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CASE STUDY: Effect of cattle and sheep grazing on stocking rate and botanical composition of subirrigated pasture

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ABSTRACT

Changes in commodity pricing and environmental concerns are changing animal agriculture throughout the United States. Adopting multispecies grazing as an alternative production system could result in improved forage utilization, increased animal performance, and reduced production costs, and thereby improve the financial stability of livestock operations. This study focused on the Silver Spur Ranch near Saratoga, Wyoming, a historical cattle ranch where sheep grazing is being integrated into irrigated and rangeland pastures. The overall objectives of this study were to evaluate the effect of multispecies grazing on changes in botanical composition and nutrient availability following grazing in subirrigated pasture. Forage DM followed the general dietary patterns of animals that were last stocked in the pasture. There were fewer forbs in the north pasture, where sheep grazing followed cattle grazing, and fewer graminoids in the south pasture, where cattle grazing followed sheep grazing. Relative depletion of CP and digestible DM was highest for forbs grazed by sheep after cattle. At the end of the first grazing period, the small north pasture (cattle grazing) had 9.7 d of grazing remaining at the current stocking rate. However, at the end of the second grazing period (sheep following cattle), the small north pasture had 14.7 d of grazing remaining. This represents a 52% increase in days of grazing remaining over the first period. The small south pasture (sheep followed by cattle) had little change from the first grazing period to the second (13.4 vs. 13.0 d).

Key words: cattle, mixed-species grazing, nutrient availability, nutrient depletion, sheep

INTRODUCTION

Multispecies grazing refers to the practice of allowing more than one species of large herbivore with different forage preferences (grasses, forbs, shrubs) to graze a common forage resource (Walker, 1994). Multispecies grazing is not a new phenomenon; it can be detected as far back as the Old Testament days of the Bible, where the words "cattle" and "sheep" appear together more than 19 times. In addition, multispecies grazing has been advocated since the inception of range sciences (Jardine and Anderson, 1919; Stoddart and Smith, 1943; Sampson, 1952). However, there is a historical perception that cattle and sheep are incompatible, likely due to perceived competition for limited forage resources (O'Neal, 1989).

The fundamental principles of grazing management include controlling intensity of grazing, timing of grazing, kind and class of herbivore, and distribution of grazing (Stoddart et al., 1975; Vallentine, 1990). Multispecies grazing leads to uniform utilization of forage resources, thereby increasing the efficiency of grazed forages and overall production on rangelands (Briske and Heitschmidt, 1991).

Dietary overlap and selection determine the effect of multispecies grazing on both pasture composition and carrying capacity. Theoretically, the proper mix and number of animals is a function of livestock dietary preferences, animal forage demand, and botanical composition (Hobbs and Carpenter, 1986). Maximum benefit from multispecies grazing will occur with the proper substitution ratio of one livestock species for another. Replacement ratios of 5 sheep per cow (based on relative differences in forage consumption) are commonly used (Vallentine, 1990). However, a suggested guideline is that one ewe

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can be added per cow on moderately stocked rangelands without affecting cattle production (Glimp, 1988), and limited studies indicate multispecies grazing can increase animal performance for both cattle and sheep (Walker 1994).

The overall objectives of this study were to evaluate the role of multispecies grazing on changes in botanical composition and nutrient availability following grazing. Specific objectives were to evaluate 1) standing crop and utilization levels in each pasture following grazing, 2) plant community composition by life form (grasses, grass-likes, and forbs), and 3) approximate change in forage availability following mixed-species grazing.

MATERIALS AND METHODS

Experimental Design

Because this study was conducted entirely on a working ranch, replication of treatment groups was problematic. Therefore, the summer 2009 study was designed as a demonstration project to provide a proof of concept for the Silver Spur Ranch. The Silver Spur Ranch is in south-central Wyoming approximately 19.3 km south of Saratoga (2,070 m above sea level). Climate is characterized by cold, wet winters and warm, dry summers with annual precipitation in the area averaging approximately 25 cm. This study focused on 2 small irrigated/subirrigated pastures overlying soils with high OM content. The vegetative composition in these pastures was similar to flood meadows, which are primarily composed of flood-tolerant graminoids and to a lesser extent forbs (mostly nonlegumes) and phreatophytic shrubs (Cooper et al., 1957). Common herbaceous species composing each pasture included Baltic rush (*Juncus balticus* Willd.), clover (*Trifolium* spp. L.), common dandelion (*Taraxacum officinale* F.H. Wigg.), Garrison creeping meadow foxtail (*Alopecurus arundinaceus* Poir.), Kentucky bluegrass (*Poa pratensis* L.), Nebraska sedge (*Carex nebrascensis* Dewey), orchardgrass (*Dactylis glomerata* L.), smooth brome (*Bromus inermis* Leyss.), and water sedge (*Carex aquatilis* Wahlenb.).

The small north pasture was 5.3 ha (13.1 acres) and the small south pasture was 7.4 ha (18.2 acres). Sixty-two cows with calves were placed in the small north pasture and 148 ewes with lambs were placed in the small south pasture on May 26, 2009. Cattle were moved into the small south pasture and sheep into the small north pasture on July 10, 2009. Cattle and sheep were removed from both pastures on July 28, 2009, and placed in a large pasture [80.9 ha (~200 acres)], which was southeast of the small pastures. Vegetation measurements were collected the same day that animals were rotated between or moved out of pastures.

Vegetation Monitoring

A paired-plot method (Bonham, 1989) was employed to measure effects of grazing on all pastures. This method requires establishment of pairs of plots at key areas. One member of the pair was enclosed in a 1.0-m^2 fenced exclosure to protect it from grazing, and the other was located approximately 5 m to the southwest within the same plant community but exposed to grazing. Six paired plots (excluded vs. grazed) were randomly placed in each pasture. Exclosures were set up in mid-May before pastures were grazed to remove bias associated with wildlife grazing before livestock. Vegetation was clipped on the end date of each grazing period in 0.5-m^2 (82 cm long × 61.5 cm wide) plots inside each 1.0-m^2 plot to 1.3-cm stubble height, identified, and separated into forb and graminoid [grass and grass-like (i.e., sedges and rushes)] life forms to estimate standing crop, composition, and utilization of plant life forms by cattle and sheep. The area clipped was nested in the center of each excluded plot to avoid bias associated with utilization inside the exclosure perimeter.

Phytomass from grazed plots represented residual herbage, and phytomass from plots protected from grazing represented total herbage production. Consequently, forage clipped in grazed plots on July 28 represented residual forage from sheep following cattle grazing (north pasture) or cattle following sheep grazing (south pasture). Following clipping, samples were dried at 60°C for 48 h and weighed to the nearest gram to base all calculations on DM (g/0.5 m^2). The difference between the 2 weights was the amount utilized expressed as percent of total herbage production. Oven-dried samples were ground to 1-mm particle size and subjected to forage analyses including percentage DM, ADF, CP, and digestible DM. Nutritional standing crop for CP and digestible DM were computed for forbs and graminoids in each grazing scenario by multiplying mean residual standing crop in exclosures and paired, grazed plots by the mean percentage of CP and digestible DM for these samples.

Forage Quality and DMI

Pasture samples were analyzed for DM, ADF (Ankom 200 Fiber Analyzer, Ankom Technology, Fairport, NY), and CP (Leco FP-528, Leco Corporation, St. Joseph, MI). Dry matter digestibility was calculated using analyzed ADF values [88.9 − (0.779 × ADF%)] (NRC, 2000). Predicted DMI was estimated from ADF and CP values [DMI/kg = (0.002774 × CP%) − (0.000864 × ADF%) + 0.09826] (NRC, 2000). To estimate DMI, it was assumed that weight was 500 kg for mature cows and 45 kg for mature ewes.

Statistical Analysis

Statistical analysis focused on descriptive comparisons between exclosures (no grazing) and paired, grazed plots (after grazing). Means and SE were thus computed to estimate forage removal and standing crop (kg/ha) of forb and graminoid CP and digestible DM in exclosures and paired, grazed plots under single-species grazing (July 10) and mixed-species grazing (July 28).

RESULTS AND DISCUSSION

Plots were clipped and utilization estimated for single-species grazing effects on July 10, 2009. One of the exclosures in the north pasture had been knocked over, thus limiting sample size to n = 2 in this pasture. Two paired sites in the north pasture (cattle use) and 3 in the south pasture (sheep use) were analyzed. Forbs composed 2.8% and graminoids 97.2% of the available forage DM in the small north pasture, whereas forbs composed 5.7% and graminoids 94.3% of the available forage DM in the small south pasture during single-species grazing. Total forage removal (±SE) was estimated to be 59.9 ± 0.7% in the cattle pasture and 41.2 ± 33.6% in the sheep pasture. Sheep use of forbs was greater (60.1 ± 28.7%) than that by cattle (53.8% ± nonestimable SE), whereas cattle use of graminoids (60.7 ± 1.1%) was greater than sheep use of graminoids (40.6 ± 33.1%).

Plots were clipped and utilization estimated for mixed-species grazing effects on July 28, 2009. Cattle had pushed over one of the exclosures in the small south pasture. Consequently, 3 paired sites in the small north pasture (sheep after cattle use) and 2 in the small south pasture (cattle after sheep use) were sampled. Forbs composed 8.6% and graminoids 91.4% of the available forage DM in the small north pasture, whereas forbs composed 2.4% and graminoids 97.6% of the available forage DM in the small south pasture during mixed-species grazing. Total forage removal (±SE) was estimated to be 52.3 ± 12.9% in the small north pasture (sheep following cattle use) and 57.7 ± 0.1% in the small south pasture (cattle following sheep use). Final sheep use of forbs was greater than that by cattle (90.1 ± 4.0% in sheep after cattle vs. 67.7 ± 22.3% in cattle following sheep), whereas final cattle use of graminoids was greater than sheep use of graminoids (57.7 ± 0.6% in cattle after sheep vs. 47.8 ± 14.1% in sheep after cattle).

The current research supports the principle that favors multispecies grazing: intraspecies (between individuals of the same species) competition is always greater than interspecies (between different species) competition (Walker, 1994). This relationship is an artifact of the ecological principle that a niche defines the ultimate distributional unit of species and no 2 species living in the same area can occupy the same niche (Grinnell, 1917). Each species of animal can utilize different portions of a common area. Thus, multispecies grazing allows for more efficient utilization of resources.

As expected, the availability of CP and digestible DM was lower in forbs and graminoids in grazed plots compared with exclosures (Table 1). However, forbs demonstrated the largest relative nutrient depletion in plots grazed by sheep after cattle (Table 1). At the end of the first grazing period (May 26–June 10), the small north pasture (cattle grazing) had 9.7 d of grazing for cattle at the current stocking level. The small south pasture (sheep grazing) during the same time frame had 13.4 d of sheep grazing remaining at the same level of stocking (Table 2). After the second grazing period (June 10–July 28), the small north pasture (sheep following cattle) had 14.7 d of grazing for cattle (62 animals) and sheep (148 animals) remaining, whereas the small south pasture (cattle following sheep) had 13.0 d of grazing remaining (Table 2).

Because pasture size differed, it is not valid to compare days of grazing remaining or animal unit months between the 2 pastures; however, it is valid to compare the change in response between both pastures. At the end of the first grazing period, the small north pasture (cattle grazing) had 9.7 d of grazing remaining at the current stocking rate. However, at the end of the second grazing period (sheep following cattle), the small north pasture had 14.7 d of grazing remaining at the used stocking rate. This represents a 52% increase in days of grazing remaining over the first period. The small south pasture (sheep followed by cattle) had virtually no change from the first grazing period to the second (13.4 vs. 13.0 d). These results may be related to timing of regrowth or grazing pressure. Cows had the opportunity to graze the north pasture first, followed by sheep grazing. It appears the increase in grazing

Table 1. Mean (SE) standing crop (kg/ha) of forb and graminoid CP and digestible DM (DDM) averaged in exclosures (no grazing) and paired, grazed plots (after grazing) under single-species grazing (July 10) and mixed-species grazing (July 28) scenarios in subirrigated pastures[1]

	Single-species grazing		Mixed-species grazing	
Item	Cattle only	Sheep only	Cattle after sheep	Sheep after cattle
Forb CP				
No grazing	31 (NA[2])	33 (25)	13 (7)	52 (28)
After grazing	14 (NA)	13 (10)	4 (2)	5 (2)
Graminoid CP				
No grazing	460 (81)	419 (55)	580 (149)	497 (61)
After grazing	180 (31)	249 (32)	245 (63)	259 (31)
Forb DDM				
No grazing	178 (NA)	171 (117)	95 (54)	332 (179)
After grazing	82 (NA)	68 (46)	30 (17)	32 (17)
Graminoid DDM				
No grazing	2,755 (324)	2,576 (184)	3,541 (710)	3,242 (330)
After grazing	1,082 (127)	1,530 (109)	1,498 (300)	1,691 (172)

[1]The study was conducted on Silver Spur Ranch in south-central Wyoming in summer 2009.

[2]Standard errors that were not estimable because n = 1.

Table 2. Effects of multispecies grazing on total available grazing days[1]

Pasture[2]	Sample date	Total grazing days available[3]	AUM[4]
North	July 10	9.7	9.0
South	July 10	13.4	13.7
North	July 28	14.7	12.4
South	July 28	13.0	12.1

[1]The study was conducted on Silver Spur Ranch in south-central Wyoming in 2009.

[2]The north pasture was grazed by cattle (62 cow–calf pairs) from May 26 to June 10 and by sheep (148 ewes and lambs) from June 10 to July 28. The south pasture was grazed by sheep (148 ewes and lambs) from May 26 to June 10 and cattle (62 cow–calf pairs) from June 10 to July 28.

[3]Calculated from total digestible DM available in the pasture at the used stocking rate. Dry matter digestibility was calculated using analyzed ADF values [88.9 − (0.779 × ADF%)]. Predicted DMI was estimated from ADF and CP values [DMI/kg = (0.002774 × CP%) − (0.000864 × ADF%) + 0.09826] (NRC, 2000). To estimate DMI, it was assumed that weight was 500 kg for mature cows and 45 kg for ewes.

[4]Assuming 680.2 kg required per animal unit month (AUM; Vallentine, 1990).

days available when sheep grazed the north pasture (July 10–July 28) was likely due to plant growth occurring at a greater rate than the sheep were consuming. However, in the south pasture, sheep grazing was followed by cattle grazing. Once cattle were allowed to graze the south pasture, growth and consumption appeared to reach an equilibrium, with no increase or decrease in animal unit months or available grazing days at the current stocking rate. It has been well documented that multispecies grazing will allow for greater forage utilization than single-species grazing alone (Glimp, 1988; Walker, 1994). However, these data suggest that allowing sheep to follow cattle grazing subirrigated pastures may allow for greater graminoid regrowth during the peak-growing season compared with allowing cattle to follow sheep. In addition, forb DM was 2.5-times higher (2,614 vs. 1,036 kg) on July 28 in the north pasture (cattle followed by sheep grazing) than in the south pasture (sheep followed by cattle grazing), suggesting that sheep left more graminoids because they had greater access to forbs, which they prefer, than they would have had in the south pasture, where cattle followed sheep grazing. However, the greater availability of forb DM in the north pasture leading to greater graminoid availability after sheep grazing ended is at least partially refutable given that there was 1.5-times greater (42,920 vs. 27,701 kg) graminoid DM available in the south pasture compared with the north pasture during mixed-species grazing. In light of greater proportions of preferred forage available to cattle and sheep in their respective pastures during mixed-species grazing, the greater number of grazing days remaining in the north pasture compared with the south pasture suggests that sheep following cattle grazing resulted in more residual forage than cattle following sheep grazing.

IMPLICATIONS

The nutrient utilization and composition data suggest that there was grazing selection occurring, especially with the sheep utilizing more forbs. The effect of selection in the current study is difficult to ascertain because plant composition in each pasture was almost exclusively graminoids. However, the pastures were contiguous to each other and had similar soils, hydrology, and climate affecting plant growth. Therefore, these results suggest that sheep following cattle grazing may be more beneficial than cattle following sheep grazing in subirrigated pastures dominated by graminoids. Although there was a short sample time, small pasture, and limited numbers, the 52% increase in available grazing days when sheep followed cattle should not be ignored. Perhaps the selectivity of the sheep while grazing allowed for regrowth of the plants that were initially grazed by cattle. Nevertheless, future research is warranted in a more controlled setting to determine the benefits of multispecies grazing.

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LITERATURE CITED

Bonham, C. D. 1989. Measurements for Terrestrial Vegetation. John Wiley and Sons, New York, NY.

Briske, D. D., and R. K. Heitschmidt. 1991. An ecological perspective. Pages 11–26 in Grazing Management: An Ecological Perspective. Timer Press Inc., Portland, OR.

Cooper, C. S., R. R. Wheeler, and W. A. Sawyer. 1957. Meadow grazing—1: A comparison of gains of calves and yearlings when summering on native flood meadows and sagebrush-bunchgrass range. J. Range Manage. 10:172.

Glimp, H. A. 1988. Multi-species grazing and marketing. Rangelands 10:275.

Grinnell, J. 1917. Field test of theories concerning distributional control. Am. Nat. 51:115.

Hobbs, N. T., and L. H. Carpenter. 1986. Viewpoint: Animal unit equivalents should be weighted by dietary differences. J. Range Manage. 39:470.

Jardine, J. T., and M. Anderson. 1919. Range Management on the National Forests. U.S. Department of Agriculture Bulletin 790. USDA, Washington, DC.

NRC. 2000. Nutrient Requirements of Beef Cattle. 7th rev. ed. Natl. Acad. Press, Washington, DC.

O'Neal, B. 1989. Cattlemen Versus Sheepherders: Five Decades of Violence in the West, 1880–1920. Eakin Press, Austin, TX.

Sampson, A. W. 1952. Range Management Principles and Practices. John Wiley and Sons Inc., New York, NY.

Stoddart, L. A., and A. D. Smith. 1943. Range Management. McGraw-Hill Book Co., New York, NY.

Stoddart, L. A., A. D. Smith, and T. W. Box. 1975. Range Management. 3rd ed. McGraw-Hill Book Co. Inc., New York, NY.

Vallentine, J. F. 1990. Grazing Management. Academic Press Inc., San Diego, CA.

Walker, J. W. 1994. Multispecies grazing: The ecological advantage. Sheep Res. J. Special Edition:52–64.