EFFECTS OF BODY WEIGHT, FRAME SIZE AND PREVIOUS RATE OF GAIN ON THE ENERGY CONTENT OF GAIN OF STEERS

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Story in Brief

The energy concentration or composition of gain is an important variable in beef cattle feeding systems. The National Research Council (NRC, 19766 and 1984) use equations based on body weight, rate of gain, frame size and calf or compensating yearling designation to predict this value. A recently developed dynamic computer growth model (Oltjen, 1983) also makes this estimate. The factors affecting energy concentration of gain in the NRC system and the computer model are compared in this study. The results from the computer model agree with the NRC (1984) system regarding body weight and frame size unlike NRC estimates, model estimates of composition of gain for calves and compensating yearlings converge as body weight increases. In this model, energy composition of gain is more sensitive to rate of gain than the NRC equations are.

(Keywords: growth model, body composition, net energy)

Introduction

Predicting gain of beef cattle not only requires some estimate of energy available for gain, but also an estimate of the energy concentration of that gain, so that the retained energy may be converted to the more familiar weight gain. Conversely, when the weight gain of cattle is known, a prediction of the composition of that gain also requires an estimate of the energy concentration of gain. Feeding standards make an estimate of this concentration for several different conditions; however, more recent computer models of animal growth allow this to be estimated directly. The objective of this paper is to compare estimates of the energy concentration of empty body weight gain of beef steers for the National Research Council (NRC, 1976 and 1984) feeding standards and for the dynamic model of beef cattle growth of Oltjen (1983).

Materials and Methods

Equations for the energy content of gain of implanted steers as given by the NRC (1976 and 1984) is shown in Table 1, assuming empty body weight gain is 95.6% of live weight (shrunk) gain (NRC, 1984).

Energy content of gain for the Oltjen (1983) model was calculated using NRC (1984) net energy values for desired rates of gain, and then iterating on feed intake each day to achieve that rate of gain throughout the feeding period. Because the model predicts both empty body fat and protein accretion, the energy concentration in the gain is the energy in the protein and fat gain divided by the rate of empty body

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weight gain. Medium frame implanted calves and compensating yearlings were started at 200 and 300 kg live weight with condition scores (1, extremely thin - 10, extremely fat) of 5 and 3, respectively; large frame cattle were 20% heavier.

Table 1. Energy concentration of empty body weight gain (EBG, kg) for steers of different type and body weight (BW, kg).

Steer type	Energy in gain (Mcal/kg)	Source
All	$(.05515+.00748*EBG)\ BW^{.75}$	NRC (1976)
Medium frame calves	$.0635\ EBG^{.097}BW^{.75}$	NRC (1984)
Medium frame yearlings	$.0562\ EBG^{.097}BW^{.75}$	"
Large frame calves	$.0562\ EBG^{.097}BW^{.75}$	"
Large frame yearlings	$.0498\ EBG^{.097}BW^{.75}$	"

Results and Discussion

Energy value of gain increases from about 3 to 6 Mcal/kg as body weight increases from 200 to about 500 kg when rate of gain is held constant at a kg/d (figure 1). The former NRC (1976) did not differentiate between frame size and age (calf or compensting yearling), and its estimate is nearest to the more recent NRC (1984) value for medium frame calves (MC). Medium frame compensating yearlings (MY) and large frame calves (LC) have corresponding lines which reflect less energy in gain than for the medium frame calves, but greater than for large frame compensating yearlings (LY). In figure 2, body weight is held constant but gain is allowed to vary. The same sort of comparison between the two NRC publications and between frame size and age or previous nutrition as in figure 1 may be made, with similar magnitude of effects. The variation in the energy value of gain, however is less for rate of gain (figure 2) than for body weight (figure 1).

Using the Oltjen (1983) model to compare the effect of body weight on the energy value of gain, energy in gain increases from about 3 to 66 Mcal/kg as body weight increases from 200 to about 500 kg (figure 3). Frame size effects are similar to the NRC (1976), with large frame cattle about 1 Mcal/kg lower at similar body weights. However, the lines for compensating yearlings, although starting at nearly the same point as the NRC, do not remain below the calf lines as body weight increases. Instead they converge as the animal becomes larger, suggesting a similar composition of gain later in a feeding period.

A direct comparison of the NRC equations and Oltjen (1983) model is made in figures 4 and 5 for medium frame steers. NRC (1984) calves have energy concentrations of gain above all other lines (figure 4), but the lines for NRC (1984) compensting yearlings is within .2 Mcal/kg of the model's calf line throught and the model's compensating yearling line between about 350 and 500 kg body weight. Whether calves' gain consists of more fat at all weights than genetically similar cattle which have experienced a period of restricted nutrition should be investigated. The dynamic model used here contradicts this hypothesis and the slightly higher line for the compensating yearlings at greater body weight causes

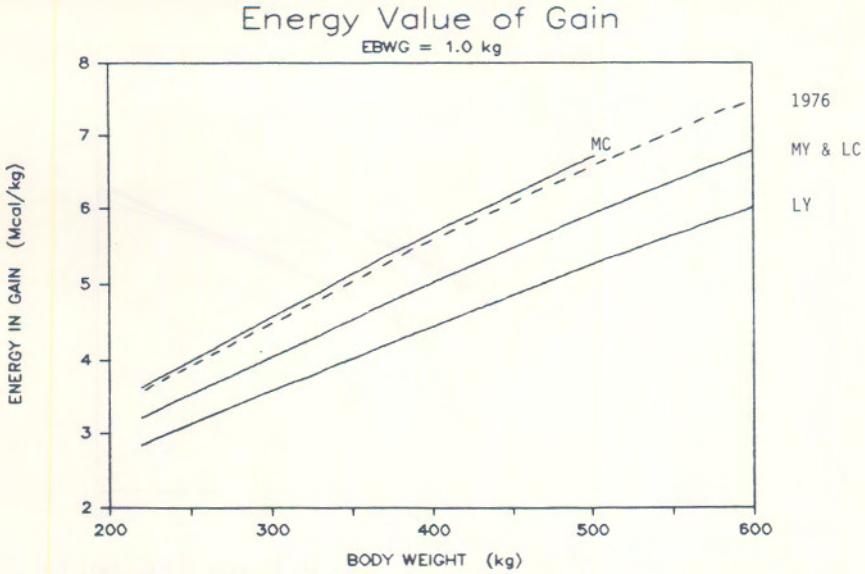

Figure 1. Energy concentration of daily empty body weight gain (1 kg, EBWG) for steers of different body weight: 1976 - NRC (1976); MC - medium frame calves, MY - medium framecompensating yearlings, LC - large frame calves and LY - large frame compensating yearlings from NRC (1984).

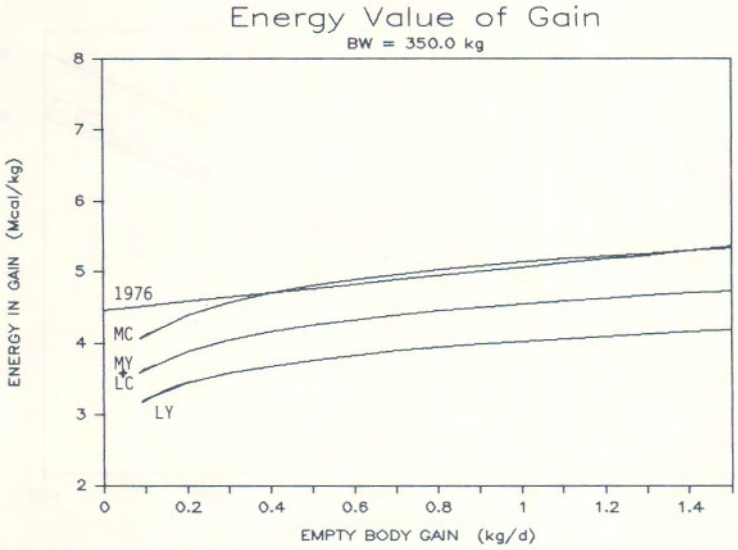

Figure 2. Energy concentration of different empty body weight gain for steers of 350 kg body weight: 1976 - NRC (1976); MC - medium frame calves, MY - medium frame compensating yearlings, LC - large frame calves and LY - large frame compensating yearlings from NRC (1984).

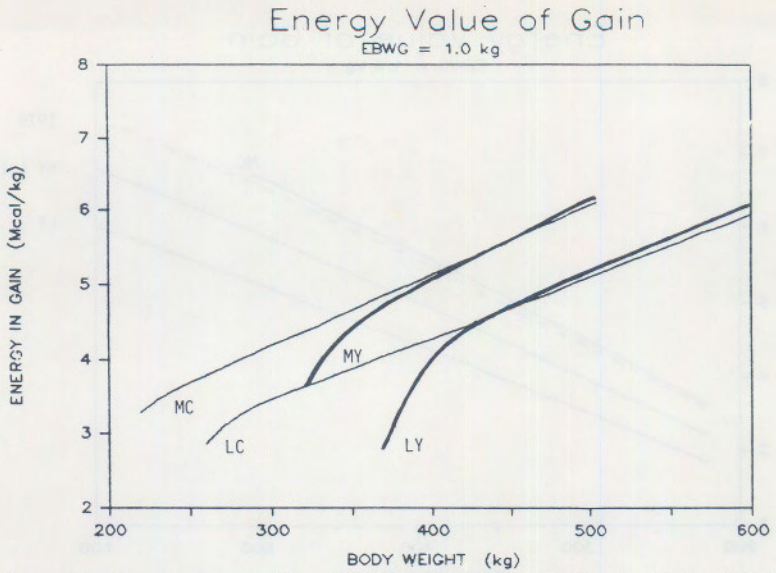

Figure 3. Energy concentration of daily empty body weight gain (1 kg, EBWG) for steers of different body weight: MC- medium frame calves, MY- medium frame compensating yearlings, LC - large frame calves and LY - large frame compensating yearlings from Oltjen (1983).

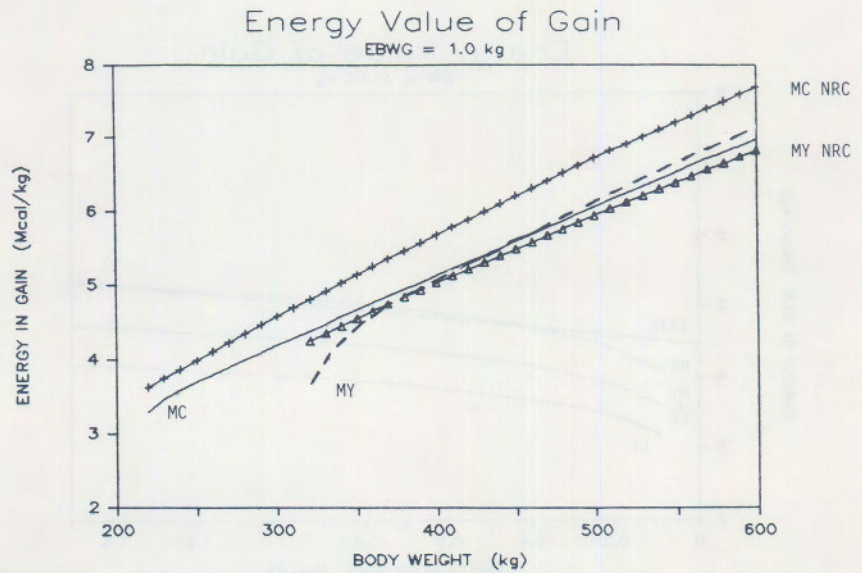

Figure 4. Energy concentration of daily empty body weight gain (1 kg, EBWG) for steers of different body weight: MC NRC - medium frame calves and MY NRC - medium frame compensating yearlings from NRC (1984), MC - medium frame calves and MY - medium frame compensating yearlings from Oltjen (1983).

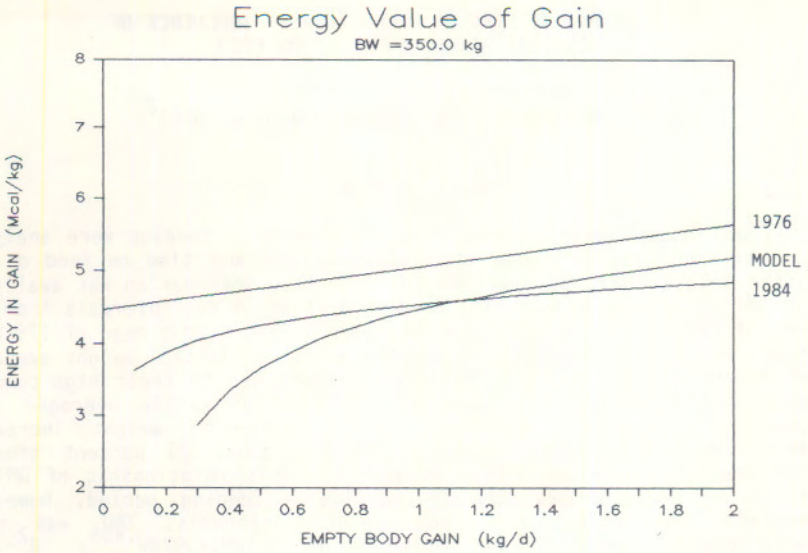

Figure 5. Energy concentration of different empty body weight gain for medium frame yearling steers of 350 kg body weight: 1976 - NRC (1976), 1984 - NRC (1984) and MODEL - Oltjen (1983).

compositional differences to narrow as the animals grow.

In figure 5 the effect of rate of gain for yearlings weighing 350 kg is compared. As shown previously, the former NRC (1976) equation estimates higher values than NRC (1984). The lines for the more recent NRC and the Oltjen (1983) model intersect at about 1.1 kg/d gain, with the model being more sensitive to gain. Corresponding compositions of gain (% fat) for the NRC (1976), NRC (1984) and the model are 43, 37 and 30 for .5 kg/day; 47, 41 and 40 for 1.0 kg/d; and 51, 43 and 45 for 1.5 kg/d empty body gain, respectively.

In conclusion, the effects of body weight and frame size on energy content of gain of beef steers are similar for the Oltjen (1983) model and the NRC (1984). Model estimates for both yearlings and calves are more similar to NRC compensating yearling estimates, with NRC calf energy content of gain particularly greater at increased body weight. However, the Oltjen (1983) model is more sensitive to rate of gain than the NRC (1976 and 1984) equations.

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