IMPLICATIONS OF MANIPULATING THE EWE LIVE WEIGHT PENALTY IN MATERNAL SHEEP INDEXES IN NEW ZEALAND

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SUMMARY

Understanding the consequences of selection represents an important part of the development of a genetic improvement program. The weighting applied to the adult ewe live weight (EWT) estimated breeding value (EBV) in New Zealand dual purpose flocks is currently highly topical with breeders having contrasting views as to the appropriateness of the current strong downward selection emphasis. This research assessed the implications of selection using a restricted ewe live weight index, and quantified the loss of efficiency of selection on indexes with varying economic weights, and a zero economic weight, for the EWT EBV, in flocks recording and not recording EWT.

Results showed that recording ewe weight enables EWT EBV change to be restricted while achieving increased rates of gain in early growth traits. The current dual purpose production (DPP) index (Byrne *et al.* 2012) was also found to be robust to a 17 to 33% reduction in the EWT economic weight, resulting in a 2 to 4% loss in efficiency of selection on the current DPP index for all flocks that are either recording or not recording EWT. While selection indexes were robust to changes in EWT economic weights, if the EWT economic weight was set to zero, equivalent to a decision to exclude EWT from the breeding goal, the loss in efficiency of selection on the current DPP index was 16%.

One option for industry could be to implement a 33% reduction in EWT economic weight which would result in no reduction in genetic potential for ewe mature size while selection candidates with superior growth rate would rank more consistently with ram breeder and buyer expectations. While this compromise would typically result in a 2 to 4% loss in efficiency of the current DPP, such an outcome is preferable to exclusion of EWT from the breeding goal as currently practiced by some breeders who object to a strong negative penalty on EWT, because that strategy leads to a 16% reduction in the economic value of genetic progress.

INTRODUCTION

Understanding the consequences of selection represents an important part of the development of a genetic improvement program. It enables breeders and farmers to understand how animal performance will change over time as a result of selection. A number of sheep breeders have provided feedback to Beef + Lamb New Zealand Genetics (B+LNZ Genetics) that some of the consequences of selection on the current DPP index are not desirable. Of specific concern is the loss of gain in early growth, as a result of using a negative economic weight on the EWT EBV. Depending on the level of recording and accuracy of prediction, the current DPP index may increase or decrease ewe weight (Table 1). While it is recommended that a negative economic weight on the EWT EBV be included in the DPP index, some breeders are requesting that this be dropped in the genetic evaluation of their flocks. Moving forward breeders and farmers would like to have the ability to be able to control EWT with continual improvement in early growth.

The aim of this research was to assess the implications of selection using a restricted EWT index and to quantify the los, of efficiency, relative to the current DPP index, of selection on overall indexes with varying economic weights for the EWT EBV, in flocks recording and not recording EWT.

MATERIALS AND METHODS

Data collation. The Sheep Improvement Limited Database (Newman *et al.* 2000) was used to identify 79 flocks of different breeds (Romney, Perendale, Coopworth and Composite) that were recording or not recording EWT from 2006-2013. This data was collated into high and low EWT BV accuracy datasets from flocks recording or not recording EWT. A quantification of the expected loss of efficiency of selection on indexes with varying economic weights for EWT was undertaken (Table 1).

Data analysis. The first step of the approach involved estimating the regression coefficients of each trait of interest on the index (DPP) in question, within high and low accuracy datasets from flocks recording or not recording EWT. These regression coefficients (b), interpreted as how many units of progress in a trait can be expected per unit change in the index, can be derived from genetic variances of traits and indexes, as follows:

$$b_{T,I} = r_{T,I} \times \sqrt{\left(V_T / V_I \right)} \quad \text{\{Equation 1\}},$$

where r is the correlation and V is the variance for trait T and index I, respectively. These values are very simply calculated for any set of selection candidates which have EBVs for the traits of interest, and for any specified index.

The next step is to set as a benchmark the rate of genetic progress being achieved using the current index. This can be evaluated by looking at the averages of index values for animals born by birth year over recent years, a standard and routine practice in most genetic evaluation systems. If we assume that the vast majority of genetic progress comes from selection of a single type of selection candidate (e.g. progeny tested sires), then response to selection (R) on the current index (IC) is:

$$R_{IC} = i \times r_{IC,TM} \times \sqrt{(V_{TM})} / L \quad \text{\{Equation 2\}},$$

where i is the selection intensity, r is the accuracy of selection of candidates on the current index (IC), V is the variance for true overall merit (TM), and L is the generation interval. If we assume that selection intensity and generation interval will be the same irrespective of what index is used to achieve genetic progress (this is reasonable for similar indexes with just moderately modified weightings on the same or similar traits as in the current index), then the relative rates of response in two indexes will be:

$$R_{IN} / R_{IC} = r_{IN,TM} \times \sqrt{V_{TM}} \Big/ r_{IC,TM} \times \sqrt{V_{TM}} \quad \text{\{Equation 3\}},$$

where IN is the new index, and the other parameters are described in equation 2. We can predict response in any trait of interest (R_T) resulting from selection on the new index so that 100 units of index progress is achieved based on combining Equations 1 and 2 above to be:

$$R_T = 100 \times r_{T,IN} \times \sqrt{V_T / V_{IC}}$$

It is important to note that in the above calculation, the correlation described is for the trait of interest with the new index (IN) being considered, while the variance of the current index (IC) is used to standardise the results in the denominator of the equation.

The equations can be easily adapted to predict response in one index that arises from selection on another index. This is achieved by treating the index of interest in the same way as we treated the trait of interest as described above.

RESULTS AND DISCUSSION

Results show that when selection candidates have high accuracy for the EWT eBV, selection on the current DPP index is expected to result in a modest reduction in EWT (Table 1). Table 1 also shows that the recording of EWT enables the EWT EBV change to be restricted while achieving increased rates of gain in early growth traits (e.g. for high accuracy recorded flocks, CW response increases from 0.058 to 0.071, when EWT is restricted to zero). A similar result was observed for flocks that are not recording EWT, although the realised increases in rates of gain in early growth rate are much smaller (e.g. for high accuracy non recorded flocks, CW response increases from 0.067 to 0.068). This is because an almost equivalent weight (-146) to the current weight (-149) is required to restrict EWT EBV gain in flocks not recording EWT (Table 1).

Table 1. Expected responses (regression coefficients) for each trait and index if selecting for 100 cents of progress in the current index.

Dataset		**High accuracy**				**Low accuracy**			
Ewe live weight (EWT)		**Recorded**		**Not recorded**		**Recorded**		**Not recorded**	
Selection candidates		**n=247,840**		**n=69,725**		**n=28,333**		**n=63,085**	
Accuracy of EWT eBV		**67.6%**		**63.5%**		**49.7%**		**50.3%**	
Economic weight for EWT eBV (cents)[1]		**Cur -149**	**New -109**	**Cur -149**	**New -146**	**Cur -149**	**New- 177**	**Cur -149**	**New -210**
eBV[2]	**unit**								
NLB	lamb	0.011	0.011	0.012	0.012	0.008	0.008	0.010	0.010
SUR	lamb	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
SURM	lamb	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WWT	kg	0.094	0.113	0.126	0.128	0.143	0.125	0.165	0.129
WWTM	kg	0.050	0.053	0.044	0.044	0.079	0.075	0.060	0.051
CW	kg	0.058	0.071	0.067	0.068	0.084	0.072	0.087	0.063
EWT	kg	-0.067	0.000	-0.006	0.000	0.047	0.000	0.095	0.000
FW12	kg	0.012	0.014	0.013	0.013	0.019	0.018	0.016	0.012
LFW	kg	0.002	0.002	0.002	0.002	0.003	0.002	0.002	0.002
EFW	kg	0.011	0.012	0.011	0.012	0.017	0.015	0.014	0.011
Index[3]	**unit**								
DPP (IC**)**	¢	100.0	98.63	100.0	99.99	100.0	99.33	100.0	96.99
DPPR (IN**)**	¢	97.31	98.64	99.98	99.99	98.68	99.33	94.19	97.03

[1] Cur: Ewe live weight economic weight in the current index; New: Ewe live weight economic weight required to restrict change in ewe live weight. [2] eBV, Estimated breeding values; NLB, number of lambs born; Sur, survival; SurM, survival maternal; WWT, weaning weight; WWTM, weaning weight maternal; CW, carcase weight; EWT, ewe live weight; FW12, fleece weight at 12 months; LFW, lamb fleece weight; EFW, ewe fleece weight. [3]Index: DPP (using current ewe live weight economic weight); DPPR, dual purpose restricted to zero change in EWT eBV (using the restricted ewe live weight economic weight)

When the accuracy of prediction of genetic merit for EWT EBV is low, significantly higher economic weights are required to restrict genetic change in EWT, for recording (-177) and (-210) non recording flocks (Table 1). With this level of weighting, associated reductions in response to selection for early growth traits are apparent. The magnitude of this reduction (from responses to selection in current index) is greater for non-recording flocks compared to recording flocks. This shows an inability to identify genetic variation for adult ewe weight independent of early growth, when the trait is not recorded or predicted with low accuracy.

As theory defines, results showed that selection indexes are robust to modest changes in the economic weight for EWT (Figure 1). For example if the current economic weight is dropped or increased by 50%, 95-96% of the current DPP will still be realised for flocks that are either recording or not recording ewe live weight. This efficiency increases to above ~99% with a 17% increase or decrease in the economic weight for EWT.

If the EWT penalty is set to zero, equivalent to the practice of dropping EWT from the breeding goal, the loss in efficiency of the current DPP was 16%. To encourage industry to keep EWT in the breeding goal, the EWT penalty could be dropped by 33%, resulting in no reduction in genetic potential for ewe mature size when accuracy is high in flocks measuring the trait while selection candidates with superior growth rate would rank more consistently with ram breeder and buyer expectations. While this compromise could result in a 2 to 4% loss in efficiency of selection on the current DPP index for all flocks that are either recording or not recording EWT, this is a far better outcome for industry than a 16% loss from dropping EWT from the breeding goal.

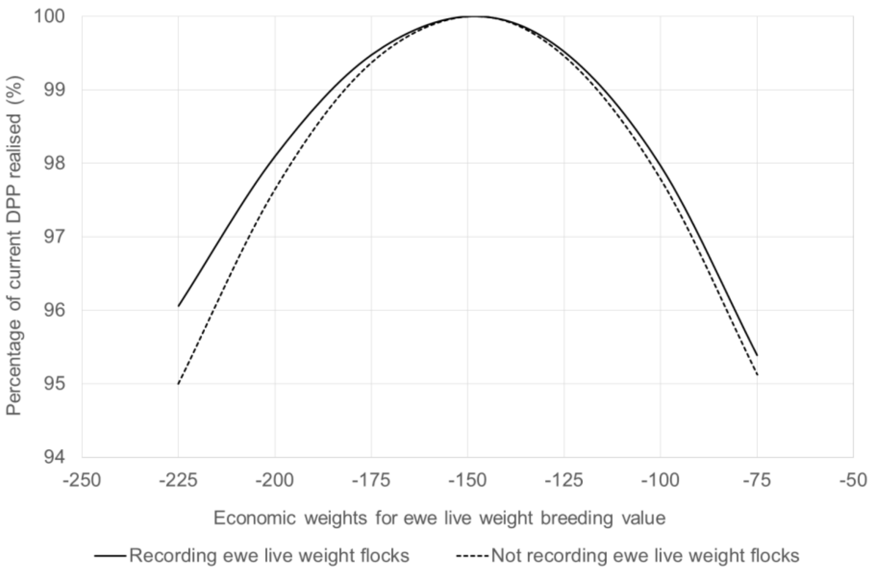

Figure 1. The effect of different economic weights for adult ewe live weight estimated breeding values on the percentage of current Dual purpose production index (DPP) realised for selection candidates from flocks that are recording or not recording ewe live weight.

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