

**THE IMPACTS ON SELECTION FOR ECONOMIC MERIT OF INCLUDING
RESIDUAL FEED INTAKE TRAITS IN BREEDING OBJECTIVES
AND OF HAVING RECORDS AVAILABLE**

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SUMMARY

A study was conducted to quantify the separate and combined impacts on selection for economic merit of including residual feed intake (RFI) traits in beef cattle breeding objectives and of having records available. RFI is a trait of interest in numerous livestock species. It was defined here for young animals at pasture (RFI-P), in the feedlot (RFI-F), and in cows (RFI-C). Results showed selection response in total economic merit increased by up to 65% for breeding objectives where RFI-P, RFI-F, and RFI-C were all included. A large proportion of the benefit (more than 50%) came from being able to include RFI traits in the breeding objective, suggesting major benefits may be realised even where a suitable industry measure is not yet available. Residual feed intake should be considered in breeding objectives and selection where parameter estimates are available. Estimates of genetic variance are among those most needed for RFI-C, and are likely to need to be understood in cows that are approximately maintaining or even losing weight.

INTRODUCTION

Residual or net feed intake (RFI or NFI) is a measure of feed efficiency of interest in numerous livestock species. In beef cattle it is calculated as feed intake adjusted for metabolic liveweight and weight gain during a 70 day feed intake test (Arthur *et al.* 2001). Feed intake data is scarce and difficult to obtain at pasture. Beef industry recording initially focused on using IGF-I as an indirect criterion (Moore *et al.* 2005), but this largely ceased after the genetic association proved inconsistent for RFI measured post-weaning or in the feedlot (Barwick *et al.* 2009). Recently a review was conducted for industry to reconsider the status and potential for genetic evaluation of RFI. This paper reports on a study from that review where the aim was to examine both the separate and combined impacts on selection for economic merit of being able to incorporate RFI traits in the breeding objective and of having records available. The study also serves to illustrate the RFI traits of different classes of animals potentially needed in breeding objectives.

METHODS

Trait definition. While NFI and RFI are synonymous terms, for convenience in this study we use NFI in referring to records on seedstock and RFI when referring to the commercial herd traits that are a needed part of the breeding objective. NFI-P and NFI-F are measures obtained post-weaning or in the feedlot, respectively (Jeyaruban *et al.* 2009). A minimal set of RFI traits for inclusion in breeding objectives was taken as being traits of young animals at pasture (RFI-P) and in the feedlot (RFI-F), and of cows at pasture (RFI-C). RFI traits were each defined adjusted for the feed required for maintenance and weight gain. RFI-C was defined over all parts of the year except when there would usually be a cow feed surplus. Feed requirement for RFI traits was estimated using SCA (1990) procedures, in line with the method of costing feed used for other breeding objective traits. Other traits considered in the breeding objective were the young animal traits:

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calving ease (direct and maternal), sale liveweight (direct and maternal), dressing %, saleable meat %, carcass rump fat depth, and carcass marbling score; and the cow traits: cow weaning rate, cow survival rate, and cow liveweight (Barwick and Henzell 2005).

Parameter estimates. Estimates needed for this study were assembled from published and unpublished results in Angus data (Jeyaruban *et al.* 2009), from matrices used in earlier modelling (Kahi *et al.* 2003; Archer *et al.* 2004), and from a range of studies across other British, European and tropical breeds. Genetic variances for RFI-P, RFI-F and RFI-C, defined using SCA (1990), were 0.48, 0.61 and 0.48 kg²/d² respectively; and those for NFI-P and NFI-F (Jeyaruban *et al.* 2009) were 0.22 and 0.50 kg²/d² respectively. The information available was limited; there is little information, for example, for RFI-C. Genetic correlations were utilised between RFI traits and other existing measures, including fatness. To assist understanding of the genetic correlations between RFI (and NFI) and potential energy store measures such as fatness and liveweights, meta-analyses were conducted of published estimates. These showed small consistent, positive relationships between the estimate and the difference in time between when the energy store and RFI measures were taken. The genetic correlations used between scanned fat depths and NFI (and RFI) were consequently positive, moderate to low, and slightly higher for NFI-P than for NFI-F.

Breeding objective cases. Three breeding objectives were derived using BreedObject (Barwick and Henzell 2005) and covered self-replacing and terminal production, and grass or 150d feedlot finishing. The aim was to represent what might be expected for residual feed intake in a range of situations. With respect to the addition of RFI traits, the terminal system breeding objective implicated RFI-P; the self-replacing grass finished system implicated both RFI-P and RFI-C; and the self-replacing 150d-fed system implicated all of RFI-P, RFI-F, and RFI-C.

Index modelling. Two levels of incorporation of residual intake traits in selection were modelled using the selection index program MTIndex. The first level involved adding the RFI-P, RFI-F, and RFI-C traits to breeding objectives. The interest was in the effect this has on selection response in economic merit compared to a base case where selection is instead based on the index derived for the breeding objective without RFI traits (the current situation in industry). Response in economic merit in the base case was evaluated with and without (shown in parentheses in Table 1a) adding the value of the correlated change that is predicted to be occurring in RFI traits. The records available to the index in each case were 17 measures commonly available in BREEDPLAN.

The second level considered NFI-P and NFI-F records being available to indexes in addition to commonly available records. Selection here was on the index derived for the breeding objective that included RFI traits. The combined effects of the two levels of incorporation were then also considered to show the total effect of incorporating residual feed intake traits in selection.

Predicted responses. The selection responses presented are predicted 10-year responses in the total breeding objective, assuming a generation interval of 5 years, a standardised selection intensity of 1.40, and no change in variance with selection. The corresponding correlated responses in NFI-P and NFI-F (similar trends existed for RFI-P and RFI-F) are also presented.

RESULTS

Selection response in economic merit increased by up to 37% (\$43.68 v \$31.83 per cow) when selection was on indexes derived for breeding objectives that had RFI traits included, as against not included (Table 1a,b). In the base case, ignoring the value of correlated change in RFI traits (results shown in parentheses in Table 1a) resulted in either under- (\$38.11 v \$39.90) or over-estimation (\$37.52 v \$31.83) of the total economic response and over-estimation of the accuracy

Table 1. Predicted 10-year responses in economic merit, and correlated responses in post-weaning (NFI-P) and feedlot net feed intake (NFI-F), from selection for 3 breeding objectives (TGF – Terminal Grass Fed, SRGF – Self-Replacing Grass Fed, SRFE – Self-Replacing Feedlot Export) using indexes derived for objectives that differed in their inclusion of RFI traits or which had different records available

Index information	Breeding objective						
	TGF	SRGF	SRFE	TGF	SRGF	SRFE	
	Response (\$ per cow)			Correlated responses in NFI (kg/d)			
<i>a) Selection on the Index derived for the objective that does not include residual feed traits¹</i>							
Common records ²	39.90 (38.11)	32.31 (32.31)	31.83 (37.52)	NFI-P:	-0.08	-0.03	+0.22
accuracy	0.46 (0.48)	0.32 (0.38)	0.28 (0.39)	NFI-F:	-0.25	-0.03	0.00
<i>b) Selection on the Index derived for the objective that includes residual feed traits</i>							
Common records	42.73	38.64	43.68	NFI-P:	-0.31	-0.36	-0.28
accuracy	0.49	0.38	0.38	NFI-F:	-0.42	-0.36	-0.56
Common records + NFI-P ³	43.34	43.18	52.56	NFI-P:	-0.42	-0.59	-0.53
accuracy	0.49	0.43	0.45	NFI-F:	-0.53	-0.62	-0.81
Common records + NFI-F ³	45.08	41.10	47.91	NFI-P:	-0.45	-0.50	-0.45
accuracy	0.51	0.41	0.41	NFI-F:	-0.73	-0.67	-0.90

¹Response in \$ is shown augmented by the value of the correlated responses in RFI traits. The response in \$ without this augmenting is shown in parentheses

²Commonly available records: an own record, sire and dam record (where relevant), and 25 half-sib records for 17 measures commonly recorded in BREEDPLAN

³Information equivalent to a record on the individual

of selection (eg. 0.39 v 0.28). Unfavourable correlated change in NFI-P (eg. +0.22 kg/d over 10 years) was predicted to be occurring in the feedlot case. Note also that correlated change occurring in feedlot residual feed intake has no value in pasture-only systems.

Compared to selection on commonly available records, also having an NFI record increased response in economic merit by up to 20% (\$52.56 v \$43.68 per cow with an NFI-P record) in the self-replacing feedlot case, 12% (with an NFI-P record) in the self-replacing grass-fed case, and 5% (with an NFI-F record) in the terminal case (Table 1(b)).

The total increase in response in economic merit from incorporating residual feed intake in selection, relative to the current industry situation, was for the terminal, self-replacing grass-fed and feedlot cases: 9% (\$43.34 v \$39.90), 34% (\$43.18 v \$32.31), and 65% (\$52.56 v \$31.83) with an NFI-P record, and 13% (\$45.08 v \$39.90), 27% (\$41.10 v \$32.31), and 51% (\$47.91 v \$31.83) with an NFI-F record, respectively (Table 1a,b). A large percentage (consistently more than 50%) of this benefit came from incorporating the RFI traits in the breeding objective.

DISCUSSION

The predicted total impact on economic merit from incorporating residual feed intake in selection is clearly large. It was largest for the self-replacing feedlot case, where RFI-P, RFI-F,

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and RFI-C were all in the breeding objective. Substantial correlated decreases in residual feed intake also occurred, and there were simultaneously favourable changes in numerous other traits (not shown). While these results obviously depend on the parameter estimates used, and there is little knowledge for RFI-C, they suggest residual feed intake traits should be considered in beef industry breeding objectives and selection where it is possible. The results also illustrate the general need for breeding objectives to include all important traits: when an important trait is ignored accuracy of selection is likely to be overestimated and estimates of responses misleading.

The fact that more than 50% of the increased response in economic merit came from including RFI traits in the breeding objective means industry could capture a lot of benefit even while there is no cost-effective industry measure that is available. The benefit here came from the different index that was able to be used as a result of taking account of moderate to low genetic correlations between RFI and existing measures. The information needs for general inclusion of RFI traits in breeding objectives, however, remain substantial. As well as needing genetic correlations with other existing measures to be better substantiated, genetic parameter knowledge is lacking for RFI-C. Of that needed for RFI-C, perhaps most needed initially are estimates of the trait genetic variance as it is defined for the breeding objective. There is some evidence that RFI in cows is different under restricted feeding than under *ad-libitum* feeding (Herd *et al.* 2011). RFI in cows is expected to be of direct value to the production system over much of the year, but perhaps not when there is a feed surplus. The period of the year when RFI-C has direct value probably corresponds to times when cows are either roughly maintaining or even losing weight, so it is for cows in that condition that understandings of RFI genetic variance are most needed.

CONCLUSIONS

Residual feed intake should be incorporated in breeding objectives and selection for economic merit where it is possible, especially where the breeding objective is affected by all of RFI-P, RFI-F, and RFI-C. There can be major benefit from incorporating residual feed intake traits in breeding objectives even though a suitable industry measure may not yet be available. Estimates of the genetic variance of RFI-C are among the genetic parameter estimates most needed and are likely to need to be understood for cows that are approximately maintaining or even losing weight.

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