

Stocking System Effects on Soil and Forage Characteristics, and Performance of Fall-Calving Cows Grazing Cool-Season Grass Pastures (A Progress Report)

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Summary and Implications

The effects of stocking densities of fall-calving Angus cattle grazing cool-season pastures on cow and calf performance; forage mass, quality, and botanical composition; soil carbon content and compaction; and grazing selectivity of cattle were evaluated. Two blocks of three 10-acre cool-season pastures, divided into 1-acre paddocks, were grazed by 10 fall-calving Angus cows by one of three stocking systems: rotational stocking (RS, low stocking density), strip stocking (SS, moderate stocking density), and mob stocking (MS, high stocking density). Pastures were grazed from mid-May through late September in 2010 (yr 1) and 2011 (yr 2). Cattle received a daily live forage dry matter (DM) allowance of 4.0 and 3.2% of cow body weight (BW) in yr 1 and 2, respectively. Cattle in RS pastures were moved to new paddocks after initial forage sward height, measured with a falling plate meter (8.8 lb/yd²), was reduced by 50% by measurement (yr 1), and after the estimated intake at 3.2% of cow BW/day (yr 2). Cattle in SS and MS pastures received strips containing 100 and 25% of the daily forage allowance one and four times per day, respectively. Cow BCS did not differ between treatments in any month of either year. Cow BW was greater in MS than RS and SS pastures in June of yr 2 and greater in RS than MS pastures in August of yr 2, but did not differ in any other months of either year. Birth weight and average daily gain (ADG) of live calves at the end of the trial did not differ between treatments in either year; however, there were fewer calves per cow in MS pastures at the termination of the trial in yr 2. Forage sward height did not differ between treatments in any month of either year. Rotational stocking decreased forage disappearance in yr 2 compared to strip or mob stocking. Forage disappearance was lower in RS than SS and MS pastures in May and June of both years and was greater in RS than SS pastures in September of yr 1, but did not differ in any other months. Forage botanical composition prior to grazing each year did not differ between years, but dead forage as a percent of total forage DM was lower in RS than SS and MS pastures in yr 2. Soil bulk density from 0-3 inches in yr 1, water infiltration rate into the soil in either year, and penetration

resistance at depths of 0 and 3 inches in yr 2, did not differ between treatments in any month. Soil penetration resistance at 6 inches was greater in SS than RS and MS pastures in May, and was greater in MS than SS pastures in August. Grazing selectivity did not differ between treatments in yr 1. Results suggest that, at constant forage allocation, mob stocking does not affect cow or live calf performance, but may reduce the proportion of surviving calves. Mob stocking also does not affect forage mass, botanical composition, or soil compaction measures within the first two years of implementation.

Introduction

Rotational stocking (RS) systems have been demonstrated to increase forage yield, improve establishment and persistence of legume species, and improve animal production per acre. Mob stocking (MS) is a form of rotational stocking that features grazing stockpiled forages at high densities for a short duration with extended rest periods. Grazing selectivity of cattle may be reduced and forage utilization increased by reducing the amount of forage available to cattle at any time. Allowing forage to mature may reduce forage quality and impair individual livestock performance. Long rest periods may result in enhanced root and leaf growth. Legume establishment is fostered by allowing reseeding, maintenance of root reserves, and removal of grass competition and shading. Soil organic matter may be increased by greater amounts of roots, concentrated distribution of manure, and incorporation of manure and trampled forage matter into the soil. With increased stocking density comes a risk of soil compaction; however, this may be countered by frequent movement of cattle and increased amounts of soil organic matter. The objective of this two-year study was to determine the effects of increasing stocking density while maintaining a constant forage allowance on cattle, forage, and soil properties.

Materials and Methods

In March 2010, red clover (*Trifolium pratense*) was broadcast-seeded onto two 30-ac cool-season grass fields at the ISU Beef Nutrition Farm near Ames, IA. Soil types in block 1 were primarily Clarion loam (56.6%) and Webster clay loam (26.9%) while soil types in block 2 were primarily Clarion loam (29.2%), Canisteo clay loam (27.0%), Webster clay loam (18.5%), and Nicollet loam (14.9%). Soil test results from May 2010 for blocks 1 and 2, respectively, were Bray-P of 40.3 and 74.3 ppm, K of 139.3 and 250.3 ppm, and buffer pH of 7.3 and 7.3.

Because of the high levels of Bray-P and K and high pH of the soils in both blocks, no additional fertilizer was added to either block. At the initiation of grazing in May 2010, major forage species in blocks 1 and 2 (respectively) were tall fescue (*Festuca arudinacea* Schreb., 42.3 and 62.5% of live forage dry matter [DM]), Kentucky bluegrass (*Poa compressa*, 24.4 and 27.6%), orchardgrass (*Dactylis glomerata*, 12.8 and 3.0%), reed canarygrass (*Phalaris arudinacea*, 10.7 and 2.2%), and smooth bromegrass (*Bromis inermis*, 9.3 and 0.1%). Fields were divided into three 10-ac pastures, each divided into ten 1-ac paddocks. In May 2010, pastures were randomly assigned to one of three grazing treatments: RS, strip stocking (SS), and MS; pastures received the same treatment in 2011.

Sixty fall-calving Angus cows (mean body weight [BW] 1291 and 1371 lb and body condition score [BCS] 4.84 and 4.84 on a 9-point scale, for yr 1 and 2 respectively) were blocked by BW and BCS and ten were allotted to each pasture in mid-May of each year. On May 14 (yr 1) and 24 (yr 2), all cattle were moved to the first paddock of their respective pastures. Cattle in RS and SS pastures initiated grazing immediately, but cows in both MS pastures in yr 1 and one MS pasture in yr 2 remained in the first paddock with grass hay supplementation until forage sward height in the next paddock reached a minimum height necessary to maintain a stocking density of 350,000 lb BW/ac at the daily live forage DM allocation rate (4.0 and 3.2% of total BW in years 1 and 2, respectively). While in the first paddock, cattle in MS pastures consumed 125 and 10 lb of hay as-fed in years 1 and 2 respectively. Forage sward height was measured with a falling plate meter (8.8 lb/yd²) at ten randomly-selected sites per paddock before initiation of grazing to determine live forage mass and residency time (RS) or strip size (SS and MS). Sward heights were similarly measured after cattle left a paddock to allow estimation of forage disappearance by grazing or trampling. Cattle in RS pastures were given access to an entire 1-ac paddock and were rotated to a new paddock daily for the first 20 days of grazing to prevent excessive forage maturity. After this, RS cattle were moved to a new paddock when initial sward height was reduced by 50% by measurement with the falling plate meter (yr 1) and after a calculated residency time, determined by dividing the total live forage DM by the required daily forage intake (total cow liveweight x % daily allowance; yr 2). Paddocks in SS pastures were divided into strips providing the daily forage allowance; cattle were given access to an additional strip each day, with no back fence. Paddocks in MS pastures were divided into strips providing 25% of the daily forage allowance; cattle were moved to a new strip with a back fence four times daily. All cattle had *ad libitum* access to water and salt, and a trace mineral mix (Framework 365 Mineral; Kent Feeds, Inc; Muscatine, IA) was limit-fed once per week.

Cows were weighed after being fed grass hay *ad libitum* for a minimum of three days at the initiation and

termination of the experiment to adjust for gut fill. Cows were also weighed unshrunk and BCS was determined by the same individual each month. Calves were weighed at birth and at termination of grazing. Surviving calf percentage was determined for each pasture by dividing the number of calves present at the end of the trial by the number of cows allocated to the pasture.

Forage samples, hand-clipped to 1-inch stubble height, were taken monthly at three randomly-selected 2.7-ft² sites per paddock. Samples in each pasture were composited into three fractions: paddock A (sacrifice/control paddock), paddocks that had been grazed in the current rotation, and paddocks that had not been grazed in the current rotation. Forage was hand-sorted into live grass, broadleaf weed, and legume species, and dead forage, and in May of both years, grass samples were further separated by species. Samples were dried at 140°F for 48 h and weighed to determine forage DM and botanical composition. Total live forage and dead forage were ground separately to pass a 1-mm screen for analysis of *in vitro* dry matter digestibility (IVDMD) and crude protein (CP).

Soil samples measuring 2 x 3 inches were collected at three sites per paddock in May, July, and October of each year for analysis of total soil C and soil bulk density. All visible roots were removed from a subsample and the soil was air-dried for four days, ground, and submitted for total soil C analysis. The remaining soil sample was dried at 100°C for four days to determine soil bulk density. A 0.875 x 6-inch core was collected and split into two 3-inch sections. Sections were dried at 100°C for four days to determine soil moisture from 0 to 3 and 3 to 6 inch depths. In yr 2, soil penetration resistance was measured at 1-inch intervals to a depth of 6 inches with a cone penetrometer with a diameter of 0.505 inches (Spectrum FieldScout SC 900 Soil Compaction Meter; Spectrum Technologies Inc., Plainfield IL).

Water infiltration rate was measured at two randomly-selected sites per paddock in May, July, and October of each year. Four inch tall double-ring infiltrometers (6 and 12 inch diameters for the inner and outer rings, respectively; Turf-Tec International, Tallahassee FL) were pounded two inches into the soil and filled with water. Water was added to fill the central ring at 30 min, 90 min, and whenever the water level dropped to one inch below the top to maintain a ponding depth of 2 to 1 inches, and the volume and time were recorded. Water infiltration rates were calculated from the average times and volumes of the last three water additions; or as the average infiltration rate over the final hour (30 to 90 min) if fewer than three additions of water were made. Soil was sampled with a 0.875 x 6 inch probe adjacent to each infiltration site and dried at 100°C for four days to determine antecedent soil moisture.

Grazing selectivity was analyzed on two consecutive days in June, July, and August of each year. One ruminally-fistulated steer was assigned to each pasture and allowed to acclimate for at least five days. On sampling days, the

rumens of steers were evacuated, the steers allowed to graze for two hours, and selected forage collected from the rumens. Samples of available forage were simultaneously hand-clipped at two 2.7-ft² sites within the same strips or paddocks that the cattle were grazing. Forage and rumen samples were dried and ground for analysis of IVDMD, CP, and acid- and neutral-detergent fiber (ADF and NDF). Concentration of each forage component in the selected forage was divided by concentration in the corresponding hand-clipped sample to calculate a selectivity index for that forage component.

Data were analyzed by the MIXED procedure of SAS. Models included year, month, treatment, block, and month*treatment interactions. Individual pastures (treatment*block) served as a random statement for analysis of repeated measures. Results are reported as least-squares means, with significance noted if $P \leq 0.05$ and with trends noted if $P \leq 0.10$.

Results and Discussion

By design, stocking density of cattle differed between treatments (Figure 1). Cow BW was greater for MS compared to RS and SS pastures in June of yr 2 ($P = 0.01$) and greater for RS than MS pastures in August of yr 2 (month*treatment, $P = 0.08$, Figure 2). Body weight of cows in MS pastures in June may have been great because of gut fill; cows in MS pastures had been moved to a new strip prior to weighing, while cows in SS and RS pastures had not. At the time of weighing in August, more cows in MS than RS pastures had given birth (5 in MS pastures compared to 1.5 in RS pastures). Cow BCS did not differ between treatments in any month of either year ($P > 0.10$). While cattle received the same daily forage DM, daily rotations of RS cattle early in the season were expected to improve forage quality for later months, by removing mature tissue and stimulating regrowth. However, forage quality differences, if any, apparently did not translate into improved cattle performance. Cattle in MS pastures consumed 10.4 and 3.3 lb grass hay as-fed per cow per day in years 1 and 2 respectively; this apparently did not contribute to improved performance.

Birth weight and ADG of calves present at the termination of grazing did not differ between treatments in either year ($P > 0.10$, Table 2). In yr 1, the proportion of calves remaining at the termination of grazing per cow allotted to pasture did not differ between treatments. In yr 2, there were fewer calves per cow at the termination of grazing in MS pastures than in RS or SS pastures ($P = 0.02$). The higher number of calves lost to abortion, morbidity, or mortality in MS pastures in yr 2 implies greater stress to animals in these pastures. Cattle in MS pastures may have been affected by acute heat stress, as they were limited to 154 to 237 ft²/cow, in pastures containing endophyte-infected tall fescue.

Despite the different stocking systems, forage sward height did not differ between treatments in any month of

either year ($P > 0.10$, Figure 3). Forage disappearance resulting from consumption or trampling by cattle tended to differ between treatments in yr 2 ($P = 0.06$, Figure 4) but not yr 1 ($P > 0.10$). Disappearance was lower for RS than SS or MS pastures in May and June (month*treatment, $P < 0.05$) of both years because of daily rotations of RS cows to new paddocks. Disappearance was also greater for RS compared to SS pastures in September of yr 1 (month*treatment, $P = 0.08$). The lack of difference in forage disappearance between stocking systems seems to result from equal forage allowance being provided to cows, regardless of stocking density.

Forage botanical composition prior to initiation of grazing in May of yr 2 did not differ from May of yr 1 ($P > 0.10$, Table 2). While MS is thought to increase legume content, no differences were observed in legume content as a percent of live forage DM between treatments or between years. The absence of a greater increase in legume content of MS and SS pastures may be caused by the slow movement of cattle through paddocks, which delayed grazing of some paddocks until after the ideal time for legume establishment; and the paddocks being regrazed in later months of yr 1, which allowed consumption or trampling of growing legumes. Furthermore, the high fertility of soil classes at the research location may have stimulated growth of cool-season grasses, which provide competition against legume establishment and persistence. As designed, botanical composition did not differ between treatments in May of yr 1. Dead forage DM, as a percent of total forage DM, tended to be lower in RS than SS and MS pastures in yr 2 ($P = 0.07$). Increased forage disappearance in RS pastures in September of yr 1 may have reduced the amount of forage residue in those pastures, contributing to less dead and weathered forage at the start of the following grazing season.

Soil bulk density from 0-3 inches in yr 1 did not differ between treatments in any month ($P > 0.10$). Similarly, water infiltration rate did not differ between treatments in any month in either year ($P > 0.10$, Figure 5). Soil penetration resistance in yr 2 at 0, 1, 2, 3, and 4-inch depths did not differ between treatments in any month ($P > 0.10$, Figure 6). At the 5 and 6-inch depths, penetration resistance was greater in SS than RS and MS pastures in May, but was greater in MS than SS pastures in October (month*treatment, $P < 0.10$). However, the absence of altered penetration resistance at shallower depths in MS pastures suggests that differences at the 5 and 6-inch depth may result from factors other than stocking density. Soil compaction results suggest that, while practices such as mob stocking increase cattle stocking density, the rapid movement of the cattle between strips counteracts the increased animal pressure on the soil. However, soil type may greatly influence response to compaction.

Grazing selectivity results from yr 1 show no differences between treatments in any month for selection of IVDMD and CP ($P > 0.10$). The IVDMD and CP values of

selected and available forage also did not differ between treatments in any month. These results suggest that, despite being presented with less forage at any given time, cattle in MS pastures are still able to select a higher-quality diet than the average of the forage presented to them.

Conclusions

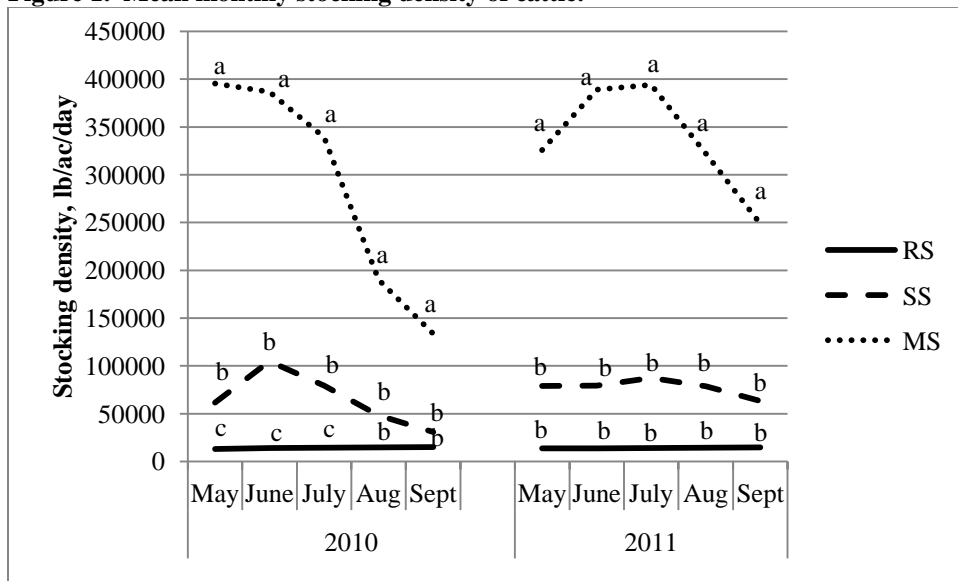
Preliminary analysis and results suggest that mob stocking, compared to rotational stocking at the same forage allowance, does not alter cow BW or BCS or the birth weight or ADG of surviving calves; increase legume content of pastures or alter forage sward height; or increase soil compaction over two grazing seasons. Thus, there seems to be no advantage of mob stocking over other forms of rotational stocking. Furthermore, the greater maturity of forage in some paddocks, the lack of shade, and concentration of cattle in a mob stocking system may increase the susceptibility of cows and calves to heat stress.

It should also be noted that results are likely to differ by site as soil type differences may influence forage and compaction responses. Experimental pastures, predominantly loams and silt-loams, have a high organic matter content that increase grass competition against legume establishment and persistence and make soils resilient to compaction. Soils high in clay or sand may respond more dramatically in organic matter, legume establishment, and soil compaction when mob stocked, compared to the pastures used in this experiment.

Acknowledgements

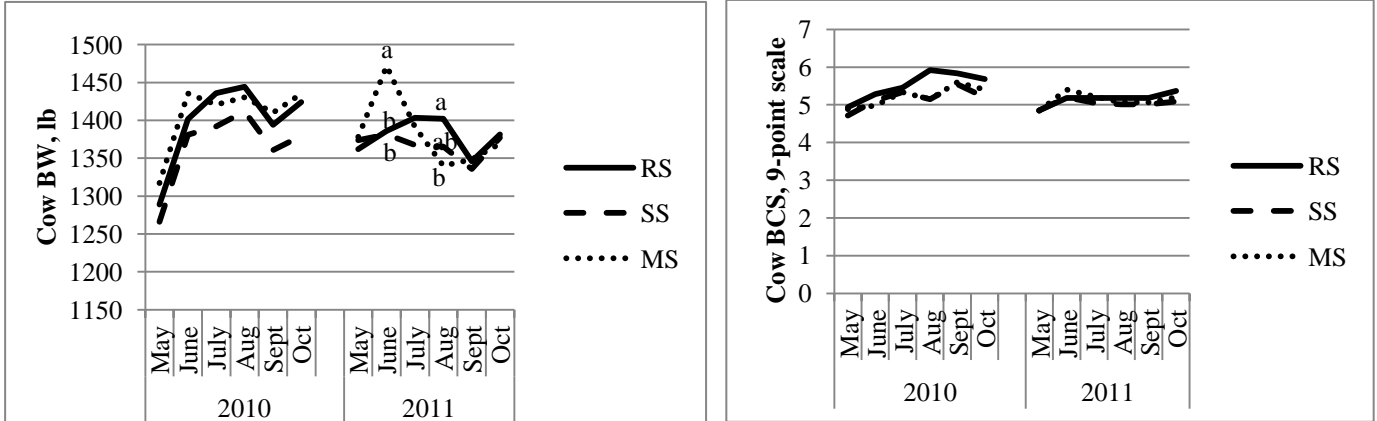
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Figure 1. Mean monthly stocking density of cattle.



^{a,b,c}Within a month, means without a common superscript differ, $P < 0.05$

Figure 2. Effect of stocking system on mean cow body weight and body condition score.



^{a,b}Within a month, means without a common superscript differ, $P < 0.10$.

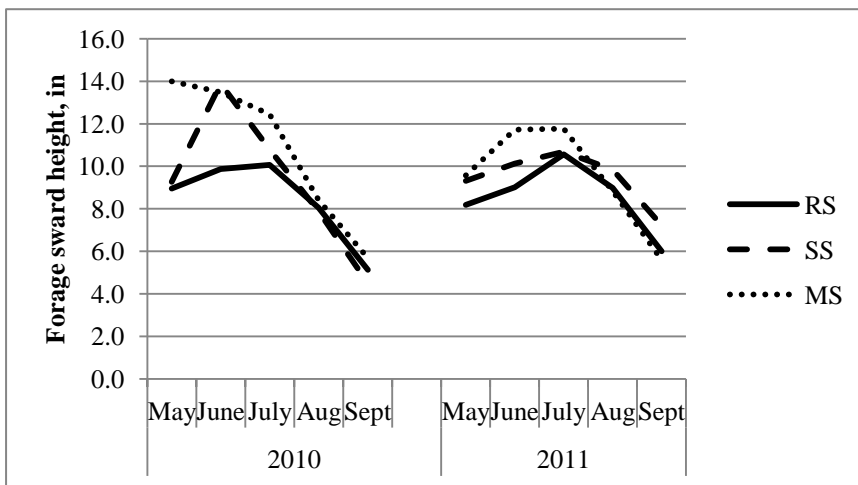
Table 1. Effect of stocking system on calf birth weight and average daily gain (ADG) and percent of live calves at end of trial.

	Calf birth weight (lb) ¹		Calf ADG (lb/day) ¹		Live calves at end of trial (% of cows allotted to pasture)	
	2010	2011	2010	2011	2010	2011
RS	72.9	72.2	2.5	2.3	90.0	100.0 ^a
SS	74.2	66.4	2.4	2.4	85.0	100.0 ^a
MS	72.9	66.5	2.4	2.3	90.0	65.0 ^b

¹For calves present at the end of the trial.

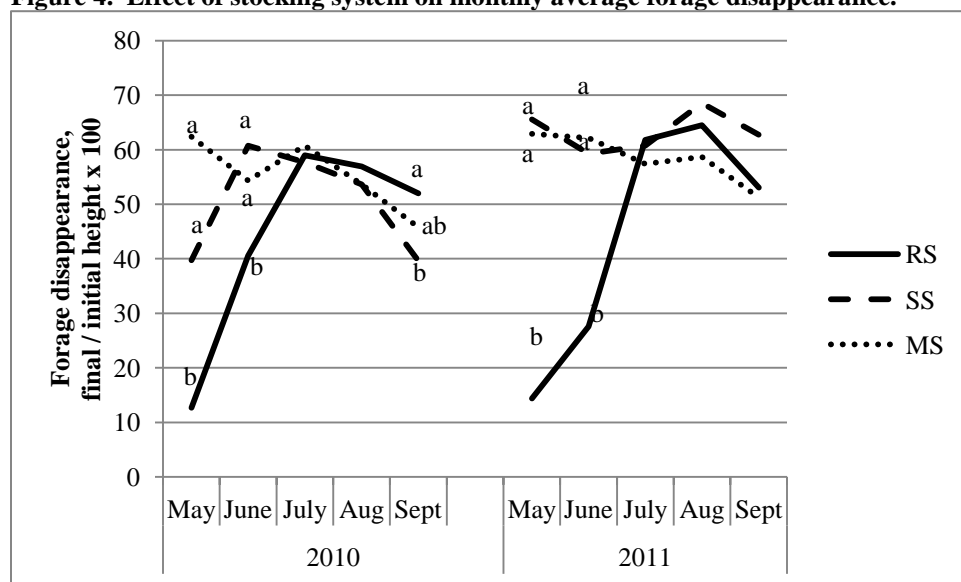
^{a,b}Within a column, means without a common superscript differ, $P < 0.05$.

Figure 3. Effect of stocking system on monthly average forage sward height.



No differences were observed between treatments in any month, $P > 0.10$.

Figure 4. Effect of stocking system on monthly average forage disappearance.



^{a,b}Within a month, means without a common superscript differ, $P < 0.10$.

Table 2. Effect of stocking system on forage botanical composition prior to grazing each year.

	May 2010 ¹				May 2011			
	Dead forage ^a	Live grass ^b	Weeds ^b	Legumes ^b	Dead forage ^a	Live grass ^b	Weeds ^b	Legumes ^b
RS	10.9	98.1	1.5	2.7	7.7 ^c	92.5	0.0	7.5
SS	13.4	95.8	0.5	0.6	12.4 ^d	91.9	1.7	6.3
MS	5.9	98.7	0.9	1.2	11.1 ^d	95.2	0.4	4.4

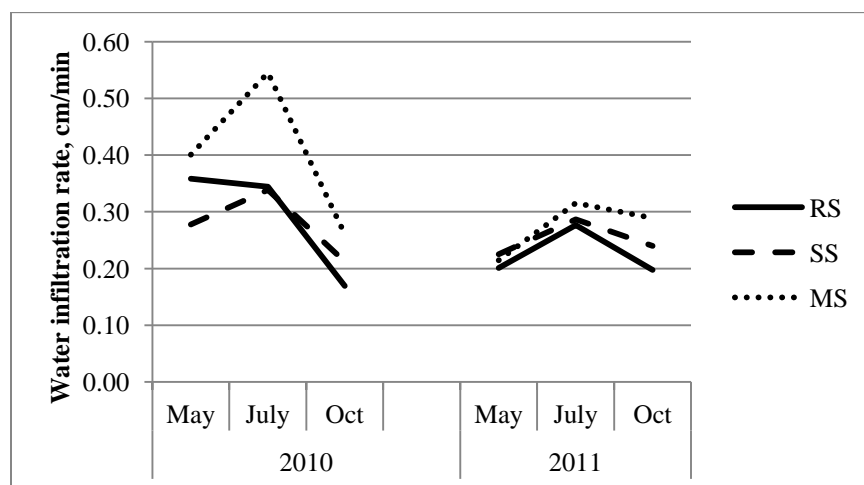
^aExpressed as a percent of total forage dry matter.

^bExpressed as a percent of total live forage dry matter.

¹No differences were observed between treatments or between years, $P > 0.10$.

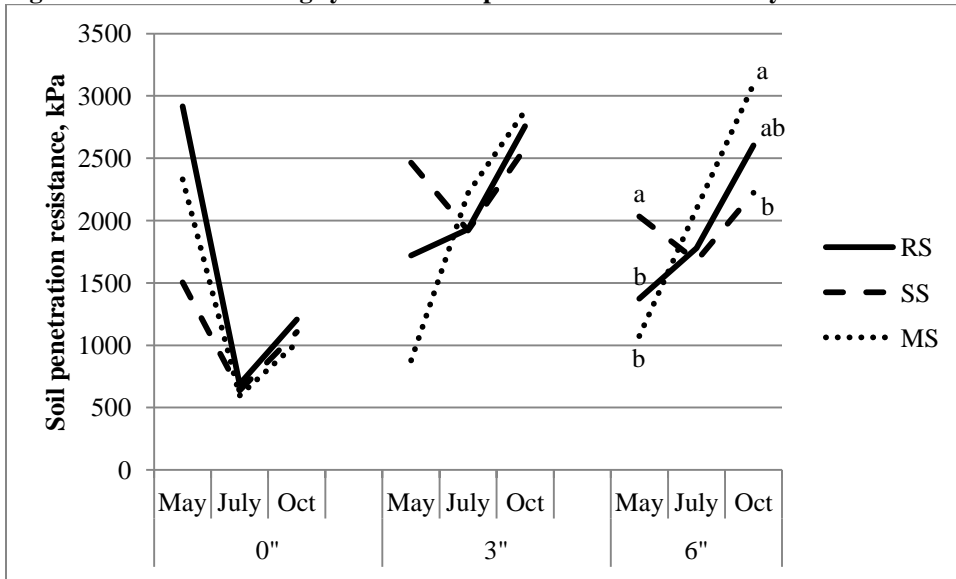
^{c,d}Means within a column without a common superscript differ, $P < 0.10$.

Figure 5. Effect of stocking system on water infiltration rate.



No differences were observed between treatments in any month of either year, $P > 0.10$.

Figure 6. Effect of stocking system on soil penetration resistance in year 2.



^{a,b}Within a month, means without a common superscript differ, $P < 0.10$.