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AN EX-POST COST-BENEFIT ANALYSIS OF THE OVITA LAMB SURVIVAL PROJECT

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SUMMARY

Improving lamb survival has both economic and animal welfare benefits for sheep farmers. However, genetic improvement is often considered of little practical benefit because of the low trait heritability and recording limitations, especially under extensive management. The Ovita Lamb Survival research project improved industry recording and genetic evaluation of lamb survival from 2003. To quantify research impacts, an ex-post cost-benefit analysis was undertaken using genetic trends of direct and maternal lamb survival breeding values from 1995 until 2023. In 2023, the average direct breeding value for lamb survival in dual-purpose ram breeding flocks was 1.98% higher than in 1995, and the maternal breeding value was 1.10% higher than in 1995. Conservative gene flow calculations indicate that genetic improvements are likely responsible for an additional 337,000 commercial lambs weaned in 2023, worth $54 million per year to the New Zealand economy. Accounting for inflation, genetic lags and the timing of the research investment (2003-2012), and a discount rate of 8%, the net present value was estimated at $164 million. These results provide strong evidence of the returns from the Ovita investment.

INTRODUCTION

The number of lambs born is a critical component of productivity and profitability on New Zealand sheep farms. Despite advances in management practices, lamb survival remains a significant issue for farmers (Greer *et al.* 2015). Improving lamb survival not only impacts economic returns but also addresses animal welfare concerns.

Lamb survival is a complex trait, influenced by direct and maternal genetic and environmental effects. Therefore, genetic improvement is often considered of little practical benefit because of the low trait heritability and recording limitations, especially under extensive management (Morris *et al.* 2000). Ovita was a joint research venture between AgResearch and Beef + Lamb New Zealand (2003-2013). One workstream commencing in 2003 was to examine ways to improve lamb survival through the identification of genetic markers. This project resulted in the collection of 103,000 detailed lamb survival and mortality records from 38 New Zealand performance-recorded flocks (Kerslake *et al.* 2005; Everett-Hincks and Duncan 2008; Everett-Hincks *et al.* 2014) and resulted in improvements in the recording and genetic evaluation for this trait, progressively implemented from 2012. Along with this research, there were several technological developments, including pregnancy scanning, foetal aging and full and partial DNA parentage. Genomic selection was implemented in 2017, and single-step genomic evaluation in 2019, all increasing the accuracy of the survival breeding values.

When lamb survival and mortality records were used to estimate genetic parameters, the total (direct + maternal) heritability estimates were low (0.007±0.002 to 0.058±0.003) for survival traits and moderate (0.38±0.01) for lamb birth weight (Everett-Hincks *et al.* 2014). For the traits studied, the heritability attributed to maternal effects (expressed when the ewe lamb produces progeny) accounted for at least half to two-thirds of the total genetic variation, indicating that genetic progress could be made by selecting ewe lambs based on their estimated breeding values for lamb survival. Additionally, it was established that accurate recording of survival to weaning was more important than component lamb mortality traits in an effective breeding program. As a result, a revised lamb survival trait was developed and implemented into Sheep Improvement Limited (SIL), the national performance recording and genetic evaluation system (Vanderick *et al.* 2015). Lamb survival (SUR) is currently included in both maternal (NZMW) and terminal (NZTW) indexes, with survival maternal (SURM) additionally included in NZMW (Santos *et al.* 2015).

MATERIALS AND METHODS

Genetic trends in direct (SURgBV) and maternal (SURMgBV) lamb survival from 1995 until 2023 were obtained from nProve (formerly SIL) for NZ dual-purpose maternal flocks (NZGE v6; GE analysis 42120). Numbers of breeding ewes, lambs tailed (docked) from ewes, and all processing and export data were obtained from the Beef + Lamb New Zealand Economic Service.

A simplified gene flow model was used, assuming that rams were first used as rising two-year-olds and kept for three years, the realised value of SURgBV in a commercial flock from the ram team was the average breeding value (BV) of stud rams born 3-5 years prior, halved (as rams only account for half of the genetic improvement in progeny). This then flows onto daughters, with the realised value of SURgBV in commercial ewes, the average BV of the sire team used 5-7 years prior, halved, assuming a replacement rate of approximately 33% (Farrell 2020). The direct BV of the commercial flock in any given year was calculated as the sum of the ram and ewe BVs. The assumption is that the majority of recognised profit from lambs born is in the subsequent calendar year. The model for SURMgBV in commercial ewes follows the same pattern, with the realised value being half the average BV of stud rams born 5-7 years prior. The total increase in lamb survival from BVs was calculated by summing the direct BV and the maternal BV within a given year.

To calculate the extra number of lambs weaned, the following equation was used:

$$Extra\ lambs\ weaned = ewes\ mated\ \times \frac{lambs\ born}{ewes\ mated} \times commercial\ BV$$

Lambs born to ewes mated were calculated using industry data (B+LNZ Economic Service). Estimates of average survival vary in the literature; however, in this model, an average survival of 0.88 from birth to weaning was used (Everett-Hincks *et al.* 2014) to back-calculate the number of lambs born. Survival from tailing to weaning was assumed to be 0.98 (Byrne *et al.* 2012), and industry tailing numbers were adjusted accordingly.

The number of carcasses processed per year was estimated from total lamb meat expressed on a carcass weight equivalent, divided by the average export lamb weight. The value of lamb meat and co-products (including skins) per carcass was calculated by dividing the Free on Board (FOB) total value by the estimated number of carcasses (B+LNZ Economic Service) and adjusted for inflation (Reserve Bank of New Zealand Inflation Calculator). This was used to calculate the value of the additional lambs weaned per year, in which the lambs were processed using 2023 as the base year.

Ovita investment was obtained from internal AgResearch records and adjusted for inflation as above ($4.2 million in 2023 dollars). The net present value (NPV, using a discount rate of 8%) was estimated for the period 2003-2023 (the period from when Ovita investment started).

RESULTS AND DISCUSSION

In the 2023 birth year, the average SURgBV in Dual-purpose ram breeding flocks was 1.98% higher than in 1995, and SURMgBV was 1.10% higher than in 1995 (Figure 1). Values did not change markedly between 1995 and 2003, when the Ovita program began. In Terminal flocks, where there is no selection for SURMgBV, the average value was 0.06% compared to 1995. The average

SURgBV for terminal flocks, which is included in the terminal worth selection index, has increased by 0.95%.

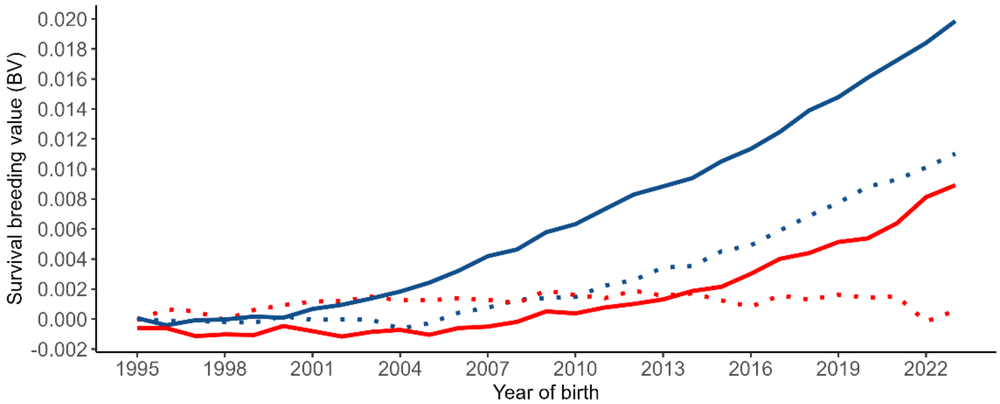

Figure 1. Genetic trends in SURgBV (solid line) and SURMgBV (dashed line) in B+LNZ Genetics recorded dual-purpose (blue) and terminal (red) flocks by year of birth

In 2023, New Zealand grazed 14.8 million ewes, with 127% lambs tailed to ewes mated. A conservative gene flow model suggested that an extra 337,000 lambs were weaned in 2023, because of genetic improvements in lamb survival since 1995 (Figure 2). Including the value of lamb meat and co-products (including skins), this is worth $53 million per year to the New Zealand economy. Accounting for genetic lags, changes in NZ ewe numbers, and the timing of the research investment, the Net Present Value of the investment is $164 million using a discount rate of 8%.

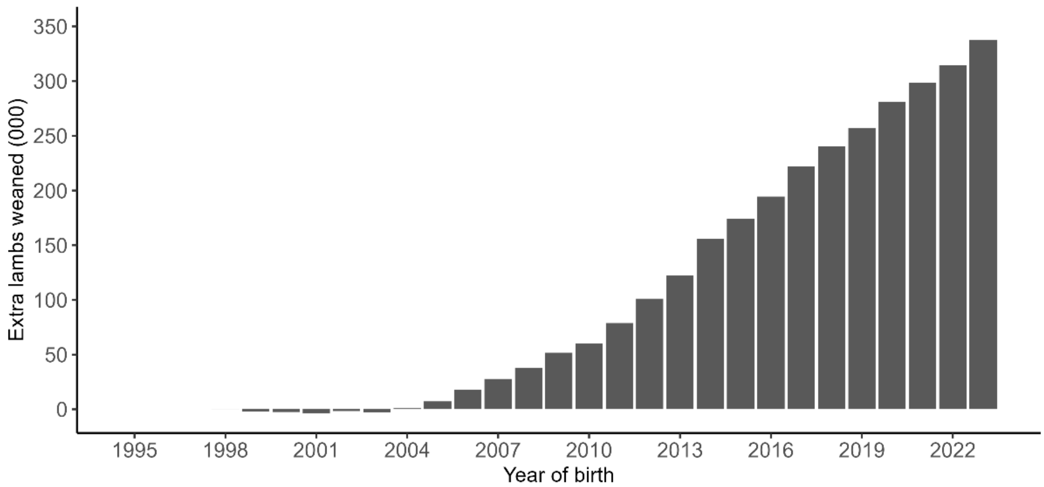

Figure 2. Estimated number of extra lambs weaned in the national sheep flock from the implementation of direct and maternal survival breeding values

These results have several observations and caveats. The first is that the results presented here do not include the difference in average direct and maternal survival BVs of all stud ram lambs born, and those of the rams sold to commercial farmers. That data is not available and will have varied over time as recording, selection indices, and breeding values improved. However, this benefit is likely to be substantial. On the converse, B+LNZ recorded flocks probably only account for some 90% of rams sold in New Zealand. A second interesting observation is that when expressed on a per carcass basis, the inflation-adjusted value of lamb meat and co-products (including skins) has increased on average by $1.50/year over the 1995-2004 period. This reflects heavier carcass weights, increased carcass processing within New Zealand and a shift to exporting chilled rather than frozen meat. This partially compensates for the lower numbers of ewes wintered.

Another caveat is that when comparing genetic trends with industry production data, such as lambs tailed to ewes mated, is that these data are not adjusted for changes in the number of animals in the various land classes over time. This is required to more accurately calculate the proportion of increased farm productivity that is attributable to genetics. Secondly, accurate pregnancy scanning data is not recorded, even though this is collected by many commercial farmers, meaning that industry figures on lamb survival are not available.

Ascribing changes in genetic gain over time to specific changes in the genetic evaluation is also difficult. Direct survival BLUP breeding values were first available in 2001, and maternal breeding values in 2005, with genomic breeding values in the 2017-2019 period. However, their inclusion, parameters used, and index weighting have varied over time. Perhaps more importantly, the survival trait was poorly recorded until 2012, when existing data were subjected to a forensic examination and strict data filters were implemented. This was also accompanied by increasing use of DNA parentage and pregnancy scanning data. Genomic selection is expected to best assist in sex-limited traits, expressed late in life, and notably, maternal survival breeding values are now increasing more rapidly.

In undertaking this evaluation, several future opportunities were identified to improve lamb survival more rapidly; perhaps the most important is that whole ram breeding flock genotyping, coupled with accurate recording of the trait, will greatly increase the rate of genetic progress in maternal lamb survival. This is shown in increases in individual pedigree-recorded flocks, which have been two to four-fold greater than the industry average.

CONCLUSION

In conclusion, this study demonstrates that an inflation-adjusted $4.2M investment in a low heritability trait has yielded substantial returns driven by improved trait recording and increased utilisation of genomics. Further, it highlights the potential for even greater benefits and supports expanding this approach to a wider variety of traits.

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