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.

September 2025
Water infiltration tests

Single-ring water infiltration tests were conducted to compare different management practices. In each case, a six-inch-diameter metal ring obtained from the NRCS was driven three inches into the ground. Then, one inch of water was poured into the ring and the time required for the water to completely disappear from the surface was recorded. After waiting one minute, a second inch of water was applied and the time was again recorded. If the water had not completely infiltrated after 60 or 90 minutes (depending on the date), the remaining water was measured and an infiltration rate was calculated.

Grazed vs. non-grazed areas of crop fields

From April 8-11, 2025, infiltration was measured inside and outside of grazing exclosures on Dakota Lakes fields 0-7 and 1-7, as well as two nearby grazed fields not owned by Dakota Lakes. In one Dakota Lakes field, grazing had no impact (Table 1). On the second field, there was no difference in the first-inch infiltration rate but grazing slowed infiltration of the second inch to 0.27 in/min, which is still adequate to handle all but the most extreme rainfall events (Figure 1). In comparison, the nearby grazed fields not owned by Dakota Lakes (Figure 2) were much slower (0.01 in/min vs. 0.27+ in/min), probably

Figure 1. The crop residue of this no-till field was grazed but abundant soil armor remains. Infiltration was 0.27 inches/ minute.

Figure 2. The crop residue from this tilled field was grazed, leaving very little soil armor. Infiltration was 0.01 inches/ minute.

Table 1. Within an experiment, values followed by the same lowercase letter are not different. Not all experiments were statistically tested. Each value is the mean of at least three infiltration rings.

Field name	Soil type	Treatment	Rate, 1st inch, in/min.	Rate, 2nd inch, in/min.	Experiment
0-7	Dorna silt loam	Grazed	1.2	0.43 a	A
0-7	Dorna silt loam	Not-grazed	1.1	0.45 a	
1-7	Dorna silt loam	Grazed	1.3	0.27 a	B
1-7	Dorna silt loam	Not-grazed	1.7	0.42 b	
Not DLRF	Ree loam	Tilled, grazed	0.04	0.01 a	C
Not DLRF	Lowry silt loam	Tilled, grazed, former prairie dog town	0.04	0.01 a	
1-2	Lowry silt loam	Dead grass crowns	*	0.23 d	D
1-2	Lowry silt loam	Interspaces	*	0.03 d	
Shields pasture	Lowry silt loam	Tallgrasses	0.13	0.04 a	E
Shields pasture	Lowry silt loam	Exotic grasses	0.11	0.04 a	
Field 2-1 margin	Sully silt loam	Tallgrasses	2.32	0.36 a	F
Not DLRF, pasture south of 2-1 margin	Sully silt loam	Grazed exotics	0.05	0.03 b	
North Unit SE margin	Promise clay	Tallgrasses	4.29	1.35 a	G
Not DLRF; pasture north of North Unit SE	Promise clay	Grazed exotics	0.45	0.05 b	
4-4	Millboro silt loam	Cropland	1.5	0.63 a	H
4-4 margin	Millboro silt loam	Tallgrasses	1.2	0.32 a	
3-1	Dorna silt loam	Cropland	0.22	0.04 a	I
3-1/3-2 margin	Dorna silt loam	Tallgrasses	0.11	0.04 a	
3-2	Dorna silt loam	Cropland	0.1	0.01 a	

*Only one inch (the “second” inch) was applied as this field had recently received irrigation and rainfall.

because they had been tilled and because grazing left very little residue remaining on the surface. This was particularly interesting because one of the fields had been a prairie dog town on grassland until one year before the measurements. Grassland typically has high infiltration rates but, in this case, any infiltration benefit from having been grass appears to have been gone within a year of being tilled. Unfortunately, we do not have measurements from the time when the land was in grass so we do not know what the infiltration rate was before it was tilled.

Terminated grass vs. interspaces

Field 1-2, where alfalfa-orchardgrass grew for four years before it was chemically terminated, was tested on July 11, 2025. In this case, rings were placed on top of the dead grass crowns, which were still easily identifiable, or in the interspaces where alfalfa had presumably grown. We found that infiltration of the second inch was relatively fast (0.13 in/min) but did not statistically differ between treatments.

Native tallgrasses vs. exotic cool season grasses

In the Shields pasture we compared infiltration rate between native tallgrasses (usually big bluestem) and exotic cool season grasses. Exotic grass was usually crested wheatgrass but sometimes was cheatgrass. Rates did not differ among these functional groups.

We also tested tallgrass borders of our properties, one at the main farm (Sully silt loam) and one at the North Unit (Millboro clay), with adjoining pastures that were grazed shorter and consisted of different species. Water infiltrated much faster in our tallgrass borders than in the adjacent pastures. However, this experiment cannot determine if the cause was the different species or the different management. The tallgrass borders are often hayed and sometimes grazed but, in general, are used relatively lightly compared to the adjacent pastures which are typically grazed quite short.

Cropland vs. adjacent perennial grass

Tallgrass (switchgrass and big bluestem) borders at the main farm were tested and compared with adjacent cropland on July 25, 2025. Surprisingly, no differences were found between grass borders and cropland.

Impact of winter grazing

On May 13 and 14, 2025, soil samples were collected with a hammer probe in fields where corn residue was grazed during the previous winter. Samples were divided into 0-3" and 3-6" segments and were measured for bulk density and gravimetric moisture. Both fields contained removeable grazing exclosures. On field 0-7 and 1-7, these exclosures have prevented grazing on portions of the fields since 2017 and 2019, respectively. We did not find differences in moisture or bulk density between grazed and non-grazed areas in either field.

Soil samples were collected from the same locations on July 9 (Field 1-7, corn, depths 0-6", 6-12", 12-24", 24-36") and July 24 (Field 0-7, canola, depths 0-6" and 6-12"), 2025, and sent to Ward Laboratory to test pH, organic matter, nitrate, ammonium, P, K, S, Mg, Zn, Fe, Mn, Ca, Na, Cu, and respiration. None of the tests differed between grazed and non-grazed areas of field 0-7. On field 1-7, we found differences ($p < 0.05$) in nitrate and K. Nitrate nitrogen was 17 ppm in grazed areas and only 14 ppm in non-grazed areas. Potassium was 207 ppm in grazed areas and only 171 in non-grazed areas. No differences were found in other tested soil properties. These results are consistent with our measurements in previous years. That is to say, differences in soil nutrients due to grazing have been minor or non-existent.

Residue samples were collected from three fields in June 2025 (Figure 3). Every field grew wheat in 2024 and was followed by a cover crop that was swathed and then grazed (irrigated fields) or grazed standing (dryland field). In each field, four quadrats (0.5 x 0.5 m) were placed on the ground and all crop residue on the surface or standing was collected and dried at 55-60° C. Mean residue was 4800 lb/ac on the two irrigated fields and 4700 lb/ac on the dryland field. The residue included cover crop residue and grain crop residue. The residue fragments were not sorted but based on expert opinion, ~1000 lb/ac may have come from cover crops with the balance 3000-4000 lb/ac coming from grain crops. To put this in perspective, these fields would have produced ~2000-2500 lb/ac/yr post-harvest residue. So, the residue remaining after grazing the cover crop was equivalent to a little more than two years of post-harvest residue.

Figure 3. The "soil armor" from the prior wheat crops has been removed for weighing.

Pasture soil and vegetation

As in previous years, drone imagery was collected monthly on the Shields pasture to evaluate grazing, seeding, and spraying treatments (Figures 4 and 5). Unlike past years, the pasture was not grazed in 2025. This provided the opportunity to evaluate whether the impact of early season targeted grazing during previous years would persist when grazing ceased.

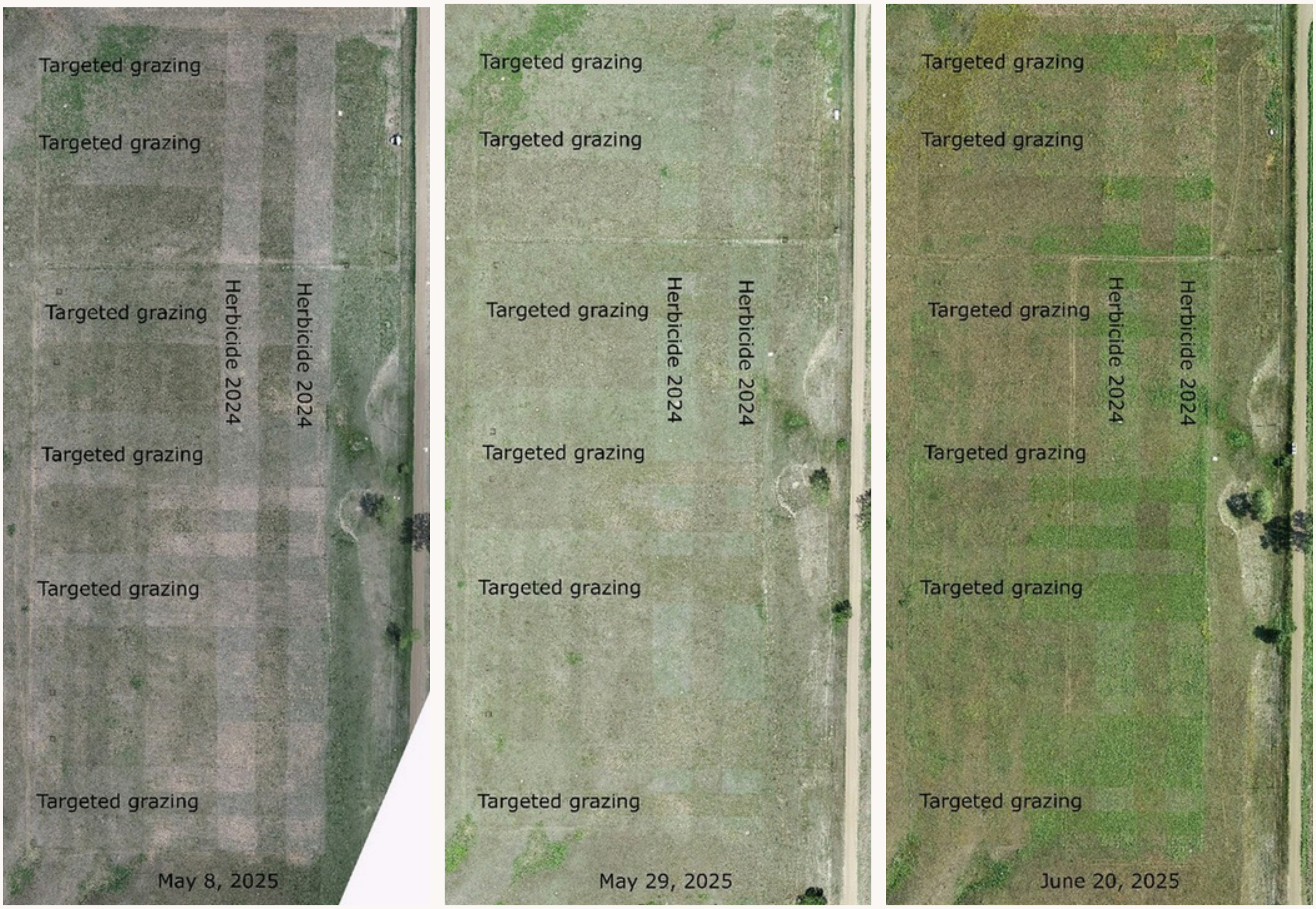

Figure 4. Sequence of images of the Shields pasture. Herbicide treatments run north-south and grazing treatments run east-west. The pasture was not grazed in 2025. The impact of herbicide applied in 2024 is still apparent as strips running north-south in the spring. In early May, herbicide strips are gray (because the cool season grasses have been removed) but by late May they have begun to green-up. By late June, they are bright green because they are dominated by warm season grasses. The legacy of targeted grazing from 2022 to 2024 is barely discernible. Reseeded plots are noticeable in May, appearing as light gray horizontal strips, and in June as bright green horizontal strips.

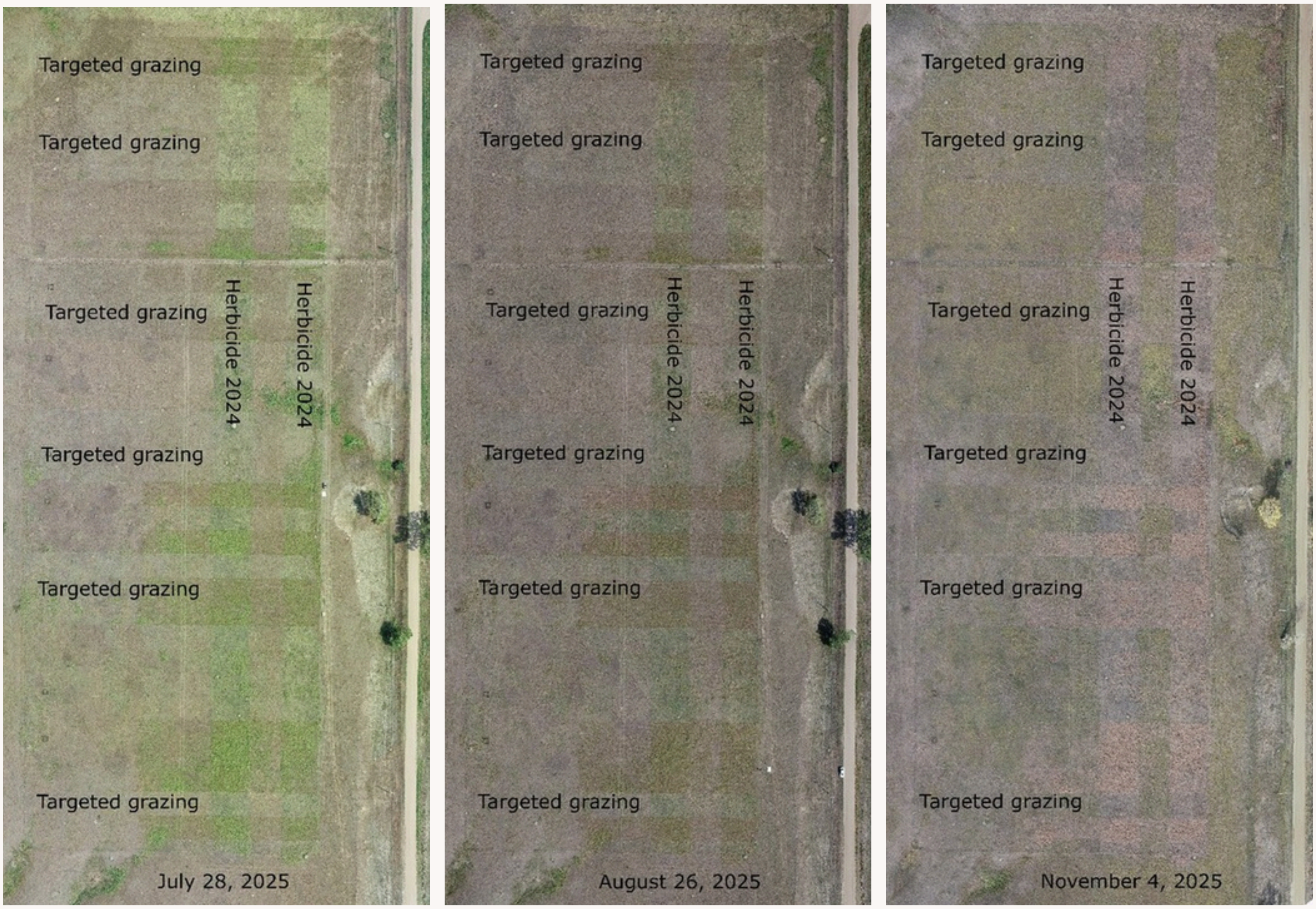

Figure 5. Sequence of images of the Shields pasture. Herbicide treatments run north-south and grazing treatments run east-west. The pasture was not grazed in 2025. The impact of herbicide applied in 2024 still appears as green strips in July and August but has flipped to brown by November. In contrast, the non-sprayed strips appear green in November because autumn rain caused the cool season grasses to regrow.

Soil samples were collected in the Shields pasture with a Giddings probe from June 9-11. Nine cores were collected from each plot and separated by depth (0-2”, 2-6”, 6-12”, 12,24”, 24-36”, and 36-48”). The nine cores from each depth were composited. Cores were weighed, a subsample was dried and reweighed, and the moisture content was used to estimate dry weights and calculate bulk density. Cores were weighed, a subsample was dried and reweighed, and the moisture content was used to estimate dry weights and calculate bulk density. The samples were sent to Ward Laboratory for analysis of organic carbon (OC), total carbon (TC), and inorganic carbon (IC). Each time a core was collected, the presence or absence of a warm-season tallgrass plant within one foot of the core was noted. The number of plants was divided by the number of cores at each experimental unit to calculate the tallgrass percentage. These values ranged from 0 to 100%. Means for seeded and non-seeded areas were 60% and 0%, respectively.

Statistical analysis showed that neither bulk density nor any of the carbon measurements were affected ($p>0.05$) by grazing (targeted grazing vs. summer only grazing), seeding (seeded with C4 tallgrasses vs. no seeding), or tallgrass percentage. Bulk density and carbon were only affected by sampling depth (Table 2). It is interesting to note that, although organic carbon decreased with depth, inorganic carbon did the opposite. Thus, total carbon was more stable with changes in depth than either organic or inorganic carbon.

The most important finding of this analysis is that soil carbon was not affected by six years of established native tallgrasses nor by three years of targeted grazing. It is our opinion that reports of dramatic changes in soil carbon caused by short-term changes in rangeland grazing management should be regarded with caution in this environment.

Table 2. Shields pasture soil properties as affected by depth. Within a column, values followed by the same lowercase letter are not statistically different ($p > 0.05$). Grazing treatments, seeding treatments, and dominant pasture vegetation did not impact soil carbon or bulk density.

Depth, in.	Total carbon, %	Organic carbon, %	Inorganic carbon, %	Bulk density, g/cm3
0-2	3.47 a	3.28 a	0.19 ab	0.96 a
2-6	1.43 b	1.42 b	0.01 a	1.15 b
6-12	1.18 c	1.16 c	0.01 a	1.09 c
12-24	1.08 c	0.84 d	0.23 b	12-48” depth: 1.14 b
24-36	1.38 b	0.70 d	0.68 c	
36-48	1.44 b	0.69 d	0.75 c	

On May 9, 2025, standing biomass was measured in areas of the Shields pasture that received early season targeted grazing (650 lb/ac) during the previous three years and those that did not (490 lb/ac), but this result was not statistically different ($p = 0.17$). Both areas received summer grazing. This ran contrary to expectations, as we had hypothesized that early season grazing would be detrimental to cool season grasses and decrease their production in subsequent years. We also hypothesized that legacy targeted grazing would reduce the number of reproductive stems on cool season invasive grasses. This was tested by counting the number of reproductive stems within 0.25 m^2 quadrats on June 23-24, 2025. The number of smooth brome reproductive stems was reduced ($p < 0.05$) from 26/yd^2 to 3/yd^2. However, reproductive stems of other species (i.e., Kentucky bluegrass, crested wheatgrass, cheatgrass) were not affected ($p>0.05$). This result differed from 2024, when targeted grazing had a marginal to strong impact on all perennial invasive grasses but did not affect cheatgrass, an annual.

From Sep. 8 to 15, 2025, step-point-count measurements of individual species were collected in the Shields pasture and the data were used to calculate relative abundance. Two areas were sampled and analyzed independently: 1) Seeded in 2017 only, and 2) seeded in 2017 and reseeded in 2019. The area seeded only in 2017 had a much weaker stand than the area reseeded in 2019, but there was still an interactive effect of Seeding and Spraying. Specifically, areas treated with Roundup to eliminate cool season grass in 2017 have maintained higher proportions of seeded warm-season tallgrasses into 2025 (Table 3). Targeted grazing from 2022-2024 did not have an impact on tallgrasses. However,

Table 3. Frequency of warm season tallgrasses (seeded grasses) and shortgrasses as affected by targeted grazing and herbicide. Within a column, values followed by the same lowercase letter do not differ ($p > 0.05$).

	Seeded grasses, %	Warm-season shortgrasses, %
Targeted grazing	2 a	60 a
Summer grazing only	2 a	36 b
Roundup	9 a	
No herbicide	1 b	

targeted grazing did increase warm season shortgrasses (e.g., blue grama). Targeted grazing also reduced abundance of exotic cool season grasses where herbicide was not sprayed in 2017, but had no impact where glyphosate was used in 2017 (Table 4). Thus, in this instance, targeted grazing shifted dominance from cool season grasses to short warm season grasses, rather than shifting to tallgrasses, as was our objective. We speculate that limited tallgrass abundance prevented tallgrasses from taking advantage of the opportunity provided by targeted grazing, whereas the more common shortgrasses were well positioned to increase their abundance under this situation. Looking at response by specific species, rather than functional group, we found that targeted grazing reduced smooth brome abundance where herbicide was not applied in 2017 but didn’t impact crested wheatgrass.

Table 4. Frequency of exotic cool season grasses as affected by herbicide. Within a column, values followed by the same lowercase letter do not differ ($p > 0.05$).

	Grazing treatment	Exotic cool season grasses, %
No herbicide	Summer grazing only	54 a
No herbicide	Targeted grazing	9 b
Roundup	Summer grazing only	41 a
Roundup	Targeted grazing	19 a

The second site was seeded in 2017 and reseeded in 2019. The 2019 reseeding was more successful than the initial seeding, probably due to more rainfall in 2019. In 2024, some of these plots were sprayed with glyphosate and atrazine to control the cool season grasses that had recovered from the chemical applications of 2017 and 2019 (Figure 6). We found that the 2024 herbicide application increased frequency of seeded tallgrasses and reduced abundance of exotic cool season grasses (Table 5). In addition, there was a trend ($p=0.08$) for targeted grazing to reduce exotic cool season grasses from 44% to 4%, but only where we didn't spray herbicide in 2024, because exotic cool season grasses were already 0% where we sprayed (Table 6).

Table 5. Grass response to herbicide use. Within a column, values followed by the same lowercase letter do not differ ($p > 0.05$).

	Seeded warm-season tallgrasses, %	Exotic cool season grasses, %
Herbicide 2024	51 a	0 a
No herbicide in 2024	28 b	24 b

Figure 6. This photo of the Shields pasture was taken on June 23, 2025. The effect of herbicide applied in 2024 can be seen as a line running from the bottom right of the photo towards the top-center. On the right, the yellowish color is caused by the abundance of exotic cool season grasses that have already produced seedheads. On the left, where herbicide was sprayed, the native warm season grasses are more apparent and remain in the vegetative growth stage.

Table 6. Exotic cool-season grass abundance, %, as affected by grazing and herbicide. There was a trend (p=0.08) for statistical significance of the result.

	Summer grazing only	Targeted grazing
Herbicide 2024	0	0
No herbicide in 2024	44	4

On Oct 30, 2025, plots were resampled for biomass. This time, biomass was sorted into three categories: seeded grass, non-seeded grass, and non-seeded forbs. No seeded forbs were present. Total biomass did not differ (p > 0.05) between plots that received targeted grazing from 2022-2024 and those that did not. In 2024, targeted grazing reduced the proportion of biomass coming from non-seeded grasses and increased the proportion coming from non-seeded forbs, but this result did not persist as a legacy effect in 2025 (p=0.16 and p=0.64, respectively). Targeted grazing may have had a limited impact (p=0.06) on the proportion of biomass coming from seeded grasses (18% vs. 4% for targeted grazing and summer only, respectively).

On Game, Fish, and Parks land, three rangeland treatments were applied in 2019 and monitoring continues. Treatments included: 1) broadcasting native grass, forb, and woody seed, 2) broadcasting seed and then unrolling a bale on it, and 3) a control. There were four replications. All plots have been grazed from 2019 to 2023, usually early in the spring. They were deferred from grazing in 2024 and 2025. Monitoring via step-point count continues. In 2025, the treatment where seed was broadcast without a bale on top had greater frequency of seeded species (13%) than the other treatments (2%). It also had a lower percentage of exotic cool season grasses (65% vs. 84%). The dominant seeded grass species has shifted from big bluestem in early years to sideoats grama more recently. In addition, sideoats grama was found in the unseeded plots in 2025. The spread of a native grass into unseeded plots is encouraging. It might also indicate sideoats grama is better adapted than big bluestem at the experimental site.

As in 2024, step-point transects were collected at Dakota Lakes' new property, Raptor Roost. The most common species remained similar in their proportions to 2024: blue grama (23%), crested wheatgrass (16%), sand dropseed (10%), and western wheatgrass (6%).

Hay production (1050 lb/ac) in our four-yr-old dryland alfalfa field continued to decline and it was terminated on June 30 after four years of production, as scheduled. To replace it, we seeded a different field to switchgrass with canola in hopes that we could harvest the canola and allow the switchgrass to establish. Unfortunately, the switchgrass establishment was a failure except on the edge of the field, where inadvertent application of herbicide terminated canola and allowed switchgrass to grow without competition.

The irrigated forage field (alfalfa/orchargrass mixture) was also transitioned back to grain crops and replaced with a new field planted to alfalfa/meadow brome. Peas were used as a nurse crop and this field produced 4050 lb/ac across two cuttings (Figure 7).

Figure 7. July 10, 2025. On the right is an established stand of switchgrass. On the left is the newly planted alfalfa-meadow brome mixture. It was established with a pea companion crop and had been harvested for forage once when this photo was taken.

A Giddings probe was used to collect soil samples to 48" deep at Dakota Lakes Research Farm.

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