Allocating forage to fall-calving cow-calf pairs strip-grazing stockpiled tall fescue

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ABSTRACT: In a 2-yr study, we evaluated the effect of different forage allocations on the performance of lactating beef cows and their calves grazing stockpiled tall fescue. Allocations of stockpiled tall fescue at 2.25, 3.00, 3.75, and 4.50% of cow-calf pair BW/d were set as experimental treatments. Conventional hay-feeding was also evaluated as a comparison to grazing stockpiled tall fescue. The experiment had a randomized complete block design with 3 replications and was divided into 3 phases each year. From early December to late February (phase 1) of each year, cows and calves grazed stockpiled tall fescue or were fed hay in the treatments described above. Immediately after phase 1, cows and calves were commingled and managed as a single group until weaning in April (phase 2) so that residual effects could be documented. Residual effects on cows were measured after the calves were weaned in April until mid-July (phase 3). During phase 1 of both years, apparent DMI of cow-calf pairs allocated stockpiled tall fescue at 4.50% of BW/d was 31% greater (P < 0.01) than those allocated 2.25% of BW/d. As allocation of stockpiled tall fescue increased from 2.25 to 4.50% of cow-calf BW/d, pasture utilization fell (P < 0.01) from 84 ± 7% to 59 ± 7%. During phase 1 of both years, cow BW losses increased linearly (P < 0.02) as forage allocations decreased, although the losses in yr 1 were almost double (P < 0.01) those in yr 2. During phases 2 and 3, few differences were noted across treatment groups, such that by the end of phase 3, cow BW in all treatments did not differ either year (P > 0.40). Calf ADG in phase 1 increased linearly (P < 0.01) as stockpiled tall fescue allocations increased (y = −26.5x + 212; R² = 0.97) such that gain per hectare for cow-calf pairs allocated stockpiled tall fescue at 4.50% BW/d was nearly 40% less (P < 0.01) than for those allocated 2.25% of BW/d. Allocating cow-calf pairs stockpiled tall fescue at 2.25% of BW/d likely optimizes its use; because cow body condition is easily regained in the subsequent spring and summer months, less forage is used during winter, and calf gain per hectare is maximized.

Key words: fall-calving, forage allocation, stockpiled tall fescue


INTRODUCTION

Fall-calving of beef cows is gaining popularity with producers in the Midwestern United States. Advantages frequently cited for fall-calving include greater conception rates, lower calf loss at or near parturition, and greater market prices for calves (Bagley et al., 1987; Sprott et al., 2001). In addition, fall-calving cows typically have greater BCS at calving and breeding than do spring-calving cows (Janovick, 2002) and have more body reserves for BW cycling (Freetly et al., 2000). However, due to the high costs associated with feeding stored forage and concomitant lactation demands, the fall-calving cow incurs approximately 27% greater expense over winter compared with a nonlactating, spring-calving cow (Brees and Horner, 2007).

One way to reduce winter feed cost is to strip-graze stockpiled tall fescue (Lolium arundinacea Schreb) pastures. Several studies show that strip-grazing stockpiled tall fescue with nonlactating beef cows reduces the need for stored feed and labor for feeding (Hitz and Russell, 1998; Clark, 2003). However, few studies have examined the relationship between animal performance and forage allocation levels for lactating beef cows during winter. We hypothesized that cows provided a greater allocation of stockpiled tall fescue would...
Figure 1. Annual timeline of activities describing the major events for each experimental phase beginning with pasture preparation in August and ending with the final cattle BW in July.

exhibit less BW loss over winter than cows allocated less forage. We further hypothesized that calf gain per hectare would be maximized at lower forage allocations due to greater stocking densities. Our objective was to determine how allocating different levels of stockpiled tall fescue would influence pasture utilization as well as performance of lactating beef cows and their calves.

MATERIALS AND METHODS

The experimental protocol was reviewed and approved by the University of Missouri Animal Care and Use Committee.

A 2-yr grazing experiment was conducted from December 2, 2004 to July 18, 2005 (yr 1) and from December 1, 2005 to July 12, 2006 (yr 2) at the University of Missouri Forage Systems Research Center near Lincoln, Missouri (39° 51′ N, 93° 6′ W). The experiment was divided into 3 phases each year. During phase 1, cows and calves grazed stockpiled tall fescue from December 2 to February 23 in yr 1 and from December 1 to February 22 in yr 2 (Figure 1). During phase 2, cows and calves were commingled and managed as a single group and fed stockpiled tall fescue and hay from late February until weaning in April to measure the residual effects from phase 1. Phase 3 was designed to measure the residual effects on the cows. Phase 3 began after the calves were weaned and sold in April and ended in mid-July. During this phase, the cows (which were still commingled as 1 group) grazed cool-season grass-legume pastures.

Treatments and Experimental Design

Treatments were stockpiled tall fescue allocated on a daily basis at 2.25, 3.00, 3.75, or 4.50% of cow-calf pair BW. An additional treatment included hay fed ad libitum as a comparison to cow-calf pairs grazing stockpiled tall fescue. The experimental design was a randomized complete block with 5 treatments replicated 3 times.

Pasture Management for Stockpiled Tall Fescue

The experiment was conducted on a 50-ha block divided into twelve 4-ha pastures and 3 hay-feeding areas (described later). Pastures were established more than 20 yr before the experiment was initiated and contained tall fescue as the predominate species. Orchardgrass (Dactylis glomerata L.), Kentucky bluegrass (Poa pratensis L.), red clover (Trifolium pratense L.), and birdsfoot trefoil (Lotus corniculatus L.) were subordinate components. The subordinate components were less than 15% of the DM available, as assessed in the autumn of 2004 using a modification of the step-point method described by Evans and Love (1957). No difference \((P > 0.05)\) in species composition was found across pastures. Approximately 53 ± 8.6% of the tall fescue plants were endophyte-infected \(\text{[Neotyphodium coenophialum (Morgan-Jones and Gams; Glenn, Bacon, and Hanlin)]}\) when tested on November 2, 2004 and May 11, 2006 using the procedure of Hiatt et al. (1999).

Pastures were harvested for hay during the spring and summer before stockpiling. In mid-August, the pastures were grazed and then clipped to a height of 8 cm and then fertilized with 90 kg/ha of N with ammonium nitrate. Soil samples were collected and analyzed annually. Lime, P, and K were applied in mid-August according to the recommendations of the University of Missouri Soil Testing Laboratory (Brown and Rodriguez, 1983). After fertilization, pasture growth was allowed to accumulate until early December, when the grazing was initiated.
**Animal Management**

In mid-November each year, 75 multiparous, cross-bred (Gelbvieh and Angus) cows and their calves were stratified by cow BW and age and calf age and sex into 15 groups of 5. Cows were calved between September 15 and October 15 annually. After stratification, groups were randomly assigned to treatments. Water and trace-mineralized salt blocks were available ad libitum to cows and calves. In early December of both years, a Gelbvieh or Simmental bull was added to each group to initiate a 45-d breeding season.

Stockpiled tall fescue was strip-grazed using a temporary electric fence at the forage DM allocations described above for each treatment. Animals began grazing nearest the water source in each pasture and were moved into new forage every 3.5 d, based on their respective treatment DM allocation rate. Treatment groups were rotated between pastures within a block at the end of each 21-d period to minimize the effect of pasture variation on animal performance. Coinciding with the movement of treatment groups between pastures was the placement of a temporary electric back-fence to prevent animal access to previously grazed areas. Mixed-grass hay was fed to the animals during ice (>10 mm) and snow (>500 mm) events, which for the entire 2 yr of the experiment totaled 5 d.

The hay treatment utilized cool-season, grass-legume, large round bales harvested the previous spring. Bales were stored outside in an uncovered but well-drained location. Cows and calves assigned to the hay-feeding treatment were fed hay to ensure ad libitum access via round bales in feeders and restricted to a pasture area of 1 ha. Forage in this area was grazed to a height of 4 cm before the beginning of the experiment. Bale rings were checked daily, and more hay was offered to cows in another bale ring before the last bale was fully consumed. Bales were weighed and sampled for DM and nutritive value before being fed. No stockpiled tall fescue was allocated in the hay treatment.

**Forage Measurements**

Forage pregrazing yield from each pasture was measured annually by clipping ten 0.8 × 4.6-m strips to a 2-cm height with a tractor-mounted flail-type harvester before the beginning of grazing in December. Additional pregrazing harvests were taken from areas designated but not yet allocated for grazing every 21 d throughout phase 1. At the end of each 21-d period, 12 strips were clipped from the grazed areas to determine postgrazing yield. Apparent DMI (pasture DM disappearance) was calculated as the difference in the yields of each pre- and postgrazing harvest (Casler et al., 1998). Forage DM yield changes due to weathering within a 21-d period were calculated as the pregrazing DM yield at the beginning of the period minus the pregrazing yield for the next-to-be allocated strip 21 d later. However, these changes were small (typically 2 to 3% DM loss) within a period and did not substantially change the apparent DMI measurements. Pasture utilization was calculated as ([1 – (postrazing DM yield/pregrazing DM yield)] × 100). Snow during the second harvest of yr 1 resulted in inaccurate forage DM measurements, and the data were not included in the analysis.

Grab samples collected from each harvest strip were composited for a single pasture. The composited samples were divided into 2 subsamples of approximately 300 g each. The first subsample was analyzed for DM in a forced-air oven for a minimum of 24 h at 90°C. The second subsample was frozen, freeze-dried, ground through a cyclone mill (UDY Corp., Ft. Collins, CO) to pass a 1-mm screen, and analyzed for nutritive value.

Crude protein and in vitro true digestibility (IVTD) were measured with near-infrared reflectance spectroscopy using the scanning, calibration, and validation methods described by Westerhaus et al. (2004; Table 1). Crude protein for calibration samples was calculated as 6.25 times the total N concentration determined with a Leco FP-428 nitrogen analyzer (Leco Corp., St. Joseph, MI). In vitro true digestibility was determined by running a 48-h in vitro digestion followed by washing with a NDF solution (Spanghero et al., 2003). Ruminal fluid was collected from a cannulated cow offered a forage-based diet.

**Animal Measurements**

Cow and calf BW were determined at the beginning and end of grazing stockpiled tall fescue (phase 1), at weaning (phase 2), and in midsummer (phase 3; cows only). Cow and calf BW were measured on 2 consecutive mornings without prior removal from water or pasture. An experienced technician assigned BCS to all cows using a 9-point scale, where 1 = emaciated and 9 = obese (Wagner et al., 1988). On April 12 of yr 1 and April 4 of yr 2, cow pregnancy rates were determined by rectal palpation and ultrasonography.

**Statistical Analyses**

Apparent DMI, pasture utilization, and forage nutritive value were analyzed as a randomized complete block with 5 treatments and 3 replicates, as described by Steel and Torrie (1980). The model used included year and blocks as main plots, allocation levels (treatments) as subplots, and all possible interactions. Year and interactions with year were considered as random effects and all others as fixed effects. Repeated measures ANOVA procedures were used to test the effects of treatments. PROC MIXED (SAS Inst. Inc., Cary, NC) was used assuming first-order autoregressive correlation among the repeated measures. Within a phase, animal performance data, except cow conception, were also analyzed as a randomized complete block using the model described above. The experimental unit for all measurements in animal performance was the group of 5 cow-calf pairs on each of the 12 pastures or 3 hay-
Table 1. Calibration statistics for near-infrared spectroscopic determination of CP and in vitro true digestibility content in stockpiled tall fescue

<table>
<thead>
<tr>
<th>Population, % of DM</th>
<th>n</th>
<th>R²</th>
<th>Mean</th>
<th>SEC¹</th>
<th>SECV²</th>
<th>1 – VR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP</td>
<td>60</td>
<td>0.95</td>
<td>12</td>
<td>0.29</td>
<td>0.39</td>
<td>0.91</td>
</tr>
<tr>
<td>In vitro true digestibility</td>
<td>50</td>
<td>0.98</td>
<td>76</td>
<td>1.27</td>
<td>1.99</td>
<td>0.95</td>
</tr>
</tbody>
</table>

¹SEC = standard error of calibration calculated in modified partial least squares regression.
²SECV = standard error of cross-validation calculated in modified partial least squares regression.
³1 – VR = 1 minus the variance ratio calculated in cross-validation in modified partial least squares regression.

According to the NRC (2000), a beef cow weighing 610 kg in midlactation requires 12.7 kg of DM/d. Forage DMI estimates for the suckling calf are somewhat variable, but most sources suggest that the calves in this study would consume 3 to 4 kg of DM/d of forage (Wyatt et al., 1977; Anstotegui et al., 1991). Thus, the total amount of forage needed by a cow-calf pair is predicted to be 16 kg of DM/d. Although cow-calf pairs allocated stockpiled tall fescue at 2.25% BW/d showed far greater pasture utilization than has been reported during the growing season (Gerrish et al., 1995), it was lower than the nearly 100% utilization required to meet these DMI targets. Baker et al. (1981) concluded that daily forage allocations of 5.1, 3.4, and 1.7% of cow-calf pair BW resulted in 8.8, 8.5, and 7.3 h of grazing each day and daily OM intake of 11.6, 10.2, and 7.05 kg/cow. Similarly, Virkajarvi et al. (2001) found that when forage allocation to dairy cows was decreased from 5.1 to 3.6% of BW, pasture utilization increased from 61 to 78%. We observed that cow-calf pairs allocated stockpiled tall fescue at 2.25% of BW/d had ample forage for grazing during the first 2 d each time a new strip was offered (every 3.5 d) but lacked grazable forage for the 24 to 36 h before the next offering.

RESULTS AND DISCUSSION

Apparent DMI and Pasture Utilization

Apparent DMI and pasture utilization of stockpiled tall fescue was affected by forage allocation (P < 0.03) and year (P < 0.04). However, the interactions were not significant (P > 0.09), so data were combined across years. Averaged across treatments, apparent DMI of cow-calf pairs was 18.2 ± 0.7 kg/d for yr 1 compared with 15.5 ± 0.7 kg/d for yr 2 (P = 0.04). As a consequence, pasture utilization averaged 77 ± 2.0% in yr 1 compared with 63 ± 2.0% for yr 2 (P = 0.04). The differences between years were attributed to variations in weather. Year 1 was a wet winter with total precipitation measuring 142 mm during phase 1, whereas yr 2 was a drier winter with only 64 mm of total precipitation (Figure 2). In yr 1, cows likely had greater energy requirements for body temperature regulation (NRC, 2000) than in yr 2.

Apparent DMI was greatest for cow-calf pairs allocated stockpiled tall fescue at 4.50% of BW/d (Figure 3). At 19.4 ± 1.7 kg/d, they consumed 31% more (P < 0.01) DM than cow-calf pairs allocated 2.25% of BW/d. This difference in DMI led to obvious changes in pasture utilization, with utilization averaging 59 ± 7% when cow-calf pairs were allocated 4.50% of BW/d to nearly 85 ± 7% utilization when cow-calf pairs were allocated 2.25% of BW/d (P < 0.01; Figure 3). Our data show that as the allocation of stockpiled tall fescue is decreased by 1 percentage unit of cow-calf BW/d, pasture utilization increases by about 11 percentage units. Additionally, throughout phase 1, cow-calf pairs in the hay treatment used 19.5 ± 1.7 kg/d of hay (data not shown).

According to the NRC (2000), forage DMI estimates for the suckling calf are somewhat variable, but most sources suggest that the calves in this study would consume 3 to 4 kg of DM/d of forage (Wyatt et al., 1977; Anstotegui et al., 1991). Thus, the total amount of forage needed by a cow-calf pair is predicted to be 16 kg of DM/d. Although cow-calf pairs allocated stockpiled tall fescue at 2.25% BW/d showed far greater pasture utilization than has been reported during the growing season (Gerrish et al., 1995), it was lower than the nearly 100% utilization required to meet these DMI targets. Baker et al. (1981) concluded that daily forage allocations of 5.1, 3.4, and 1.7% of cow-calf pair BW resulted in 8.8, 8.5, and 7.3 h of grazing each day and daily OM intake of 11.6, 10.2, and 7.05 kg/cow. Similarly, Virkajarvi et al. (2001) found that when forage allocation to dairy cows was decreased from 5.1 to 3.6% of BW, pasture utilization increased from 61 to 78%. We observed that cow-calf pairs allocated stockpiled tall fescue at 2.25% of BW/d had ample forage for grazing during the first 2 d each time a new strip was offered (every 3.5 d) but lacked grazable forage for the 24 to 36 h before the next offering.

Postgrazing Nutritive Value

Crude protein concentrations in stockpiled tall fescue after grazing (postgrazing) averaged 12 ± 0.2% and were unaffected (P > 0.20; data not shown) by forage allocation. However, IVTD postgrazing was influenced by forage allowance during both years (P < 0.1) and was positively correlated to forage allocation (R² = 0.99; Figure 4). Additionally, all measures of postgrazing nutritive value were lower (P < 0.05) than pregrazing values (Table 2; Figure 4). Roth et al. (1990) documented that as grazing pressure decreases, cattle select for leaf tissue and avoid stems. Cow-calf pairs allocated stockpiled tall fescue at 4.50% of BW/d likely had the opportunity to select forage with greater CP and IVTD concentrations compared with cow-calf pairs allocated less forage. Cow-calf pairs in the 2.25% of BW/d treatment had little opportunity for selection due to the lack of forage in the 24 to 36 h before the next allocation.

Cow Performance

Phase 1. Interactions between year and treatment were observed (P < 0.05) for cow BW, BCS, and BW

feeding areas. Orthogonal contrasts were used to examine the linear, quadratic, and cubic responses across the different allocations of stockpiled tall fescue. Additional contrasts were used to compare the hay treatment to all allocations of stockpiled tall fescue and the 2.25% of BW allocation to all other allocations (3.0, 3.75, and 4.5% of BW/d) of stockpiled tall fescue. Where applicable, regression analysis was used to explain variable responses using least squares analysis of function and fit (Steel and Torrie, 1980) using PROC REG of SAS. Differences between treatments in conception rates were analyzed by χ² analysis using PROC FREQ of SAS.
change during phase 1; thus, data are presented by year. In yr 1, cow BW averaged $606 \pm 5$ kg at the beginning of phase 1 (Table 3). During phase 1, cow BW losses increased linearly as forage allocations decreased ($P = 0.01; y = 10.4x - 123.1; R^2 = 0.70$). Cows in the 2.25% of BW/d treatment lost 105 $\pm 5$ kg during phase 1, which was at least 19 kg more ($P < 0.01$) than any of the other stockpiled tall fescue allocations. Cows in the hay treatment lost 43 $\pm 5$ kg, which was about half as much BW ($P < 0.01$) as the other treatments. In yr 2, cow BW averaged $611 \pm 2$ kg at the beginning of phase 1, but changes in cow BW were much less ($P < 0.01$) than in yr 1. Cows in the 2.25% of BW/d treatment lost 24 $\pm 5$ kg during phase 1 (Table 3), which was substantially less than during the same time during yr 1 ($P < 0.01$). In yr 2, cow BW loss decreased linearly ($P = 0.02; y = 9.5x - 47.6; R^2 = 0.97$) as the forage allocation increased, with cows in the 4.50% of BW/d treatment losing only 3 $\pm 5$ kg during phase 1. Cows in the hay treatment lost 25 $\pm 5$ kg during phase 1 of yr 2, which did not differ ($P = 0.12$) from any of the stockpiled tall fescue allocations. We attribute the large differences in BW change between years to the difference in weather conditions mentioned previously.

At the end of phase 1, cows in the hay treatment had a BCS of $5.2 \pm 0.10$, which was a loss of $0.5 \pm 0.11$ units over this phase (Table 4). Cow BCS during phase 1 of yr 1 responded quadratically ($P = 0.01$) to stockpiled tall fescue allocation (Table 4). During yr 1, cow-calf pairs allocated stockpiled tall fescue at 3.00, 3.75, and 4.50% of BW/d lost 1.2 BCS units, which was less ($P < 0.01$) than the $1.9 \pm 0.11$ BCS units that cows allocated 2.25% of BW/d lost (Table 4). During yr 2, cow BCS loss during phase 1 ($0.4 \pm 0.09$) did not differ between any treatments ($P = 0.89$).

Although fall-calving cows are expected to lose BW and BCS over winter (Bagley et al., 1987; Janovick et al., 2004; Coffey et al., 2005), producers using stockpiled tall fescue can manage this loss by judicious forage allocation. Because the amount of on-farm stockpiled forage may be inadequate for the entire winter-feeding period (Gerrish, 1999), maximizing this resource by limit feeding while ensuring that cow BW and BCS loss is acceptable is likely to maximize economic returns. However, there are limitations. The cows in this experiment were in optimum condition at the beginning of winter and were able to withstand some loss in BW and BCS and still be within the guidelines recommended for fall-calving cows in the Midwest (Whittier et al., 1993). Despite the BW and BCS losses for cows during phase 1, in both years conception rates did not differ (yr 1 $P = 0.11$; yr 2 $P = 0.26$) for all treatments and averaged
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Figure 3. Pasture DM utilization and apparent DMI of cow-calf pairs as a function of stockpiled tall fescue allocated during phase 1. Data were pooled over 2 yr of experimentation. Error bars represent 2 times the SE (n = 6 for each mean).

93%. This reproductive success shows that stretching forage supplies by limit feeding stockpiled tall fescue does not necessarily result in low conception rates for fall-calving cows. However, had cows entered into phase 1 at a lower BW and BCS, the cows likely would have dropped to levels considered unacceptable for reproductive success (Whittier et al., 1993).

**Phases 2 and 3.** During yr 1, cows from the hay treatment lost 48 ± 5 kg during phase 2, which was 25 to 34 kg more (P < 0.01) than cows that had grazed any of the 4 stockpiled tall fescue allocations during phase 1 (Table 3). During phase 2, BW loss was not different (P = 0.30) for cows that had previously grazed any of the stockpiled tall fescue allocations. In yr 1, cows allocated 2.25% of cow-calf BWd in phase 1 improved their BCS in phase 2 by 0.8 ± 0.13 units, compared with an average of 0.40 ± 0.13 units for the other stockpiled tall fescue treatments (P = 0.01; Table 4). During yr 2, cows lost an average of 44 ± 6 kg during phase 2 (P = 0.46; Table 3), resulting in the treatment differences in cow BW at

<table>
<thead>
<tr>
<th>Table 2. Amounts and nutritive value (pregrazing) of stockpiled tall fescue and hay offered to cow-calf pairs during phase 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Treatment</strong></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td><strong>Year 1</strong></td>
</tr>
<tr>
<td>Stockpiled tall fescue offered, kg/cow-calf pair</td>
</tr>
<tr>
<td>Hay fed, kg/cow-calf pair</td>
</tr>
<tr>
<td>CP during phase 1, % of DM</td>
</tr>
<tr>
<td>IVTD during phase 1, % of DM</td>
</tr>
<tr>
<td><strong>Year 2</strong></td>
</tr>
<tr>
<td>Stockpiled tall fescue offered, kg/cow-calf pair</td>
</tr>
<tr>
<td>Hay fed, kg/cow-calf pair</td>
</tr>
<tr>
<td>CP during phase 1, % of DM</td>
</tr>
<tr>
<td>IVTD during phase 1, % of DM</td>
</tr>
</tbody>
</table>

1Stockpiled tall fescue allocated as a percentage of cow-calf pair BW/d or hay fed ad libitum.
2Cow-calf pair grazing allocations of stockpiled tall fescue were fed hay only when weather conditions did not permit grazing.
3IVTD = in vitro true digestibility.
Figure 4. Relationship between forage allocation and in vitro true digestibility (IVTD) of postgrazed forage during phase 1 for yr 1 (2004 to 2005) and yr 2 (2005 to 2006). Error bars represent 2 times the SE (n = 12 for each mean).

the end of phase 1 still being detectable at the end of phase 2 ($P < 0.01$). In yr 2, cows in the hay treatment lost $0.6 \pm 0.07$ BCS units during phase 2, which was a greater ($P = 0.03$) loss than cows allocated stockpiled tall fescue during phase 1 (Table 4).

During phase 3, cow BW increased considerably both years. In yr 1, cow-calf pairs allocated stockpiled tall fescue at 2.25% BW/d during phase 1 gained $119 \pm 7$ kg during phase 3 (Table 3) compared with $98 \pm 7$ kg for the other allocations of stockpiled tall fescue ($P = 0.03$). In yr 2, cow BW gain in phase 3 averaged $65 \pm 7$ kg with none of the treatments differing ($P > 0.18$). In both years, cow BW at the end of phase 3 did not differ or was greater than that recorded at the beginning of phase 1. Cow BCS recovered by 1.2 to 1.8 units during phase 3 in both years (Table 4). However, with the exception of the hay treatment in yr 1, BCS did not differ across treatments ($P > 0.05$) with BCS values at or above those recorded at the beginning of phase 1 in both years (Table 4).

Janovick et al. (2004) in Iowa and Bagley et al. (1987) in Louisiana reported that fall-calving cows gained 32 to 50 kg of BW from April to August. In our study, the rapid BW gains recorded once cows had access to spring pasture show that cows fed a minimal amount of winter feed can easily recover their BW and BCS even if losses in winter are substantial. Because costs to feed livestock in winter are substantially greater than the costs once pasture growth resumes in spring (Brees and Horner, 2007), maintaining additional BW on cows in winter would presumably be of little benefit, because the cows can easily recover from this loss when pasture growth resumes in spring. Additionally, in most pasture systems in the Midwest, forage growth in spring is greater than the ability of most cow herds to consume the forage before quality falls to unacceptable levels (Roberts, 1999). Thus, compared with well-conditioned cows, thinner cows could consume a greater proportion of their BW as forage in spring, which may balance pasture growth and animal consumption.

Calf Performance

Phase 1. Calf ADG in yr 2 was greater ($P < 0.05$) than yr 1. However, there were no year × treatment interactions ($P > 0.05$), and therefore, data were averaged over both years. Calf ADG increased linearly ($P < 0.01$) as allocations of stockpiled tall fescue increased
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Table 3. Body weight and BW change of cows during phases 1, 2, and 3 for yr 1 (2004 to 2005) and yr 2 (2005 to 2006)

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment1</th>
<th>SEM2</th>
<th>Contrasts, P-value</th>
<th>Hay vs. other allocations3</th>
<th>2.25 vs. other allocations4</th>
<th>L5</th>
<th>Q5</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>Initial BW, kg</td>
<td>611 610 611 599 600</td>
<td>5</td>
<td>&lt;0.001</td>
<td>0.003</td>
<td>0.01</td>
<td>0.07</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>BW change for phase 1, kg</td>
<td>−105 −86 −78 −82 −43</td>
<td>5</td>
<td>&lt;0.001</td>
<td>0.30</td>
<td>0.26</td>
<td>0.61</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>BW change for phase 2, kg</td>
<td>−14 −19 −23 −21 −48</td>
<td>5</td>
<td>0.81</td>
<td>0.03</td>
<td>0.34</td>
<td>0.05</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>BW change for phase 3, kg</td>
<td>119 91 98 105 101</td>
<td>7</td>
<td>0.41</td>
<td>0.21</td>
<td>0.52</td>
<td>0.51</td>
<td>0.14</td>
</tr>
<tr>
<td>Year 2</td>
<td>Initial BW, kg</td>
<td>610 612 610 615 608</td>
<td>2</td>
<td>&lt;0.001</td>
<td>0.06</td>
<td>0.02</td>
<td>0.56</td>
<td>0.98</td>
</tr>
<tr>
<td></td>
<td>BW change for phase 1, kg</td>
<td>−24 −21 −13 −3 −25</td>
<td>5</td>
<td>0.12</td>
<td>0.26</td>
<td>0.16</td>
<td>0.57</td>
<td>0.80</td>
</tr>
<tr>
<td></td>
<td>BW change for phase 2, kg</td>
<td>−36 −41 −46 −46 −52</td>
<td>6</td>
<td>0.18</td>
<td>0.76</td>
<td>0.86</td>
<td>0.67</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>BW change for phase 3, kg</td>
<td>64 59 69 57 74</td>
<td>7</td>
<td>0.27</td>
<td>0.75</td>
<td>0.41</td>
<td>0.68</td>
<td>0.60</td>
</tr>
</tbody>
</table>

1Stockpiled tall fescue allocated as a percentage of cow-calf pair BW/d or hay fed ad libitum.
2Standard error of the mean, n = 75 cows/yr.
3Orthogonal contrast of hay fed ad libitum vs. the mean of all allocations of stockpiled tall fescue.
4Orthogonal contrast of allocating stockpiled tall fescue at 2.25% of cow-calf pair BW/d vs. allocating 3.00, 3.75, or 4.50%.
5L = linear; Q = quadratic; C = cubic.

(y = 0.063x + 0.513; R² = 0.91; Figure 5). However, the slope of this line shows that allocating more stockpiled tall fescue to cow-calf pairs to increase calf ADG would be an inefficient process. For instance, to improve calf ADG from 0.65 to 1.0 kg, it would require allocating cow-calf pairs more than 7.7% of BW/d, with calf G:F ratio of less than 1:100. Additionally, calf gain per hectare decreased linearly (P < 0.01) as stockpiled tall fescue allocations increased (y = −26.5x + 212; R² = 0.97). Thus, by allocating stockpiled tall fescue to cow-calf pairs at 2.25% of BW/d, gain per hectare was maximized at 155 ± 11 kg/ha compared with 97 ± 4 kg/ha for those allocated 4.50% of BW/d (P < 0.01; Figure 5).

Our data show that lactating beef cows lose BW over winter regardless of the amount of stockpiled tall fescue allocated, whereas calf ADG increases modestly with forage allocation. Johnson et al. (2003) found that for Brangus cows, a 0.07% BW/d increase in forage DMI was associated with a 1 kg increase in milk yield. Because Rutledge et al. (1971) and Lake et al. (2005) concluded that the major variation in calf weaning weight could be attributed to milk production of the dam, it is probable that as the amount of stockpiled tall fescue allocated to cow-calf pairs declines, so does milk production and thus, calf ADG. However, beef production was maximized not where ADG was greatest but rather when a limited amount of stockpiled forage was fed and stocking density could be maximized. Although there are limitations to how far this relationship extends, several researchers showed that a modest reduction in

Table 4. Body condition score of cows during phases 1, 2, and 3 of yr 1 (2004 to 2005) and yr 2 (2005 to 2006)

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment1</th>
<th>SEM2</th>
<th>Contrasts, P-value</th>
<th>Hay vs. other allocations3</th>
<th>2.25 vs. other allocations4</th>
<th>L5</th>
<th>Q5</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>Initial BCS</td>
<td>6.0</td>
<td>0.9</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.02</td>
<td>0.01</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>BCS change for phase 1</td>
<td>−1.9 −1.3 −1.0 −1.4 −0.5</td>
<td>0.11</td>
<td>0.07</td>
<td>0.01</td>
<td>0.13</td>
<td>0.07</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>BCS change for phase 2</td>
<td>0.8 0.3 0.3 0.5 0.2</td>
<td>0.13</td>
<td>0.29</td>
<td>0.64</td>
<td>0.68</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td></td>
<td>BCS change for phase 3</td>
<td>1.7 1.8 1.7 1.6 1.6</td>
<td>0.10</td>
<td>0.04</td>
<td>0.46</td>
<td>0.82</td>
<td>0.42</td>
<td>0.82</td>
</tr>
<tr>
<td>Year 2</td>
<td>Initial BCS</td>
<td>6.6</td>
<td>0.12</td>
<td>0.74</td>
<td>0.53</td>
<td>0.44</td>
<td>0.67</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td>BCS change for phase 1</td>
<td>−0.4 −0.4 −0.5 −0.4 −0.3</td>
<td>0.09</td>
<td>0.03</td>
<td>0.84</td>
<td>0.96</td>
<td>0.74</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>BCS change for phase 2</td>
<td>−0.3 −0.3 −0.4 −0.4 −0.6</td>
<td>0.07</td>
<td>0.51</td>
<td>0.40</td>
<td>0.83</td>
<td>0.27</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>BCS change for phase 3</td>
<td>1.4 1.2 1.3 1.4 1.4</td>
<td>0.12</td>
<td>0.45</td>
<td>0.20</td>
<td>0.77</td>
<td>0.05</td>
<td>0.40</td>
</tr>
</tbody>
</table>

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5L = linear; Q = quadratic; C = cubic.
individual animal performance often increases animal production per hectare (McCartor and Rouquette, 1977; Hart et al., 1988; Virkajarvi et al., 2001). Because stockpiled tall fescue is often the least cost source of feed during winter in the Midwest, and the amount of this feed on farm is often limited (Gerrish, 1999), allocating this forage at 2.25% of cow-calf pair BW/d would optimize economic use.

**Phase 2.** At weaning, all calves averaged 195 ± 8 kg ($P = 0.33$). Our weaning weight results indicate that there would be little benefit to providing cow-calf pairs stockpiled tall fescue at an allocation of more than 2.25% of BW/d during winter. In systems in which stockpiled tall fescue is used as the winter forage source, calf weaning weights above 195 kg are more likely to be realized with supplementation with greater quality feedstuffs or using some sort of creep-grazing strategy than by allocating cow-calf pairs more than 2.25% of BW/d in early winter.

Results from this grazing experiment show that as allocation of stockpiled tall fescue is decreased, cow BW, calf ADG, and apparent DMI decrease, but the amount of land required to winter a fall-calving herd also decreases. Forage allocations for stockpiled tall fescue are optimized at 2.25% of cow-calf BW/d, because of the following: 1) calf weaning weights are comparable to greater forage allocations, 2) cow BW loss in winter is easily regained in spring and early summer, 3) land requirements are decreased, and 4) calf gain per hectare can be increased by nearly 40%.

**LITERATURE CITED**


