FLUCTUATION IN EWE LIVEWEIGHT DURING PERIODS OF RESTRICTED NUTRITION IS INFLUENCED BY SIRE

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SUMMARY

The ability to maintain weight during adverse seasons is an important characteristic in mature ewes. Ewes that lose less weight will be in better condition at mating and throughout pregnancy resulting in higher fertility, fecundity and lamb survival, and lower ewe mortality. Liveweight data (corrected for greasy fleece and conceptus weights) from mature Merino ewes was analysed to determine factors implicated in differences in liveweight loss during summer, autumn or winter. Liveweight loss during these periods was affected by differences between site ($P<0.001$) and age of the ewe ($P<0.001$). There were also significant ($P<0.01$) differences between sires within breed in the weight fluctuation of their daughters during periods of nutritional restriction. Liveweight change over summer, autumn or winter was not affected by previous reproductive performance, and liveweight change did not affect the subsequent reproductive performance of ewes. These findings indicate it is possible to select ewes more resilient to liveweight loss during periods of limited feed availability without necessarily affecting reproductive performance.

INTRODUCTION

Merino ewes continue to dominate the national flock, accounting for 89% of adult ewes (Curtis 2009), and are the backbone of the Australian wool and sheep meat industry. The energy costs to maintain breeding ewes and their replacements represent between 60 and 75% of the total energy requirements for most flocks (Coop 1961; Fogarty *et al*. 2003). Improving the efficiency of energy use of these ewes is likely to improve the profitability of sheep enterprises in two ways. Firstly it could enable farmers to maintain higher stocking rates, and secondly it could reduce the feed costs during summer and autumn when much of the energy for maintenance is provided by grain or forage supplements (Young *et al*. 2011). Young *et al*. (2011) also suggest that the economic value of improving resilience to liveweight loss may be greater for Merino based production systems with a focus on lamb production and poorer pastures.

Resilience indicates an animal's ability to maintain a stable body environment through responsiveness to a broad range of external environmental factors (Veerkamp *et al*. 2009), and there appear to be genetic differences in the innate ability of some ewes to maintain liveweight when nutrition is limited. Adams *et al*. (2002) found that a heavier strain of Merino wethers lost less liveweight when grazed on dry, poor quality pastures over summer. Rose *et al*. (2011) also reports that liveweight change over summer-autumn is moderately heritable in Merinos based on an analysis of the Merino Resource flocks in Western Australia (Greeff and Cox 2006). More needs to be known about the potential size of the genetic difference in resilience to liveweight loss between animals from different flocks, across breeds, and how this trait relates to production traits. Ewes that are more resilient to liveweight loss could be heavier at joining and through pregnancy and this would be expected to have beneficial effects on reproductive performance (Oldham *et al*. 2011). In this paper we hypothesise that genetic variation in resilience to liveweight loss will be evident between sires used in flocks across Australia.

MATERIALS AND METHODS

The Information Nucleus flock comprises eight flocks located at different sites across Australia, and from 2007 to 2011 about 4000 Merino and Maternal ewes were mated each year to 100 industry sires. A full description of the Information Nucleus Flock is provided by van der Werf *et al*. (2010). In this paper we used data for 1036 Merino and Border Leicester x Merino ewes born in 2007 at six of the sites. These ewes were weighed at regular intervals throughout their life resulting in 19,416 liveweight records from their birth, to lamb weaning in 2010. The average number of weight measurements per ewe was 18.7. Liveweights were corrected for a) wool weight, calculated from greasy fleece weights and assuming constant wool growth rates during the year; and b) conceptus weight calculated using equations from the GRAZPLAN model (Freer *et al*. 1997). All ewes had extensive data collected for existing and new traits in meat and wool, parasite resistance and reproductive performance. Forty one sires were included in the analysis, after excluding sires that only had progeny at a single site.

This paper focuses on the changes in ewe liveweight that occurred during late summer, autumn or winter depending on the site. Supplementary feeding practices and food on offer differed between the sites according to season and year, but on average flocks at all sites lost weight over the period examined. The average age of ewes at the start of the period of liveweight loss was 572 in their first reproductive cycle and 903 days in their second reproductive cycle. At Cowra in NSW, Rutherglen in VIC, Struan and Turretfield in SA and Katanning in WA, the period of liveweight loss occurred prior to and during joining in summer/autumn. At Armidale in NSW the period of liveweight loss occurred during winter after joining. On average, the period of liveweight loss was 59 days. We expressed the liveweight loss trait in terms of kilograms of weight loss and as a percentage of average weight during the reproductive year (joining to joining).

Liveweight change was analysed using a linear mixed effects model in SAS (SAS Institute, Cary, NC) with fixed effects for site, ewe birth type and rear type, age of ewe, previous reproductive status of the ewe (birth type and rear type), ewe breed and sire within ewe breed. Individual identification and dam were included as random effects. All first and second order interactions were included in the starting model and non-significant terms ($P>0.05$) were removed in a stepwise process. In separate analyses a range of covariates were included in the starting model to test their effects on liveweight change. These were: estimated breeding values (calculated on within flock analysis) for weight, fat depth and eye muscle; and the total weight of lamb weaned per ewe previous to the liveweight loss. Birth type, rear type and total weight of lamb weaned were also analysed using linear mixed effects models before adding liveweight change as a covariate to examine the effect of liveweight loss on subsequent reproductive performance.

RESULTS

The magnitude of liveweight loss during summer, autumn or winter differed significantly between sites ($P<0.001$). Sire within breed had a significant effect ($P<0.01$) on liveweight loss and the range between sire groups was -5.0% to 4.8% for ewes sired by Merinos and -5.6% to 0.1% for ewes sired by Border Leicesters (Figure 1). Liveweight loss was also affected by ewe age ($P<0.001$), with three year old ewes losing 6.3% of their average bodyweight and two year old ewes losing 7.6%. Interactions between site and age of ewe ($P<0.001$) and site by breed ($P<0.001$) were also significant.

Estimated Breeding Values of ewe progeny had significant ($P<0.01$) but small effects on their liveweight loss over summer, autumn or winter. Across the range of breeding values for yearling weight in this analysis (-13.7 to 9.5kg) there was a predicted reduction in liveweight loss of 2.05kg for the average ewe which weighed 55kg.

The impact of liveweight loss on subsequent reproductive performance indicated no significant effects on number of lambs born, number of lambs weaned or total weight of lambs weaned. Similarly, there was no carry over effect from previous birth type or rear type of ewes on weight loss during the subsequent summer, autumn or winter (Figure 2).

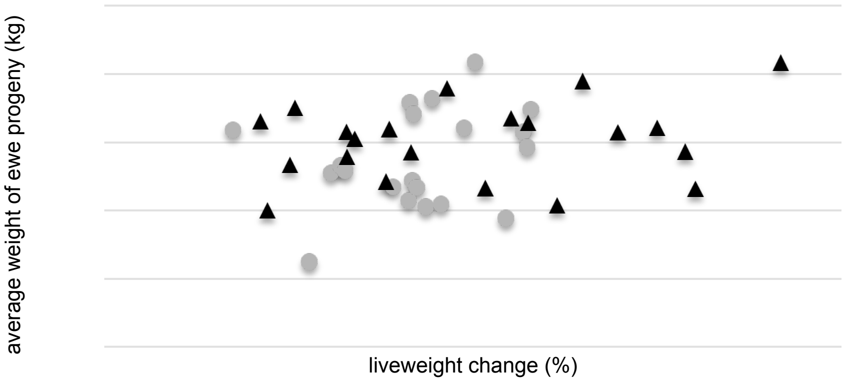

Figure 1. Relationship between the predicted liveweight change (%) during summer, autumn or winter and average weight (kg) of ewe progeny from Merino ewes sired by Merinos (□) or Border Leicesters (□). The data represent the average for ewe progeny grazed at six INF sites across Southern Australia over two years.

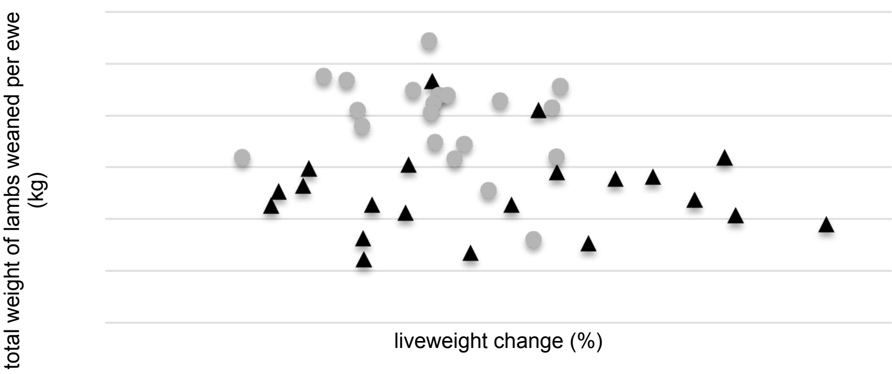

Figure 2. Relationship between predicted liveweight change (%,) and total weight of lamb weaned (kg) for ewe progeny from Merino ewes sired by Merinos (□) or Border Leicesters (□). The data represent the average for ewe progeny grazed at six INF sites across Southern Australia over two years.

DISCUSSION

The results in this paper indicate large sire effects on the liveweight loss of their ewe progeny during summer, autumn or winter and this aligns well with our original hypothesis. Together with the heritability estimates for this trait reported by Rose *et al*. (2011), it should therefore be possible to breed sheep for reduced liveweight loss during times of restricted nutrition. Furthermore, there was no effect of previous reproductive performance on liveweight change during summer, autumn or winter and no effect of liveweight change during these periods on subsequent reproductive performance. Rauw *et al*. (2010) also reported no effects of ewe liveweight change on the weight of lambs weaned.

The ability to select ewes that are more resilient to nutritional restriction is of economic and ethical relevance. A ewe that is reproductively capable and is adaptable to variation in available nutrition will allow greater returns through reduced requirements for supplementary feeding, or through increased stocking rates (Young *et al*. 2011). In addition, ewes that are more adaptive to change are more likely to thrive and reproduce in increasingly uncertain farming conditions with ongoing benefits for animal welfare.

Two year old ewes had proportionately greater liveweight loss than three year old ewes. This aligns well with previous work by Rose et al (2010) and may suggest that ewes from these age groups require differential management to optimise performance.

It appears that it is possible to select ewes that are more resilient to limited feed availability without necessarily affecting production traits such as the total weight of lambs weaned per ewe. However, the trait is poorly understood and while the biology underpinning genetic differences in resilience is not known it will be linked to differences in rumen function and physiological drivers of appetite and efficiency of feed use from poor quality diets, and is currently under investigation.

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