VARIATION IN THE LIFETIME REPRODUCTIVE PERFORMANCE OF MERINO EWES

G. J. Lee, K. D. Atkins and M. A. Sladek

Cooperative Research Centre for Sheep Industry Innovation, NSW Department of Primary Industries, Orange Agricultural Institute, Forest Road, Orange, NSW 2800, Australia

SUMMARY

The variation between ewes in lifetime (2-6 years of age) reproductive performance within 3 research flocks maintained at Trangie in central western NSW was analysed. For each of the flocks, there were large differences ($P<0.001$) in lifetime net reproduction rate (NRR), and each of its components (fertility, fecundity and lamb survival), between each of the NRR quartiles. The difference in net reproduction between the ewes in the top quartile compared with those in the bottom quartile was equivalent to an additional lamb per ewe annually. These results identify reproductive levels that could be achieved, establish a basis for selection to improve performance and provide a means to segment the breeding flock for differential management.

INTRODUCTION

The average reproductive performance of Australian specialist sheep enterprises over the period 1977-2007 was 76.6 lambs marked /100 ewes joined but increasing at only 0.04% units annually (ABARE, 2008). The slow rate of progress is despite the availability of both genetic (Purvis *et al.* 1987) and management options (Langford *et al.* 2004) to improve reproductive rates.

There is a genetic influence on each component but heritability estimates are low (Safari *et al.* 2007), in part due to the nature of the annual expression of the traits. Variability, though, is quite high for reproductive traits such that within-flock selection is likely to lead to permanent but relatively slow genetic improvement.

Within-year management options to improve reproductive performance include nutritional inputs to improve the flock average condition/liveweight at joining and parturition, leading to higher fertility, fecundity and lamb survival (Langford *et al.* 2004). Managing whole flocks to increase liveweight/condition at joining to improve reproductive performance can be economically marginal, even after accounting for flow-on benefits to dam and progeny wool production (Young 2008). However, if we could identify segments of the flock that will achieve above average responses to higher management inputs then we should improve the benefit:cost ratio.

Knowing the extent of variation in the reproductive performance within the flock would indicate the current potential, and potentially identify flock segments that might respond to differential management. This paper reports the variation in the lifetime (2-6 years of age) reproductive performance within 3 research flocks run at the Agricultural Research Centre, Trangie in central western NSW.

MATERIALS AND METHODS

Lifetime reproductive data (ages 2-6 years) were available from 3 flocks of Merino ewes (D-Flock, C-Flock and QPLU$) run at the Agricultural Research Centre, Trangie. In each of these flocks, lambing and weaning performance of the ewes was routinely recorded. Lambing and weaning data for at least 3 joinings were available for 2430 D-Flock ewes (born 1975-1983), 1819 C-Flock ewes (born 1984-1993) and for 3037 QPLU$ ewes (born 1993-2002). Descriptions of flock structure and management have been provided elsewhere for D-Flock (Mortimer and Atkins 1989), C-Flock (Mortimer *et al.* 1994), and QPLU$ (Taylor and Atkins 1997).

Statistical analyses. Data on the number of times each ewe was joined, the number of years the ewe lambed, the total number of lambs born and the number of lambs weaned were obtained over the reproductive life (2-6 years of age) of the ewes in the flock. From these values lifetime fertility (no. times ewe lambed/no. joinings), fecundity (no. lambs born/ no. times ewe lambed), lamb survival (no. lambs weaned/no. lamb born) and net reproduction rate (no. lambs weaned/no. joinings) were calculated for each ewe, giving one lifetime record per ewe.

The term genotype in these analyses represents bloodline (D-Flock), animals with the same proportion of genes from each bloodline (C-Flock) and selection line within bloodline (QPLU$).

Adjustments to lifetime net reproduction for genotype and year of birth were made using ASReml (Gilmour *et al.* 2002) and the residual values used to rank individuals. For each quartile of the distribution of adjusted lifetime net reproduction rate (NRR), the adjusted mean NRR and each of its component traits were estimated using ASReml (Gilmour *et al.* 2002), fitting the effects of genotype, year of birth and NRR quartile.

RESULTS

The mean reproductive performances for each of the component traits and NRR of each flock are shown for each of the performance quartiles in Table 1. Across flocks, the differences in NRR between each of the quartiles were of a similar magnitude. Within each flock, the mean NRR was significantly (P<0.001) different between each of the quartiles, with the difference between the lowest and highest quartiles being 0.99 (D-Flock), 1.03 (C-Flock), and 1.19 (QPLU$) lambs weaned annually.

Table 1. Lifetime reproductive performance and its components (adjusted for genotype and year of birth effects) for each quartile ranked on net reproduction of Merino ewes from three different flocks

		1st quartile	2nd quartile	3rd quartile	4th quartile	sed
Fertility	D-Flock	0.481 a	0.713 b	0.820 c	0.907 d	0.010
	C-Flock	0.652 a	0.857 b	0.928 c	0.975 d	0.011
	QPLU$	0.542 a	0.752 b	0.853 c	0.949 d	0.011
Fecundity	D-Flock	1.259 a	1.297 a	1.370 b	1.562 c	0.018
	C-Flock	1.262 a	1.301 a	1.413 b	1.647 c	0.019
	QPLU$	1.310 a	1.396 b	1.497 c	1.693 d	0.018
Survival	D-Flock	0.475 a	0.733 b	0.812 c	0.880 d	0.012
	C-Flock	0.530 a	0.773 b	0.849 c	0.914 d	0.013
	QPLU$	0.401 a	0.716 b	0.821 c	0.906 d	0.011
Net reproduction	D-Flock	0.251 a	0.629 b	0.875 c	1.244 d	0.008
	C-Flock	0.407 a	0.810 b	1.064 c	1.431 d	0.010
	QPLU$	0.246 a	0.689 b	1.002 c	1.433 d	0.008

abcd - means within rows with the same subscript are not significantly different (P>0.05)

The differences in both fertility and survival between each of the quartiles were significant (P<0.001) in each of the flocks. Over 90% of ewes within the highest performing quartile were fertile compared to only 48 to 65% within the lowest performing quartiles of each flock. Of the lambs born to ewes in the highest quartile, 88 to 91% survived compared with only 40 to 53% of lambs born to the poorest performing ewes, although the former had more than twice as many multiple births. In each of the flocks, twice as many ewes in the highest quartile had multiple births compared with the poorest performing ewes, and represented more than half the ewes lambing within the highest performing ewes.

DISCUSSION

Differences in net reproduction between the bottom and top quartiles of the order of 3.5-6.5 times demonstrate the large degree of variation between ewes over their lifetime in the reproductive performance within Merino flocks and that achievable reproduction rates by Merino ewes are much higher than current expectations based on whole flock means. Ewes from the highest quartile were each producing at least 1 lamb annually more than ewes from the bottom quartile, which on average only lambed every second year and when they did lamb only reared half of their lambs. The top ewes were also able to rear 90% of the lambs born despite having significantly more multiple births (55-69% of ewes lambing).

At least three opportunities are available to take advantage of the large within-flock variation to improve reproductive rates using strategies targeted at different segments of the breeding flock.

Firstly, the influence of the highly productive ewes can be increased by retaining them for an additional year or two beyond the normal cast-for-age. The ewes in the top NRR quartile in these flocks produced 41% of the lambs weaned and there may be production advantages in keeping these ewes to older ages. However, further information on the implications for other production traits of retaining these ewes for longer, and their capacity to continue reproducing (at levels higher than likely replacement ewes) at older ages will be required. This strategy would increase overall performance of the breeding flock through both their higher mean performance and the effect of their retention on flock structure, i.e. reducing the number maiden replacements required.

Secondly, remove ewes with low reproduction from the breeding flock. Only 8% of lambs were produced by the bottom quartile, so removing these ewes from the breeding flock at an early age can substantially improve the average reproductive performance of ewes within the selected age groups. The average reproductive rate of these ewes is so low that over the 5 breeding cycles they would not produce sufficient ewe lambs to replace themselves in the breeding flock. Regardless of their genetic merit in other production traits, removal of these animals from the breeding flock will have little effect on genetic progress in those traits. These ewes might be retained as wool producers, depending on their wool production potential. However, while removing these animals from the breeding flock will increase NRR of the ewes retained, the actual response achieved in the whole breeding flock will depend on (1) the age of culling, (2) the difference in NRR between the culls and replacement ewes and (3) the proportion of replacement maiden ewes.

Thirdly, target management interventions to those flock segments most likely to produce the largest economic responses. While management interventions at the whole flock level to increase average liveweight/condition at joining can have significant economic benefits (Young 2007) in some situations, in others they are economically marginal, even after accounting for flow-on benefits to dam and progeny wool production (Young 2008). Advocates of managing the whole flock to increase liveweight/body condition to improve conception rates and/or survival (Behrendt *et al.* 2006a) appear to assume (in the absence of data to the contrary) that all animals have an equal chance of responding to additional inputs. Little if any attention has been directed to within-flock variability in responses to improvements in, for example, liveweight/body condition. The exception is the management in late pregnancy of ewes based on litter size (Behrendt *et al.* 2006b), acknowledging the relative needs of twin-bearing and single-bearing ewes. Given the extent of variation presented, it appears likely that the requirement for management inputs, and the timing of those inputs, could vary between different segments. Differentially managing flock segments would direct inputs only to those segments with the greatest potential to respond, reducing the total inputs and costs. For example, responses among the poorest performing ewes may not be sufficient to cover input costs, while the highest performing ewes may already be close to attaining their potential. Additional research is required to test these hypotheses.

The second and third of these strategies require early prediction of ewe lifetime reproductive performance. An earlier report (Lee and Atkins 1996) based on D-Flock ewes suggested that reproductive performance in early life (2- or 3-years old) could predict reproductive performance in later life, although the accuracy of that prediction was increased if the information from the two years was combined. Subsequent analyses of C-Flock and QPLU$ data have confirmed those observations (G.J. Lee, K.D. Atkins and M.A. Sladek, unpublished data) indicating early identification would be feasible.

To obtain lifetime records for individual animals will require permanent individual identification, individual measurement and an appropriate system for recording data. The increasing use of electronic identification of ewes and on-farm scanning services has made the collection of information on individuals less labour intensive and reduced the costs (Pope and Atkins 2008). The availability of lifetime records can increase the accuracy of selection of young animals by including the dam's reproductive performance as a selection criterion in the index (Lee *et al.*, 2009).

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