GENETIC VARIATION IN FEED INTAKE AND EFFICIENCY OF MATURE BEEF COWS AND RELATIONSHIPS WITH POSTWEANING MEASUREMENTS

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INTRODUCTION

Providing feed to animals is a major cost to beef production, and so improving the efficiency with which feed is utilised is an important goal to cattle breeders. In many beef production systems, a large proportion of the feed used is consumed by the cow breeding herd, while young growing animals consume feed which is often of higher value. A review of the literature showed that genetic variation in feed efficiency of younger animals exists, but there is little information available on the relationships of feed intake and efficiency measured post-weaning with these traits in mature breeding cows (Archer *et al*. 1999). This paper reports results from a study examining feed intake and efficiency traits of beef cows and their relationship to similar measurements taken post-weaning.

MATERIALS AND METHODS

Data used in this study were part of a larger project described by Arthur *et al.* (2001). A total of 1781 young bulls and heifers were tested in 10 groups for feed intake, growth and efficiency at Trangie Agricultural Research Centre shortly after weaning at approximately 7 to 9 months. The bulls and some of the heifers were bred using a range of Angus sires from industry over the spring calving Angus cow herd at the Agricultural Research Centre. Other heifers were sourced from industry autumn calving herds with sire identified, and included Angus, Hereford, Poll Hereford and Shorthorn breeds. The test consisted of a 21 day introductory period, followed by a 70 day test period, and animals were fed a pelleted ration with approximately 10 MJ ME/kg dry matter (range was 9.7 to 10.5) and 16 to 18% protein, in an automated feed intake recording facility. Further details on the post-weaning test and experimental design are given by Arthur *et al.* (2001).

Following the post-weaning test, all heifers entered the cow herd (spring or autumn calving) and were given at least two opportunities to calve. Cows were only culled after two consecutive failures to calve. After the birth of their second calf cows were not mated, and approximately 10 weeks after the calf was weaned the cows were re-tested for feed intake and growth in the automated feeding facility. Data on 751 cows tested in 7 groups was available. The test was conducted in a similar manner to the post-weaning tests, with a 14 to 21 day introductory period and a 70 day test period. The mature cow test used the same pelleted ration as the post-weaning test, and the cows had *ad libitum* access to feed.

Definition of traits. The same procedures were used to define similar traits for the post-weaning and mature cow tests. Trait abbreviations have been given subscripts of "pw" and "cow" to distinguish measurements taken post-weaning and on mature cows respectively. The average daily feed intake (DFI) of the animals was adjusted to 10 MJ ME/kg dry matter. Weight of individual animals (measured weekly) were regressed against time on test and the regression coefficients used to calculate average daily gain (ADG) over the test period, and mid-weight (average of the start and end weights) raised to the power of 0.73 ($MidWt^{0.73}$). Residual feed intake (RFI) was calculated as actual (daily) feed intake minus feed intake predicted based on ADG and $MidWt^{0.73}$. The equations used to predict feed intake were developed by regression using data from the first seven post-weaning tests (separate equations for bulls and heifers were used) or from all of the mature cow tests. Feed conversion ratio (FCR) was calculated as DFI divided by ADG.

Statistical analyses. Genetic parameters were estimated by REML procedures using the VCE 4.2.5 software (Groeneveld and Garcia-Cortes, 1998). Previous experience analysing post-weaning data from this experiment showed that sampling of sires had created inflated genetic variances for weight traits (Arthur *et al.* 2001). To account for this, records on weight of cows at the weaning of their second calf were extracted from the national Angus and Hereford databases (3630 records from 807 sires) and the experimental dataset (843 cow weight records from 171 sires). This trait was included in all analyses which were conducted as tri-variate analyses, with the other two traits being formed from pair-wise combinations of the traits examined. All traits were analysed using an animal model with a random term for direct additive effect, a fixed effect describing contemporary groups and age as a covariate.

RESULTS AND DISCUSSION

Mature cows during the test were on *ad libitum* intake, and consumed an average of 15.7 kg/day and gained 1.19 kg/day bodyweight. These levels of intake and gain are considerably higher than might be expected from typical pasture-based cattle production systems in Australia. This, together with the fact that the cows were neither pregnant nor lactating during the test, means that caution should be used when extrapolating the results (particularly the variances) to pasture-based production systems. Alternative measures of feed intake at pasture or efficiency at maintenance feeding levels are not readily available for application to a significant number of animals, and so the results from *ad libitum* intake tests remain the best available indication of mature cow efficiency in this context.

Genetic parameters for the mature cow test traits are given in Table 1. All traits were moderately to highly heritable. The heritability of $MidWt^{0.73}_{cow}$ was higher than might be expected from other estimates of mature cow weight, indicating that inclusion of cow-weight in tri-variate analyses did not completely account for inflated genetic variance for growth traits which is a feature of this data set. However, the main focus of this study are the genetic relationships between traits, which are unlikely to be strongly influenced by this problem. Importantly, the results indicate that there is significant genetic variation in DFI_{cow} and the two measures of cow efficiency, RFI_{cow} and FCR_{cow}. Additive variances for these traits were markedly greater compared to those for the same trait measured post-weaning (Arthur *et al.* 2001). Moreover, DFI_{cow} was strongly related to RFI_{cow} at both phenotypic and genetic levels.

The phenotypic and genetic relationships between traits measured during the post-weaning and mature cow tests are presented in Table 2. At the phenotypic level, most traits (with the exception of $MidWt^{0.73}$) were only moderately correlated from post-weaning heifers to mature cows. However at the genetic level all traits, with the exception of FCR, were highly correlated across the two ages. In particular, the relationships between post-weaning and mature DFI and RFI were strong, with the genetic correlations approaching unity. These correlations are high, but are consistent with other analyses of this data using alternative approaches.

Table 1. Genetic parameter estimates among traits measured on mature cows. Heritabilities[A] are given on the diagonal, with genetic and phenotypic correlations given above and below the diagonal respectively

	DFI_{cow}	ADG_{cow}	$MidWt^{0.73}_{cow}$	RFI_{cow}	FCR_{cow}
Mean	15.7 kg/d	1.19 kg/d	110 $kg^{0.73}$	-0.54 kg/d	14.3 kg/kg
SD[b]	1.7	0.26	6	1.42	4.4
DFI_{cow}	**0.28**	0.57	0.45	0.71	-0.57
ADG_{cow}	0.42	**0.33**	0.37	0.02	-0.87
$MidWt^{0.73}_{cow}$	0.41	0.21	**0.71**	-0.21	-0.12
RFI_{cow}	0.88	0.04	0.07	**0.23**	-0.21
FCR_{cow}	-0.04	-0.73	0.01	0.23	**0.26**

[A] Heritabilities and additive variances are average results from 19 tri-variate analyses including traits in this study as well as other traits not reported here. [B]Phenotypic standard deviation.

The results show that selection for lower RFI_{pw} (a measure of feed efficiency which accounts for both maintenance and growth requirements) measured postweaning will lead to a reduction in the intake of cows together with a slight increase in cow weight ($MidWt^{0.73}$), thus improving the efficiency of the cow herd. Selection to improve FCR_{pw} (a "gross" measure of feed efficiency) will cause an increase in cow weight, with little change in cow intake. However, selection on a multi-trait index including information on feed intake (irrespective of what form feed intake is expressed in) will allow the balance between increasing growth and decreasing cow intake to be economically optimised. More importantly, the results indicate that strong genetic relationships exist between feed intake and efficiency measured post-weaning and these traits in the breeding herd.

The genetic correlations of feed intake and residual feed intake from young growing animals to mature adults have few counterparts for comparison. Niewhof *et al.* (1992) found a genetic correlation between RFI of heifers measured post-weaning and during first lactation of 0.58. Archer *et al.* (1998) found a genetic correlation between RFI of mice post-weaning and at maturity of 0.60.

Table 2. Phenotypic and genetic relationships between traits measured post-weaning and on mature cows

	Mature cow traits				
Post-weaning traits	DFI_{cow}	ADG_{cow}	$MidWt^{0.73}_{cow}$	RFI_{cow}	FCR_{cow}
Phenotypic correlations					
DFI_{pw}	0.51	0.24	0.60	0.34	0.03
ADG_{pw}	0.33	0.28	0.61	0.09	-0.07
$MidWt^{0.73}_{pw}$	0.34	0.18	0.70	0.10	0.02
RFI_{pw}	0.34	0.06	-0.02	0.40	0.06
FCR_{pw}	0.09	-0.11	-0.13	0.20	0.10
Genetic correlations					
DFI_{pw}	0.94	0.67	0.69	0.69	-0.12
ADG_{pw}	0.73	0.72	0.91	0.20	-0.30
$MidWt^{0.73}_{pw}$	0.51	0.39	0.82	0.06	0.05
RFI_{pw}	0.64	0.22	-0.22	0.98	-0.06
FCR_{pw}	0.15	-0.33	-0.54	0.75	0.20

CONCLUSION

There appears to be a strong genetic relationship between intake-related traits from shortly after weaning to maturity, indicating that some biological processes with genetic variation regulating intake and efficiency post-weaning are similar to processes regulating intake of adult animals. This is consistent with the observation that feed intake matures at a faster rate than bodyweight (Taylor *et al.* 1986). These strong relationships present the opportunity to utilise selection to improve feed efficiency of growing animals and mature cows simultaneously, based on measurements taken post-weaning prior to selection decisions being made.

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