ECONOMIC ANALYSIS OF NET FEED INTAKE IN INDUSTRY BREEDING SCHEMES

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SUMMARY

The benefit of recording net feed intake (NFI) in industry breeding schemes was investigated using a model of investment and gene flow resulting from selection activities. The results showed that where the breeding objective targets the high quality Japanese market, it is profitable to record NFI on all bulls in the seedstock sector where NFI measurement costs are as high as $450 per animal. Where the breeding objective targets a domestic grass-fed market, recording NFI on all bulls is only marginally profitable when measurement cost is $150 per animal, and is not profitable at higher measurement costs. However, with more efficient breeding scheme designs, measurement of NFI on a proportion of bulls may be profitable, even when measurement costs are greater than $150 and the domestic grass-fed market is targeted. Further work is required to provide recommendations to breeders as to how this trait should be incorporated into breeding programs.
Keywords: Feed intake, feed efficiency, beef cattle, selection, breeding schemes

INTRODUCTION

Recent research conducted by NSW Agriculture at Trangie, and by the Beef CRC has found both phenotypic and genetic variation in net (or residual) feed intake (NFI) of beef cattle (Archer *et al.* 1998; Robinson *et al.* 1997). NFI is the variation in feed intake after adjustment for growth rate and body weight during a test period. Barwick *et al* (1999) showed that inclusion of NFI as a selection criterion could increase the accuracy of selection for the breeding objective (and hence genetic gain) by between 3 % and 42 %. However, the cost of measuring NFI is high (at least an order of magnitude greater than the cost of ultra-sound scanning measurements). Therefore, whether the extra return obtained from using NFI as a selection criterion justifies the cost of recording should be critically examined.

A framework for evaluating selection criteria in an economic context in industry breeding schemes has been developed as a computer program "ZPLAN" (Nitter *et al.* 1994) and used previously to assess the benefit of including reproductive traits and ultra-sound scanning as selection criteria for Australian beef cattle (Graser *et al.* 1994). The approach models the flow of genes from a breeding sector to the commercial sector, and uses selection index theory to calculate genetic gain and the discounted economic benefits accrued over a specified period. The cost of the breeding scheme is calculated and compared to the benefits obtained to determine whether the breeding scheme is profitable or not. The study reported here used ZPLAN to examine the economic benefits obtained from incorporating NFI as a selection criterion in beef cattle breeding programs.

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METHODS

Breeding population structure. The structure of the breeding population considered was similar to that described by Graser *et al.* (1994). A self-replacing population of 200,000 breeding cows was modelled, with 10,000 cows in the closed breeding unit (where genetic gain is generated) and 190,000 cows in the commercial herd. Each year the best bulls in the breeding unit were selected (using an index including all available information) for use as sires in the breeding unit and were used for an average of 2.5 years. Replacement dams in the breeding unit were selected from first-calf heifers.

Bulls not selected as sires for the breeding unit were available for selection as sires for the commercial herd. Natural mating was used in the commercial herd with a ratio of 40 cows per bull, and bulls were used for 3 years. Ninety-nine percent of bulls used in the commercial herd were obtained from the breeding unit. The 1 % of bulls selected from the commercial herd, and all replacement dams for the commercial herd, were selected on an index not correlated with the breeding objective. No females passed from the breeding unit to the commercial herd.

Breeding objective. Two breeding objectives were considered, one for production of 650 kg steers for the high quality Japanese market where marbling has a high value (Japanese), and the other for production of 400 kg steers for the domestic market where marbling is not valued (Domestic). The breeding objectives and the derivation of economic values for NFI traits were as described by Barwick *et al* (1999), except that economic values were not discounted as ZPLAN discounts the values internally. Returns were discounted over a 25 year investment horizon.

Measurements and information sources. The selection criteria used were intended to represent the criteria currently used in beef cattle selection and recorded in BREEDPLAN V4.1, plus the new criterion of NFI. Information sources used in the index included records on the individual, sire, dam, paternal half sibs of the individual, paternal half sibs of the sire and paternal half sibs of the dam. All information sources had growth traits of young animals (weight at birth, 200, 400 and 600 days) and carcase traits (fat depth at $12^{th}/13^{th}$ rib and P8 site, eye muscle area and percent intra-muscular fat, measured on live animals using ultra-sound scanning and recorded as separate traits for males and females) recorded. Days to calving and mature cow weight information was available on the dam and on paternal half sisters of the sire and of the dam. Additional records of days to calving were available on the individual and paternal half sisters when selecting replacement females for the breeding unit. Bulls from the breeding unit were selected on an index which also included scrotal circumference records on the sire and on the individual, and NFI of the individual.

Numbers of animals in the half sib groups for each trait category were calculated from herd structure parameters, and were discounted by 0.7 to account for lower effective progeny numbers from finite sized contemporary groups. As the index subroutine of ZPLAN is not able to accept multiple information sources of the same relationship but different animals (eg. male and female half sibs), it was assumed that the female carcase traits were measured on all half sibs, but the number of half sibs in the group was multiplied by 0.8 to compensate for the poorer information obtained from bulls compared with females from ultra-sound scanning data.

Genetic parameters. Genetic and phenotypic parameters used were as described by Barwick *et al* (1999). A matrix bending routine was used to obtain a set of parameters which satisfied the requirement for positive definiteness. Genetic variance of NFI in the breeding objective traits (on young animals and mature cows) and as a criterion on post-weaning bulls was assumed to be 0.15 $kg^2.day^{-2}$, with a heritability of 0.43. Genetic correlations between the NFI criterion and NFI of young animals and mature cows was assumed to be 0.75 and 0.50 respectively. All other phenotypic and genetic correlations involving NFI were assumed to be zero, except for those with fat depth traits which were assumed to be 0.20 based on phenotypic information.

Parameter variations. Two parameters of the model were varied to examine the impact of measuring NFI on profitability of the breeding scheme. Firstly, the number of bulls selected as sires in the breeding unit was set to 20, 50 and 100 to examine the impact of different levels of breeding unit efficiency. The corresponding number of cows mated per bull were 200, 80 and 40, with the first level corresponding to a breeding scheme using AI exclusively, and the last level approximating a scheme where only natural mating is used. The second parameter varied was the cost of measuring NFI, which ranged from $150 to $450 per animal. The current cost of testing cattle in central test stations is up to $500 per animal, including cost of feed (approximately $200), of which at least part should not be counted as a measurement cost. On-farm tests might be considerably cheaper.

RESULTS AND DISCUSSION

Table 1 shows the impact of cost of NFI measurement on profitability of the breeding scheme for different levels of breeding unit efficiency. The base describes the current situation with all traits except NFI recorded. For the Japanese objective where the economic value of feed was highly negative, profit from the breeding scheme where NFI was recorded was higher than the base situation for all levels of NFI measurement cost considered, and so recording of the trait was a profitable activity. For the domestic grass-fed objective, profit from recording NFI on all bulls where cost of measurement was $150 was approximately equal to the base profit, meaning that recording NFI was marginally profitable at this cost. However, recording NFI on all bulls was not profitable when NFI measurement costs exceeded $150.

In an industry where the breeding sector and commercial sector are generally owned by different individuals, the cost of recording NFI must be recovered by the breeding sector in the form of premiums paid for superior bulls sold to the commercial sector. In the breeding scheme modelled, the premium required to recover costs was $312 to $937 per bull for NFI measurement cost of $150 to $450 respectively. However, the model used in this study was based on a "whole industry" approach, and did not consider the increase in market share which might be obtained by individual breeders.

Table 1. Effect of NFI measurement cost and number of bulls selected for the breeding unit on additional profit per cow in the breeding scheme

		No. bulls selected for breeding unit		
	NFI measurement cost	20	50	100
Japanese Objective	Base[1]	$28.50	$24.35	$20.84
	$150	+ $8.43	+ $7.76	+ $7.09
	$200	+ $7.47	+ $6.81	+ $6.14
	$250	+ $6.52	+ $5.85	+ $5.18
	$300	+ $5.56	+ $4.89	+ $4.22
	$350	+ $4.60	+ $3.94	+ $3.27
	$400	+ $3.65	+ $2.98	+ $2.31
	$450	+ $2.69	+ $2.02	+ $1.35
Domestic Objective	Base	$23.00	$20.32	$17.94
	$150	+ $0.31	+ $0.06	- $0.17
	$200	- $0.65	- $0.89	- $1.13
	$250	- $1.62	- $1.85	- $2.08
	$300	- $2.56	- $2.81	- $3.04
	$350	- $3.52	- $3.76	- $4.00
	$400	- $4.48	- $4.72	- $4.95
	$450	- $5.43	- $5.68	- $5.91

[1] Base profit with no measurement of NFI.

This study examined a basic breeding scheme where all bulls are measured for all traits. In practice, it is unlikely that all bulls will be recorded for NFI, given the high measurement cost. Therefore other schemes should be considered where only a proportion of bulls (particularly those which are potential sires for the breeding unit) have NFI recorded. Such schemes would likely be more cost-effective and profitable than the breeding scheme modelled here. This study has shown that NFI is worth recording when the objective is for the Japanese market. Furthermore, recording NFI for the domestic grass-fed objective may be profitable if design of breeding schemes was optimised. Further research effort should be invested in reducing the cost of measurement of NFI. Reducing the duration of NFI tests, or finding genetic markers for NFI, are two areas which should be investigated further.

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