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ANALYSES OF EWE STAYABILITY IN FLOCKS OF NEW ZEALAND SHEEP

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SUMMARY

A major determinant of profit for sheep farmers is ewe efficiency. A component of efficiency is the length of time a given ewe remains in a flock compared to her contemporaries. A number of terms (e.g. stayability (STAY), productive life and replacement rate) have been used to describe this trait. Breeding to improve this trait may be of significant economic value to New Zealand sheep breeders.

As an adjunct to the development of genomic selection for this trait, a series of quantitative genetics analyses were performed on a large data set derived from industry and research flocks. After quality control, a total of 697,174 animals, from 241 flocks, that were recorded between 1990 and 2009 were available. A subset of the data was analysed based on culling decisions made from the perspective of a commercial farmer or a ram breeder. The results are consistent with a higher risk of culling in ram breeder flocks. The value of STAY as a trait for selective breeding is discussed in view of the analyses.

INTRODUCTION

Productive life and STAY are likely to be important to the profitability of a breeding flock of ewes as these traits affect the costs such as the breeding of replacements (Byrne *et al*. 2012). Breeding to improve these traits may be of significant economic value to New Zealand sheep breeders while also reducing methane emissions per unit of product (Cottle and Conington, 2013). Analyses of STAY have been published using data from a sheep flock managed commercially in the United States (Borg *et al*. 2009) and from a research flock in New Zealand (McIntyre *et al*. 2012). The costs and benefits may be quite different when comparing a ram breeding flock to a commercial flock. A ram breeder has a primary objective of making genetic gain, and the commercial producer aims to maintain productive ewes in the flock for as long as possible. Therefore, ewe culling decisions may be quite different.

As an adjunct to the development of genomic selection for this trait, a series of quantitative genetics analyses were performed on data from industry and research flocks. Some outcomes from these analyses were used to gain insight into the value of STAY as a trait use to breed ewes to increase profitability.

MATERIALS AND METHODS

Data from a total of 4,030,417 animals from ram breeders was used in this study. The breeders were participants in a research program managed by Ovita and recorded on Sheep Improvement Limited. Ewe-records suitable to estimate age of ewe and culling date were identified, where typically the date of the last record for a ewe was the assumed cull date. Flocks with low numbers of animals or minimal recording of traits, ewes moved between flocks over a life-time and records shown as hogget-mating, were ignored. After the data were edited, the analyses focused on 697,174 ewes from 241 flocks born between 1990 and 2009. The mean number of ewes in each flock was 2,893 with a range of 159 to 25,970. Exit codes were assumed to be defined according to information on Sheep Improvement Limited (Walker and Young, 2009). Five flocks (total n=41,317) had sufficient ewe exit code recording, which was culling based on commercial reasons (C, n=8,375), culling on knowledge reasons (K, 10,053), or unknown/missing (U, n=1,592;

missing data=21,297). These five flocks, excluding the animals with unknown/missing records, were used to investigate STAY from the perspective of a commercial producer (cSTAY). Results from one of these flocks have been described previously (McIntyre *et al*. 2012). Linear mixed models were fit with flock and birth year as fixed effects. Traits as analysed were S(3|2) to S(6|2) following (McIntyre *et al*. 2012), where S(3|2) is the probability a ewe will remain in the flock at age 3 given she was present at age 2. Other trait estimated breeding values eBVs (ewe mature weight, number of lambs born and ewe fleece weight) were derived from standard SIL models.

Statistical analyses for linear mixed models were performed in ASREML3 (Gilmour *et al*. 2009) and all other analyses including Kaplan Meier analysis and simulation were undertaken in R (R Development Core Team, 2012).

A microsimulation model, where survival was modelled as a Markov process, was developed to begin to assess the value of cSTAY, relative to other traits known to affect ewe profitability. Only animals with eBV accuracies >0.29 for S(3|2) were used in simulations (n=1,917). This model simulated the lives of ewes that had eBVs for a range of traits including traits in Sheep Improvement Limited's terminal sire index and cSTAY, ewe mature weight, number of lambs born and ewe fleece weight. As an animal passes through the model, revenue and costs are calculated. Typically, each animal was simulated for 5,000 iterations and the mean from these iterations used to calculate outcomes (revenues and costs discounted at 8% per annum). The survival of a given year was estimated from a Kaplan Meier function and this was used to estimate mean population transition probabilities. For an animal in a given year the transition probability was the sum of cSTAY and the population mean for that year. Some key assumptions were that revenue from ewes was assumed to be lambs at a value of $100 plus one-half the terminal sire index value calculated from the ewe. Similarly, mean wool weight per ewe (4.8kg), number of lambs born (1.4), and salvage cost of ewe ($2.65/kg carcase weight) were adjusted according to eBVs. Dry matter intake at a cost of $0.12/kg was estimated from NRC equations based on ewe live weight adjusted with an eBV for ewe mature weight. Other costs for ewes included shearing and crutching, animal health costs, and ewe replacement costs (Byrne *et al*. 2012).

RESULTS AND DISCUSSION

Analyses to compare the difference in culling for commercial (C) or ram breeder (K) flocks were performed. For Kaplan Meier survival analysis the status of a ewe from a commercial flock for a given year in her life-time was assumed to be culled if her exit code was C and censored if K, whereas, for a ram breeder flock an exit code of C or K was assumed to be culled. The results from this analysis are given in Figure 1. The results indicate that the survival of a cohort of commercial ewes (cSTAY) and ram breeder ewes (bSTAY) was respectively 37.7% and 8.7% after five years. These observations are consistent with a ram breeder culling policy based on knowledge of ewes such as breeding or index values.

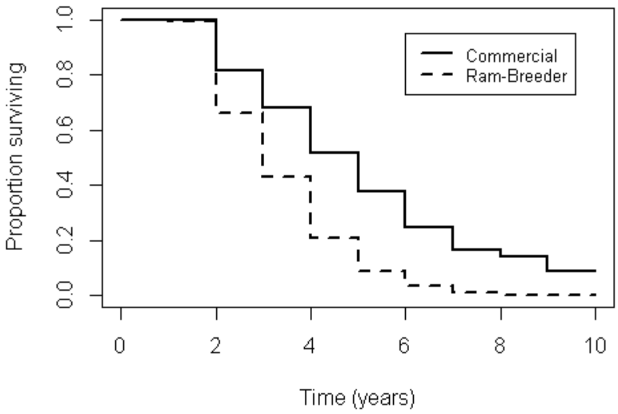

Figure 1 Kaplan Meier survival function of ewe survival in commercial versus Ram breeder flocks.

Linear mixed models were used to investigate genetic parameters. The heritability (standard error) estimated for cSTAY and bSTAY for S(3|2) was 0.048 (0.008) and 0.087 (0.002) respectively, and for S(6|2) 0.082 (0.012) and 0.071 (0.002). The bSTAY estimates are consistent with those from (McIntyre *et al*. 2012). Similar estimates for S(6|2) for cSTAY were described in Borg *et al*., 2009, but for S(3|2) their estimates were zero. Between country differences in policies, for culling ewes after their first mating season, may account for this observation.

The profit for 1,917 animals was calculated using the bioeconomic model described and the distribution of profits given in Figure 2. This is an estimate of the variation in profitability attributable to genetic variance. The results suggest there is significant variation amongst animals with a mean profitability of about $94 and range of -$42 to $272.

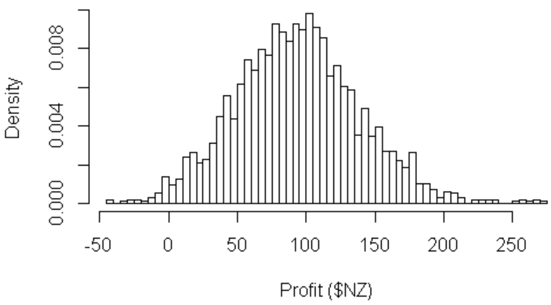

Figure 2 Distribution of live-time profits estimated for ewes. The profit of 1,917 ewes over their lifespan, as a function of estimated breeding values, was estimated by microsimulation. The average profit from 5,000 iterations for each ewe is given as a histogram.

The relative contribution of different traits to profitability was calculated by regressing scaled profit on the scaled trait eBVs S(3|2), S(6|2), ewe mature weight, number of lambs born and ewe fleece weight. The traits S(4|2) & S(5|2) were omitted as they were highly correlated to S(3|2) and

S(6|2) respectively. Economic weights were calculated by varying each trait and calculating the profit attributed to a one unit increase for a given trait. Selection index traits, that take into account the covariance between traits, were calculated by regressing profit on the different trait eBVs. These estimates are given in Table 1. The results suggest that, of the traits analysed and based on the assumptions used in the model, number of lambs born has the most economic value. cSTAY is of more value early in a ewe's life (e.g. the economic weight associated with S(3|2) and S(6|2) was $161.9 and $38.4 respectively). Ewe mature weight contributes negatively to profit through increased feed cost and ewe fleece weight contributed little to profitability. Refinement of this model will enable the calculation of economic and selection index weights to base selection. However, more data on cSTAY may be needed in order to get better estimates of genetic parameters. Moreover it will be of interest to model the value of STAY in different farming environments (Conington *et al*. 2004). Genomic selection may be useful for this trait as it is sex limited, of low heritability, and phenotypic information is recorded late in an individual's life.

Table 1. Estimated economic weightings for maternal traits and relative contributions for each trait

Trait	Economic weight ($/trait unit)	Selection Index weight ($/trait unit)	Relative contribution (%)
S(3|2)	161.90	301.18	16.0
S(6|2)	38.40	170.02	17.6
Number of lambs born	228.20	230.18	64.2
Ewe fleece weight (kg)	24.48	0.59	0.2
Ewe mature weight (kg)	-2.96	-0.38	-2.0

CONCLUSIONS

These analyses suggest that the inclusion of cSTAY in breeding indexes to optimise profitability of ewes in New Zealand will be beneficial and warrants further investigation. However, given that the heritability is low genetic progress will be slow. Further refinement of this model and inclusion of other traits will be needed to better understand its value from a breeding perspective and in relation to other traits.

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REFERENCES

Borg R.C., Notter D.R. and Kott R.W. (2009) *J. Anim Sci.* **87:** 3515.

Byrne T.J., Ludemann C.I., Amer P. R. and Young M.J. (2012) *Livestock Science* **144:** 20.

Conington J., Bishop S.C., Waterhouse A. and Simm G. (2004) *J. Anim Sci.* **82**: 1290.

Cottle D.J., and Conington J. (2013) *The Journal of Agricultural Science* **FirstView**: 1-17.

Gilmour A.R., Gogel B.J., Cullis B.R. and Thompson R. (2009) ASREML user guide release 3.0. VSN International Ltd., Hemel Hempstead, UK.

McIntyre S.B., Newman S.A.N., Young E.A. and McEwan J.C. (2012) In: Proceedings of the New Zealand Society of Animal Production. p 152.

R Development Core Team. (2012) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

Walker G. and Young M.J. (2009) SIL Technical Note - Advanced draft: Ewe longevity (or stayability). Sheep Improvement Limited, New Zealand.