds/acre.
- Livestock performance was determined by collecting two-day weights prior to turnout and after grazing ended.
- The hayed treatment was cut Sept. 24 (103 days after planting, 72 days after germination) and baled Sept. 26, 2020.
- End-of-season residue and degree of use was determined by clipping each grazed field using six 0.25 m^2 frames spread evenly across each field (36 frames total) on Sept. 23, 2020.
- Soils samples were collected: 1) Sept. 6, 2019 – just prior to seeding the winter cereals, 2) May 5, 2020 – prior to cattle grazing the winter cereals, and 3) Nov. 6 – six weeks after the cattle finished grazing the cover crop and pre-soil freezing.

Results

Average forage production for the cover crop mixture prior to implementing the grazing treatments was 1,617 pounds/acre (Figure 1). The degree of use was 38% and 56% on the 50% and 75% degree of use treatments, respectively (Figure 1). We missed our targeted grazing use levels by 24% and 25% on the 50% and 75% degree of use treatments, respectively. Yearling heifer performance was surprisingly high for both treatments. Heifers gained 1.98 and 1.61 pounds/day on the 50% and 75% grazing use treatments, respectively (Figure 2). Both grazing use treatments also improved body condition by at least a 0.4 score.

Hay production averaged 1,430 pounds/acre. Total cost for the cover crop stand was $72.01, with no economic return (Figure 3). If we put the total costs to hay production, the breakeven was $93.52/ton. Because the degree of use treatments were stocked at the same rate (rates were adjusted by field forage production), cost per head was $74.24, or $2.65 per head/day for each treatment (Figure 3).

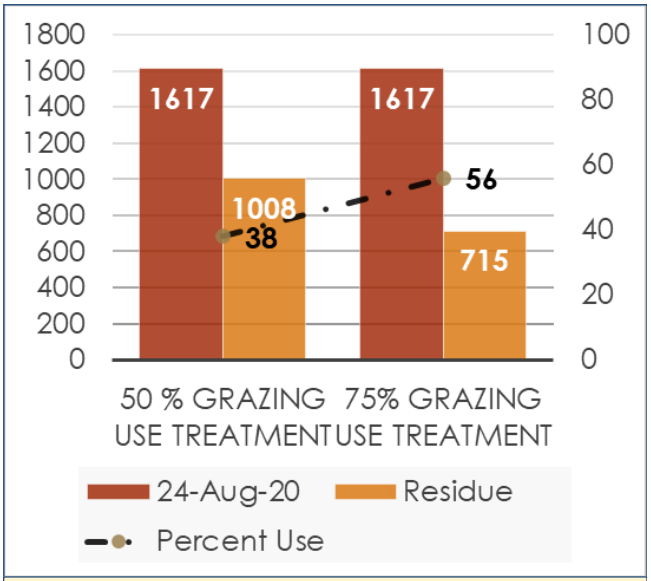


Figure 1. Forage production (lb/ac), residue after grazing (lb/ac) and degree of use (percent) by cover crop grazing treatment at Central Grasslands Research Extension Center near Streeter, N.D., in 2020.

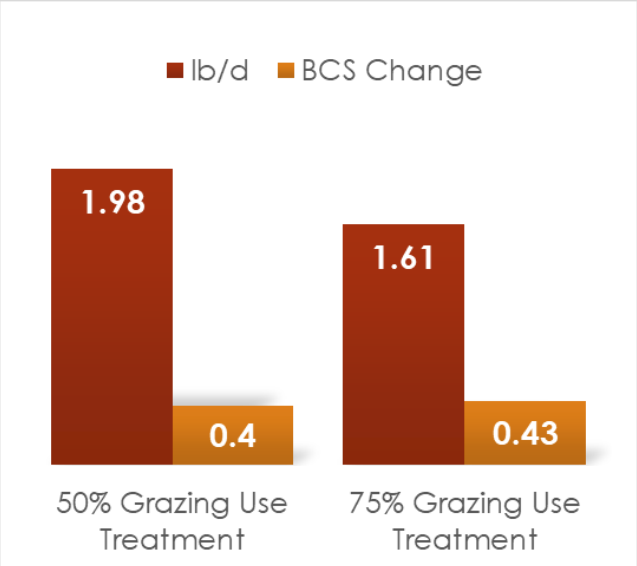


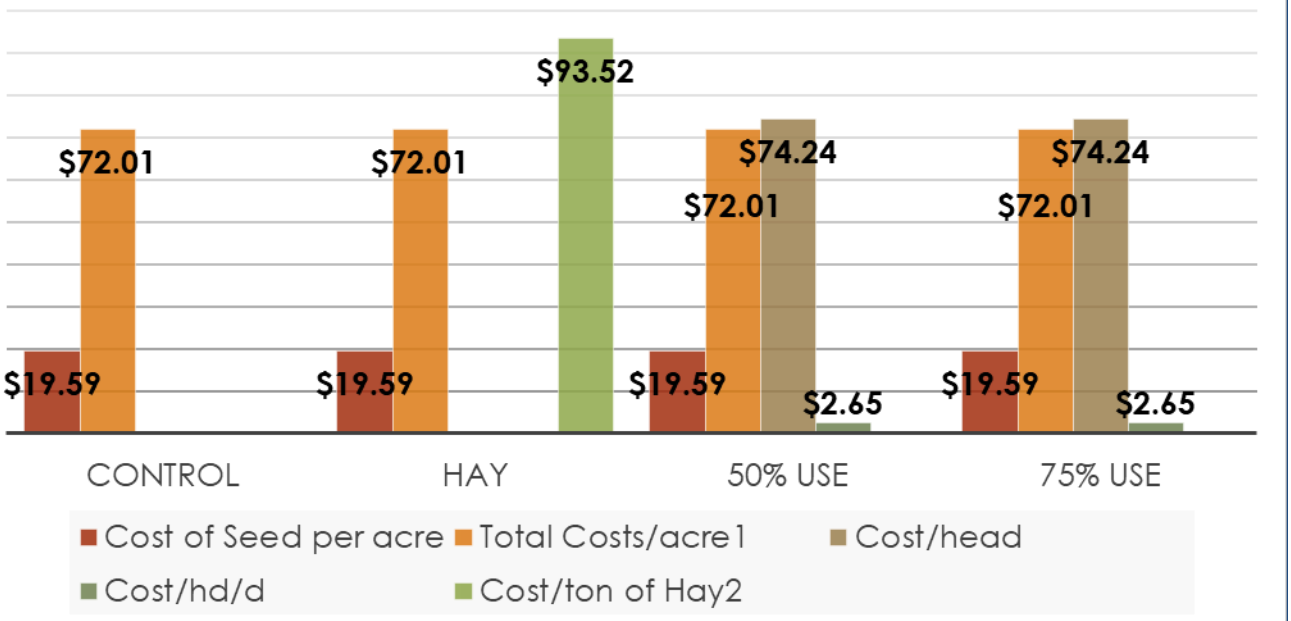
Figure 2. Yearling heifer performance and change in body condition score (BCS) by degree of grazing use treatment (28-day grazing period) at Central Grasslands Research Extension Center near Streeter, N.D., in 2020.

Although neither hay nor livestock production were economical, based on the value of the hay (about $50/ton; AllHay.com) or cost to dry lot feed a heifer ($2.05/day; Lardy, 2018), they did provide an income versus planting a cover crop without use.

Potassium increased on all treatments from an average 126 parts per million (ppm) to 229 ppm from Sept. 6, 2019, to Nov. 6, 2020. Phosphorus also increased on all treatments from Sept. 6, 2019, (treatment averages were 9 ppm) through May 5, 2020 (treatment averages were 32 ppm); however, phosphorus declined on all treatments except the 50% degree of use treatment by Nov. 6, 2020 (treatment averages were 25 ppm).

Nitrogen declined on all treatments from Sept. 6, 2019, through May 5, 2020 (Figure 4). However, nitrogen increased on both grazing treatments from May 5, 2020, through Nov. 6, 2020, while decreasing on the non-use and hayed treatments (Figure 4).

Organic matter increased on all treatments except the hayed treatments throughout the study period (Figure 5). Organic matter on the hayed treatment was the same (2.9%) on Sept. 6, 2019, and Nov. 6, 2020.



[1] Total costs per acre includes custom no-till seeding rate ($17.80/acre), custom herbicide application ($6.57/acre), actual cost of herbicide (glyphosate + Sharpen; $5.60/acre), land rent ($22.45/acre) and seed cost ($19.59/acre; USDA, National Agricultural Statistics Service.
2020). Land rental rate would be $44.90/acre. We dedicated 50% of the cost toward the winter cereal, 50% for the second crop (cover crop). Grazing period: Aug. 25-Sept. 22 (28 days).
[2] Cost per ton of hay includes total costs per acre + cost for swathing ($9.66/acre) and baling ($9.47/acre).

Figure 3. Costs of seed per acre, total costs per acre, production cost of hay (tons/acre), production cost per head of cattle and cost to graze a cow per day (head/day) at Central Grasslands Research Extension Center near Streeter, N.D., in 2020.

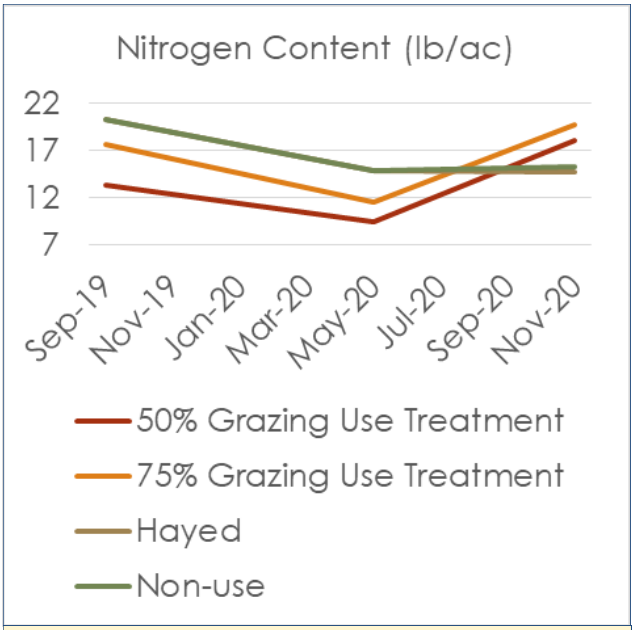


Figure 4. Nitrogen content (pounds/acre) pretreatment in September 2019 through the completion of the cover crop grazing in November 2020 by treatment at Central Grasslands Research Extension Center near Streeter, N.D., in 2020.

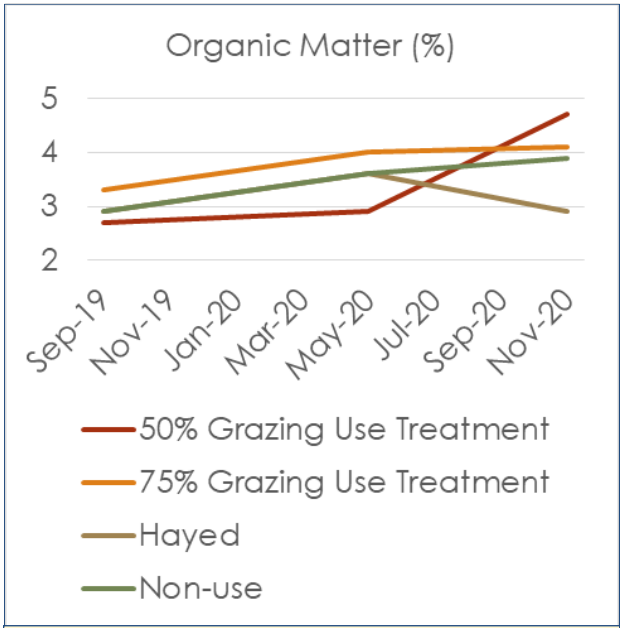


Figure 5. Organic matter (%) pretreatment in September 2019 through the completion of the cover crop grazing in November 2020 by treatment at Central Grasslands Research Extension Center near Streeter, N.D., in 2020.

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