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Residual Feed Intake

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Abstract

Introduction

Low rates of return on investment for livestock operations are a fact of life. Producers have little impact on the market price for their cattle; therefore management must be focused on the things producers can actually do something about. For many years, genetic selection programs have focused on production (output) traits, with little attention given to production costs (inputs). Recently, this view has begun to change, and the efficiency of conversion of feed (i.e., the amount of product per unit of feed input) has been recognized as more important. Numerous studies have shown what cattlemen have always known: profitability in this business depends on keeping the costs of production to a minimum. Within any beef cattle operation, feed costs are undoubtedly the main concern, since they typically account for 60 – 65 % of the total costs of production. That's why greater feed efficiency has been targeted as a means of improving the profitability of the beef industry.

One estimate of feed efficiency is the feed conversion ratio. Traditionally, this was expressed as a feed:gain ratio, but this led to the confusing result that a higher ratio meant a lower efficiency. Today, feed conversions are often expressed as a gain:feed ratio to overcome this problem. Even so, results can be misleading, because these ratios are closely correlated to the intake and rate of gain of the animal (Carstens et al., 2004). So, two animals might have similar gain:feed and still be very different in their feed intakes and rates of gain. Conversely, the same animal at different intakes would certainly have different gain:feed ratios, even though the genetics of the animal hadn't changed. Therefore, gain:feed has never taken off as a criterion for genetic selection.

Residual feed intake (RFI), defined as actual feed intake minus the expected feed intake of each animal, was first proposed as an alternate measure of feed efficiency by Koch et al. (1963). It can be defined, in other words, as the difference between actual feed intake and the expected feed requirements for maintenance of body weight and for weight gain. RFI has been adopted more intensively in other countries, such as Australia and Canada, but in the US more attention has been given to understand the biological issues around this concept. Genetic selection to reduce RFI can result in progeny that eat less without sacrificing growth performance (Herd et al. 1997; Richardson et al. 1998). In contrast to gain:feed, residual feed intake is independent of growth and maturity patterns. Therefore, RFI should be a more sensitive and precise measurement of feed utilization, since it is based on energy intake and energy requirements.

Methodology for measuring RFI

The residual feed intake is an individual record, taken in long term feeding trials (at least 70 to 84 days) where animals are housed either in individual or group pens, and accurate measurements are made of daily feed offered and refused, as well as average daily gain. Research has shown that there is considerable individual animal variation in feed intake above and below that expected or predicted on the basis of size and growth. That statement, along with the fact that individuals of the same body weight require rather widely different amounts of feed for the same level of production establishes the scientific base for measuring RFI in beef cattle.

In order to obtain RFI values, it is necessary to measure and record the daily feed intake for each animal, which can be accomplished by housing them in individual pens. Recent techniques employing electronic devices that identify each animal individually, opening specific feed bunks and measuring the feed intakes of individual animals kept in groups can also be adopted, although some difference has been observed when comparing these two types of housing. Therefore, obtaining RFI data is laborious and expensive, and this has limited its spread as a feed efficiency measurement.

Figure 1. Actual and predicted dry matter (DM) intakes by fed steers. Residual feed intake (RFI) is the difference between actual and predicted DM intakes.

Once the trial is finished, the daily feed intake is calculated from the amounts of feed offered and refused, and the average daily gain and average body weight obtained for the same period. The expected feed (or dry matter) intake is obtained from linear regression of DMI on mid-test BW.75 and average daily gain (ADG). The statistical model is: $Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$ where Y is expected dry matter intake, β_0 is the equation intercept, β_1 and β_2 are the coefficients of the equation, X1 is the mid-test metabolic body weight, X2 is the average daily gain, and ϵ is the residual. The intercept of the equation is tested and if it is not significant a new equation is fitted without the intercept. Then, the predicted feed intake of each animal is estimated using the equation. This prediction may be thought of as the “average” or expected value for animals of similar weights and rates of gain. The actual feed intake minus the predicted feed intake corresponds to the residual feed intake (Figure 1).

Results and Discussion

Figure 2 shows the relationship between dry matter intake and average daily gain, obtained from 36 animals in a recent trial conducted at the UC Davis feedlot. These data show the general trend for increasing rates of gain with higher intakes, and also the variation around that trend. For example, two an-

imals with identical intakes (7.43 kg) had more than 50% difference in average daily gain! Clearly, the more efficient animal would be much more profitable. Similarly, two animals with almost identical rates of gain (1.5 kg/day) had very different feed intakes (7.43 vs. 9.22 kg/day). Obviously, the animal with the same rate of gain and lower feed intake would be far more profitable.

Figure 2. Relationship between dry matter intake and average daily gain in fed steers

For a trait to be used as a selection criterion it must present genetic variance and be heritable. Several studies have shown heritabilities for RFI ranging from 0.14 to 0.44 and genetic variances ranging from 0.149 to 0.267 (Fan et al., 1995; Archer et al., 1997; Arthur et al., 2001; Herd et al., 2003). From a practical point of view, this means that RFI is at least as heritable as early growth. The genetic variance is limited, but it is still enough to make substantial improvement. In that sense the development of an EPD for RFI seems practical. As observed by Herd et al. (2003), selection against postweaning RFI in heifers has the potential to lead to a decrease in feed intake and improvement in feed efficiency of the breeding herd, since the correlation between post-weaning RFI and cow RFI is very high (0.98). This means that selection for lower RFI in growing animals will result in lower RFI in breeding females, thereby reducing the feed cost for the cow herd. Conclusions

Profitability depends on keeping costs to a minimum without sacrificing production or quality. Feed represents about 2/3 of costs of beef production, so more efficient conversion of feed should be a priority. Residual feed intake is the best available measure of efficiency, because it is independent of level of production; moreover, RFI is moderately to highly heritable, and so will respond to genetic selection. Selection for reduced RFI in growing animals should reduce feed costs for beef cattle in all stages of life, including the cow herd.

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RESIDUAL FEED INTAKE

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[†]Pedro Paulino was supported during his stay at UC Davis by a Fellowship from the Brazilian Ministry of Education – CAPES.

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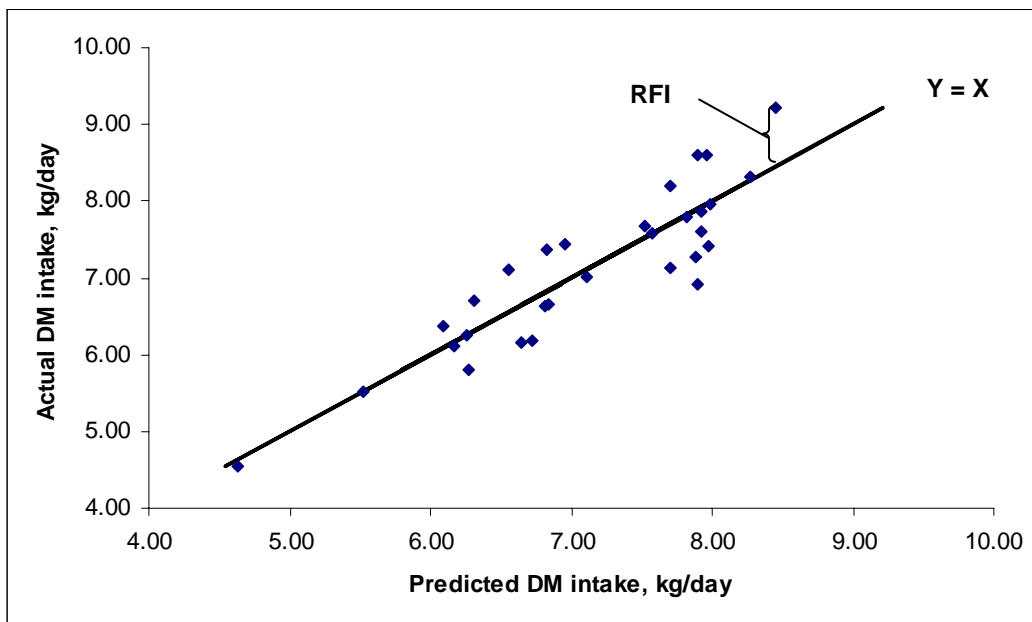


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$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

where Y is expected dry matter intake, β_0 is the equation intercept, β_1 and β_2 are the coefficients of the equation, X_1 is the mid-test metabolic body weight, X_2 is the average daily gain, and ε is the residual. The intercept of the equation is tested and if it is not significant a new equation is fitted without the intercept. Then, the predicted feed intake of each animal is estimated using the equation. This prediction may be thought of as the “average” or expected value for animals of similar weights and rates of gain. The actual feed intake minus the predicted feed intake corresponds to the residual feed intake (Figure 1).

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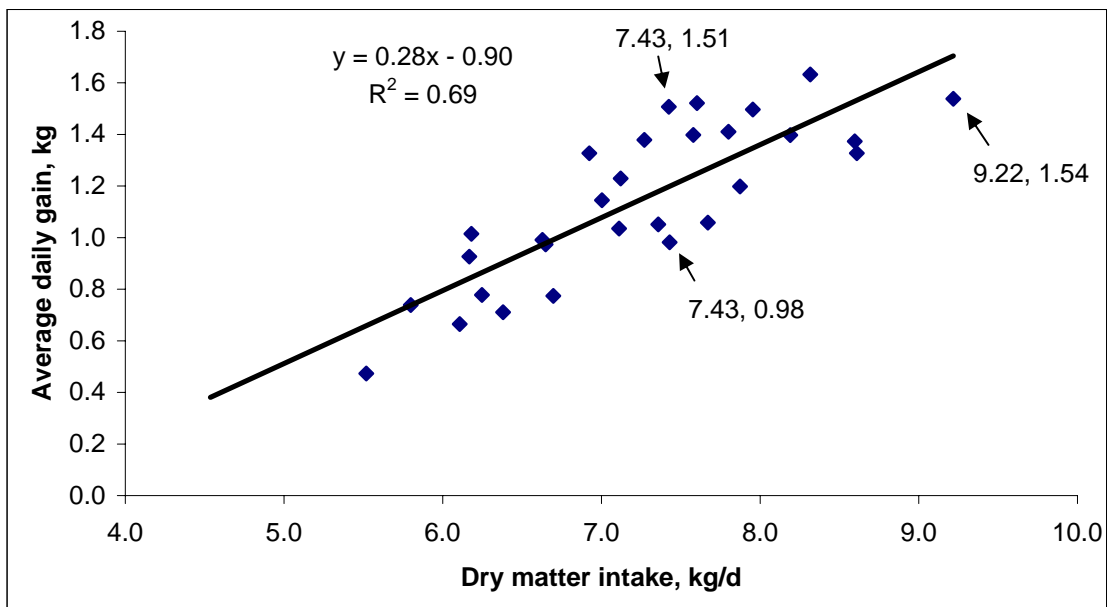


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