Within-flock selection of ewes: opportunities for gains in reproduction

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ABSTRACT

The diversity of net reproduction rate (NRR) of ewes within a flock can be used to make selection decisions regarding which ewes to keep in the breeding flock and which to cull. The difference in NRR between ewes in the top 25% of the flock and those in the bottom 25% was equivalent to an additional lamb per ewe annually. The likely future potential NRR of a ewe can be reliably identified using her combined reproductive performance at 2 and 3 years of age. Early life fertility is indicative of both the fertility and rearing ability of ewes in later life. Two within-flock ewe selection strategies can be used to improve the reproductive performance of Merino ewes in the current generation, culling poor performers early and keep productive ewes for longer in the flock. Within-flock variation in NRR indicates that the bottom 25% of ewes produce only 8% of lambs weaned in a flock while the top 25% weaned 41%. However the extent to which the NRR of the flock is improved will depend on the proportion of maidens in the flock and the difference in NRR between the culled adult ewes and that of the replacement maidens. These strategies have the potential to increase NRR by 15% over 10 years from 75% to 90%. Gain in NRR of this magnitude can be worth $8.20 per ewe on its own or $12.60/ewe where fleece weight and fibre diameter are used in an index to select replacement ewes.

INTRODUCTION

Net reproduction rate (NRR) or the number of lambs weaned per ewe joined is a composite trait influenced by many interdependent components (Snowder and Fogarty 2009) and can be a major driver of on-farm profitability particularly when prices paid for lamb and surplus sheep are high. Each of the major component traits (fertility - number of ewes lambing /ewes joined; fecundity - number of lambs born/ ewe lambing; lamb survival - number of lambs weaned/lambs born) are influenced by genetics but the heritabilities of each are very low (Safari *et al.* 2007). A selection program can lead to permanent, albeit slow, genetic improvement in reproduction. However both the variability of NRR (Safari *et al.* 2007) and repeatability of the 3 component traits are high (Lee and Atkins 1996) which indicates that within-flock selection of ewes can be used to complement genetic gains from a selection program. The challenge for commercial producers is to determine how to best use available information to establish the potential NRR of their flock and efficiently identify those ewes to keep in the breeding flock and which to cull.

RESULTS

Within flock variation in NRR and its components

Lee *et al.* (2009b) quantified the large degree of diversity of NRR within 3 flocks of Merino ewes. Based on their lifetime reproductive performance, 94% of ewes ranked in the top 25% were fertile each year, with both high fecundity (55 - 69% of ewes lambing carried twins) and high lamb survival (Table 1). In comparison, the bottom 25% of ewes were 40% less fertile, 35% less fecund with 43% fewer lambs weaned. The difference in NRR between the top and bottom 25% of ewes was equivalent to an additional lamb per ewe annually. This variation in reproduction was not related to the pre-joining liveweight and condition score of the ewes as there was only 0.4 kg and 0.1 score difference between the lowest 25% and the top 25% (Lee *et al.* 2009b). However there was a low, but significant positive correlation (0.11-0.18) with weaner/hogget liveweight connecting early growth with lifetime NRR.

Table 1. The average predicted lifetime reproductive performance of 3 resource flocks, and its components, for each quartile ranked on net reproduction of Merino ewes with the average s.e.d.*

	Flock Average	Lifetime reproduction ranking Lowest 25%	2nd quartile	3rd quartile	Top 25%	Average s.e.d
Fertility[1]	0.78	0.56	0.77	0.87	0.94	0.01
Fecundity[2]	1.42	1.28	1.33	1.43	1.63	0.02
Lamb survival[3]	0.73	0.47	0.74	0.83	0.90	0.01
Net reproduction rate[4]	0.84	0.30	0.71	0.98	1.37	0.01

* Adapted from (Lee *et al.* 2009b) [1] no. of ewes lambing/ewes joined; [2] no. lambs born/ewe lambing; [3] no. lambs weaned/lambs born; [4] no. lambs weaned/ewe joined

Early life reproduction and potential lifetime NRR

There is a strong association between the combined reproductive performance at 2 and 3 years of age (i.e. maiden and 4-tooth) and later reproductive performance. Fertility in early life is indicative of both the fertility and rearing ability of ewes in later life. 'Twice-dry' ewes had significantly lower fertility, fecundity and lamb survival than ewes that lambed either once or twice at 2 and 3 years of age (Lee and Atkins 1996). Similarly there are significant relationships between weaning performance at 2 and 3 years of age and NRR and each of its component traits. Ewes that 'twice-rear' will have a high future NRR while ewes that 'once-rear' will have a future NRR closer to 'twice-rear' ewes than 'twice-dry ewes' (Lee and Atkins 1996). These findings have recently been confirmed in other resource flocks.

Genetic variation in lifetime NRR

Heritability estimates for each of the lifetime NRR component traits (fertility, fecundity and survival) ranged from 0.11 to 0.19 (Lee *et al.* 2009a) and were higher than those previously published based on single year records. Furthermore each of the lifetime component traits had high positive genetic correlations (≥ 0.55) with lifetime NRR.

Selection strategies to improve current generation NRR

NRR in the current generation can be improved using a combination of two strategies based on within-flock ewe selection. Firstly, culling ewes that were dry at both 2 and 3 years of age or culling ewes failing to rear any lambs at their first 2 opportunities will achieve close to the maximum response in NRR of the entire breeding flock (Lee and Atkins 1996). Culling poor performers in early life will have minimal impact on the age structure of the flock and the number of surplus progeny (Table 2). Secondly extending the reproductive life of ewes with high NRR (for an additional 1 or 2 years) will achieve higher rates of improvement in whole flock performance due to fewer numbers of maiden ewes begin required as replacements. If both strategies are used the response is additive.

Table 2. Net reproductive rate of selected ewes at four – six years of age and of the entire breeding flock following selection based on two years of early reproductive performance.*

Strategy	Breeding ewes culled (%)	Flock structure (years) 2	3	4-6	Net reproduction rate Selected ewes	All breeding ewes	Ewe progeny surplus to breeding flock
No culling	0	0.20	0.20	0.60	0.81	0.75	0.17
Cull dry/failed at least once	62	0.32	0.32	0.36	0.94	0.76	0.06
Cull dry at least once	47	0.29	0.29	0.42	0.91	0.76	0.09
Cull twice dry/fail	23	0.23	0.23	0.54	0.88	0.78	0.16
Cull twice- dry	12	0.22	0.22	0.56	0.86	0.77	0.17

* Adapted from (Lee and Atkins 1996)

Estimated economic effect of improving NRR

A combination of ewe lifetime selection (cull poor performers and keep high performers an additional 1-2 years) and genetic improvement (select rams using ASBVs for reproduction) can increase NRR from 75 to 90 % (i.e. +15%). Simulations using the Smart Merino (V1.3) software were based on a flock of 2,000 breeding ewes with 5 age groups and a base NRR of 75%. The base flock ewes cut 6 kg (greasy) of 20.5 µm wool with an adult liveweight of 52 kg. Replacements were selected using a Merino DP7% index that uses a 7% micron

premium plus high liveweight reproduction emphasis. Five year average wool market prices (2002-2007) and meat value for sale animals of $45 for a 45kg animal were applied. The economic value of increased NRR to 82% in 5 years and 90% in 10 years was estimated under 2 scenarios: i) no effective wool selection and ii) fleece weight and fibre diameter used in an index to select replacement breeding ewes (Table 3). Economic responses due to NRR and selection for wool can increase profit separately but the NRR response will provide greater selection intensities and complement the selection response.

DISCUSSION

Early identification of poor performers and retention of ewes in the breeding flock with high NRR is an effective means of making current generation gains in reproduction. The within flock variation in NRR identified by Lee *et al.* (2009b) suggests that achievable reproduction rates by Merino ewes are much higher than current expectations based on whole flock means. This finding along with the fact that reproductive performance across years is not a random event but a repeatable source of variation within ewes (Lee and Atkins 1996) provides the foundation for within-flock selection of ewes to improve NRR. The bottom 25% of ewes in the breeding flock typically produce only 8% of the total lambs and culling these ewes from the breeding flock as soon as they can be reliably identified can improve the average NRR of the 'selected' flock by nearly 20% (Lee *et al.* 2009b). However, the extent to which NRR of the whole breeding flock is improved will depend upon the proportion of maidens in the flock and the difference in NRR between the culled ewes' adult performance and that of the replacement maidens as maiden ewes have relatively poor reproductive performance. Increasing number of age groups in the breeding flock by retaining the top performers for an additional 1 to 2 lambings will reduce the proportion of maidens in the flock and increase both the selection intensity applied to the maidens and the number of high value young surplus sheep available for sale. Simulations of the estimated economic effect indicate an increase in NRR of 15% would be worth $25,200 for a flock of 2,000 breeding ewes (+$12.60 GM/ewe) due to the flock having an increased wool cut and weight of animals available for sale.

Reproductive performance at 2 and 3 years of age can be easily determined using information from pregnancy scanning and assessing udders of ewes at marking or weaning. Pregnancy scanning will provide data on both fertility and fecundity while udder assessment, indicating lamb survival, will identify those ewes who reared their lamb/s. A recent national survey of Merino sheep producers found that 32% scanned their ewe flocks for pregnancy status and 56% assessed both maiden and adult ewes at marking or weaning for reproductive performance (Curnow et al. unpublished data). Furthermore producers were actively using this information in their management decisions. However the survey indicated that maiden ewes were generally given a second chance to fall pregnant the following joining while adult ewes tended to be culled from the breeding flock on the basis of being dry once. Based on the findings of Lee and Atkins (1996) this current common decision process is clearly inefficient as it can lead to a high proportion (47 - 62%) of ewes being culled from the breeding flock solely on the basis of reproduction (Table 2) with fewer ewes being available for culling to achieve improvement in other production traits. Combining information from early reproductive performance (ie at 2 *and* 3 years of age) requires accurate identification and matching of individual ewes with their pregnancy scanning and udder assessment information. This can easily be achieved on farm using a variety of strategies ranging from the very simple (i.e. ear notches or coloured tags denoting, dry, single or twin at scanning and 'lambed and lost' at udder assessment) to more complex (i.e. manually recording numbered tags or full RFID).

CONCLUSION

Ewe lifetime selection involves using scanning information to cull low performing ewes and extend the life of high performing ewes in the breeding flock. Used in combination with genetic improvement, NRR of a flock can be increased by 15% in 10 years with an estimated economic effect of +$12.60 gross margin/ewe.

KEY WORDS

within-flock ewe lifetime selection, Merino ewes, net reproduction rate, fertility, fecundity, lamb survival

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