DAKOTA LAKES RESEARCH ✦ FARM

# Livestock Integration

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## Why Livestock are Integrated at Dakota Lakes

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Livestock play a vital role in harvesting cover crops and perennial forages used in crop rotations. Livestock grazing generates short-term economic returns while forages provide long-term soil benefits. Grazing crops in the field, rather than removing grain and hay, ensures that organic matter and mineral nutrients remain in place and are returned to the soil.

Perennials offer additional advantages. Their deep root systems stay active deeper in the soil and for a longer portion of the growing season compared to annuals. These roots transport nutrients from deeper layers back to the surface, making them accessible to subsequent crops. In areas with high water tables, perennials also help reduce salinity by drawing down excess water and mitigating saline seeps. When cattle graze cropland and consume supplemental feed such as soybean meal and grain, most of the nutrients and organic matter from those inputs remain on the land, contributing to soil fertility.

**Figure 1. May 13, 2024. Targeted grazing in the Shields pasture left little standing vegetation. The quadrat in this photo was used to measure biomass (average 180 lb./ac. across all paddocks) remaining after grazing.**

## September 2024

On April 30, 2024, Dakota Lakes received 60 head of spayed heifers from a local rancher. Average weight was 749 lb. On May 6, the heifers began grazing in the Shields pasture as part of a targeted grazing research project. For the next week, the heifers grazed each paddock until grass was very short (180 lb./ac. standing forage remaining) and then moved to a new paddock each day. They grazed the rest of the Shields pasture until they moved to Raptor Roost (the "new" land purchased by Dakota Lakes at the end of 2023) on May 31. They remained at Raptor Roost while grazing annual forage (a.k.a. "cover") crops until July 8. The forage crops were a mixture of oats, barley, triticale, and pearl millet.

There were two cover crop fields with staggered planting dates so that the fields would not mature at the same time. On June 13, the heifers moved to the second field and remained there until July 2. Due to a rain event during this period, the heifers were temporarily relocated to a grass pasture for five days to minimize damage to field soils. They returned to the first field to graze its regrowth from July 2-8.

The staggered planting date for the forage crops worked relatively well for its intended purpose, which was to delay maturity in the second field. However, growing conditions were better for the first field than the second. Had both fields been planted at the same time, the second field would likely have been more productive but perhaps overly mature when it was grazed.

The first field was 12 inches tall and 1400 lb./ac. when we started grazing. On July 2, when the heifers returned to regraze this field, it was 20 inches tall and had 4400 lb./ac. In the second field, forage height and mass increased from 7 inches and 400 lb./ac. at the start of grazing to 14 inches and 3100 lb./ac. at the end. Both fields lacked ground cover at

**Figure 2. Ready to receive! This photo was taken on Sep. 24, 2024, one day before Dakota Lakes received 151 steers averaging 768 lb. each. Winter wheat had been harvested from this field (North Unit “South” field) on July 18 using a stripper head. Because the previous two crops on this field were wheat, there was abundant soil “armor” provided by wheat straw. Wheat stubble can still be seen standing. The cover crop was a mixture of barley, oats, triticale, and German foxtail millet, planted on August 6. This is a dryland field with heavy clay soils.**

planting and were therefore grazed conservatively so there would be surface residue after grazing.

Across the 35-day period, the 60 head grazed 146 acres of cover crop, resulting in 14.4 animal-days/ac. These yearlings were only 0.84 animal unit equivalents, so it was the equivalent of 12 animal units * day/ac. (not to be confused with “animal-unit-day,” which is 30 lb. of forage).

The cost to produce the cover crop was $149/ac. (Table 1), or $10.32/animal/day. The cost to produce the cover crop was nearly double what Dakota Lakes would typically spend because weeds on this property, which was under Dakota Lakes management for the first time, had not been well controlled in previous years. However, even if the crop had cost half as much, it would not have been profitable without the incentive provided by the NRCS EQIP program. Greater profitability would have required increased forage yield and/or more aggressive grazing, though residue retention remained a primary objective.

**Table 1. Cover crop expenses, $/ac., for four cover crop fields at the Dakota Lakes Research Farm. We did not include the cost of chemicals used to terminate the cover crops. Herbicide application was unusually high for Raptor Roost fields because this land, under management for the first time by Dakota Lakes, had a large weed seedbank.**

| | Field name | | | | |
|---|---|---|---|---|---|
| | **Raptor Roost SE Quarter** | **Raptor Roost SW Quarter** | **North Unit - South** | **0-3** | **2-6** |
| Planting date | Apr. 11 | May 10 | Aug. 6 | Aug. 8 | Aug. 7 |
| Irrigation (kWh only) | none | none | none | 29.40 (5") | 20.58 (3.5") |
| Seed | 28.65 | 25.31 | 20.04 | 34.35 | 34.35 |
| MAP & KCl | 12.07 | 12.07 | | | |
| Fertilizer application | 7.65 | 7.65 | 7.65 | 7.65 | 7.65 |
| Fertilizer UAN + S | 20.10 | 20.10 | | | |
| Fertilizer 28-0-0 | | | 19.19 | 19.19 | 19.19 |
| Seeding | 19.90 | 19.90 | 19.90 | 19.90 | 19.90 |
| Herbicide application | 16.70 (2X) | 25.05 (3X) | 16.70 (2X | 16.70 (2X) | 0 |
| Herbicide | 37.10 | 44.98 | 15.61 | 16.98 | 0 |
| Swathing | none | none | none | 18.10 | 18.10 |
| Total expense | 147.17 | 155.06 | 99.09 | 162.27 | 119.77 |

When the heifers transitioned from rangeland to cover crop, fecal samples were collected and sent to the GANLAB for analysis. The results showed that, on May 31, the heifers were predicted to be gaining 1.5 lb./day on range while consuming a diet of 9.4% crude protein (CP) and 62% digestible organic matter (DOM). Five days later, on the cover crop, they were predicted to gain 2.8 lb./day on a diet that was 19% CP and 73% DOM. Thus, although the range diet was not bad, the annual forage diet at this time of year was much better.

In mid July, the heifers returned to the targeted grazing experiment before being shipped out on August 5. Starting in mid July, they received 2 lb. of flaxseed meal per head per day because of the declining quality of the grass pasture. At the end of the grazing period, the heifers weighed 854 lb., for a gain of 105 lb./hd over 97 days, or 1.1 lb./hd/day, which was considerably shy of the desired 1.5 lb./hd/day. Dakota Lakes was paid $0.00125/lb. liveweight/day, which came out to exactly $1.00/hd/day.

The flaxseed meal fed for the last two weeks was valued at $0.40/hd/day. Other cash expenses were limited to salt and mineral. The NRCS EQIP program paid for the cover crop at Raptor Roost. There was also rental expense for the Shields pasture (72 ac. * $50/ac. = $3,600) which came out to $60/hd or $1.43/hd/day. The pasture was used rather conservatively, and quite a bit of residue was left behind. The economics of this usage was not favorable. For it to be economical, rent would need to be less than $50/ac. if leaving that much residue, or the pasture would need to be grazed more aggressively.

## Pasture Experiments

Phase two of the Shields pasture targeted grazing experiment entered its third year in 2024. On May 8, 2024, grass samples were collected to determine if two years of targeted grazing affected cool season grass production. Samples were collected immediately before the paddocks were grazed. Paddocks that had received early-season targeted grazing (340 lb./ac.) in prior years had less biomass (p=0.07) than those that did not receive targeted grazing (570 lb./ac.). The biomass estimates for both treatments were low because of the early date of sample collection.

Targeted grazing took place May 6 to May 12, when crested wheatgrass was in the 2-3 leaf stage. This was about 10 days earlier than previous years because of the early spring weather in 2024. As in the past, half of the paddocks were grazed very short during this time while the others were deferred.

A second evaluation was conducted June 17–19 by counting reproductive culms (stems) of exotic perennial grasses in areas that received targeted grazing and those that were not yet grazed. Targeted grazing reduced ($p < 0.001$) the number of reproductive culms of exotic perennial grasses from 103 to 28/yd$^2$ but it did not reduce ($p=0.65$) the number of cheatgrass culms (92/yd$^2$; Fig. 1). Furthermore, the three perennial exotics were not affected equally. Targeted grazing reduced ($p=0.02$) Kentucky bluegrass from 36 to 1/yd$^2$ and reduced ($p=0.06$) smooth brome density from 55 to 3/yd$^2$, but the difference between summer-only grazing (75/yd$^2$) and targeted grazing (32/yd$^2$) was not statistically significant for crested wheatgrass.

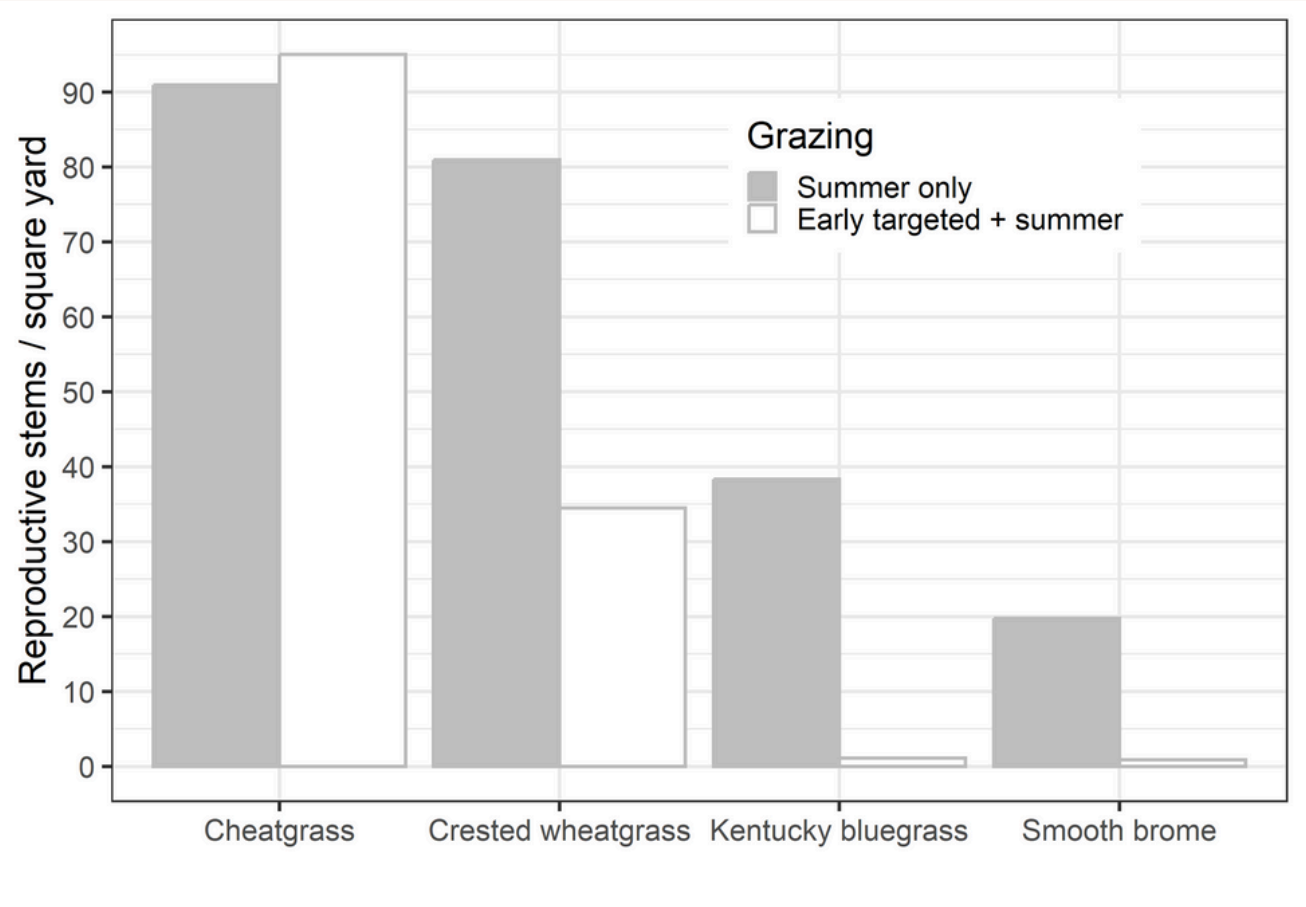



**Figure 3. The number of reproductive culms of dominant exotic grasses in paddocks that received targeted grazing in May for three years, compared with those that did not. All paddocks were grazed in late June or July. There may be slight discrepancies between values in this figure and values presented in the text. Values in the figure include all experimental replicates. Values in the text (those used for statistical analysis) included only those replicates where the exotic grass was present in one of the treatments.**

All paddocks in the targeted grazing experiment were grazed between July 9 and 24 and subsequently rested before a step-point count survey of selected plots was conducted Sep. 4-12. A step-point count survey identifies individual species along a transect. The resulting data can be used to calculate a percentage of “hits” for each species. The date of the sampling meant the cool season grasses, especially cheatgrass, had already experienced some senescence and therefore were underestimated relative to the warm-season grasses.

Results showed that the seeding and spraying done in 2017 still impacted the abundance of seeded warm-season grasses (big bluestem, switchgrass, little bluestem, Indiangrass, and sideoats grama). Plots with both glyphosate and seeding were composed of 14% seeded grasses while those that were seeded but did not receive glyphosate only had 1% seeded grasses. Three years of targeted grazing nearly doubled the frequency of seeded grasses—however, the result was not statistically significant due to high variability in the data. On the other hand,

**Figure 4. The herbicide treatment was effective at controlling cool season grasses. The left side of this photo was treated with herbicide; the right was not. Numerous smooth brome seedheads are visible on the right half.**

targeted grazing significantly increased short-statured warm-season grasses (from 31% to 60%) and forbs (from 3% to 8%) while decreasing exotic cool-season grasses (from 51% to 10%).

A new treatment was introduced to the pasture by re-spraying some plots with herbicide (26 oz Roundup RT3/ac and 12 oz LO-VOL 6/ac) before warm-season grasses had greened up (Figures 4-6). The impact of the herbicide was visually apparent and supported by the step-point-count data. Sprayed areas had greater frequency of seeded warm-season grasses (48% vs. 31%) and lesser frequency of exotic cool season grasses (0% vs. 25%) but spraying did not affect other functional groups.

In 2019, an experiment tested rangeland seeding methods on South Dakota Game, Fish & Parks property. Step-point counts performed in 2024 revealed that broadcasting seed continues to be more effective than broadcasting seed

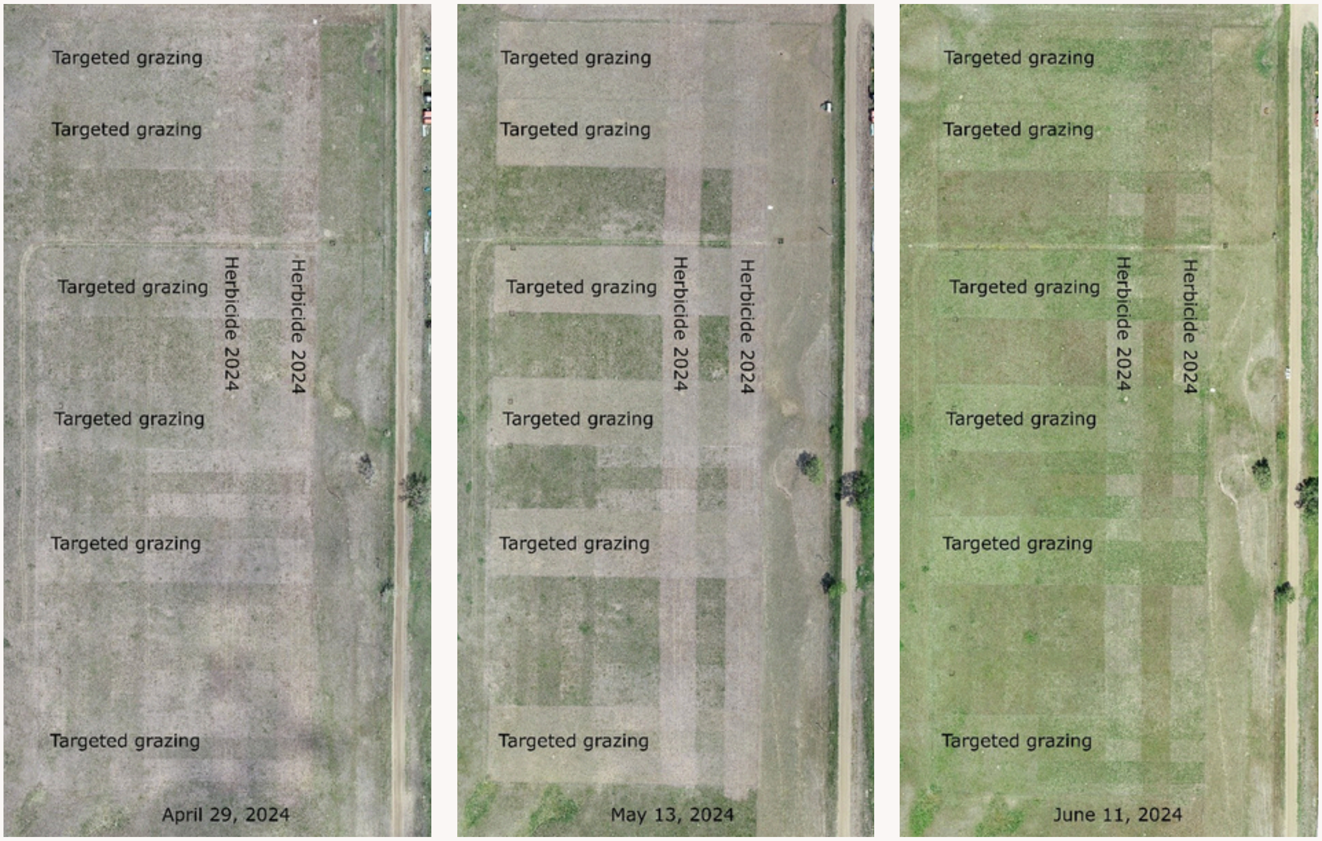



**Figure 5. Sequence of images of the Shields pasture. Herbicide treatments run north-south and grazing treatments run east-west. The May 13 image was taken immediately after targeted grazing ended. At that time, herbicide and targeted grazing treatments appeared similar because both nearly eliminated cool season grass growth. The effect of targeted grazing appears moderated in the June 11 image, because grazed grasses were regrowing but those terminated with herbicide were not.**

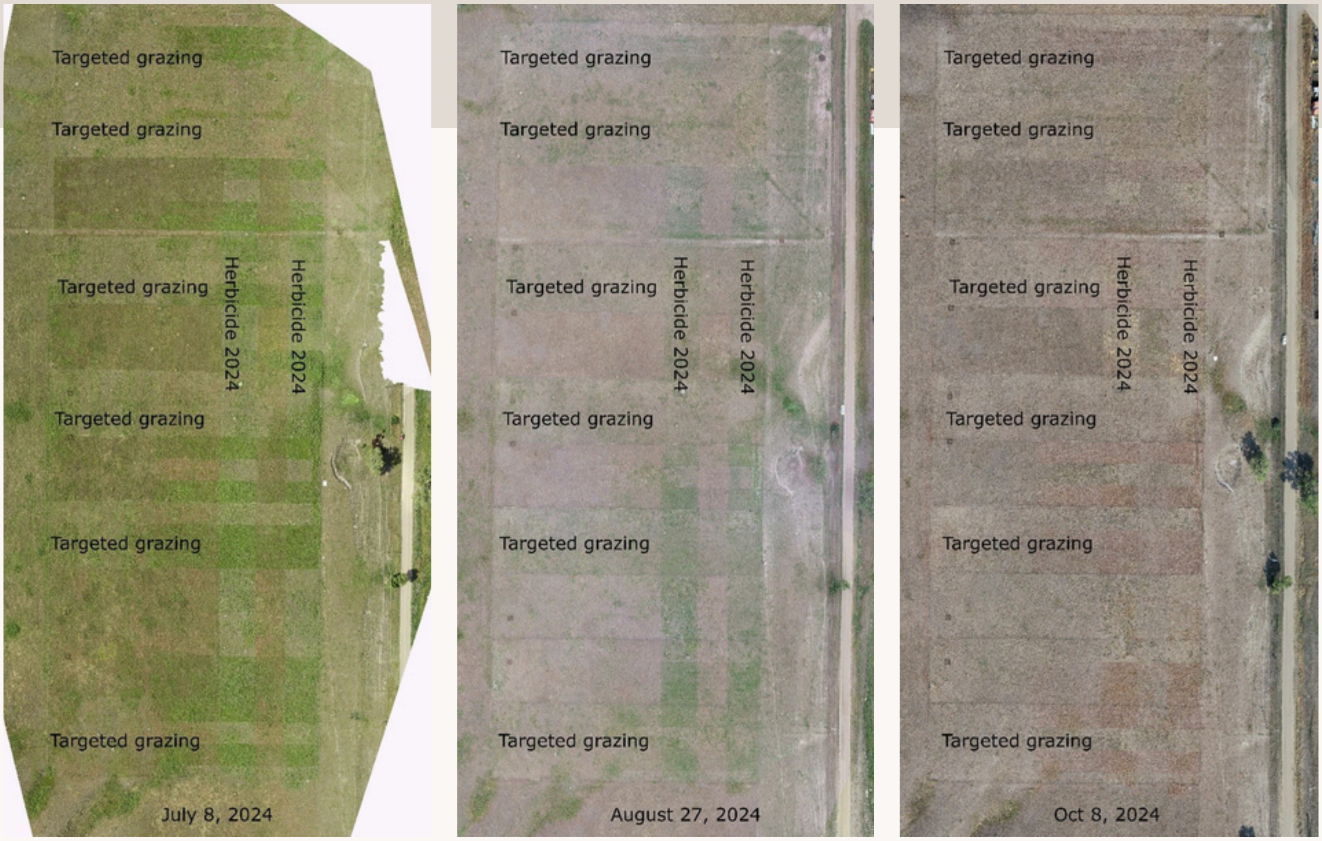
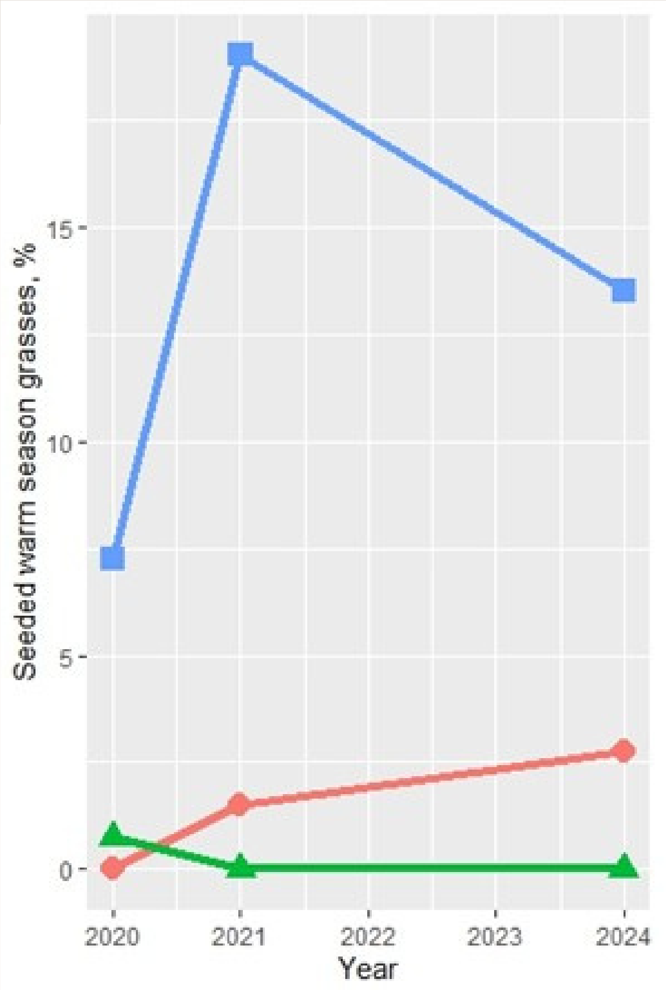


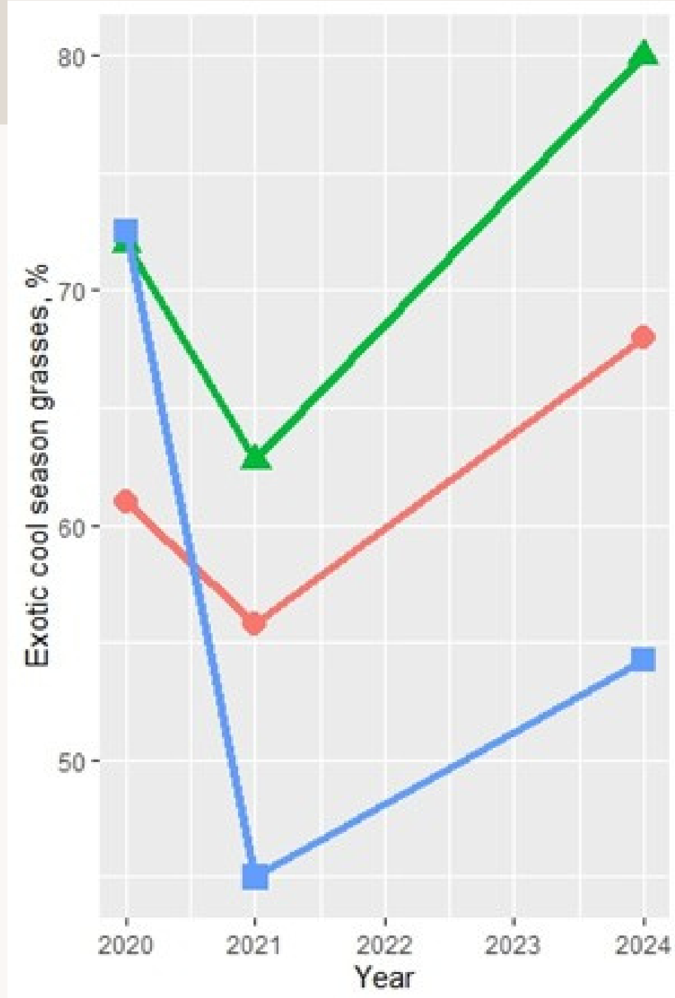

**Figure 6. Sequence of images of the Shields pasture. Herbicide treatments run north-south and grazing treatments run east-west. On July 8, immediately before summer grazing, the effect of targeted grazing still closely resembled the effect of herbicide. By August 27, the appearance of the two treatments had diverged.**

and then rolling a bale over the top of the seed (Figure 7).

At Dakota Lakes' new property, Raptor Roost, step-point-count measurements were conducted on July 16, 2024 to provide baseline vegetative cover data (Figure 8, Table 2). Transect #1 was on the eastern side of the pasture. Much of northern transect #1 passed through a prairie dog town that was sprayed with herbicide in the spring of 2024 and seeded to native grasses. It remained "weedy" at the time of sampling. Transect #2 was in the center of the pasture. It passed through the wetland on the east/northeast side of the dam. Transect 3 remained mostly on the uplands. At its northernmost extent, transect 3 neared the disturbed area that had been a corral. Results of the three transects are shown in the following table (p. 11). Across all transects, blue gramaa (25%) was the most common species, followed by crested wheatgrass (13%), sand dropseed (10%), western wheatgrass (9%), and pigweed (7%). While parts of the pasture contain an abundance of annual weeds or exotic grass, there were also areas dominated by economically valuable species such as sideoats grama and big bluestem.

Plots containing a mix of switchgrass and big bluestem growing on Opal clay soils of Dakota Lake's North Unit were sampled on Sep 27, 2024 to measure biomass production. Four replicates averaged 8400 lb./ac. when cut near ground level. Adjacent rangeland plots dominated by Kentucky bluegrass and western wheatgrass averaged 2500 lb./ac.



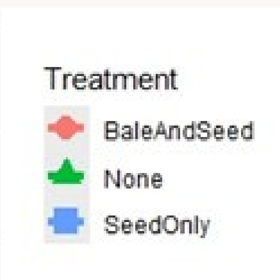




**Figure 7. On the land owned by SD Game, Fish & Parks, treatments that received only broadcast seed continue to have a higher percentage of seeded grasses than plots that had a bale rolled onto them after broadcasting. In 2021, the most common seeded grass was big bluestem. In 2024, big bluestem was surpassed by sideoats grama. This site received early season targeted grazing from 2019-2023 but was not grazed in 2024. Despite the presence of seeded warm-season grasses, cool season exotics remained dominant on the site.**

**Figure 8. The tool used to collect step-point-count data. Photo taken Sep. 29 in the Shields pasture.**

## Table 2. Percentage of each species along three transects in the Raptor Roost pasture at Dakota Lakes

| Transect 1 | | Transect 2 | | Transect 3 | |
|---|---|---|---|---|---|
| **Species** | **Percent** | **Species** | **Percent** | **Species** | **Percent** |
| Blue grama | 30 | Foxtail barley | 15 | Blue grama | 29 |
| Pigweed | 23 | Western wheatgrass | 15 | Crested wheatgrass | 26 |
| Creeping jenny | 8 | Blue grama | 14 | Sand dropseed | 14 |
| Sand dropseed | 8 | Kentucky bluegrass | 11 | Sedge | 7 |
| Western wheatgrass | 7 | Prairie cordgrass | 10 | Western wheatgrass | 7 |
| Forb | 5 | Sideoats grama | 7 | Kentucky bluegrass | 3 |
| Kochia | 5 | Big bluestem | 5 | Purple 3-awn | 3 |
| Pigeongrass | 4 | Cocklebur | 5 | Alfalfa | 2 |
| Witchgrass | 4 | Cheatgrass | 3 | Creeping jenny | 2 |
| Purple 3-awn | 3 | Sand dropseed | 3 | Buffalograss | 1 |
| Lamb’s quarter | 1 | Buffalograss | 2 | Fescue sedge | 1 |
| Sedge | 1 | Green needlegrass | 2 | Giant ragweed | 1 |
| | | Sweetclover | 2 | Green needlegrass | 1 |
| | | Sedge | 2 | Kochia | 1 |
| | | Crested wheatgrass | 1 | Lamb’s quarter | 1 |
| | | Giant ragweed | 1 | Mare’s tail | 1 |
| | | | | Pigweed | 1 |
| | | | | Rush | 1 |
| | | | | Sweetclover | 1 |

# Crop Fields

On June 28, stand counts were performed on Fields 0-7 and 1-7, which had been grazed in the prior year. Each field included long-term exclosures. Grazing did not significantly impact plant density; both fields averaged 13 plants per 10 linear feet.

On June 12, soil samples were collected from Field 1-7, which had been swath-grazed the previous winter. Samples were collected to 36” deep in grazed and non-grazed areas. Depth increments were 0–6”, 6–12”, 12–24”, and 24–36”. Corn was at the V4 stage. Lower iron levels were found in grazed areas (5.5 ppm vs. 6.7 ppm; $p = 0.05$). A small difference in Olsen P was observed at the 24–36” depth (5.3 ppm in grazed vs. 5.8 ppm in non-grazed), but no significant differences appeared above 24”. No other nutrient, pH, or organic matter differences were detected. These findings are consistent with previous years, where minimal soil nutrient differences were observed between grazed and ungrazed treatments.

The 51-acre “North” field, composed of heavy clay soil, was grazed for the first time in fall 2023. On June 14, soil samples were collected to 12” depth inside and

**Figure 9. July 18, 2024. Hay and grain were fed in portable feed bunks on this alfalfa field during the previous winter. Most of the spilled hay had degraded by the time this photo was taken, but where there was a particularly large pile, some remained in July. You can also see a darker green color stretching away towards the upper-right corner of the photo. This marks the location of the portable feed bunks, where the soil was enriched with nitrogen and other nutrients.**

outside grazing exclosures. Soils were divided into 0-6” and 6-12” increments. As with the other field, there were few differences among the many parameters tested, including soil organic matter, carbon, and pH. We did find a difference in sodium concentration between grazed (271 ppm) and non-grazed (344 ppm) at the 6-12” depth but there was no difference at 0-6” (83 ppm).

During the previous winter, alfalfa harvested from field 3-1 was fed in bunks placed on the field (Figure 9). Bunks were moved every few days when feeding. On June 3, immediately before the first alfalfa cutting, alfalfa yield, kochia yield, and the number of alfalfa plants in field 3-1 were measured at three distances (5', 15', and 45') from the bunk locations in both east and west directions. None of the three measurements differed significantly among distances. Mean alfalfa yield in these small plots was 2200 lb./ac and kochia was 210 lb./ac. Mean plant density was 12 alfalfa plants per yard$^2$. Machine-harvested yield for the field was 19 bales for the first cutting and 3 for the second cutting. Assuming a bale weight of 1100 lb., harvested yield was 1740 lb./ac for the first cutting and ~ 2000 lb./ac for the year. Adjusted for moisture, dry matter yields were 1430 and 1654 lb./ac. For comparison, the irrigated field of alfalfa-orchardgrass yielded four cuttings for a total of 7,290 lb./ac on a dry matter basis.

Forage samples were also submitted to Ward Laboratories for analysis. No differences were found among treatments for the following: crude protein (21%), ADF (31%), NDF (37%), NDF digestibility (43%), ash (9%), lignin (7%), ether extract (2.4%), total digestible nutrients (0.65), P (0.26), K (3.2), Ca (1.9), Mg (0.51), Na (0.023), Fe (80),

**Table 3. Concentration of two nutrients in forage tissue, as impacted by feeding on the alfalfa hayfield. Within a column, values followed by the same letter are not different ($p > 0.05$).**

| Distance, ft. | Sulfur, % | Manganese, ppm |
|---|---|---|
| 3 | 0.35 a | 106 a |
| 15 | 0.27 b | 64 b |
| 45 | 0.28 b | 54 b |

Cu (5.5), B (54), or Mo (0.22). However, sulfur and manganese concentrations were higher at 3' from bunk centers than at 15' or 45' (Table 3). Zinc followed a similar pattern but only on the west side of the bunk, (the direction the steers approached the bunk from), and there was more zinc on the west side than the east side (Table 4). All three of these nutrients had positive, statistically significant correlations with

**Table 4. Concentration (ppm) of zinc in forage. Within a column (row), values followed by the same lowercase (uppercase) letter are not different ($p > 0.05$).**

| Distance, ft. | East | West |
|---|---|---|
| 3 | 23 a A | 31 a B |
| 15 | 22 a A | 20 b A |
| 45 | 22 a A | 24 b A |

**Table 5. Soil nutrient concentrations in an alfalfa field (Field 3-1), as affected by distance from the feed bunk. Feed bunks were moved every ~three days during winter. Samples were collected in the following spring. Within a column, numbers followed by the same lowercase letter are not statistically different ($p > 0.05$).**

| Distance from feedbunks | Nitrate N, lb./ac. | Olsen P, ppm P | K, ppm | Na, ppm | B, ppm | Soluble salts, mmho/cm |
|---|---|---|---|---|---|---|
| 3' | 89 a | 14 a | 609 a | 16 a | 0.58 a | 0.36 a |
| 15' | 21 b | 12 ab | 376 b | 8 b | 0.37 b | 0.14 b |
| 45' | 7 b | 11 b | 341 b | 7 b | 0.38 b | 0.13 b |

the percentage of kochia in the sample. That is to say, as the percentage of kochia increased, so did the concentration of these minerals. Thus, the change in overall forage mineral value was probably NOT due to changes in alfalfa, but rather was due to changes in the quantity of kochia in the sample.

On June 4, the day following forage harvest, soil samples were collected from 0-6" in the alfalfa field at the same locations as the vegetation measurements. Anticipated differences in soil properties between the area west of the bunks vs. the area east of the bunks (because the cattle approached the bunks from the west and may have caused more disturbance on the west side) did not materialize. However, areas 3' from bunk centers showed nutrient enrichment in N, Olsen P, K, Na, B, and soluble salts (Table 5). The degree of enrichment varied across nutrients, ranging from an increase of 26% (Olsen P) to over 500% (nitrate N). Distances of 15' and 45' did not differ from one another for any nutrient. Distance did not affect pH, organic matter, S, Ca, Mg, or cations (Table 6).

Despite the measurable increase in economically significant nutrients due to feeding on the alfalfa field, bunk feeding on the alfalfa field was discontinued due to soil surface damage in the winter months, particularly on fields lacking soil armor. A grass-alfalfa mixture might reduce negative impact by increasing ground cover relative to pure alfalfa..

**Table 6. Soil nutrient concentrations in an alfalfa field (Field 3-1). Concentrations of these nutrients were not affected by distance from the feed bunks.**

| pH | Organic matter, % | Sulfate, ppm | Ca, ppm | Mg, ppm | Cations, me/100g |
|---|---|---|---|---|---|
| 6.2 | 4.0 | 68 | 56 | 26 | 16 |

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