Supplementation with Ground Corn is Cost Effective for Increasing Weight Gain of Steers Grazing Bermudagrass

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Abstract
Weight gain of stockers generally declines in the middle to late grazing season and a reduction in grass digestible energy has been implicated. Steers grazed bermudagrass (Cynodon dactylon) during a 2-year experiment in west-central Arkansas. Animal and pasture responses were compared for treatments including supplementation with ground corn (2 lb per steer per day) over the whole grazing season (112 days), supplementation only in the late grazing season (56 days), and no supplementation (control). Two feeding intervals of 24 and 48 h also were compared for the supplementation treatments. In vitro dry matter digestibility (IVDMD) declined throughout the grazing season in 2002 and during the first 80 days in 2001. Supplementation for the whole grazing season generally resulted in greater average daily gain (ADG) and weight gain per acre than late-season supplementation and the control. Weight gain did not differ between 24- and 48-h feeding intervals. Feeding ground corn to steers grazing bermudagrass can effectively increase ADG if fed for the whole grazing season at a rate of 2 lb per steer per day.

Introduction
Bermudagrass is a warm-season perennial grass that is widely used for grazing by cattle in the southeast USA, but cattle weight gains typically slump in the middle to late grazing season (2,8,15,16). Lower weight gain during the late summer may be associated with decreased organic matter digestibility (7,11). Supplementation with small quantities of high-energy concentrate can enhance weight gains of growing cattle on grass pastures (1,3,4,5,12). Aiken (1) showed increases in average daily gain (ADG) of steers as daily corn consumption increased from 0 to 3 lb per steer. Gain stabilized between 3 and 5 lb per steer per day consumption rates. Cost effectiveness of supplementing with corn to steers grazing bermudagrass could improve if strategically done in the later grazing season when there are deficits in dietary energy intake. Furthermore, time and labor could be saved if cattle are fed at 48-h intervals rather than at 24-h intervals.

Grazing Experiment
The grazing experiment was conducted in 2001 and 2002 at Booneville in west-central Arkansas. Procedures used in the experiment were approved by the location Animal Use and Care Committee. At the start of each grazing season, 56 steers at the start of each grazing season were weighed after a 12- to 14-h fast from feed and water. They were then dewormed with Ivermectin (Merck, Inc., Whitehouse, NJ), implanted with Synovex-S (Fort Dodge Animal Health, Fort Dodge, IA), and randomly assigned to the bermudagrass pastures. There were five treatments including an unsupplemented control and four ground corn
supplement treatments. Pasture was the experimental unit. Ground corn was fed either the whole grazing season of 112 days or the second half of the grazing season (56 days). For both of these treatments, corn was offered at feeding intervals of either 24 or 48 h. Steers were group-fed within an experimental unit to provide either 2 lb ground corn per steer per 24-h interval or 4 lb ground corn per steer per 48-h interval. There were three randomized complete blocks. The blocks contained either common bermudagrass (Block 1), common and 'Tifton-44' bermudagrasses (Block 2), or common and 'Midland' bermudagrasses (Block 3). The common-Midland block was large enough for only four pastures, so one treatment was left out of this block each year. In 2001, the whole-grazing season supplementation and 48-h treatment was not evaluated, and in 2002, the late-grazing season supplementation and 48-h combination was not evaluated. Therefore, each of these treatments had three replicates for one of the two years and two replicates for the other year.

The pastures were fertilized with N at a rate of 75 lb/acre on 18 April and 19 June 2001, and on 10 May and 19 June 2002. An extra application of N at 50 lb/acre was applied on 17 May 2001 because heavy rains following the April application may have leached N before bermudagrass was actively growing.

Pastures were continuously stocked with four tester steers that remained on a given pasture during the entire grazing season. Similar steers were added or removed from pastures as needed to maintain forage mass between 2500 and 3000 lb dry matter per acre. Grazing was initiated on 5 June in 2001 by steers of average body weight (BW) of 544 ± 5.4 (SE) lb and on 30 May in 2002 by steers of average BW of 607 ± 5.4 lb. Shrunken weights were taken on Days 1 and 56 and at the termination of grazing on Day 112. A mineral and vitamin supplement that contained Ca, P, Na, Mg, K, Cu, Se, Zn, and vitamins A, D, and E was offered free choice in all pastures.

Animal and Pasture Measurements

Steers were ultrasonically scanned using an Aloka SSD-500V (Aloka Co. Ltd., Tokyo, Japan) instrument at the initiation and conclusion of grazing. Cross sections of the ribeye muscle were scanned between the 12th and 13th ribs to measure external fat thickness and ribeye area (Fig. 1). External fat thickness was measured at a point approximately three-quarters of the distance between the terminal medial and lateral points of the ribeye.

Disk meter height was recorded from 50 random locations in each pasture at 14-day intervals. Herbage also was clipped to ground level beneath the disk from two locations within each pasture at 28-day intervals. These samples were dried in a forced-air oven at 140°F for 48 h and weighed for DM determination. Regression equations of DM per unit of land area against disk meter height were developed and used to quantify average forage mass of each pasture.

Forage samples were collected at 2-week intervals to determine nutritive value. Forage was clipped at a 1-inch height from three randomly placed 1.8-ft² quadrats within each pasture. Samples were dried at 140°F for 72 h and ground through a 1-mm screen. Ground samples were scanned with a Model 500

Fig. 1. An ultrasound scan of the ribeye cross-section between the 12th and 13th ribs.
Bran+Leubbe Spectrophotometer (Bran+Leubbe, Inc., Buffalo Grove, IL). Wet chemistry was performed on a third of the samples for each year. Crude protein (CP) was determined with a Kjeltech 1030 Auto Analyzer (Tecator, Höganas, Sweden), and IVDMD was determined using the Goering and Van Soest (6) procedure modified for the Ankom Daisy II In Vitro Digester (Ankom Technology Corp., Fairport, NY). Samples for each year were combined to establish calibration equations using the Partial Least Squares Regression Procedure (14).

**Statistical Analysis**

Pasture carrying capacity (steer days/acre) at the targeted forage mass, ADG, weight gain per acre (ADG × pasture carrying capacity), and increases in ultrasound ribeye area and external fat thickness were analyzed using a split-plot design. Year was evaluated as the main-plot treatment (error = block × year) and supplementation treatment as the sub-plot treatment (error = residual) using PROC MIXED of SAS (16). Mean separation was performed on least square means using the PDIFF option (13). Nutritive value data were evaluated in a repeated-measures analysis using the PROC MIXED procedure. Years were analyzed separately for the nutritive value data because days on pasture for each year did not correspond with the same calendar day. All statistical inferences were determined at the 5% level of significance.

Cost of additional weight gain was analyzed following procedures described by Aiken (1). Costs of corn per incremental pound increase in ADG (cost of additional gain over the control) were calculated over a range of ground corn costs of $90 to $250/ton corn at ten-dollar intervals. Cost of additional gain was analyzed using PROC TTEST of SAS (13) to determine if cost of additional ADG was significantly lower than breakeven costs. Breakeven costs were set to reflect low ($0.60/lb BW), moderately low ($0.80/lb BW), moderately high ($1.00/lb BW), and high ($1.20/lb BW) cattle prices.

**Rainfall and Herbage Mass**

Rainfall in 2001 was below the 29-year average in June, July, and August, and was below the average in June but above it in July and August in 2002 (Fig. 2). Forage mass across treatments averaged 2590 ± 80 lb dry matter/acre in 2001 and 2830 ± 20 lb dry matter/acre in 2002. These forage masses provided sufficient forage for diet selection so that forage quality was likely the major limitation on steer performance.

![Rainfall graph](image)

**Pasture Carrying Capacity**

There was a year effect on carrying capacity at the targeted forage mass, with capacities being higher in 2002 (261 steer days/acre) than in 2001 (198 steer days/acre). A 32% increase in carrying capacity from 2001 to 2002 was likely due to the higher rainfall during July and August 2002. Carrying capacity at the targeted forage mass was similar among treatments.
Nutritive Value

Forage IVDMD and CP were not affected by management treatments. In vitro DMD gradually declined over the grazing season in both years, but the relationship was quadratic in 2001 and linear in 2002 (Fig. 3). In 2001, IVDMD was 63.7% on Day 9 but declined and stabilized at approximately 50% between days 60 and 80 and had an upward trend toward the end of the season. Rainfall was slightly higher than normal in September and likely promoted new growth with higher digestibility. Conversely, IVDMD in 2002 was 59.2% on Day 7 and declined linearly to 48% by Day 112. Rainfall late in the 2002 season was below average and likely did not sustain bermudagrass growth. Other experiments (1,2) showed that bermudagrass IVDMD gradually declined through the early grazing season and stabilized through the middle and late grazing season.

Fig. 3. Trends in in vitro dry matter digestibility (IVDMD) and percent crude protein (CP) over days on pasture (DOP) during the grazing seasons (2001 and 2002).

Crude protein was initially above 13% in both years, but gradually decreased to approximately 9.5% by Day 40. Crude protein increased following the second application of N on Day 14 in 2001 and Day 20 in 2002 (Fig. 3). A similar trend in CP over the grazing season was shown by Aiken and Brown (2) and Aiken (1). Crude protein increased for the last two sample dates in 2001, which was likely in response to higher than normal rainfall in September. The relationship was cubic in 2002 because CP increased following the second application of N and then declined after Day 90.

Steer Weight Gain

There was no year main effect or year × treatment interaction for ADG or weight gain per acre. Whole-season supplementation increased ADG over that of the control, but supplementation during the latter half of the season did not. The strong response to whole-season supplementation with small quantities of corn agrees with Aiken (1). Apparently there is a benefit to increasing dietary energy in the early grazing season when bermudagrass has moderate concentrations of digestible energy. Average daily gain did not differ between 24- and 48-h feeding intervals for either whole- or late-season supplementation. Huston et al. (9) reported that lactating cows fed 14.0 lb cottonseed meal once a week maintained body weight and condition as well as cows fed cottonseed meal at 2.0 lb/day.

Weight gain per acre was higher for whole-season supplementation than for the control and late-season supplementation. There was no difference in weight gain per acre between the control and either feeding interval for late-season supplementation, which further indicated the benefit of supplementing during the entire grazing season.
Ultrasound Measures

Initial ultrasound ribeye area was 6.24 inch$^2$ in 2001 and 6.97 inch$^2$ in 2002, and initial external fat thickness was 0.18 inch in 2001 and 0.25 inch in 2002. There was no year main effect or year × treatment interaction on ultrasound measures. Increases in ultrasound ribeye area and external fat thickness were greater with supplementation for the whole grazing season than for the control, but the increases were similar between whole- and late-grazing season supplementation treatments (Table 1). Aiken et al. (3) observed increases in the rate of external fat deposition as ADG increased beyond 2 lb/day. In the present experiment, whole-season supplementation increased ultrasound ribeye area 67% compared to the control and fat thickness 122% compared to the control.

Table 1. Least square means for steer weight gain and ultrasound measures of ribeye area (UREA) and external fat thickness (UFAT) in response to corn supplementation for either the whole grazing season (WGS) or late grazing season (LGS), and a no supplement control. Feeding intervals of 24 and 48 h were combined with the two supplementation treatments.

<table>
<thead>
<tr>
<th>Treatment</th>
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<th>Weight gain</th>
<th>Ultrasound measures$^x$</th>
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<tr>
<td></td>
<td></td>
<td>ADG (lb/day)</td>
<td>Gain$^y$ (lb/acre)</td>
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<td>Control</td>
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<td>1.67 b$^2$</td>
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</table>

$^x$ Increases in measures (final – initial)

$^y$ Total weight gain over the grazing season (ADG × carrying capacity)

$^z$ LSMEANS in columns with different superscripts are significantly different ($P < 0.05$).

Cost of Weight Gain

Cost of additional ADG for the whole-grazing season treatment was below the breakeven cost for the range of corn prices with moderate and high cattle prices (Fig. 4). Cost of corn less than $200/ton was necessary for cost of additional ADG to fall below the breakeven with the low cattle price. Aiken (1) reported that cost of additional ADG for a daily supplementation rate of 3 lb ground corn per day was below the breakeven for a similar range of corn costs and cattle prices as used in the present study.
Supplementing steers with ground corn at 2 lb/day provided cost-effective increases in ADG and gain per acre if fed for the whole grazing season, but not with restricting it to the second half of the season. Therefore, there is benefit to supplementing dietary energy in the early grazing season even though bermudagrass digestibility and CP are at a maximum at this time. The experiment further indicated that corn can be fed at 48-h intervals, rather than 24, to reduce time and labor. Corn costs were below the breakeven cost for a wide range of corn and cattle prices, but supplementation should be avoided when cattle prices are low and corn costs are above $200/ton. Steers backgrounded for feedyard finishing on bermudagrass can be fed ground corn at 48-h intervals (4 lb per steer) to provide cost-effective increases in weight gain and body condition.

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Literature Cited