Sheep - Meat

RATES OF GENETIC GAIN IN NEW ZEALAND SHEEP

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SUMMARY

Rates of genetic gain in New Zealand sheep doubled in 140 Dual Purpose flocks, from 30 to 60 cents/yr, and 62 Terminal Sire flocks, from 35 to 60 cents/yr, after establishment of the Sheep Improvement Ltd (SIL) genetic evaluation system in 1999. Further incremental gains of a similar magnitude led to triple the rates of gain pre-SIL after establishment of the Meat & Wool New Zealand Central Progeny Test and the start of SIL-ACE across-flock, across-breed genetic evaluations in 2004. Flocks were classified based on genetic merit for 2004-2006 as; "**Leader**" high merit / high rate of gain; "**Gaining**" below average merit / high rate of gain; "**Slipping**" high merit / low rate of gain; and "**Trailing**" below average merit / low rate of gain. Leader and Gaining flocks were more likely to make use of high merit sires from other flocks. Slipping and Trailing flocks were more likely to make repeated use of older sires of low genetic merit. These data show that high rates of gain are achievable by flocks adopting optimal ram selection and use policies. The challenge is getting more flocks to adopt such policies.

INTRODUCTION

Prior to 1999, genetic evaluations for sheep flocks in New Zealand were largely done within-flock using sire model BLUP, through a number of service providers. In 1999 Sheep Improvement Ltd (SIL) was established as the single national performance recording and genetic evaluation service for the New Zealand sheep industry (Geenty 2000). SIL made individual animal model BLUP evaluations available on-demand leading to more accurate measures of genetic merit, in particular for reproduction measured as litter size (Newman *et al*. 2000).

Since 1999 SIL has continued to evolve, more flocks have joined, and more flocks participate in regular across-flock genetic evaluations. The Alliance (now Meat & Wool New Zealand) Central Progeny Test (CPT) began with matings in 2002 (Campbell *et al*. 2003). This provided genetic connectedness between breeds and breed groups that led to the large-scale, across-flock, across-breed genetic evaluation, SIL-ACE, starting in 2004 (Young and Newman 2009).

Previously no work has been carried out to estimate rates of genetic gain across the New Zealand sheep industry. SIL-ACE data provides the means to assess this. More than 300 flocks, which are estimated to breed greater than 50% of rams used by industry, participate in SIL-ACE.

MATERIALS AND METHODS

Data from the December 2007 SIL-ACE evaluation were made available by SIL. Average genetic merit was calculated for flocks over the period 1990 to 2006 based on data for animals born in these years. One hundred and forty flocks were designated as Dual Purpose (DP) and 62 as Terminal Sire (TS) based on breed. Approximately 1.6 million animals were in the evaluation of which 700 thousand were born in the years 2004-2006, inclusive.

Genetic merit was assessed as an overall index for DP sheep, combining information on Growth, Wool & Reproduction, and as an overall index for TS sheep, based on Growth and Meat (carcass merit based on body weight and ultrasound scanning). Consideration of changes in index components has been reported elsewhere (Amer 2009).

SIL indexes for overall merit combine information across relevant traits in the genetic evaluation (Amer 2000). SIL has reviewed index weightings and added more goal traits since

1999. The latest information on indexes and their component traits is available on the SIL website (www.sil.co.nz). Most SIL flocks use the standard SIL DP Overall or TS Overall indexes. Some flocks use variations on these but few use their own indexes.

Average genetic merit and average rate of genetic progress were calculated for each flock over four (unequal) time periods, where data were available. For some flocks, there were no data in the first period as they were not recording on SIL at that time. The periods were 1990-1994, 1995-1998, 1999-2003 and 2004-2006. The first two periods cover the time before SIL evaluations, while the period 2004-2006 covers the time when SIL-ACE results became available to help breeders compare genetic merit of animals from different flocks and breeds.

Using data from the fourth period (2004-2006) flocks were placed in one of the following four classes, separately for DP and TS flocks, based on average genetic merit and average genetic gain.

- **Leaders** – high merit, fast gain
- **Gaining** – below average merit, fast gain
- **Slipping** – high merit, below average gain
- **Trailing** – below average merit, below average gain

Aspects of flock structure and breeding strategy were studied to explain class differences: flock size, generation intervals (male and female), source of sires, average merit of sires (homebred *vs*. outside), merit of repeat use sires and proportion of lambs with unknown parents.

RESULTS AND DISCUSSION

Average rate of gains for DP and TS flocks are shown in Figure 1. Prior to SIL, gains were in the region of 30 cents/year. In the early years of SIL these increased to close to 60 cents/year and following the establishment of SIL-ACE, which utilized across breed connections from the CPT, this increased by about the same amount again, to close to 90 cents/year.

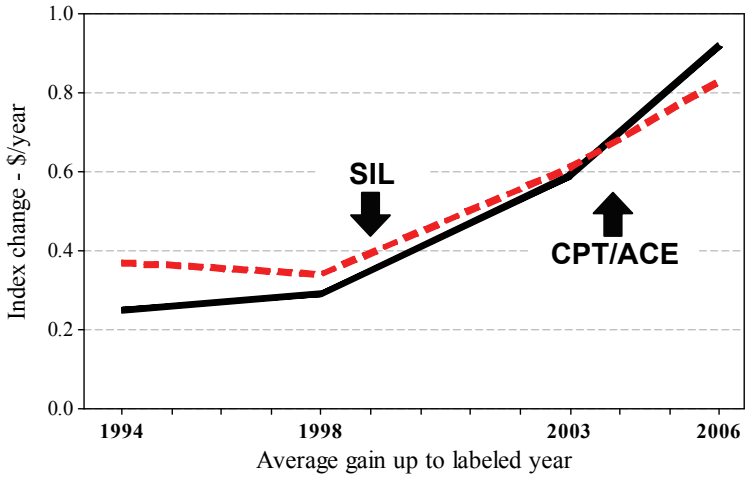

Figure 1. Average rate of gain in SIL-ACE overall indexes for Dual Purpose (solid line) & Terminal Sire (dashed line) sheep. NB: The Y-axis is rate of gain so anything greater than zero is genetic gain. Times that SIL & CPT/ACE were established are indicated.

Not all of these increases in rate of genetic gain can be attributed to SIL or to SIL-ACE. It is likely that breeders made more effective use of SIL figures as they gained confidence with experience. It might be argued that breeders using these systems are more innovative than those that do not. However, a number of flocks considered to be of high genetic merit or to have high

rates of genetic gain fall outside the sample of flocks used in this analysis due to poor genetic connectedness or through not participating in SIL-ACE. Without evidence to the contrary, we assume that the trends reported here are representative of industry trends.

Increased rates of genetic gain have also come from sources other than use of SIL, CPT and SIL-ACE information. Breed substitution, or "blending" has occurred in some flocks so "breed" composition of the industry has changed. Exotic breeds imported into NZ in the last few decades brought new genetics into the mix. No work has been reported on the relative performance of these exotics and local breeds from which we can assess the impact exotic genetics has had on these genetic trends. However, SIL-ACE results (available at www.sil.co.nz) clearly show that many sheep with outstanding genetic merit are purebreds from "traditional" breeds.

Average merit and rates of genetic gain varied over time for all flocks. Using average figures for the four time periods eliminates some of this noise. Table 1 presents average rates of gain for DP and for TS sheep, broken down into the four flock classes and the four time periods. These data clearly show the dramatic increases in genetic gain achieved by the Leader and Gaining flocks following the introduction of SIL and then of SIL-ACE. They also highlight that the Slipping and Trailing flocks made relatively modest gains over the same periods.

Table 1. Annual rates of genetic gain in overall economic index across 4 classes of Dual Purpose and across 4 classes of Terminal Sire flock participating in the SIL-ACE evaluation.

	Dual Purpose sheep index ($)			Overall	Terminal Sire sheep index ($)			Overall
Time period	Trailing	Slipping	Gaining	Leader	Trailing	Slipping	Gaining	Leader
2004-2006	0.57	0.60	1.34	1.41	0.38	0.44	0.86	1.05
1999-2003	0.47	0.75	0.51	0.71	0.27	0.55	0.66	0.71
1995-1998	0.14	0.49	0.08	0.45	0.19	0.32	0.53	0.33
1990-1994	0.17	0.30	0.11	0.39	0.19	0.46	- [1]	0.14

[1]With only one Terminal Sire flock classified as Gaining had animals present in the 1990-1994 time period, so a trend was not calculated.

Only two factors of flock structure and breeding strategy were associated with flock classification. Flocks with high rates of genetic gain were more likely to be using high merit sires from other flocks, while flocks with low rates of gain tended to repeatedly use low merit sires.

It is illuminating to consider the cumulative genetic changes over the years studied relative to industry production statistics for the DP index and two of its components (Amer 2009). These changes were greater than $8 for DP overall index, with more than $5 of this coming after 1999. Associated changes for two component BV traits were 1.4kg for carcass weight, with more than 900g coming after 1999, and more than 5% for number of lambs born (most coming after 1999). The relatively larger change for Reproduction under SIL is expected because genetic merit for litter size was based on very little information from relatives in earlier evaluation schemes.

Overall phenotypic performance of the New Zealand sheep industry improved over the period 1990-2006. Meat & Wool New Zealand Economic Service information (Davison, pers. comm.)

shows carcass weight increased by 2.5kg (14.4 to 16.9) and average lambing percentage by 16% (101.6 to 117.9). These provide the best estimate of actual industry performance against which we can assess the impact of the genetic changes we have described here. We conclude that genetics have contributed significantly to increases in industry performance.

Major differences were seen between individual flocks in rates of genetic gain (Figure 2). While the average flock gained close to $1/year on index from 2004 to 2006, some flocks gained more than $1.50/year and others gained less than 50c/year. This implies that breeders with a long-term commitment to using modern genetic improvement methods are making very good gains.

CONCLUSIONS

Better genetic evaluation methods and large-scale across-flock, across-breed genetic evaluations have each led to dramatic increases in rates of genetic gain in the New Zealand sheep industry. However, there still exists great variation in rate of genetic gain for flocks using these systems. Key features of the breeding strategies of the high merit, fast gaining, "Leader" flocks suggest that making use of high merit rams from other flocks and not using older sires repeatedly has led to higher rates of genetic gain.

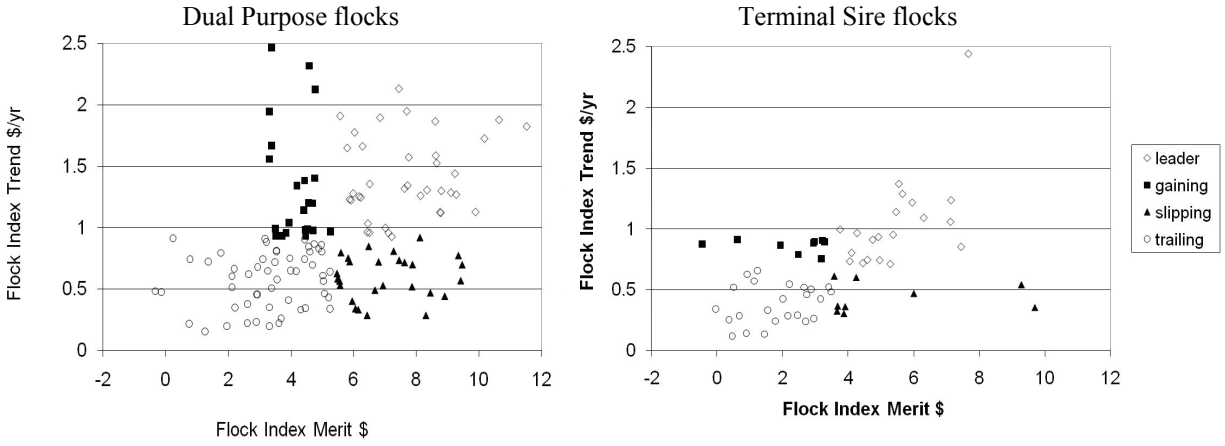

Figure 2. Dual Purpose and Terminal Sire flocks classified into 4 categories based on average index merit and average index trend for the 2004-2006 period.

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