NET ENERGY CALCULATION FROM FEEDLOT PERFORMANCE DATA

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Story in Brief

A mathematical method was developed to calculate energy values for diets from general feedlot measurements, feed intake and rate of gain of cattle. Usefulness and limitations of this method to evaluate cattle performance data are discussed.

Introduction

Energy values of feedstuffs for cattle were determined initially by digestion-metabolism trials (TDN). Adjustments for the effect of level of feed intake on digestibility and methane loss have been added in certain metabolizable (ME) systems. In the California net energy (NE) system developed by Lofgreen and Garrett (1968), energy retention is determined at several levels of energy intake and energy needs for maintenance and growth are divided. Experiments to determine NE values for feeds are complex and expensive to conduct, but the NE system predicts feedlot performance quite accurately. Most large feedlots project weight of cattle fed in large pens by accumulating daily weight gains predicted from feed intakes and net energy values of the diets fed. Such projections are normally within 1% of determined final weights of cattle after 100 days of feeding.

Feeding trials are much simpler to conduct than NE trials. Rate of weight gain and feed to gain ratio are typically calculated from feeding trial results. These two values are usually closely related, as extra feed consumed can be used for gain which will improve feed efficiency. Since feed to gain ratio changes with both feed intake and energy value of the diet, methods to adjust for feed intake differences and calculate NE values from performance data would help refine NE values for a wider variety of conditions. Several mathematical solutions to calculate NE values are possible. The objective of this paper is to outline the most direct solution and to illustrate application and limitations of calculated NE values.

Materials and Methods

Net energy needs for maintenance and gain for steers and for heifers were obtained from Lofgreen and Garrett (1968) and converted to English units:

$$NE_m \text{ (mcal/day)} = .0426\ W^{.75};$$

For steers calves,

$$NE_g \text{ (mcal/day)} = (.0132ADG + .00078ADG^2)\ W^{.75};$$

For heifer calves,

$$NE_g \text{ (mcal/day)} = (.0141ADG + .00144ADG^2)\ W^{.75};$$

where W is weight (ideally shrunk) in pounds and ADG is daily gain in pounds.

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The above equations allow values for NE_m and NE_g requirements to be calculated from gain and weight of steers or heifers. One can rearrange the equation to calculate the NE_m and NE_g of a diet, called CNE_M and CNE_G in this paper to differentiate calculated from experimentally determined energy values. To do this, the relationship of NE_m to NE_g must be fixed to provide a unique solution. This relationship can be determined based on the relationship of each to ME of the diet (Lofgreen and Garrett, 1968). This relationship (in English units) is: $NE_g = 115.3 - (4983/NE_m)$; where NE_g and NE_m are net energy for gain and maintenance expressed in mcal per hundred pounds of dry diet.

Using this relationship, an iterative calculator or a computer program can be employed to solve CNE_m and CNE_g from mean weight, weight gain and feed intake of cattle in a feeding trial. To simplify the solution, the quadratic equation can be solved directly. The equations become:

$$E = 2.54\ NE_m + 1.098\ FI;$$
$$F = NE_g - 1.153\ FI;$$
$$G = 2.4178\ NE_m;$$

where E, f and G are constants, NE_m and NE_g are net energy requirements for gain and maintenance in mcal/day as calculated from performance above, and FI is daily feed intake in pounds per head per day.

Then: $CNE_m\ (mcal/cwt) = 22.7(-E-(E^2+4FG)^{.5})/F;$
$CNE_g\ (mcal/cwt) = 115.3 - (4983/CNE_m);$
$CME^g\ (mcal/kg) = (2.2577 - \log_{10}\ (3496/CNE_m))/.2213;$
$CTDN\ (\%) = CME\ /\ .036155;$

where CMC and CTDN are calculated ME and TDN, respectively.

Using these equations, CME and daily CME intake can be calculated from feedlot trials. These values are more independent and potentially more useful in experiments than gain and feed efficiency values though they cannot be used as directly in calculating cost of gain.

As an example, if a 500 pound steer is fed to 1000 lb at a rate of 2.5 pounds per day with feed intake of 18 pounds of dry matter per day, NE_m = 6.10 mcal/day; NE_g = 5.44 mcal/day; E = 35.26; F = -15.31; G = 14.75; CNE_m = 79.6 mcal/cwt; CNE_g = 52.7 mcal/cwt; CME = 2.78 mcal/kg CTDN = 76.9%.

Results and Discussion

Applications

Since 1979, OSU research reports have presented CME, CNE_m or CNE_g values, usually listed as ME and footnoted as values calculated from animal performance and intake data. In most trials, CME values were within a few percent of ME values calculated from diet composition. Exceptions were apparent when weather stress reduced performance (Gill et al., 1984) and when steer equations were used for bulls (Gill et al., 1983). CME values were especially useful in estimating value of new feeds (Martin et al., 1984) and feed additives for various weights of cattle (Witt et al., 1980).

Calculations also proved useful in evaluating grain or forage processing procedures which often alter feed intake. Use of these equations helps differentiate between feed efficiency changes due to feed intake versus those due to metabolic changes (Ferrell et al., 1983; Doran et al., 1984). CME values indicate that treatment of forage with hydroxides increases feed intake enough to explain all of the increase in feed efficiency achieved by such treatment (Horn et al., 1981). The equations are routinely used to adjust feed intake records for a pen when one animal in a pen dies so that records are incomplete. Calculations also help detect problem pens in an experiment. They also are useful to check whether performance data in the literature is reasonable or unreasonable based on diet composition and feed intake.

Limitations

The applicability of calculated energy values is dependent on 1) the relationship of NE_m to NE_g, 2) the equations to estimate the requirements for NE_m and NE_g and 3) the accuracy of performance data. The standard relationship of NE_m and NE_g was assumed. Various factors may alter this relationship. For example, monensin has been suggested to decrease the NE_m requirement but not alter the NE_g requirement of cattle.

Current equations underestimate gains of heavier cattle (Gill et al., 1981; Owens and Gill, 1982). More recent energy requirement equations for yearlings have been proposed (Lofgreen, 1977) and could be employed in more refined calculations. These are:

For yearlings, NE_m (mcal/day) = $.0426\ W^{.75}$;
For yearling steers, NE_g (mcal/day) =
$(.0132ADG + .00078ADG^2)\ W^{.75}$;
For yearling heifers, NE_g (mcal/day) =
$(.0141ADG + .00144\ ADG^2)W^{.75}$;

with definitions as described previously.

Weighing conditions of cattle in feedlot trials are much more variable than carcass weights and energy determinations used in net energy experiments. Dressing percents will vary with gastro-intestinal fill and degree of of finish. Use of carcass weights rather than live weights should reduce this source of error as illustrated by Gill et al. (1976).

Finally, feed additives, implants, cattle type or stress may influence the energy requirement of animals and not the energy value of feeds. In such cases, it is inappropriate to adjust the energy values of feeds even though such adjustments may simplify application. Certain new drugs and hormones may influence body composition. Current equations are based on an assumed body composition at a specific weight. If treatments or body types alter this assumption, the determined CME values will be biased. Adjustments for frame size and sex as presented by Minish and Fox (1982) may be useful for such adjustments. Nevertheless, comparison of treatments within a study using cattle of a similar type and origin should be valid unless body composition is altered by treatment.

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