Brief Research Update: Using Soybean Hulls to Supplement Kentucky Forages

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Introduction

Cattle grazing forages alone generally don't consume sufficient nutrients to meet their genetic potential for growth. Research information suggests that energy, rather than protein, limits cattle growth when grazing properly-managed tall fescue pastures. Therefore, supplemental energy is often incorporated into the diet to balance nutrients and increase gains. Carbohydrate-based energy supplements are generally classified as fiber- or starch-based. Fiber-based energy supplements are commonly by-product feedstuffs rich in highly digestible fiber, such as soybean hulls, corn gluten feed, and beet pulp. Cereal grains are the most common source of starch-based energy supplements, including corn, sorghum, and barley. Starch-based supplements have high energy values, but have been shown to have the potential to decrease forage digestion. Fiber-based supplements do not exhibit such effects, and therefore can have feeding values similar to grains when fed as supplements to grazing animals. However, the relative differences observed between starch- and fiber-based supplements may be related to forage quality and other factors that change during the course of the grazing season. We have conducted several experiments to evaluate growth responses at different times of the year by stocker steers grazing endophyte-infected fescue and supplemented with corn or soybean hulls and to identify the effects of different supplementation strategies on forage intake and utilization.

Corn vs. Soybean Hulls

Our first studies were designed to determine the feeding value of soybean hulls, relative to corn, when used as a supplement for stocker steers grazing endophyte-infected fescue. Additionally, we were interested in determining whether the relative value of soybean hulls changed as forage quality changed across the summer grazing season. Steers (534 to 639 lb initial weight) grazed within 15 acre pastures during two summers (2000 and 2001) and also in one study on stockpiled fescue (January – March, 2001). Early-season stocking rates were set at 1550 to 1630 lb live weight/acre during the summer grazing seasons and reduced in mid-season (when forage availability became limiting) to about 900 lb live weight/acre. With stockpiled fescue, stocking rates were set at approximately 1025 lb live weight/acre. Steers had free-choice access to mineral and fresh water and received: 1) no supplement, 2) cracked corn or 3) pelleted soybean hulls once daily in the morning. Supplements were fed in bunks to pasture groups at .75% (as-fed) of body weight (equivalent to 4.5 lb of supplement for a 600 lb steer). The amount of supplement was adjusted throughout each grazing season to maintain the feeding amount at 0.75% of body weight as cattle gained weight. To prevent carryover effects of supplement treatments and allow us to determine whether responses were similar across time, steers were re-allotted to experimental pastures at the end of each 28-day period in such a way as to balance the number of steers in a pasture group that had previously been on each of the treatments. Also at this time, supplement treatments were reassigned to the pasture groups.

Steer gains are shown in Figure 1. Despite some numerical differences in response to supplements during different months, statistical analysis indicated that the supplement effect was independent of month (month x supplement interaction, P = 0.64). In general, gains were lowest during mid-summer (June in 2000 and July in 2001) as is common on endophyte-infected fescue. Low gains during these times are a function of increased plant maturity and of decreased intake in response to heat stress, which is exacerbated by the presence of the endophyte. Across the entire study, average daily gains averaged 1.18, 1.62, and 1.70 lb/d for the non-supplement, corn, and soybean hull groups, respectively. Supplementation increased (P < .01) gains, and gains by steers supplemented with soybean hulls tended (P = .12) to be greater than for those receiving cracked corn. In order to help evaluate the economic potential of supplementation, we calculated partial conversion efficiencies, which indicate the pounds of pounds of additional gain per pound of supplement consumed (Table 1). It is important to note that these values were determined with supplementation at .75% of body weight and would be expected to vary with different supplement amounts. In general, partial conversion efficiencies of supplementation are improved (higher values) with lower levels of supplementation. Partial conversion efficiencies in the neighborhood of 10% are common with energy supplementation on a variety of forages. With the exception of July, 2000, when we obtained essentially no additional gain with the soybean hulls, the partial conversion efficiencies for soybean hulls remained at or greater than 8%. With corn, however, these efficiencies were less than 7% in 7 of the 13 periods of this study. Thus, not only was the average partial conversion efficiency better for soybean hulls, the likelihood of obtaining economic benefit from soybean hull supplementation was greater, as well.

Published values for the energy concentration of corn suggest that it has about 90% TDN whereas soybean hulls have only about 77% TDN. These studies showed that book values for energy values of feedstuffs are inaccurate when feeds are used as supplements for forage-based diets. This is because supplements can have positive or negative effects on the intake and digestibility of forages. We therefore conducted additional studies to evaluate the effect of these supplements on forage intake and use. Endophyte-infected tall fescue hay was harvested at four different maturities during the 2000 grazing season: 1) vegetative, 2) boot stage, 3) heading-stage, and 4) mature and fed free choice to ruminally cannulated steers (500 lb). Each hay was fed in combination with the same supplement treatments described above. Chemical composition of the four hay maturities and supplements is presented in Table 2. Both supplements decreased forage intake by a similar amount (Figure 2; an average decrease of .46 lb of forage intake for each pound of supplement fed). Since this decrease was less than 1 to 1, supplementing increased total intake (forage + supplement) with both corn and soybean hulls. However, the two supplements had different effects on digestibility. This is best shown with neutral detergent fiber (NDF) digestibility (Figure 3). Compared with the control treatment, soybean hulls either had no effect (vegetative hay) or increased (other hay maturities) NDF digestibility, whereas corn either had no effect (vegetative and mature hays), or decreased NDF digestibility (boot and heading-stage hays). Thus, using a starch-based supplement (corn) resulted in less digestible energy consumption by the steers. This depression in digestible energy accounted for the numerically lower gains with corn, as compared with soybean hulls, in the performance study.

Amount of Soybean Hulls

The previous studies demonstrated the relative value of supplementing with soybean hulls vs. corn. However, the effects of soybean hulls on forage intake and digestibility, and thus on animal growth, would be expected to depend on the amount of supplement fed. Thus, we conducted additional experiments to evaluate the influence of different amounts of pelleted soybean hulls on forage intake and utilization, and on performance of grazing stocker steers. In the first experiment, we fed ruminally cannulated steers (1049 lb) endophyte-infected tall fescue hay (14.1% CP; 68.0% NDF) on a free choice basis and supplemented this hay with: 1) no supplement, 2) 0.33%, 3) 0.67%, 4) 1.00%, or 5) 1.33% of body weight of pelleted soybean hulls (equivalent to 0, 2, 4, 6, and 8 lb of supplement daily for a 600 lb steer). As in the previous experiment, each unit of soybean hulls consumed resulted in a decrease in forage intake of about .46 units (Figure 4). However, digestibility did not change in a linear fashion (Figure 5). Rather, it increased to a plateau with about 1.0 % of body weight of soybean hulls, and decreased slightly with the next increment of soybean hulls. Thus, one might anticipate that there would be a plateau in the gain response of steers to increasing amounts of supplemental soybean hulls. This is generally in agreement with results from the first year of a two-year grazing study. Figure 6 shows the effects on average daily gains of either no supplement or three different levels of supplemental soybean hulls: 2, 4, or 6 lb/steer daily, when fed to stocker steers (average initial weight = 591 lb) grazing endophyte-infected fescue (average response across a 140-day grazing season in 2002). These levels equate to about 0, 0.3, 0.6, and 0.9% of body weight across the duration of this study. Gains were relatively low during this year, primarily as a result of very dry conditions during the summer. Although gains continued to increase with each added increment of soybean hulls, the magnitude of the response was less with each increment. We obtained 0.33 lb of additional gain from the first 2 lb of soybean hulls, 0.32 lb from the next 2 lb, and .12 lb from the final 2 lb, resulting in partial conversion efficiencies of 0.17, 0.16, and 0.06 for each 2 lb increment of soybean hulls.

This information can be used with supplement pricing information to compare the value of supplementation against the value of the added gain, as shown in Table 3. For example, with a partial conversion efficiency of 10% and a supplement cost of $80/ton, it costs $.40 for each additional pound of gain. When working with the supplement costs, it is important to include the actual cost of supplement delivered to the bunk, which will include processing, delivery, labor, and fuel costs. Thus, one can see that unless supplement prices are very inexpensive and/or cattle prices are quite high, it is very difficult to reap economic value in the form of additional cattle weight from supplementation when partial conversion efficiencies are below 7%. Although additional studies will be conducted to determine how consistent this response is, current information suggests that soybean hull supplementation for cattle grazing endophyte-infected fescue in excess of 0.7% of body weight will be unlikely to provide economic benefits in the form of additional gain.

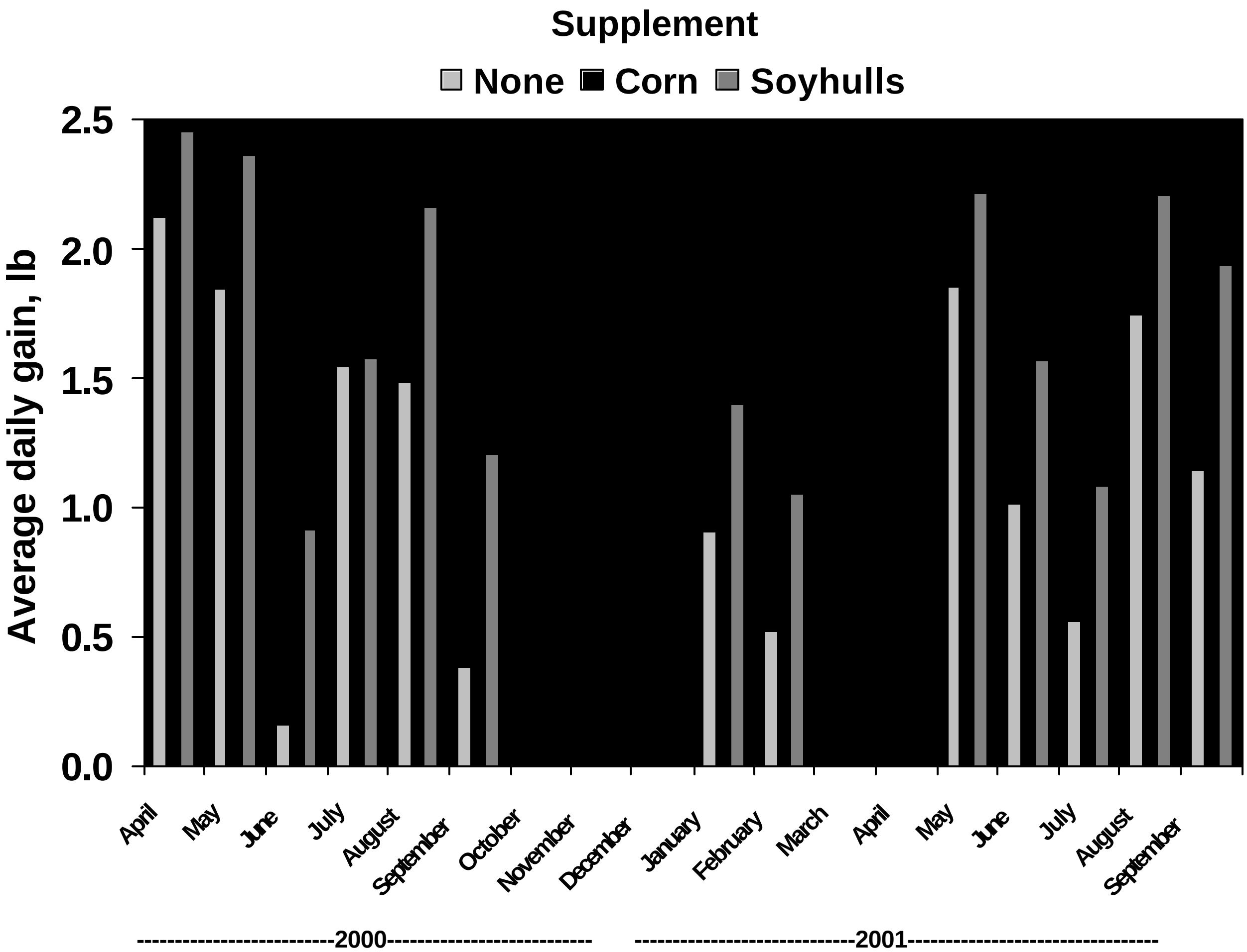

Figure 1. Average daily gain of steers receiving no supplement, or cracked corn or soybean hulls at 0.75% of body weight during each period of the experiment. Refer to text for listing of average responses for each treatment.

Table 1. Partial conversion efficiencies for corn and soybean hulls offered at 0.75% of body weight during each month of the experiment, pounds of additional gain (over unsupplemented cattle) per pound of supplement (as-fed basis).

	Corn	Soybean Hulls
April, 2000	4.8%	8.3%
May, 2000	6.3%	11.6%
June, 2000	14.1%	15.4%
July, 2000	5.5%	0.7%
August, 2000	5.6%	12.8%
September, 2000	13.7%	15.2%
January, 2001	12.3%	10.2%
February, 2001	4.3%	10.4%
May, 2001	2.5%	8.1%
June, 2001	5.5%	11.2%
July, 2001	11.9%	10.1%
August, 2001	11.2%	8.3%
September, 2001	14.3%	13.5%
Average[a]	8.8%	10.5%

[a]This average has been calculated as the average gain response above control for each group divided by the average supplement quantity fed, and thus does not equal the arithmetical mean of the numbers listed above (the ratio of averages does not equal the average of ratios).

Table 2. Chemical composition of tall fescue hays and supplements.

Item	Vegetative hay	Boot stage hay	Heading stage hay	Mature hay	Soybean hulls	Corn
Organic matter, % DM	90.1	92.3	92.5	93.7	93.8	98.3
Crude protein, % DM	17.4	15.6	8.3	7.8	13.9	9.0
Neutral detergent fiber, % DM	68.7	73.9	73.8	76.8	64.3	12.0
Acid detergent fiber, % DM	35.4	37.9	42.3	43.2	46.2	3.4

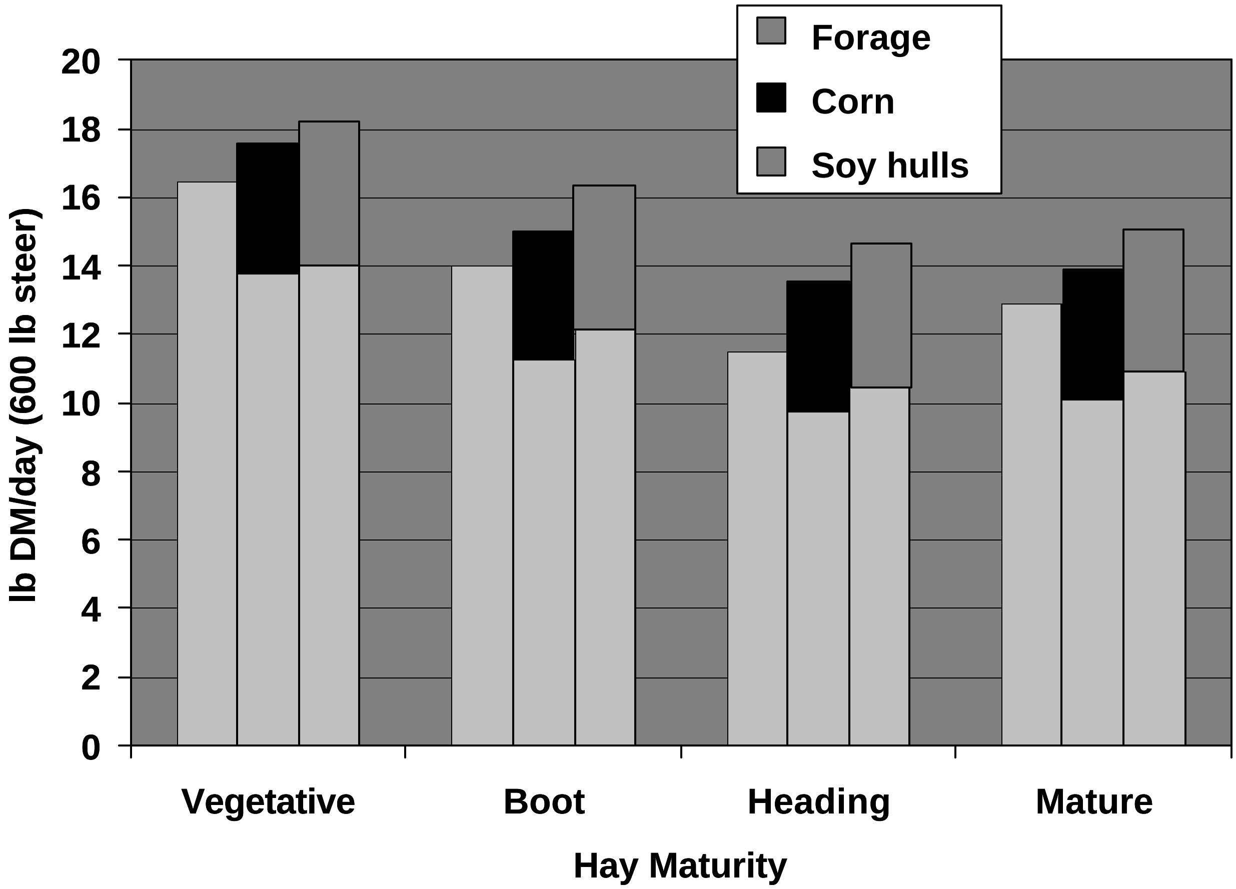

Figure 2. Intake of hay and supplement dry matter (by a 600 lb steer) as affected by forage maturity and supplement type. Both supplements resulted in a similar (P = 0.56) depression in forage intake of about 0.46 pounds of hay per pound of supplement consumed, averaged across forage maturities.

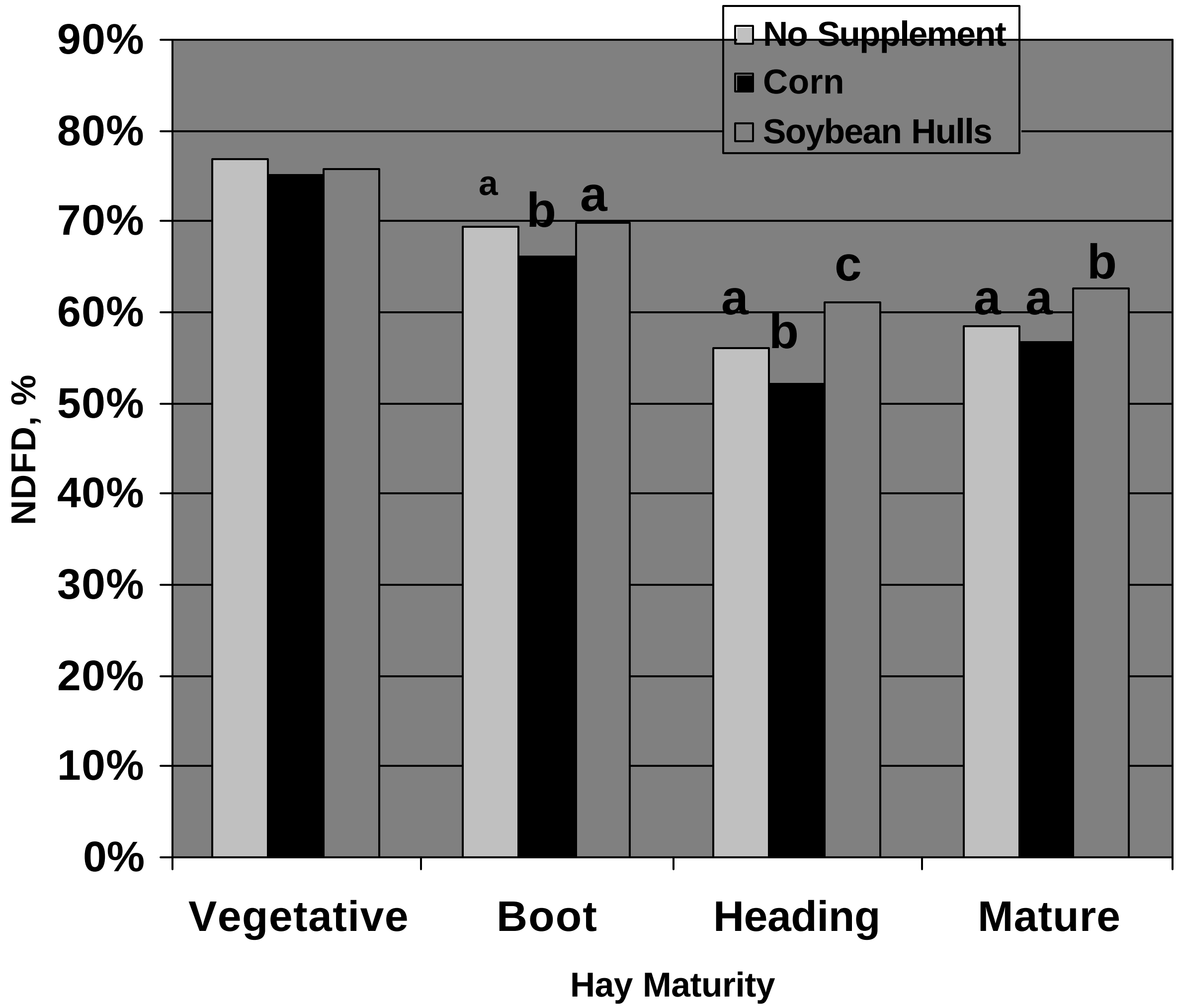

Figure 3. Neutral detergent fiber digestibility (NDFD) as affected by hay maturity and supplement type. [a, b, c]Means within a hay maturity with different superscripts differ ($P < 0.05$). Soybean hulls either had no effect, or increased NDFD, whereas corn supplementation decreased NDFD compared to control with both the boot stage and heading stage hays.

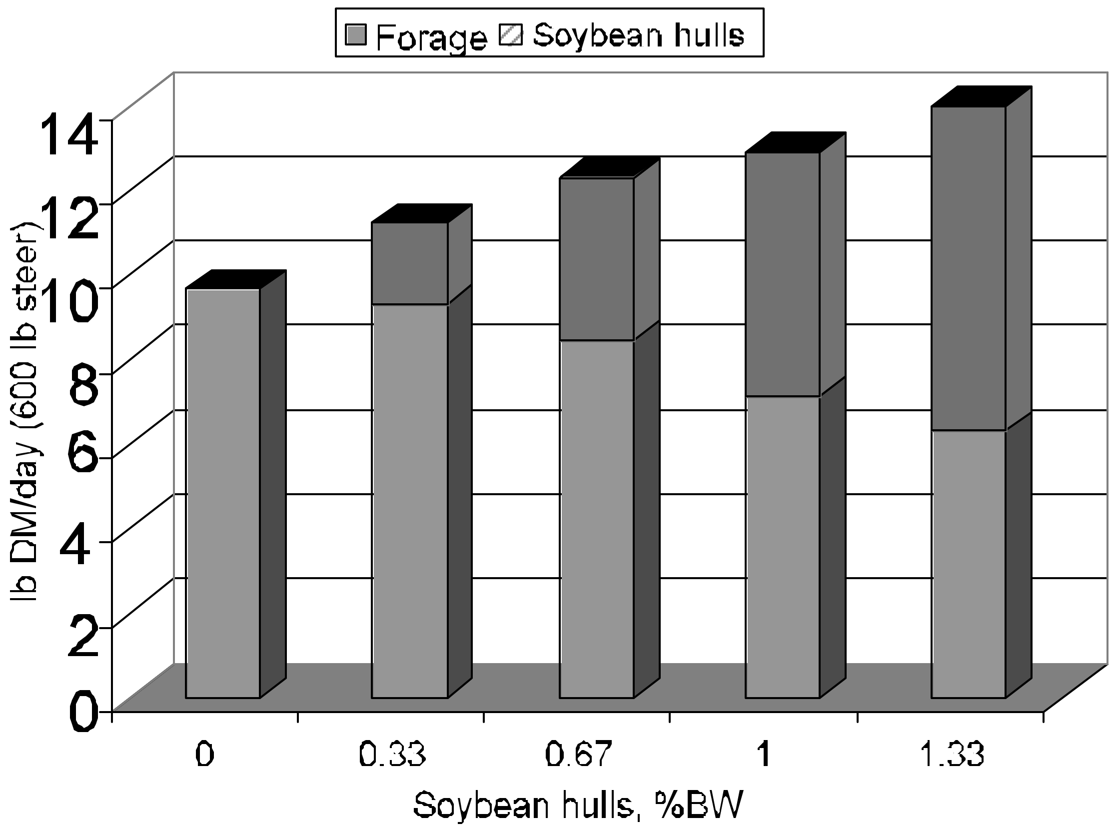

Figure 4. Intake of hay and supplement dry matter (by a 600 lb steer) as affected by increasing amount of soybean hulls. Forage dry matter intake was decreased and total dry matter was increased in a linear (P < 0.02) fashion with increasing soybean hulls. Each unit increase in soybean hulls resulted, on average, in a 0.46 unit decrease in forage intake

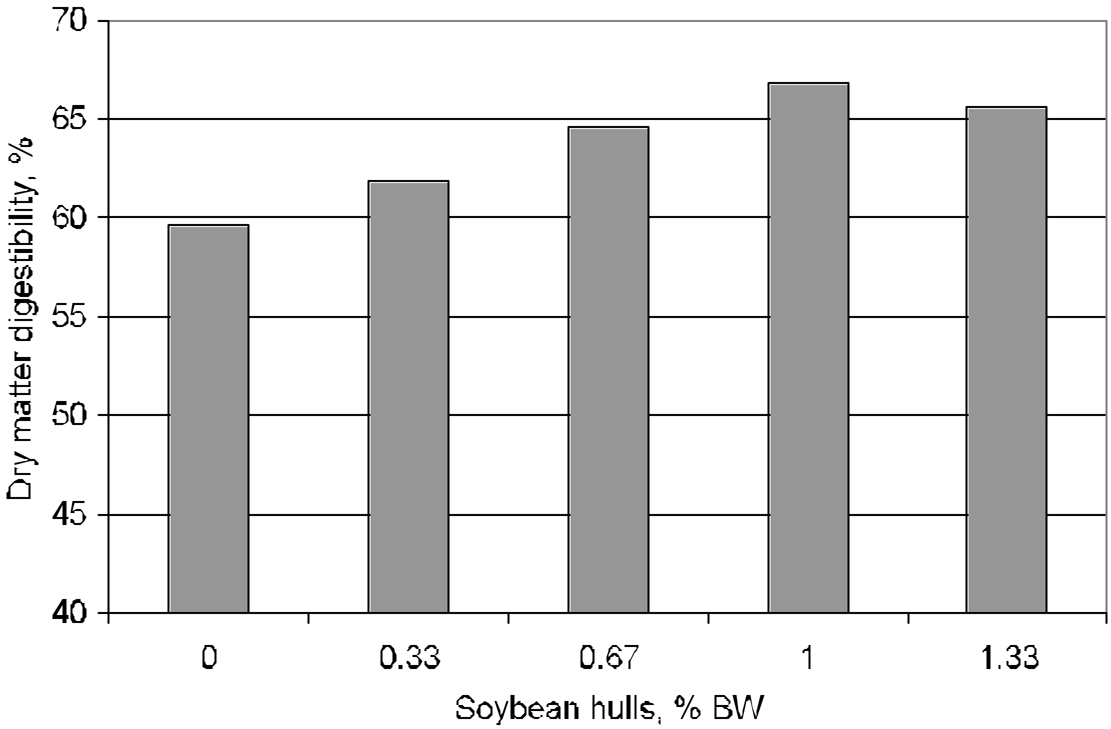

Figure 5. Dry matter digestibility as affected by increasing amount of soybean hulls. Dry matter digestibility increased in a quadratic (P = 0.01) fashion with increasing soybean hulls. Digestibility reached a maximum with about 1% of body weight of soybean hulls, and decreased slightly when levels exceeded this.

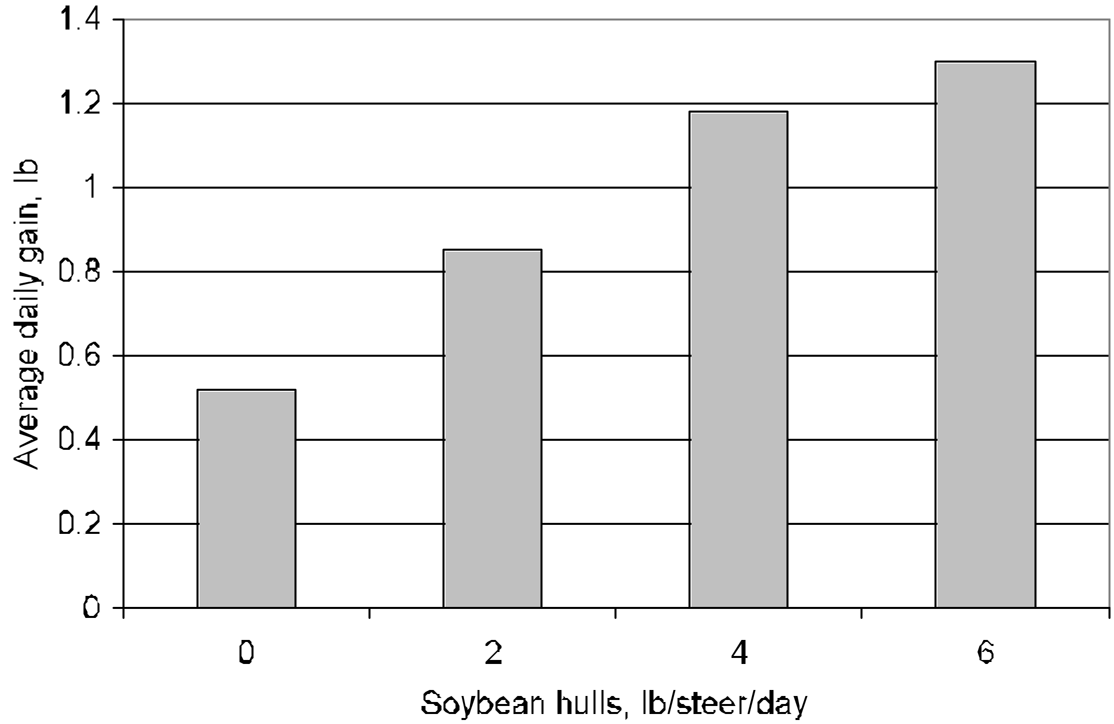

Figure 6. Average daily gain as affected by increasing amount of soybean hulls. ADG increased in a quadratic (P = 0.01) fashion with increasing soybean hulls.

Table 3. Supplement cost per pound of additional gain at various supplement prices and partial conversion efficiencies.

Supplement Price		Partial Conversion Efficiency							
$/Ton	$/pound	5%	7%	10%	12%	14%	16%	18%	20%
$ 60.00	$0.030	$0.60	$0.43	$0.30	$0.25	$0.21	$0.19	$0.17	$0.15
$ 70.00	$0.035	$0.70	$0.50	$0.35	$0.29	$0.25	$0.22	$0.19	$0.18
$ 80.00	$0.040	$0.80	$0.57	$0.40	$0.33	$0.29	$0.25	$0.22	$0.20
$ 90.00	$0.045	$0.90	$0.64	$0.45	$0.38	$0.32	$0.28	$0.25	$0.23
$100.00	$0.050	$1.00	$0.71	$0.50	$0.42	$0.36	$0.31	$0.28	$0.25
$110.00	$0.055	$1.10	$0.79	$0.55	$0.46	$0.39	$0.34	$0.31	$0.28
$120.00	$0.060	$1.20	$0.86	$0.60	$0.50	$0.43	$0.38	$0.33	$0.30
$130.00	$0.065	$1.30	$0.93	$0.65	$0.54	$0.46	$0.41	$0.36	$0.33
$140.00	$0.070	$1.40	$1.00	$0.70	$0.58	$0.50	$0.44	$0.39	$0.35
$150.00	$0.075	$1.50	$1.07	$0.75	$0.63	$0.54	$0.47	$0.42	$0.38
$160.00	$0.080	$1.60	$1.14	$0.80	$0.67	$0.57	$0.50	$0.44	$0.40
$170.00	$0.085	$1.70	$1.21	$0.85	$0.71	$0.61	$0.53	$0.47	$0.43
$180.00	$0.090	$1.80	$1.29	$0.90	$0.75	$0.64	$0.56	$0.50	$0.45
$190.00	$0.095	$1.90	$1.36	$0.95	$0.79	$0.68	$0.59	$0.53	$0.48
$200.00	$0.100	$2.00	$1.43	$1.00	$0.83	$0.71	$0.63	$0.56	$0.50