IDENTIFYING BULLS SUPERIOR FOR NET FEED INTAKE, INTRAMUSCULAR FAT AND SUBCUTANEOUS FAT

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SUMMARY
The presence of positive genetic correlations between Net Feed Intake (NFI) and live animal fatness traits implies that continued selection against NFI (for improved feed efficiency) could be accompanied by a reduction in fatness. Findings are inconclusive on the correlation between NFI and intramuscular (or marbling) fat. The greatest potential financial benefits from lowering feed intake accrue in the feedlot sector, so selection for lower NFI should be carried out in conjunction with careful monitoring of live animal and carcase fatness traits. The genetic correlations are low, and divergent selection for NFI has demonstrated that adequate levels of subcutaneous and intramuscular fat can be maintained while lowering NFI. Industry testing for NFI has identified a number of sires superior for each of these traits.

Keywords: selection, feed efficiency, marbling, rib fat

INTRODUCTION
Net Feed Intake (NFI) is a measure of feed efficiency calculated as the difference between an animal's actual feed intake, and its predicted feed intake based on liveweight and growth rate. Data generated from both research and commercial industry testing for NFI forms the basis of a Trial BREEDPLAN Estimated Breeding Value (EBV) for NFI that has been available since early 2002. To date, 3 breeds, Angus, Hereford and Poll Hereford, have sufficient well-linked data to have their data analysed to calculate across herd EBVs.

Economic analyses show that a significant increase in net present value of benefit to both the breeding sector and the feedlot sector of the Australian beef industry can be expected through industry adoption of genetic improvement in NFI (Exton *et al*. 2000). Further, calculations of genetic gain and economic benefit from incorporation of NFI as a selection criteria in commercial breeding programs showed considerably greater benefits are available when breeding objectives target long-term, grain-fed markets (Archer and Barwick 1999).

Evidence exists that there is a genetic relationship between NFI and subcutaneous fat depth, with more efficient (lower NFI) animals tending to be leaner than less efficient animals (Arthur *et al*. 2001; Herd *et al*. 2003). Results to date for intramuscular (or marbling) fat (IMF) are not conclusive. There is 1 preliminary report of an antagonistic genetic correlation between NFI and IMF (Robinson *et al*. 1999), but McDonagh *et al.* (2001) did not find any difference in visual marbling score or objectively measured IMF for carcases of feedlot steers following divergent selection for NFI. Careful selection of suitable bulls to produce progeny that meet the strict carcase requirements for quality grain-fed markets, as well as being more feed efficient, may be critical when including NFI in breeding programs. The objective of this study was to determine whether it is possible to identify bulls that are genetically superior for NFI, subcutaneous fat and IMF.

MATERIALS AND METHODS
The Angus Society of Australia has the largest number of animals recorded (4,496 records from 2,294 animals measured) for NFI. Data for bulls recorded on the current Angus Society database (http://abri.une.au/online/, accessed 13th October 2003) with 2003 BREEDPLAN EBVs for NFI, IMF and 12/13 rib fat, with accuracy for each greater than 70% (n = 42), were used in this study. Correlation analysis was performed on these traits using MS Excel to investigate the degree of association among the 3 traits.

The Angus Society currently publishes 4 selection indexes, developed through BREEDOBJECT (Barwick *et al.* 1994), which include the Japanese B3 $Index representing the quality grain-fed market. Data on bulls with exceptional NFI (top 15%, accuracy >50%), IMF (top 20%, accuracy >50%) and Japanese B3 $Index (top 20%) were used to examine the $Indexes of these bulls.

RESULTS

Figure 1 shows a significant ($P<0.05$), but weak, relationship ($r^2 = 0.1014$) between EBV for rib fat and EBV for NFI. Figure 2 shows EBV for IMF *v*. EBV for NFI of the same Angus bulls. The relationship ($r^2 = 0.0002$) between these traits was not significant. These EBVs support the assertion that there is a genetic relationship between NFI and subcutaneous fat, but no clear relationship between NFI and IMF. Figures 1 and 2 show that there are bulls available to Australian beef cattle breeders that are genetically superior for NFI, IMF and subcutaneous fat, being those in the upper left quadrant of each graph.

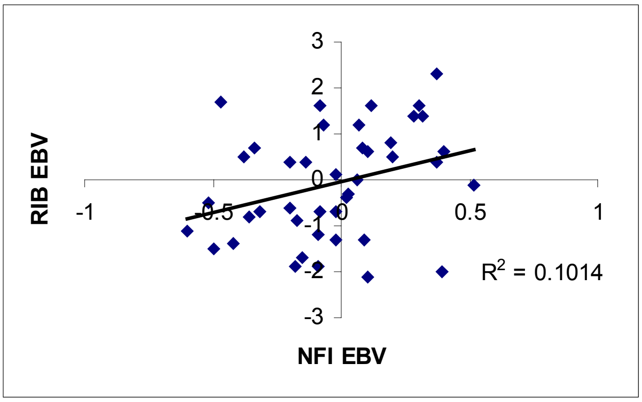

Figure 1. Rib fat EBV *v*. net feed intake (NFI) EBV of Australian Angus bulls.

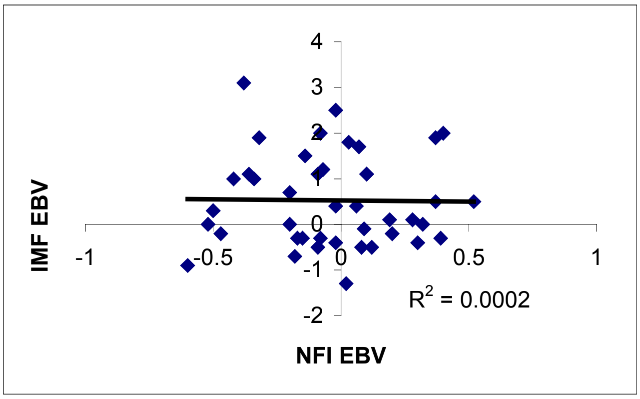

Figure 2. Intramuscular fat (IMF) EBV *v*. net feed intake (NFI) EBV of Australian Angus bulls.

Table 1 shows a number of young (born 2000 and 2001) industry bulls that have exceptional NFI, IMF and Japanese B3 $Index. The results indicate that there are bulls within the beef industry with high genetic merit for both NFI and IMF, as well as a high $Index. The use of such bulls in seedstock and commercial breeding programs will make significant gains in efficiency, marbling and profitability in the Australian beef industry.

DISCUSSION

The results of this study are in general agreement with most of the genetic and phenotypic relationships among these traits from studies published in the last few years. Data from 1,180 Angus bulls and heifers tested postweaning for NFI (Arthur *et al.* 2001) showed a slight genetic association with subcutaneous 12/13 rib fat ($r_g = 0.17$) and a negligible association with P8 fat ($r_g = 0.06$). Steer progeny of high efficiency and low efficiency parents following a single generation of divergent selection for postweaning NFI, grown on pasture, then finished for slaughter in a feedlot, also showed a slight association with subcutaneous fat measured by ultrasound prior to slaughter (Herd *et al.* 2003). Steers from high efficiency bulls had less fat ($P<0.05$) over the 12/13th rib and P8 rump (rib 10.2 mm vs 11.6 mm, P8 rump 13.1 mm vs 14.8 mm). There was no measurable difference ($P>0.05$) in fat depth at the rump site on the carcase following slaughter.

Table 1. The EBVs, Japanese B3 $Index and Percentiles for industry identified bulls born in 2000 and 2001.

Bull	NFI		IMF		Japanese B3 Index	
	EBV	Percentile	EBV	Percentile	$Index	Percentile
Ythanbrae New Design 036 V599	- 0.95	Top 1%	1.2	Top 15%	$106	Top 1%
Ythanbrae Precision V397	- 0.71	Top 5%	1.0	Top 15%	$87	Top 5%
Bald Blair Future Direction W79	- 0.68	Top 5%	2.1	Top 1%	$82	Top5 %
Ythanbrae Precision V984	-0.51	Top 5%	1.1	Top 15%	$78	Top10 %
Ythanbrae Precision V212	- 0.51	Top 5%	0.9	Top 20%	$87	Top 5%
Bald Blair Future Direction W86	- 0.50	Top 5%	1.5	Top 10%	$76	Top 10%
Bald Blair New Design V86	- 0.48	Top 10%	1.8	Top 5%	$78	Top 10%
Ythanbrae New Design 036 V975	- 0.47	Top 10%	2.1	Top 1%	$87	Top 5%
Ythanbrae Precision V939	- 0.45	Top 10%	0.9	Top 20%	$82	Top 5%
Ythanbrae New Design 036 V467	- 0.41	Top10 %	1.6	Top 5%	$93	Top 1%
Ythanbrae Direction V874	- 0.39	Top 10%	1.5	Top10 %	$71	Top 20%
Ebony Hills Visionary V73	- 0.37	Top 10%	1.5	Top10 %	$67	Top 20%
Ythanbrae Precision V865	-0.35	Top 15%	1.2	Top 15%	$85	Top 5%
Ebony Hills Vagabond V46	- 0.35	Top 15%	1.2	Top 15%	$80	Top 10 %
Ebony Hills Vince V44	- 0.33	Top 15%	0.9	Top 20%	$71	Top 20%
Kenny's Creek Wordsworth W220	- 0.32	Top 15%	2.1	Top 1%	$86	Top 5%
Kenny's Creek WYVILL W67	- 0.31	Top 15%	2.8	Top 1%	$94	Top 1%
Ythanbrae New Design 036 V574	- 0.31	Top 15%	1.7	Top 5%	$100	Top 1%
Ythanbrae New Design 036 V935	- 0.31	Top15 %	1.4	Top 10%	$100	Top 1%
Ythanbrae Direction V917	- 0.29	Top 15%	2.4	Top 1%	$96	Top 1%
Ythanbrae New Design 036 V546	- 0. 29	Top 15%	2.3	Top 1%	$97	Top1 %
Ebony Hills Virtuoso V764	- 0.29	Top 15%	1.6	Top 5%	$83	Top 5%

Associations between NFI and IMF are less clear. Carcases of high and low efficiency selection-line steers (McDonagh *et al.* 2001) showed no difference in visual marbling score or objectively measured IMF%. However, Robinson *et al.* (1999), reported a small positive (antagonistic) genetic correlation (r_g = 0.17) between NFI and IMF where both had been measured on feedlot steers. The difference between these results may be due to differences in age and maturity at which the steers were assessed in the 2 studies.

Industry results show that bulls exist with above average EBV for NFI and IMF that could be used to sire superior progeny to be grain-fed for quality export markets where improved feed efficiency and marbling are especially important. Both traits should be included in breeding decisions. The lack of strong genetic correlation between them means that selection for both to maintain or improve IMF and to reduce NFI will be effective. Industry testing for NFI has generally been conducted on animals identified at weaning as being genetically superior for other important economic traits, and has identified a number of sires as having significantly lower than average NFI (more feed efficient) and significantly higher than average marbling. As the number of industry animals tested increases, the number of sires identified as being genetically superior for both traits will also increase.

The challenge facing the beef industry is to identify as many sires as possible that will produce progeny with reduced feed requirements, hence lower feed costs, and that are suitable for the grain-fed export markets. An economic ranking for individual bulls for specific markets is provided by combining relevant EBVs for different traits into a single selection index, giving the highest possible correlation with the breeding objective. Variations in index values between sires indicate differences in expected profitability between each cow joined to those sires.

The results of this study imply that feed efficiency can be genetically improved by using EBVs for low NFI. However, it is recommended that a balanced selection index approach (such as $Index), as in BREEDOBJECT (Barwick *et al.* 1994), should be used to ensure a biological as well as an economic balance among all profitability traits.

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