Consequences of selection for residual feed intake in beef cattle

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Abstract

Abstract

In all livestock systems, feed accounts for the greatest cost of production. Therefore, improvements in the production efficiency by reduced feed inputs would be a significant economic benefit to Australian ruminant production systems, particularly for beef cattle. Residual feed intake (RFI) is the difference between an animal's actual feed intake and that which would be expected based on production. Selection for residual feed intake enables a reduction in inputs (feed) with no or minimal change in outputs (mature weight and growth rate). However, the biological processes underpinning variation in residual feed intake are unclear.

Many authors have hypothesised that part of the variation in RFI may be due to differences in energetic efficiency through changes in heat production, these being in part due to differences in protein metabolism. Following three generations of divergent selection for RFI, eight High and eight Low-RFI heifers were fed at both 105 and 180% of predicted maintenance feed requirements. Between-RFI line and feeding-level differences were assessed for energy intake, protein metabolism, heat production, body composition, energy and nitrogen balance and digestibility. The RFI lines did not differ in protein metabolism or heat production. The High-RFI heifers deposited 51 and 56% more subcutaneous fat at the P8 rump and 12/13th rib sites, respectively, with no difference in eye muscle area gain or average daily weight gain. The greater fat deposition of High-RFI heifers was due to a larger ad libitum feed consumption compared with the Low-RFI heifers. Energy and nitrogen balance did not differ between the RFI lines. The energy transactions indicated no difference in the efficiency

of energy use on 105% maintenance, although when fed 180% of maintenance the differences in feed intake suggest variation in appetite as the mechanism contributing to RFI. All of the extra energy consumed by High-RFI heifers above maintenance and deposition of protein was associated with additional energy retained as fat.

Despite the variation in residual feed intake being accounted for by variation fat deposition high and low RFI animals still differ significantly in actual feed intake. A potential explanation of this difference could be variation in the energy status and appetite between high and low RFI animals. Eight High and eight Low-RFI heifers were fed at either 105 or 180% of predicted maintenance feed requirements. Plasma were analysed for glucose, insulin, non-esterified fatty acids (NEFA) and ghrelin from blood samples taken before during and after feeding. There was no difference between the circulating ghrelin of low and high RFI heifers, however, have a reduced feed intake compared to high RFI heifers. It could be hypothesised that the low RFI heifers had a reduced sensitivity to circulating ghrelin whilst the high RFI heifers appear to have weaker negative feedback mechanisms from fatness to reduce feed intake. Additionally, low RFI heifers may be more stressed and certainly appear to be mobilising adipose tissue to produce NEFA as an energy source.

The performance of low RFI-EBV Angus steers in a large commercial feedlot by reduced feed consumed with no adverse effects on final turnoff weight. Low RFI-EBV steers consumed on average 270kg less feed than medium RFI-EBV and high RFI-EBV steers, resulting in a saving of $53 (at $200/tonne) of feed per animal. Low RFI-EBV steers finished with less subcutaneous fat measured at the 7/8th rib, which may impact on market specifications. Dressing percentage and seam fat were higher in the low RFI-

EBV steers. Together, this would be expected to result in a greater yield of retail beef with no reduction in visual meat quality or marbling grade. Breeding to reduce RFI, may change distribution of carcass fat but the consequences may not be as severe as previously thought as not all fat depots appear to be equally affected. Meat tenderness may be slightly reduced, but with longer ageing periods, this is unlikely to be a problem.

Cows genetically differing in fatness appear to behave similarly to animals differing in RFI. Low fat genotype cows consume considerably less feed and energy than expected based on their weight, weight gain, growth of the calf and the growth of the gravid uterus. Thus, low fat genotype cows had a lower RFI during both periods of measurement than the high fat genotype cows. Low fat genotype cows had higher mature weights (as these genotypes appear to have a later maturity pattern) with no differences in the weight gains of cows and calves or the weaning weights of calves from these cows, similar to low RFI cows. High fat genotype cows had a greater appetite and ate more, as do high RFI cows. Both of these types of cows are possibly fatter as they have greater appetites and eat more (Chapter 8). Whilst not conclusive, high fat genotype cows and high RFI cows tend to both have higher calving rates, weaning rates and weaning weights per cow exposed. These differences between high and low fat genotypes cows are exactly as expected from cows divergent in RFI. The conclusion is that given the high phenotypic and genotypic correlations between fatness and RFI, selection for feed efficiency may be most easily and cheaply achieved by selecting for fatness.

Direct selection for feed efficiency in beef cattle (FCR) in the past has indicated some potential drawbacks. One issue is that FCR is highly correlated with average daily gain; therefore selection for high growth alone is much more cost-effective than measuring individual feed intake. Another problem is that this measure of feed efficiency would tend to select for animals with greater muscle mass and less fat deposition. Additionally, selection for increased FCR results in increased mature size and increasing the size and energy requirements of cows would not be a goal of most commercial operations.

Due to these issues with selecting for feed conversion ratio (FCR), it was anticipated that RFI may be an alternative to genetic selection for FCR(Koch *et al.*, 1963). It was thought that RFI could be used for genetic selection with much more confidence in beef production systems as it was supposed to be independent of average daily gain, body weight and mature size. However, all the evidence from the experiments conducted herein show that the only biological mechanisms that appear to be affected through selection for RFI is appetite and activity at constant weight and daily gain. The 2 main implications are not trivial: 1) animals that have a greater appetite and consume more energy at constant weight and daily gain, deposit more energy as fat, and 2) animals that deposit more energy as fat do this due to a greater appetite.

Evidence from this thesis concludes that reducing maintenance requirements through selection for RFI may not be possible and may be detrimental to animal fitness. However, if RFI is to be used as a tool for improving feed utilisation, then adjustment for body composition would need to be considered. Given that improving feed utilisation is only reasonable in the growing animal, then feed conversion would be much easier to implement given the high generic and phenotypic correlations between

FCR and growth rate. Currently, producers do not have good measures for the variation in feed utilisation for maintenance to target in selection programs. In the absence of such measures, producers should be encouraged to focus on measurable output traits in their selection programs.