BENEFITS OF GENETIC SUPERIORITY IN RESIDUAL FEED INTAKE IN A LARGE COMMERCIAL FEEDLOT

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SUMMARY

Growth, feed intake, feed efficiency and carcass traits on 208 yearling Angus steers differing in genetic merit for residual feed intake (RFI) were measured in a large commercial feedlot. At feedlot entry the steers were drafted into three groups: high efficiency (HE; midparent RFI-EBV ≤-0.3kg/day, medium efficiency (ME: midparent RFI-EBV >-0.3 to 0.14 kg/day), and low efficiency (LE; midparent RFI-EBV ≥0.16 kg/day), and feedlot performance evaluated over 251 days. Whilst individual animal weight and carcass data were collected, daily feed consumption was recorded on a group basis. The HE steers grew as fast or faster than either the ME and LE steers (1.11 ±0.02 (sd) *v* 1.06 ±0.01 and 1.07 ±0.02kg/day). At slaughter the HE and ME groups were heavier than the LE group (713 ±5 and 714 ±5 *v* 701 ±5 kg). The HE steers consumed less feed than the ME and LE steers over the 251 days (10.4 *v* 11.8 and 11.1kg/day). Compared to the LE steers, the HE steers had a 10% lower FCR and 0.98kg/day lower RFI. Carcass weight and dressing percentage were lowest in the LE steers, and eye muscle area was highest in the ME steers. Subcutaneous rib fat depth on the carcass was lower in the HE steers than for the ME and LE steers (15.6 ±0.6 *v* 17.6 ±0.6 and 20.7 ±0.6mm). AUSMEAT and USDA marbling scores were highest in the ME group and not different for the HE and LE groups. The experiment showed that genetic superiority in RFI reduced feed consumed over 251 days of feeding in a large commercial feedlot with no compromise in weight gain, carcass weight, dressing percentage or marbling grade.

INTRODUCTION

Genetic improvement in feed efficiency has the potential to reduce feed costs in a feedlot operation whilst still maintaining production levels. Residual feed intake (RFI) is a measure of feed efficiency and is the difference between actual feed intake by an animal and its expected feed intake based on its requirements to maintain weight and for its growth (Arthur *et al*. 2001). This experiment aimed to validate the benefits from feeding steers bred from parents known to be of high, medium and low genetic merit for RFI in a large commercial feedlot.

MATERIALS AND METHODS

Cattle breeding and RFI groups. The Angus steers were bred at the NSW DPI Agricultural Research Centre, Trangie, NSW. Trial Net (or residual) Feed Intake (NFI) estimated breeding values (RFI-EBV) which are produced by BREEDPLAN were available for their sires and dams.. The sires and dams were sorted on their RFI-EBV and mated in 2005 to produce offspring that were genetically-divergent for feed efficiency. The steer calves were managed together with their dams till weaning and continued to be managed together until feedlot entry. Of the 271 steers weaned, 1 died, 2 were excluded because of poor leg structure, another 6 excluded because of uncertain parentage, and 42 failed to attain the specified induction weight. These 42 steers contained roughly equal proportions of high, medium and low efficiency candidate animals. The remaining 216 steers were drafted into three groups: being of high efficiency (HE; midparent RFI-EBV ≤-0.3kg/day; N=73), medium efficiency (ME: midparent RFI-EBV >-0.3 to 0.14 kg/day; N=73), and low efficiency (LE; midparent RFI-EBV ≥0.16kg/day; N=70), and sold to the cooperating feedlot. The HE steers were the progeny of 14 sires, the ME steers were the progeny of 14 sires (8 in common with the HE group), and the LE steers were progeny of 9 sires (1 in common with the ME group; no sire had progeny in all 3 groups). Sire RFI-EBV ranged from -0.92 to 1.24kg/day, with a mean accuracy of 67% (range 44 to 87%). Dam RFI-EBV ranged from -1.13 to 0.87kg/day, with a mean accuracy of 63% (range 49 to 77%).

Feedlot management and slaughter. Steers were inducted into the feedlot in October 2007 at an average age of 447 ±17 (sd) days and placed into three separate pens. Splitting of efficiency groups to provide replication was not possible. They received a starter ration for the first 16 days and then 2 intermediate ration formulations for another 16 days, before being placed on the finisher ration. In total they were fed for a 251 days. Feed delivered into each pen was electronically recorded. During the experiment four steers were pulled and treated for health reasons (2 HE; 2 LE), and 4 steers (3 HE: 1 ME) were sold early to meet a market order. These 8 steers were not included in the data analysis. The steers were weighed at induction, after 113 days and after they were killed on day 252. Average daily gain in weight (ADG) for each steer was calculated as change in weight divided by the number of days. After stunning and bleeding the body was weighed and 14kg added for blood loss (the usual weight of blood loss from steers of this weight recorded in the abattoir) to determine the final weight of each steer. Carcasses were split, and weighed separately before being chilled overnight. The left-side was quartered between the 7th and 8th ribs, and rib fat depth and area of the eye muscle, AUSMEAT marble score (1 (nil) to 9 (abundant)) and USDA marble score (100 to 900 by units of 10).

Data analysis The weight of feed delivered into each pen each day was adjusted to being equivalent to a ration with an energy density of 12MJ ME/kg DM, because of the differences in energy density between the three rations initially fed and the finisher ration. Weight of feed was then divided by the number of animals in the pen to calculate feed consumed on a per head basis. The way feeding was managed and recorded in the feedlot was known to increase apparent day-to-day intake per head. Analysing the data as means for consecutive three-day blocks reduced day-to-day variation whilst still allowing underlying trends in feed consumption to be apparent.

Without individual-animal feed intake data it was not possible to calculate individual animal feed conversion ratio (FCR) or RFI. For each pen, FCR was calculated by dividing pen DFI by ADG of the steers in the pen. To calculate RFI for each pen, the equations of SCA (1990) were used to predict DFI by each pen for each period based on the average (mid-period) weight for steers in the pen and ADG over the period. The predicted DFI was deducted from the observed DFI for each pen to calculate RFI. Differences between means for growth and carcass traits for the 3 efficiency groups were analysed in a General Linear Model (GLM) with pen as the only fixed effect. These traits were also regressed against the midparent RFI-EBV, and if found to be significantly different from zero was taken as evidence of a genetic association. Average age at induction of steers in the ME group was 452 ±21 days compared with 445 ±16 and 444 ±13 days for steers in either the HE or LE groups. Age was included as a covariate in the GLM and regression models and means for the three groups are presented as LS-means. Trends in DFI over time and differences between pens were modeled by fitting curves in the form of splines to the data for each pen and analysed using ASREML (Gilmour *et al*. 1999). The final model with a spline curve (with 8 knot points) fitted for each group accounted for 18.3% of the variation in DFI for the 3 groups. The standard error about the predicted DFI for each group for each day was multiplied by 2 to give an approximate 95% confidence interval about each spline.

RESULTS AND DISCUSSION

The HE steers showed advantages in lower feed intake, no compromise in growth rate, and improved feed conversion over the first 113 days on feed that were sustained over the full 251 days on feed. There was no difference in induction weight between the HE and LE groups, although the ME group were heavier (Table 1). The HE steers grew as fast or faster than either the ME and LE groups over the first 113 days and over 251 days. By day 113 and at slaughter the HE and ME groups were heavier than the LE group. Regression coefficients for induction and final weights, and ADG over 251 days, with midparent RFI-EBV were not significantly different from zero providing evidence for lack of strong associations with genetic variation in RFI. The regression coefficient for weight at, and ADG to 113 days showed a small advantage in daily gain associated with lower midparent RFI-EBV. The regression models for these growth traits against age and midparent RFI-EBV had R^2 ranging from 10%, for weight at induction, to1.3% for ADG over 251 days, showing that even where statistically-significant, genetic variation in RFI only explained a small part of the variation in growth performance.

Table 1. Means (±se) for feedlot performance and carcass traits for Angus steers in high, medium and low efficiency groups, and regression coefficients with midparent RFI-EBV.

	Efficiency group			Regression coefficient
	High	Medium	Low	
Number of animals	68	72	68	
Midparent RFI EBV (kg/day)	-0.52 ± 0.02^a	-0.09 ± 0.02^b	0.62 ± 0.02^c	
Weight at induction (kg)	435 ± 4^a	448 ± 3^b	432 ± 4^a	-1.1 ± 4.2
ADG days 1-113 (kg/day)	1.31 ± 0.02^a	$1.28 \pm 0.02^{a,b}$	1.22 ± 0.02^b	-0.07 ± 0.03*
Weight at day 113 (kg)	583 ± 4^a	593 ± 4^a	570 ± 4^b	$-9.2 \pm 4.8^†$
ADG days 1-251 (kg/day)	1.11 ± 0.02^a	1.06 ± 0.01^b	$1.07 \pm 0.02^{a,b}$	-0.03 ± 0.02
Final weight (kg)	713 ± 5^a	714 ± 5^a	701 ± 5^b	-8.2 ± 5.6
FI days 1-113 (kg/day)‡	10.7	12.1	11.6	
FI days 1-251 (kg/day) ‡	10.4	11.8	11.1	
FCR days 1-113 (kg/kg)‡	8.1	9.4	9.5	
FCR days 1-251 (kg/kg) ‡	9.4	11.1	10.4	
RFI days 1-113 (kg/day)‡	-0.93	0.40	0.55	
RFI days 1-251 (kg/day) ‡	-0.81	0.63	0.17	
Hot carcass weight (kg)	417 ± 3^a	420 ± 3^a	406 ± 4^b	-8.0 ± 3.7*
Dressing percentage (%)	58.5 ± 0.2^a	58.9 ± 0.2^a	58.0 ± 0.2^b	-0.44 ± 0.20*
Rib fat depth on carcass (mm)	15.6 ± 0.6^a	17.6 ± 0.6^b	20.7 ± 0.6^c	4.7 ± 0.7*
Eye muscle area(cm^2)	76.1 ± 0.4^a	78.6 ± 0.4^b	76.1 ± 0.4^a	-0.26 ± 0.46
AUSMEAT marble score	3.0 ± 0.1^a	3.6 ± 0.1^b	3.0 ± 0.1^a	-0.07 ± 0.13
USDA marble score	477 ± 11^a	569 ± 11^b	463 ± 12^a	-19 ± 15

Means within rows with different superscripts differ significantly (P<0.05).
*denotes regression coefficient significantly different from zero at P<0.05; †at P<0.1.
‡Could not be statistically compared as individual animal data were not available.

Modeling DFI over time showed the patterns of feed consumption were similar for the 3 groups. There was a significant pen effect (P<0.001) but no significant interaction (P>0.05) between pens and time, that is all the splines had a similar shape over time. Over the first 113 days and over the full 251 days, the pen of HE steers consumed less feed than the ME and LE steers (Table 1). Compared to the LE steers, the HE steers had a 14% lower (better) FCR over the first

113 days and a 10% lower FCR over the full 251 days in the feedlot, so should have been more profitable to feed. The RFI of the HE steers was 1.5kg/day lower (better) than that of the LE steers over the first 113 days, and 0.98kg/day lower over the full 251 day period.

Carcass weight and dressing percentage were lowest in the LE steers, eye muscle area was highest in the ME steers, and the 3 traits had negative regression coefficients with midparent RFI-EBV (Table 1). Subcutaneous rib fat depth on the carcass was lower in the HE steers than for the ME and LE steers and had a positive regression coefficient with midparent RFI-EBV. AUSMEAT and USDA marbling scores were highest in the ME group and not different for the HE and LE groups, and neither marbling trait was associated with midparent RFI-EBV. The regression models for these carcass traits against age and midparent RFI-EBV had R^2 of 19% for rib fat depth, and from 11% to 0.7% for the other traits, showing that, with the exception of rib fat depth, genetic variation in RFI explained only a small part of the variation in these carcass traits.

CONCLUSIONS

This experiment demonstrated that genetic superiority in RFI had a favourable impact on the commercial performance of Angus steers by reducing feed consumed with no adverse effect on final turnoff weight. Each HE steer consumed on average 2.60t of feed compared to 2.87t by the ME and LE steers, that is, saved the feedlot 0.27t or $53 (at $200/tonne) of feed with no compromise in weight gain. The HE steers finished with less subcutaneous fat measured at the 7/8 rib which may have an impact on meeting market specifications. However marbling scores were not influenced by RFI, and dressing percentage was higher in the HE steers, which together would be expected to result in a greater yield of retail beef with no reduction in marbling grade. The feed efficiency benefit was sustained for 251 days and showed that genetic improvement of feed efficiency will reduce feed costs in a large commercial feedlot.

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