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ECONOMIC IMPACT OF CHANGES TO THE BREEDING OBJECTIVES USED WITHIN THE NEW ZEALAND BEEF BREEDING INDUSTRY

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SUMMARY

The economic impact of potential changes to the breeding objectives and selection approaches used within the New Zealand (NZ) beef industry were quantified. A selection index model was used to derive economic weightings applied to commonly recorded traits, according to current genetic trends for NZ Angus and Hereford beef breeding herds. Breeders were assumed to record a range of liveweights on young bull selection candidates, as well as days to calving on their mothers. These traits were used to predict economic response to traits within the breeding objective (growth, days to calving and calving ease). Adding additional selection criteria, focussing on gestation length and body condition score, showed a relatively modest 3% increase in the annual response to selection within relatively intensive beef farming enterprises. Use of muscle and fat scanning and recording cow mature weights, which is already quite common in the industry, demonstrated a larger increase in the annual response to selection (approximately 10%). The impact of genotype-by-environment interaction was also examined, whereby the genetic parameters were modified to reflect situations where bulls bred on lowland country for a lowland breeding objective were used on hill country. Modifications to the breeding objectives and improved selection approaches to accommodate the specific needs of hill country farmers has the potential to provide substantial improvements in potential rates of genetic progress, which could lead to increased productivity within the commercial farming environment.

INTRODUCTION

Many bull breeders in New Zealand manage and select their cattle on easier farming country than the nutritionally challenging farming conditions that the majority of commercial beef cows endure. This regularly raises the question as to whether beef cattle breeding schemes could be modified to better suit the extensive hill country environment occupied by the majority of beef cows in New Zealand. The research required to characterise this problem is likely to be both time consuming and expensive, so there is a need to first quantify the magnitude of industry benefits that might be achieved through a better understanding of the extent and impact of a genotype by environment interaction, and the role of new selection criteria in improving rates of progress. This paper reports on the impact of the current indexes on genetic change, with economic weightings applied to commonly recorded traits estimated according to typical phenotypic recording practices and rates of genetic progress observed by the NZ Angus and Hereford populations. We then report on the impact of potential changes to the economic weightings, and discuss the application of the updated indexes in both lowland and extensive hill country herds.

SELECTION INDEX MODELLING

A selection index model was used to predict the response to selection in beef breeding herds, where herd bulls aged 2 at first use are selected from the top 30% of candidates, whilst artificial insemination (AI) bulls are selected from the top 10% at 8 years of age. Twenty percent of cows were assumed to be AI mated, and 80% mated to herd bulls, with an average cow age of 4.9 years (AbacusBio, commercial data), resulting in a generation interval of 4.1 years.

Objectives

Four different phenotypic recording strategies were evaluated. In the base model (strategy 1), recorded phenotypes for birth weight (BW) and 200 and 400 days weights (w200, w400) were assumed to be available on all young bull candidates, and 90 paternal siblings. Maternal 200 day weights (w200m) and days-to-calving (DC) records were assumed available on the candidates' mothers and 30 paternal half siblings. The AI bulls were assumed to have in excess of 200 progeny with BW, w200, w400 and 600 day weight (w600), as well as 30 daughters with w200m and DC records. Strategy 2 includes recording of mature cow weight (MCW) on the candidates' mother plus 30 paternal half siblings for herd bulls, and 30 daughters for the AI bulls. Strategy 3 builds in ultrasound records for rib fat depth (FDrib) and eye muscle area (EMA), whilst strategy 4, adds in direct and maternal gestation length (GL, GLmat) and cow body condition scores (BCS).

The genetic parameters applied within the selection index model were sourced from Archer *et al*. (2004), Bourden *et al.* (1982) and Meyer *et al*. (1995). Implied economic weightings were estimated as the values that would be required to achieve levels of genetic progress derived by visual interpolation of published genetic trends in NZ herds (Angus NZ 2010; Hereford NZ trends 2010). Table 1 shows the genetic trends (in trait units) reported, relative to expected rates of progress for the recording model used by strategy 1 breeders. Differences between Angus and Hereford data were small, so data were pooled to derive economic weightings.

Table 1: Genetic trends achieved over the last 10 years by NZ Angus and Hereford herds, compared to expected rates of progress for typical NZ breeders

Trait (unit)	Angus	Hereford	Expected progress	Estimated economic weight (cents)
BWT (kg)	0.05	0.03	0.11	-69
w200 (kg)	1	1	1.33	23
w200m (kg)	0.4	0.5	0.07	50
w400 (kg)	2	1.6	2.79	101
w600 (kg)	2.8	2.1	2.73	-
MCW (kg)	2	1.9	2.03	-
CE (%)	0.02	0.03	-0.01	399
CEm (%)	0.05	0.13	0.03	211
EMA (cm^2)	0.05	0.07	0.25	241
DC (days)	-0.2	-0.16	-0.28	-200

ECONOMIC WEIGHT REVISIONS

The recording models for strategies 2, 3 and 4 were used to include additional recorded trait information, and an alternate index was devised according to assumptions around the relative importance of key traits to the NZ beef industry. The alternate index included body condition score (which is highly correlated with both BW and other weights) and a negative weighing on MCW (to account for the economic impact of heavier cows). Gestation length was also included as a profit trait, reflecting breeder's desires to shorten GL to allow heifers and cow additional time to gain condition between calving and mating.

Table 2 shows the trait unit response to selection using the current and alternate index weightings. To enable a clear comparison between the existing and alternate indexes, total economic response has been estimated using the revised index weightings only, where the trait responses (generated using each set of index weightings) were multiplied and summed over all traits within the objective. As more traits are recorded (within strategy models 2, 3 & 4) the overall economic response to selection increases. However, progress in some traits decreased, as the new information diverted selection pressure away from initially recorded traits onto those traits with new information. A good example of this can be observed in the results for strategy model 3, where, using the current index, ultrasound scan information for EMA results in an additional 28 cents of progress in EMA but only 14 cents in overall index.

Selection using the alternative index results in an increase of 50-60 cents (20%) per annum for all models. Inclusion of recorded trait information for BCS and GL had a minor impact on overall response, however the strong genetic correlation between BCS and MCW within strategy 4 resulted in larger animals, with unfavourable shifts in the genetic trends for MCW and CE.

Table 2: Trait response to selection using current and alternate index weightings, with the economic response to selection estimated using the alternate index weightings

	Current index Trait response to recording strategy					Alternate index Trait response to recording strategy				
Trait (unit)	Weight	1	2	3	4	Weight	1	2	3	4
BWT (kg)	-69	0.11	0.11	0.11	0.10	0	0.22	0.22	0.21	0.20
w200 (kg)	23	1.33	1.32	1.22	1.27	0	1.46	1.43	1.31	1.42
w200m (kg)	50	0.07	0.13	0.12	0.07	111	0.12	0.18	0.18	0.11
w400 (kg)	101	2.79	2.77	2.64	2.71	0	2.96	2.90	2.70	2.89
w600 (kg)	0	2.73	2.72	2.68	2.74	98	3.59	3.55	3.44	3.53
MCW(kg)	0	2.03	1.49	1.53	1.82	-36	3.40	2.68	2.66	2.99
CE (%)	399	-0.01	0.02	-0.01	-0.03	162	-0.15	-0.11	-0.13	-0.17
CEm (%)	211	0.03	0.01	0.03	0.04	72	0.02	0.01	0.03	0.03
FD P8 (mm)	0	0.01	0.01	0.02	0.02	0	0.01	0.01	0.04	0.03
FDRib (mm)	0	0.01	0.01	0.01	0.01	-116	0.01	0.01	0.04	0.03
IMF (cm^2)	312	-0.01	-0.01	-0.01	-0.01	0	-0.01	-0.01	-0.01	-0.01
EMA (cm^2)	241	0.25	0.25	0.48	0.48	122	0.28	0.29	0.45	0.46
DC (days)	-200	-0.28	-0.28	-0.26	-0.26	-96	-0.14	-0.14	-0.13	-0.12
BCS (units)	0	-0.01	-0.01	-0.01	0.00	3670	0.01	0.01	0.01	0.01
GL (days)	0	-0.07	-0.08	-0.07	-0.08	-274	-0.06	-0.06	-0.05	-0.07
GLm (days)	0	0.00	0.00	0.00	0.00	-128	0.00	0.00	0.00	0.00
Economic response (cents)		260	285	295	304		310	336	355	361

EXTENSIVE HILL COUNTRY GRAZING

To assess the impact of farm system type, where animals are grazed on extensive "hill" country versus easy "lowland" terrain, an alternative breeding objective was used. Two new traits were introduced to model hill country beef herds; i) Body condition score (BCS Hill); and ii) Days to calving: DC Hill). These traits were introduced to reflect a herd in which cows primarily perform a pasture clean up role on a mixed sheep and beef farm. The genetic correlation between BCS and BCS Hill was set to 0.5, the strong correlations between BCS with W600 and MCW were removed, and the correlation between DC and BCS Hill was set to -0.3. Similarly, the genetic correlation between DC Hill and DC was set to 0.5, as was the genetic correlation between DC Hill and BCS Hill. However positive (unfavourable) correlations were introduced between DC Hill and growth traits, reflecting the unsuitability of fast growing genotypes for hill country herds.

Table 3 shows the economic responses to selection for recording strategy models 3 and 4, and the breeding program and recording objectives are shifted from the lowland to the hill. When BCS and DC are recorded on the hill, similar levels of economic progress can be achieved as would be observed using the alternate index on lowland. However, selection pressure is diverted away from growth, which results in smaller cows with improved maternal weaning weights and easier calving. If BCS and DC are recorded on lowland country, and the bulls are then used to generate replacements on the hill, growth rates increase, resulting in bigger cows, longer gestation times, and loss of calving ease. This results in a gross reduction in the benefits of genetic selection. Under recording strategy 3, BCS and GL are not recorded, therefore the genotype by environment interaction effect is less severe. With strategy model 4, selection emphasis applied to BCS on lowland, results in larger cows which are less suitable for hill country farming environments.

Table 3: Impact of land type on response to selection using recording strategies 3 and 4

Recording strategy model	3: GL & BCS not recorded			4: GL & BCS recorded		
Commercial Land type	Lowland	Hill	Hill	Lowland	Hill	Hill
Breeding program land type[1]	Lowland	Lowland	Hill	Lowland	Lowland	Hill
Annual response (cents)	355	343	373	361	222	391

[1] The focus of the breeding objective used for selection is assumed to match the breeding program land type, but annual response value is based on the economic values corresponding to the commercial land type.

POTENTIAL BENEFITS TO NEW ZEALAND

Using national herd size and discounted genetic expression methodologies, it is possible to estimate the value of genetic improvements over a10 year period to the commercial beef farming tier. Over 10 years of cumulating genetic progress, 1 unit of genetic trend cumulates to 1+2+3+....+10=55. If we count a further 5 years of progress (i.e. we consider the benefits of 10 years of progress over 15 years) then the benefits increase to 105. However, if we discount the benefits to account for the time lag using a discount rate of 7% (the farm mortgage rate minus the rate of inflation), this reduces to 59.4 units of progress in present value terms.

Assuming the current rate of progress (valued using the alternate index) is $2.60 per cow mated per year, the estimated value of 10 years of genetic progress (valued over a 15 year period) is $61.8 M or $154 per cow mated. Improvements in selection criteria and /or indexes could result in increases in the rate of genetic progress and economic returns to the beef industry. A 30% increase in genetic progress, combined with an industry penetration rate of 40% (i.e. 400,000 beef cows mated per year), would result in national benefits of up to $18.5M.

To achieve significant productivity increases within the beef farming sector, further input is required from both breeders and commercial farmers as to the relative importance of traits currently used within the index. Industry consultation is needed to determine farmer attitudes for change, and to establish whether opportunities exist to optimise both index weightings and phenotypic recording practices applied within New Zealand.

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