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GxE for beef cattle breeding objectives as a consequence of differences in cow feed cost

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Summary

The presence of genotype by environment interactions (GxE) affects the decisions made by livestock producers when selecting breeding animals. Studies have traditionally focussed on selection criteria, and on a single trait basis, with most finding little evidence of GxE. This study demonstrates that substantial GxE occurs for the beef cattle breeding objective. When the length of the feeding period or cow feed price varies, or they vary in combination, the correlations between sire rankings decrease. Ignoring the occurrence of this GxE in selection risks compromising commercial production system profitability.

Keywords: GxE, beef cattle, breeding objectives, cow feed costs

Introduction

Traditionally, studies have used mixed model analyses to determine the presence of GxE for single traits by treating performance in different environments as two different traits (Falconer, 1952) and estimating the genetic correlation between these traits for these environments. Although establishing the presence of GxE for single traits has important implications for how these traits are analysed genetically, in most cases little evidence has been found to support GxE in many of the traits recorded by industry. Accordingly, these traits are often incorporated in genetic evaluation systems on the basis that animal rankings will not change between environments. Genetic evaluations, e.g. deriving estimated breeding values (EBVs), are mainly focussed on traits that are recorded and used as selection criteria in seedstock herds. In commercial production, it is the sum of all traits in the breeding objective that describes profit for the production system. Since individual breeding objective traits differ in their economic importance, it is probable that there are GxE interactions for the breeding objective that cannot be ignored in selection.

This paper demonstrates the occurrence of important GxE for commercial production system profitability which must be considered in multi-trait selection.

Material and methods

Breeding objectives

Breeding objectives for net return per cow were derived with BreedObject (Barwick & Henzell, 2005) for a system that includes a pasture backgrounding period followed by a 100 day feedlot finishing that produces 640 kg Angus steers at 22 months of age from a self-replacing cow herd at pasture. Traits in the breeding objective were sale weight, dressing %, saleable meat %, rump fat depth, marbling score, feedlot entry weight, weaning weight (direct and maternal), mature cow weight, cow weaning rate, residual feed intake-pasture, residual feed intake-feedlot, and cow condition score. Calving ease direct and calving ease maternal are breeding objective traits as well as BREEEDPLAN EBVs. The general form of the economic value for traits is Δ returns - Δ feed requirement cost - Δ non-feed management cost. The feed requirement associated with change (Δ) in each objective trait was estimated using the equations described by Freer *et al.* (2007).

Deriving selection indexes

BreedObject indexes are derived by combining the available BREEDPLAN EBVS into one aggregate EBV for the breeding objective as outlined by Schneeberger *et al.* (1992). The weightings (b) applied to the EBV selection criteria () are derived as:

$$b = \mathbf{G_{11}}^{-1}\mathbf{G_{12}}\mathbf{v} \quad (1)$$

where $\mathbf{G_{11}}$ and $\mathbf{G_{12}}$ are the genetic variances and covariances among BREEDPLAN EBVS and between these and the objective traits, respectively and $\mathbf{v}$ is a vector of trait economic values. Barwick & Henzell (2005) showed this is equivalent to deriving breeding values for the breeding objective traits () and weighting these by their respective economic values ($\mathbf{v}$), where:

$$\mathbf{G_{11}}^{-1}\mathbf{G_{12}} \quad (2)$$

The EBVs used were from the mid-September 2017 BREEDPLAN analysis for 1066 published Angus sires. The genetic parameters used were derived from industry and literature estimates and are as used for developing Australian Angus indexes.

Scenarios to examine GxE

BreedObject relies on a description of the commercial production system that includes two annual feed periods: one when there would usually be a surplus of feed beyond animal requirements, and a period when feed requirement cannot be increased without incurring a cost (i.e. a 'limited pasture' period; Walmsley *et al.*, 2015). The length of these periods is between 0 and 12 months, but they must sum to 12 months. Total feed cost for all animal categories is calculated as a function of the length of the limited feed period, the price of feed ($ per tonne) and feed quality (MJ ME/kg). In scenarios tested, the length of the limited feed period and feed price for the cow herd were varied, while those of the young animal at pasture and in the feedlot were held constant. Feed quality was also held constant at 9 MJ ME/kg.

The length of the limited feed period was 4, 6, 7, 8 or 10 months, respectively while the feed price was held constant at $160 per tonne. In further scenarios, the cow feed price during the limited feed period was valued at $1, $80, $160, $240 and $320 per tonne, respectively while the limited feed period was held constant at 6 months. In reality the length of the limited feed period and feed price vary in combination in the commercial production environment and it is expected that as the limited feed period increases feed price increases. To test GxE in this situation four other scenarios were tested, where, as the limited feed period increased from 4 months to 10 months in 2 month increments, cow feed price increased from $60 to $240 in $60 increments (4-$60, 6-$120, 8-$180, and 10-$240).

Testing GxE

The presence of GxE was determined from changes in rank order, using the correlation between sire rankings of the indexes for the different scenarios. Changes in rank expose when the best animals in one environment perform less well in another. This is as opposed to interactions that occur from scale differences, where animals can be best across environments, with only the magnitude of superiority varying (James, 2009).

Results and Discussion

The correlations between sire rankings based on BreedObject indexes derived when the length of the limited feeding period is varied from 4 to 10 months are shown in Table 1a. The correlations are 0.90 and above between indexes that are not largely different in the length of the feeding period (e.g. 4 and 6 or 8 and 10). The correlations decrease as the difference in length of the feeding period increases, falling to 0.62 between indexes with feeding periods of 4 and 10 months. Table 1b shows the correlations between sire rankings based on BreedObject indexes derived when cow feed price varies between \$1 and \$320 per ton. The correlations follow a similar pattern to that in Table 1a with correlations 0.98 and above between indexes with the most similar feed price (e.g. \$1 and \$80) and correlations decreasing as the difference in feed price increases between indexes.

Table 1. Correlations between sire rankings based on BreedObject indexes when (a) length of the limited feed period or (b) cow feed price are varied while the other is held constant.

(a) Feed Period (months)					(b) Feed Price ($/tonne)				
	6	7	8	10		$80	$160	$240	$320
4	0.98	0.96	0.77	0.62	$1	0.99	0.93	0.83	0.70
6		0.99	0.87	0.74	$80		0.98	0.91	0.80
7			0.90	0.79	$160			0.98	0.91
8				0.97	$240				0.98

The changes in rankings for two selected sires are shown in Figure 1. The sires are both ranked in the top 20 on indexes for the respective extremes of limited feed period and cow feed price, but fall outside the top 100 at the opposite extreme, in particular sire B when the limited feed period is 8 and 10 months. The sires have similar rankings when the feeding period (6 and 7 months) and feed costs (\$160 per ton) are at moderate levels.

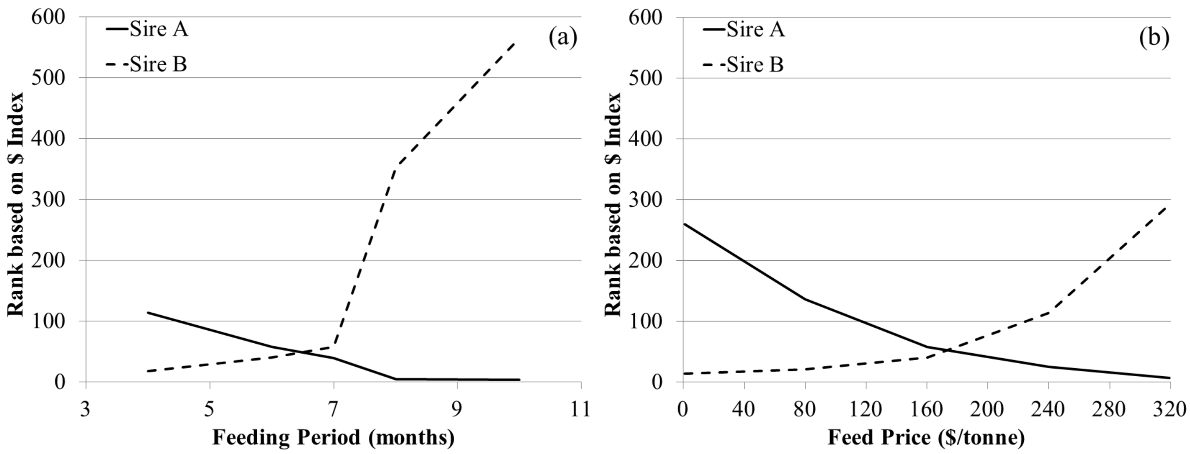

Figure 1. Rankings for two sires based on BreedObject indexes when (a) length of the limited

feed period or (b) cow feed costs are varied while the other is held constant.

Table 2 shows the correlations between sire rankings when the limited feed period and feed costs are varied in combination. They follow a similar pattern to those in Table 1 in that the correlations decrease as the difference in total cow feed cost (feeding period + cow feed price) increase.

Table 2. Correlations between sire rankings based on BreedObject indexes when the length of the limited feed period and cow feed price are varied in combination.

Feeding Period – Feed Price combinations			
	6 - $120	8 - $180	10 - $240
4 - $60	0.99	0.70	0.27
6 - $120		0.80	0.42
8 - $180			0.88

The large re-ranking and thus GxE at the multi-trait level demonstrated by the correlations in Tables 1 and 2 indicate that it is important to appropriately describe which animals are best for which environment when deriving indexes. Simply assuming that all commercial environments are similar risks incorrect selection decisions being made to the detriment of commercial profitability. The results show total cow feed cost is an important driver of GxE for the beef cattle breeding objective.

Conclusion

This paper demonstrates that substantial re-ranking of sires occurs when the limited feeding period and cow feed prices are varied. It shows there is substantial GxE for the beef cattle breeding objective. Ignoring the impact of this risks incorrect selection decisions being made which will compromise commercial production profitability.

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List of References

Barwick, S.A. & A.L. Henzell, 2005 Development successes and issues for the future in deriving and applying selection indexes for beef breeding. Aust. J. Exp. Agric. 45(7): 923-933.

Freer, M., H. Dove & J.V. Nolan (editors), 2007. Nutrient requirement of domesticated ruminants. CSIRO Publishing, Collingwood, Victoria, Australia, 270pp.

Falconer, D.S., 1952. The problem of environment and selection. Am. Nat. 86: 293-298.

James, J.W., 2009. Genotype by environment interaction in farm animals. In: Adaptation and fitness in animal populations, J. van der Werf, H-U. Graser, R. Frankham & C. Gondro (editors), Springer, The Netherlands, p 151-167.

Schneeberger, M., S.A. Barwick, G.H. Crow & K. Hammond, 1992. Economic indexes using breeding values predicted by BLUP. J. Anim. Breed. Genet. 109: 180-187.

Walmsley, B.J., M.L. Wolcott, W.S. Pitchford, D.J. Johnston & S.A. Barwick, 2015. Extended cow liveweight modelling for beef cattle breeding objectives. Proc. Assoc. Advmt. Anim. Breed. Genet. 21: 13-16.