# Utilizing Annual Forages in Single- and Dual-crop Systems for Late Fall and Early Winter Grazing

**E.M. Gaugler[1], K.K. Sedivec[1], B.W. Neville[2] and D.L. Whitted[1]**

[1]School of Natural Resource Sciences, NDSU; [2]CGREC, NDSU

*This study compares a single-crop (annual cocktail forage crop) and a dual-crop (cereal crop/annual cocktail forage crop) system subjected to three grazing treatments. Heifers fed in a dry lot served as a control. Provided that moisture is not a limiting factor, the full-use grazing system using either a single- or dual-cropping system has potential to be cost-effective. Grazing the cover crops provided neutral or positive soil-building characteristics compared with no use.*

## Summary

Annual forages planted in late summer can provide an early winter grazing option to complement rangeland. Cocktail mixtures including crops such as foxtail millet, sorghum-sudangrass, turnips and legumes can provide high-quality forage and serve as cover crops. The selection of species within a mixture offers producers the opportunity to minimize production costs. This study tested three grazing treatments on two cropping systems from 2012 through 2014.

A single-crop (annual cocktail forage crop) and a dual-crop (cereal crop/annual cocktail forage crop) system were subjected to the following treatments: 1) full use, 2) 50 percent degree of disappearance and 3) no use. Beef heifers fed in a dry lot served as a control for animal performance data. Herbage production, livestock performance and soil health were monitored for three years.

On average, cattle performance was poorest on the full-use cocktail forage crop, although all systems provided an increased final body condition score (BCS) and average daily gain (ADG) in all years. Grazing the cover crops provided neutral or positive soil-building characteristics, compared with no use.

## Introduction

Reducing costs associated with production is a common goal among livestock producers. Research has demonstrated that extending the grazing season has the ability to reduce feed costs, thereby lowering the cost of production (D'Souza et al., 1990; Adams et al., 1994). The U.S. Department of Agriculture reported in the 2012 Census of Agriculture that the highest cost experienced by a producer is purchased feed (USDA-NASS, 2014).

Annual forages have demonstrated their ability to provide high-quality feed late into the grazing season (May et al., 2007; McCartney et al., 2009), but a more thorough understanding is needed. The objective of this study was to determine the effects of an annual cocktail forage mix on herbage production, livestock performance and soil health as affected by three grazing strategies.

## Procedures

The study site consisted of nine plots that were approximately 10 acres each. The design was a randomized split-plot design with three replicates. One-half of each plot was dedicated for the annual cocktail forage crop (single-crop system), while the other half (dual-crop system) was planted to the annual cereal crop followed by the annual cocktail forage crop. The main effect was grazing treatment, and cattle fed in a dry lot served as a control. The cropping systems were subjected to the following treatments: 1) full use, 2) 50 percent degree of disappearance and 3) no use.

The annual cereal crop seeded in mid-May of 2012, 2013 and 2014 consisted of barley, oats and field peas, and barley, respectively. In 2012 and 2014, barley was seeded at a rate of 65 and 72 pounds/acre. After seeding, fertilizer was applied to achieve 50 pounds/acre of nitrogen using urea. In 2013, oats and peas were seeded at a rate of 50 pounds/acre for each species.

The annual cocktail forage mix was seeded in mid-July or early August during all years of the study. Seeding rates for the cocktail mix were 15, 10, 4, 1.5, 1 and 0.5 pounds/acre for oats, field peas, sorghum-sudangrass, sunflower, radish and turnip, respectively. In 2014, due to the unavailability of seed, sorghum-sudangrass was replaced by two varieties of foxtail millet (German and Siberian) seeded at a rate of 4 pounds/acre. Clipping for peak biomass production occurred 60 to 80 days after seeding by systematically clipping from a 0.25 meter $(m)^2$ frame placed in each split plot.

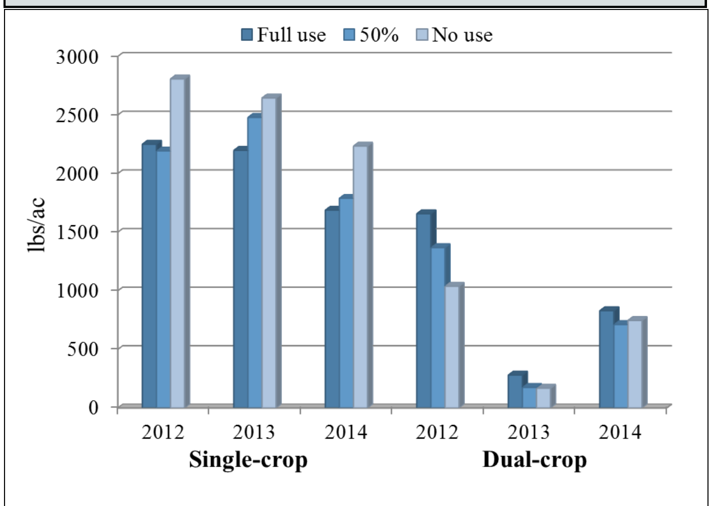
Each year, Angus crossbred beef heifers in midgestation were assigned to graze plots from mid-October to late November or early December. The stocking rate was determined by dividing the available forage by dry matter intake per day, and then dividing by 60 days (the projected grazing period). Heifer performance was determined by two-day body weights and body condition scores at the initiation and completion of the project.

Soil samples were collected to analyze the biological, chemical and physical attributes of the soil. Each year, core samples were taken in late May or early June to analyze soil nutrients and bulk density (Db). Samples were collected at 0 to 24, 0 to 6 and 0 to 6 inches in depth to measure levels of nitrate, phosphorus and potassium, respectively. Db was sampled with a 2.1-inch diameter sampler at 0 to 1.2 and 2 to 3.1 inches in depth. In early August 2012 and 2014, soil samples also were collected to determine aggregate stability. Analysis of aggregates was performed by implementing a Whole Soil Stability Index (Nichols and Torro, 2011).

## Results

*Herbage production.* The average production of the single- and dual-cropping system by treatment during 2012 through 2014 is shown in Figure 1. During all years of the study, production varied but was not different ($P > 0.05$) between grazing treatments. When considering the crop system (single vs. dual), herbage production was different ($P \leq 0.01$) between systems. The single-crop system produced greater amounts of forage compared with the dual-crop system in all three years (Figure 1).

**Figure 1.** Average production (pounds/acre) of treatment in the single- and dual-crop system during 2012 through 2014 at CGREC.




*Livestock performance.* Average daily gain was higher ($P \leq 0.05$) on the dry lot treatment, compared with the full-use grazing treatment in all three years of the study (Table 1). In 2013, ADG was higher ($P \leq 0.05$) on the dry lot, compared with the 50 percent degree of disappearance treatment; however, they were not different ($P > 0.05$) in 2012 and 2014.

*Soil health.* The soil levels of nitrate, phosphorus and potassium measured by treatment during 2012 through 2014 are shown in Table 2. The levels of nitrate indicate that a year effect occurred, but no treatment effect occurred. Measurements of phosphorus indicate no year or treatment effect, and no interactions ($P > 0.05$) between treatments.

**Table 1.** Heifer average daily gain (ADG) and body condition score (BCS) by treatment and year during 2012 through 2014 at CGREC.

| Year | Full use | 50% degree of disappearance | Drylot |
|---|---|---|---|
| **2012** | | | |
| ADG (lb/d) | 2.02a[1] | 2.43ab | 2.90b |
| Initial BCS | 5.4 | 5.3 | 5.2 |
| Final BCS | 5.4 | 5.6 | 5.6 |
| **2013** | | | |
| ADG (lb/d) | 0.70a | 1.30a | 2.80b |
| Initial BCS | 5.3 | 5.3 | 5.2 |
| Final BCS | 5.5 | 5.6 | 5.7 |
| **2014** | | | |
| ADG (lb/d) | 0.48a | 0.82ab | 1.04b |
| Initial BCS | 5.2 | 5.3 | 5.3 |
| Final BCS | 5.3 | 5.6 | 5.5 |

[1]ADG within row followed by same letter are not statistically different at $P > 0.05$.

**Table 2.** Nitrate (NO3-N)[1], phosphorus (P)[2] and potassium (K)[3] levels by treatment and year during 2012 through 2014 at CGREC.

| Year | Full use | 50% degree of disappearance | No use |
|---|---|---|---|
| | | **$NO^3$-N (lb/ac)** | |
| **2012** | 97 | 81 | 82 |
| **2013** | 243 | 148 | 176 |
| **2014** | 79 | 65 | 58 |
| | | **P (ppm)** | |
| **2012** | 19 | 6 | 134 |
| **2013** | 23 | 13 | 236 |
| **2014** | 19 | 29 | 140 |
| | | **K (ppm)** | |
| **2012** | 359 | 134 | 207 |
| **2013** | 314 | 236 | 220 |
| **2014** | 586 | 140 | 203 |

[1,2,3] $NO^3$-N, P, K sampled at 0-24, 0-6 and 0-6 inches in depth, respectively.

Unlike the no-use and 50 percent degree of disappearance treatment, potassium levels increased ($P \leq 0.05$) in the full-use grazing treatment through time. When considering the cropping system, the dual-crop displays a treatment x year interaction for potassium.

Treatments did not affect Db, but a trend of decreasing values at 0 to 1.2 and 2 to 3.1 inches persisted through time in both cropping systems (Table 3). In 2013, the dual-crop had lower ($P \leq 0.05$) levels of Db than the single-crop system.

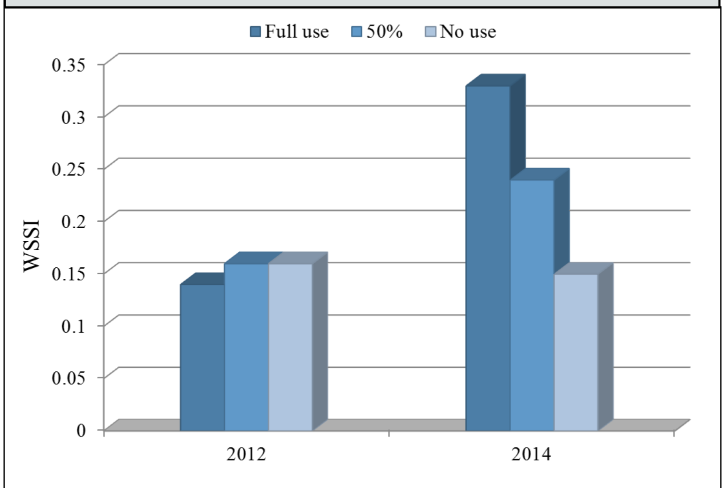
**Table 3.** Soil bulk density (Db) of single and dual-crop systems at CGREC during 2012 through 2014.

| Year | Single-crop | Dual-crop |
|---|---|---|
| **Mean Db (0-1.2" depth)** | | |
| **2012** | 1.32a[1] | 1.34a |
| **2013** | 1.21a | 1.11b |
| **2014** | 1.1a | 1.1a |
| **Mean Db (2-3.1" depth)** | | |
| **2012** | 1.37a | 1.39a |
| **2013** | 1.35a | 1.25b |
| **2014** | 1.35a | 1.33a |

[1]Db within row followed by same letter are not statistically different at $P > 0.05$.

Aggregate stability, sampled in 2012, demonstrated limited variation across treatments (Figure 2). Measurements taken in 2014 indicate an increase ($P = 0.02$) in aggregate stability of the full-use and 50 percent degree of disappearance treatments; however, the measurements showed no change ($P > 0.05$) on the no-use treatment.

**Figure 2.** Whole soil stability index (WSSI) measured by treatment and year at CGREC in 2012 and 2014.




## Discussion

The main objective of this study was to determine the potential of an annual cocktail forage mix to extend the grazing season into late-fall and early winter months. In regard to herbage production, grazing treatments did not have an effect on cropping system. However, herbage production was reduced in the dual-crop, compared with the single-crop system. This loss in herbage production on the dual-cropping system likely was a function of water availability.

When precipitation was limited in July and August, the crops planted in the dual-crop system were stressed and production was low. The most cost-effective treatment was the full-use system (data not shown). In years when moisture is adequate, the dual-crop system may be an option. However, this does not mean that the dual-crop system always will be cost-effective when moisture is adequate.

Other factors such as commodity prices, price of land, cost of fuel and market returns influence the cost effectiveness of a system. In all years, the 50 percent degree of disappearance and no-use treatments were not cost effective (data not shown).

Livestock performance was not affected by grazing treatment during the three years of this study. However, ADG of livestock in the full-use treatment was less than ADG in the dry lot. Livestock performance is an important aspect to consider when managing an operation. Depending on the goals of a producer, emphasis may be on maintaining BCS and/or improving ADG.

If considering a graze vs. no-graze scenario, this study has demonstrated that not grazing a cropping system has no benefits. In fact, both grazing treatments increased aggregate stability from 2012 to 2014. Throughout the duration of this study, Db was not impacted by treatments, but levels did decrease through time. With the exception of potassium, soil nutrients also were not impacted by treatment.

Appropriate management, as well as the goals of a producer, should be considered when determining the potential of a system. This research has demonstrated the potential of an annual cocktail forage crop to extend the grazing season. Provided that moisture is not a limiting factor, the full-use grazing system using a single- and dual-cropping system has potential to be cost-effective.

Implementation of management strategies should consider the desired livestock performance. Consideration of herbage production, livestock performance and soil health will help a producer choose the most appropriate management system.

## Literature Cited

Adams, D.C., R.T. Clark, S.A. Coady, J.B. Lamb and M.K. Nielsen. 1994. Extended grazing systems for improving economic returns from Nebraska Sandhills cow/calf operations. J. Range Manage. 47: 258-263.

D'Souza, G.E., E.W. Marshall, W.B. Bryan and E.C. Prigge. 1990. Economics of extended grazing systems. Am. J. Alternative Agric. 5: 120-125.

May, W.E., L. Klein, G.P. Lafond, J.T. McConnell and S.M. Phelps. 2007. The suitability of cool and warm season annual cereal species for winter grazing in Saskatchewan. Canadian Journal of Plant Science. 87:739-752.

McCartney, D., J. Fraser and A. Ohama. 2009. Potential of warm-season annual forages and brassica crops for grazing: A Canadian Review. Canadian Journal of Animal Science. 89:431-440.

Nichols, K.A., and M. Toro. 2011. A whole soil stability index (WSSI) for evaluating soil aggregation. Soil and Tillage Research. 111:99-104.

USDA-NASS. 2014. 2012 Census of Agriculture. www.agcensus.usda.gov/Publications/. Accessed Dec. 9, 2014.