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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 BW was greater in MS than SS 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 SS 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 SS 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.

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 arundinacea* 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%), red canarygrass (*Phalaris arundinacea*, 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 SS 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
Grazing selectivity results from
show no
difference 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.**

![Graph showing stocking density changes over months and years with superscript letters indicating significant differences.](image)

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.

![Graph showing 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.

<table>
<thead>
<tr>
<th></th>
<th>Calf birth weight (lb)(^1)</th>
<th>Calf ADG (lb/day)(^1)</th>
<th>Live calves at end of trial (% of cows allotted to pasture)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2011</td>
<td>2010</td>
</tr>
<tr>
<td>RS</td>
<td>72.9</td>
<td>72.2</td>
<td>2.5</td>
</tr>
<tr>
<td>SS</td>
<td>74.2</td>
<td>66.4</td>
<td>2.4</td>
</tr>
<tr>
<td>MS</td>
<td>72.9</td>
<td>66.5</td>
<td>2.4</td>
</tr>
</tbody>
</table>

\(^1\)For 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.

![Graph showing 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.

![Graph showing effect of stocking system on forage disappearance.]

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.

<table>
<thead>
<tr>
<th></th>
<th>May 2010</th>
<th>May 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dead forage(^a)</td>
<td>Live grass(^b)</td>
</tr>
<tr>
<td>RS</td>
<td>10.9</td>
<td>98.1</td>
</tr>
<tr>
<td>SS</td>
<td>13.4</td>
<td>95.8</td>
</tr>
<tr>
<td>MS</td>
<td>5.9</td>
<td>98.7</td>
</tr>
</tbody>
</table>

\(^a\)Expressed as a percent of total forage dry matter.
\(^b\)Expressed as a percent of total live forage dry matter.
\(^1\)No 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.

![Graph showing 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, $P < 0.10$. 