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Summary

Data from 277 treatment means in 15 previous beef cattle studies were used to develop equations to predict net energy adjusters throughout the feeding period to better predict gain with the National Research Council's 1996 Nutrient Requirements of Beef Cattle model. Early in the feeding period the net energy adjuster reduces the energy to correct for overprediction of gain and late in the feeding period the net energy adjuster increases energy to correct for underprediction of gain. The average NE adjusters were 0.88 and 1.08 for the beginning and end of the feeding period.

Introduction

The National Research Council's (NRC) 1996 Nutrient Requirements of Beef Cattle model has previously been shown to overpredict gain early and underpredict gain late in the finishing period of beef cattle. Level 1 of the NRC model contains net energy (NE) adjusters that can be used to achieve accurate prediction of gain by altering the net energy values of the diets. Predicting gain accurately is absolutely essential before the protein requirements and supplies can be accurately predicted. Accurate determination of protein requirements are important early in the finishing period to ensure metabolizable protein requirements are met and late in the finishing period to avoid overfeeding protein. The objective of this study was to use previous feeding data from the University of Nebraska to determine equations to accurately predict gain throughout the feeding period.

Procedure

Data from 277 treatment means in 15 previous beef cattle feeding studies were used to develop equations to predict NE adjusters throughout the feeding period. The feeding studies were conducted with calf-feds, short yearlings and long yearlings. Calf-feds were placed on feed in the fall months and harvested in spring (4 studies over 3 years). Short yearlings were placed on feed in late-spring months and harvested in early-fall months (7 studies over 5 years). Long yearlings were placed on feed in early-fall and harvested in the early winter months (4 studies over 2 years).

The feeding studies used had 5-day limit fed initial weights on 2 consecutive days, interim weights, and final weights calculated from hot carcass weights divided by 0.63. Interim weights were shrunk 4%. Daily feed delivery records were used to determine DMI for a pen. Regression analysis using the initial, interim and final weights was used to estimate beginning (first day on feed), midpoint, and ending (last day on feed) weights for each pen. Regression analysis was also used to determine intake for the beginning, midpoint, and end of the feeding period. Data for each pen then were used in the NRC model to determine the NE adjustments needed to obtain the correct daily gains given the observed feed intakes. Actual intake data for each pen also were compared to DMI predicted by the NRC model.

The inputs used in the NRC model were cattle implanted, fed an ionophore, under thermal neutral conditions (68° F and no mud), body condition score of 5, and fed a diet that contained 1.36 Mcal/lb ME. All cattle in the data were steers and were from crossbred cattle with no need to adjust breed maintenance requirement. Mature weight was adjusted for each pen based on fat thickness and hot carcass weight.

Results

Data showed that on average for a feeding study, daily gain is constant through the feeding period. In Figure 1, data for one of the feeding studies is shown. In all feeding studies evaluated, the R^2 was in the range of 0.98 to 0.99. Under our research conditions, these data indicate that cattle gain did not decline throughout the feeding period and this observation is supported by recent serial slaughter data (2004 Nebraska Beef Report, pp. 37-39). Implant programs may prevent the decline in gain throughout the feeding period as they increase mature weight. In this data set, cattle were harvested at about 28% body fat or when finished to Choice grade. Cattle were not overfed in these studies thus data are not available to determine gain when cattle are fed beyond 28% body fat. With gains highly correlated to days on feed, we felt that using regression equations to predict weights at the beginning, midpoint, and end of the feeding period was appropriate.

The fit of DMI on days on feed was not as good. Dry matter intake fluctuated throughout the feeding period and is shown for one feeding study in Figure 2. In all feeding studies evaluated, the R^2 was in the range of 0.08 to 0.61. With this movement in DMI, regressing DMI on days on feed was the best way to

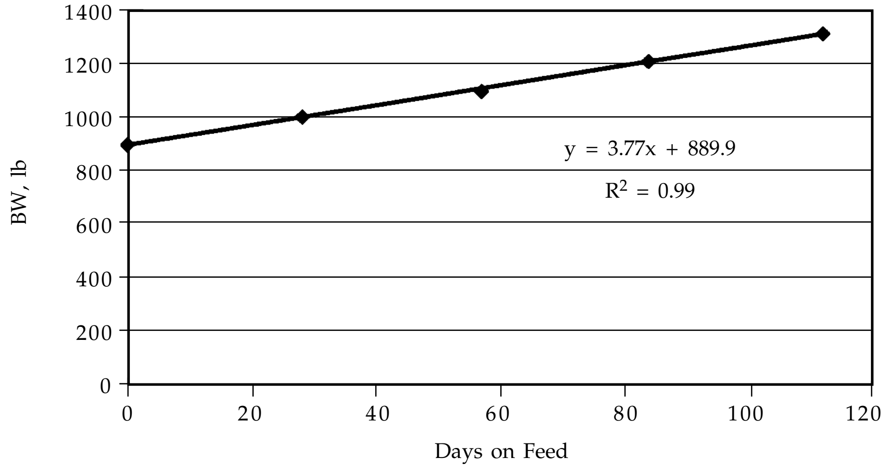

Figure 1. The average body weight for one feeding experiment throughout the finishing period for beef cattle (pens = 20).

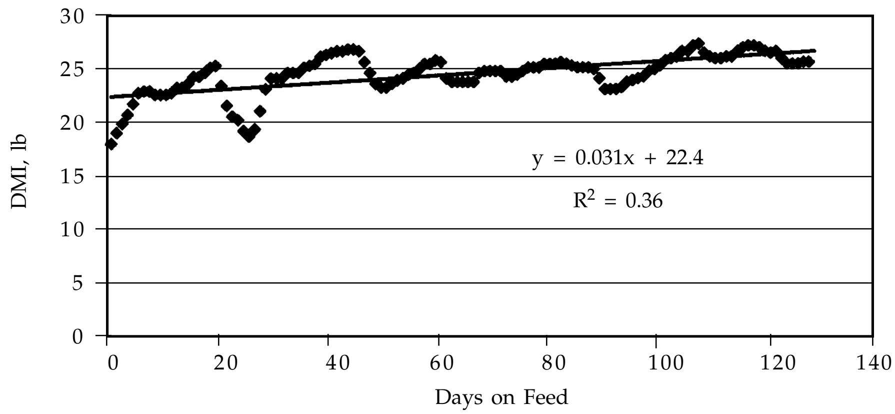

Figure 2. Average dry matter intake for one feeding expermient throughout the finishing period for beef cattle (pens = 17).

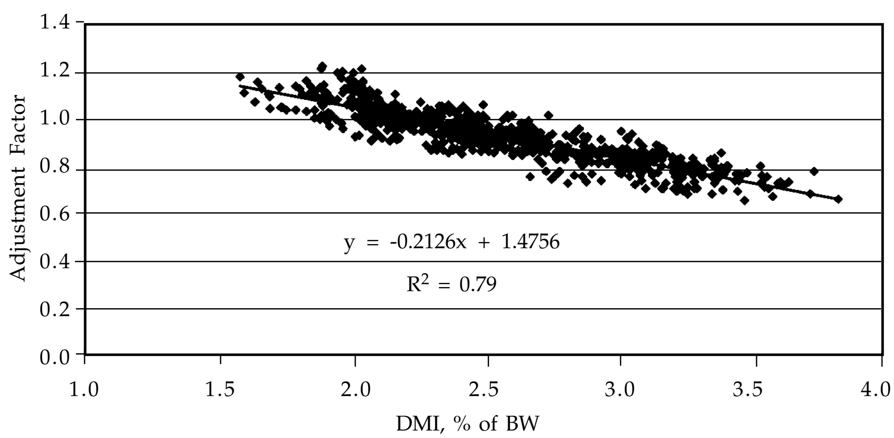

Figure 3. NE_m and NE_g adjustments factors (NRC) related to intake (pens = 277) for all three types of cattle (calf-feds, short yearlings, and long yearlings).

predict feed intake at the beginning, midpoint, and end of the feed period. Also there was variation during the step-up period and the regression equation was able to predict a number for the beginning of the feeding period.

Using the predicted weights and DMI for beginning, midpoint and end, these variables were inputted into the NRC model to get predicted performance and calculate the NE adjuster needed to correct to the observed performance. The NE adjusters were regressed on feed intake as a percentage of BW. The relationship of intake as a % of BW was good (R^2 = 0.79) when all pens were included in the analysis (Figure 3). Analyzing by cattle type as either short yearlings or long yearlings improved the relationships of intake as a % of BW to NE adjuster (R^2 = 0.92 and 0.83, respectively). However, analyzing calf-feds, the relationship of intake as a % of BW to NE adjuster decreased (R^2 = 0.75). This decrease in relationship may be created when thermal neutral conditions are used in the NRC model as it does not account for the increased maintenance requirement that occurs during environmental stress over different years. In Nebraska, cold and muddy conditions occur during the winter/spring months for the calf-fed data. This period may have a larger impact on cattle maintenance requirements than heat stress, as shown with the relationship being greatest for the short yearlings and least for the calf-feds.

In evaluation of the regression equations, the slopes and intercepts did not change between the three types of cattle. Using data from all pens of cattle defined the relationship as: NE adjuster = -0.2126 * DMI (as a % of BW) + 1.4756. Early in the feeding period when there were high intakes as a % BW, the need to adjust energy down occurs to correct the overprediction in gain. The opposite occurs late in the feeding period when low intakes as a % of BW occur and energy must be adjusted up to correct for the underprediction in gain.

Cattle consumed more throughout the feeding period (Table 1), resulting in a worsening in feed conversions from 5.80 at the beginning to 6.90 at the end. Intake as a percentage of BW decreased as the feeding period progresses from 3.0 to 2.1% of BW on average. Both weight and intake increased but

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weight increased at a more rapid rate. As cattle become heavier, the maintenance requirement increases and less of the total feed consumed is going to gain worsening feed conversion. Also as BW increases during the feeding period, the cattle become increasingly fatter. The extra fat explains part of the decrease in intake as a percentage of BW. The cattle were marketed at about 28% fat. The NRC and other literature suggest the cattle were about 15% body fat at the start of the feeding period. If final weights are adjusted to 15% body fat (1083 lb), then intake would be 2.5% of lean BW instead of 2.1% (1278 lb at 28% body fat). Average initial intakes were 3.0% of BW so there still was a reduction in intake (calculated as percentage of lean BW) as the feeding period progressed. In the data set, intakes as % of BW were 3.0% at the beginning of the feeding period, 2.5% at the midpoint of the feeding period, and 2.1% at the end of the feeding period (Table 1). Intake at 2.5% of BW for the midpoint is above commercial feedlot average (2.0% of BW; eMerge Interactive; Weathford, OK). However, the same principles apply as intakes as % of BW decline during the feeding period.

Is intake as % of BW the cause of the change in the NE adjuster from the start of the feeding period to the end? The lower feed intake as percentage of BW potentially would give greater digestion and less subacute acidosis. This may not explain all of the change in NE adjusters from 0.83 at the beginning of the feeding period to 1.04 at the end. There may be an artifact in the development of the original NE system because it was developed with feeding period means and did not directly account for the changes occurring during the feeding period as presented here.

The NE adjuster at the average weight of the cattle was 0.946. Because runs were made assuming thermo-neutral conditions, this value compared to 1.00, probably represents reduced energetic efficiency from some cold stress. If environmental conditions are inputted into the model, then 0.054 needs to be added to the intercept of the NE adjuster equation giving the following equation: NE adjuster = -0.2126 * DMI (as a % of BW) + 1.5296. With this modification, the NE adjuster at the beginning of the feeding period was 0.88 and at the end of the feeding period was 1.08. These values appear to be reasonable guidelines to use even with lower intakes.

Predicted intakes by the NRC compared to those observed with the regression equations for each pen at the beginning, midpoint, and ending of the feeding period had a fair relationship ($R^2 = 0.50$; Figure 4). Our observed intakes were greater than what was predicted by the NRC model. However, compared to industry averages (19.6 lb/day; eMerge Interactive; Weatherford, OK) our DMI appeared to be greater and NRC may be able to predict industry DMI. However, the beginning and end of the feeding period are not well predicted with the NRC model. If the NRC model predictions were accurate, the slope of the line would be 1 and intercept would be 0 and our observed equation has a slope of 0.73 and an intercept of 9.3. Feed intake was underpredicted at the beginning of the feeding period and overpredicted at the end of the feeding period.

Table 1. Summary of means for pens of cattle at the beginning, midpoint, and end of the feeding period.

Item	BW, lb	ADG, lb	DMI, lb/day	NE adjusters	DMI as % BW
Beginning					
Calf-fed	642	3.47	19.9	0.78	3.10
Short yearling	779	3.86	22.7	0.84	2.95
Long yearling	801	4.41	25.0	0.85	3.15
Total	756	3.93	22.8	0.83	3.04
Midpoint					
Calf-fed	945	3.47	21.9	0.95	2.32
Short yearling	1024	3.86	24.6	0.95	2.41
Long yearling	1060	4.41	27.8	0.94	2.63
Total	1017	3.93	24.9	0.95	2.45
End					
Calf-fed	1248	3.47	23.9	1.07	1.92
Short yearling	1268	3.86	26.5	1.04	2.09
Long yearling	1317	4.41	30.5	1.01	2.32
Total	1278	3.93	27.1	1.04	2.12

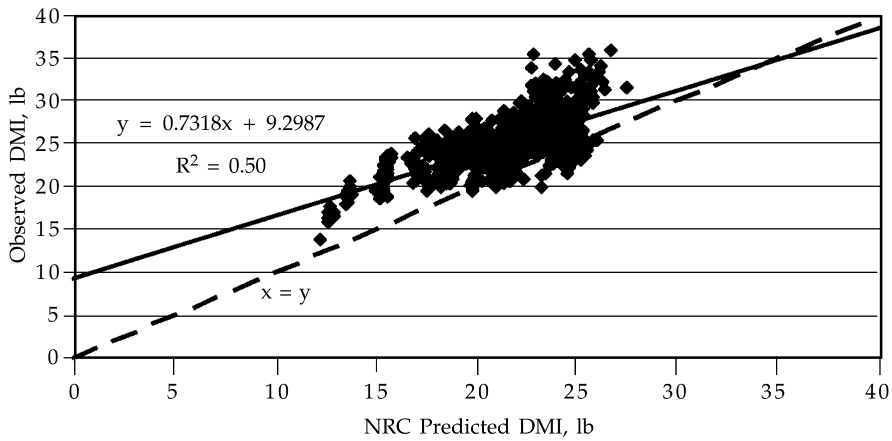

Figure 4. Observed DMI compared to the predicted NRC DMI (pens = 277).

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[2]Acknowledgments: Shawn Walter at eMerge Interactive for suppling eight years of industry data (P.O. Box 1767, Weatherford, OK 73096; (800) 654-4580).