Unpublished Report

Document ID:	SheepCRC_2_89
Title:	Benefits of retaining older ewes
Author:	Lee, G.J.; Sladek, M.A.
Key words:	sheep; older ewes; within flock; selection

Project 1.2 Reproduction efficiency

Milestone: Develop better information and tools for improving reproduction efficiency

G.J. Lee and M.A. Sladek

New South Wales Department of Primary Industries, Orange

Task R2.1.4.5: Complete study on benefits of retaining older ewes

Due Date 30/5/2011

Introduction

A combination of factors including seasonal conditions and relatively high meat prices compared to wool saw the size of the national flock in 2008 halved since 1990, and reduced by 30% since 2000 (ABARE 2008). A further 10% reduction has since occurred, the national flock now numbers just 72 million (Meat and Livestock Australia 2009). Of particular importance to the Merino wool industry is the increasing number of Merino ewes being joined to terminal sires (Curtis 2009), which can jeopardize the future sustainability of Merino breeding flocks and ultimately the size of the national clip, and eventually the prime lamb industry. A further threat to the ability to rebuild flock numbers is the low reproductive performance across the Australian sheep industry relative to world standards (Scaramuzzi 1988), with very little improvement in the last 30 years, during which an average of 76% of lambs were marked per ewe joined (ABARE 2008).

Reproductive performance of maiden ewes is characterized by below flock average fertility, fecundity and lamb survival. Reproductive performance then increases with age until 5 or 6 year-old. Flocks with fewer age groups will have a higher proportion of maidens. Retaining older ewes in the flock beyond the normal culling age would increase the number of ewes available for breeding. Retaining only the more productive older ewes would have the following advantages:

- preserve ewe numbers in a rapidly depleting national flock,
- provide higher reproduction rate across the whole flock through both proportionately fewer maidens in the breeding flock and the high reproductive performance of those older ewes retained,
- increase the potential for selection (higher selection intensity) to improve current flock performance (wool and/or reproduction) despite declining production with age, with spill-over genetic improvement into future generations,
- more surplus females being sold at a younger age for higher mutton returns,
- reduce greenhouse gas emission intensity.

Improvements can be achieved, in both the current generation and genetically, through selection based on early reproductive performance within the selected age groups. However the performance of the whole flock is diluted by the presence of a higher proportion of unselected ewes (particularly the maidens) that are required to maintain breeding flock numbers. Increasing the number of age groups would reduce the proportion of maidens in the breeding flock. Rapid improvement requires a high selection differential, which in turn further increases the proportion of maidens.

Currently within the Merino industry, maiden ewes are joined to lamb at 2 year-old, and the entire drop cast for age after 4 or 5 annual joinings. With current trends in technology and management towards targeted management of individuals/sub-groups, identifying more productive individuals to retain in the flock has become a priority.

Although the theoretical potential benefits of retaining older, more productive ewes from known, but limited, information in the literature have been established, a number of assumptions were needed. It is well known that reproductive performance and production traits, such as clean fleece weight, are negatively correlated (Lee and Atkins 1995). However,

there is no known rigorous study of possible effects of an interaction between reproductive performance and age on production traits.

As indicated by Lee *et al.* (2009), further information on the implications for other production traits of retaining ewes with a high reproductive performance for longer, and their capacity to continue reproducing (at levels higher than likely replacement ewes) at older ages will be required. Evidence from other (undomesticated/semidomesticated) ungulate species suggests that females with a high lifetime reproductive performance have greater longevity and lower reproductive costs than their less productive cohorts (Clutton-Brock *et al.* 1996; Hamel *et al.* 2009; Weladji *et al.* 2008).

Lifetime net reproductive performance has a strong genetic relationship with each of the component traits, and has a relatively high realisable heritability (compared with annual measures of net reproduction or the component traits). To use that trait both the birth and rearing status of lambs is required. It is technically possible to record reproductive performance of individual ewes (by both scanning and the use of Pedigree Matchmaker), but there is a need to demonstrate the on-farm feasibility of the collection of all these data and the best way of utilising it to improve reproductive performance of the breeding flock.

Collection of a second year's data will allow an estimated of any interactions between reproductive performance and age on productive traits.

Objective

To determine the effects of reproductive performance and age, together with any interaction, on the relative productivity (wool production and quality) of older ewes (within the normal range of ages used commercially).

Design and methodology

Two sites were established on commercial wool producing properties in 2009: one on the South-West Slopes of NSW and the other on the Central West Plains of NSW. (Sheep CRC abandoned 2 additional sites in Victoria and Queensland prior to full establishment.)

At each property, 3 ewe age groups (3-5 yr) were measured in the initial year, and measurements on these same ewes continued for a second year, retaining 6 year-old ewes in the breeding flock. Liveweights and condition/fat scores were monitored over the annual reproductive cycle with pregnancy rates determined using commercial scanners, and lamb survival and dam/offspring associations recorded using Pedigree Matchmaker (Richards and Atkins 2007). In 2010, only a minority of ewes passed through the Pedigree Matchmaker system at the South-West Slopes site, primarily associated with seasonal conditions. Also in 2010, the Central West Plains site was inundated by floodwaters prior to weaning and shearing.

At shearing, individual fleece weights were recorded and midside samples collected for measurement of yield, fibre diameter, staple strength and staple length by the Australian Wool Testing Authority.

Statistical analyses

All statistical analyses were conducted using ASReml (Gilmour *et al.* 2006). The reproductive component traits and net reproduction were each analysed fitting age, property and year as fixed effects together with their first order interactions, with animal and birth-year/property cohort fitted as random effects. Non-significant terms were sequentially removed from the model.

Production traits were similarly analysed with the inclusion of scanning status (dry, single- or multiple-bearing ewes) and its first order interactions with other main effects. Non-significant terms were sequentially removed from the model.

To further determine whether ewes with a higher longer-term reproductive capacity differed in their productive capabilities, the total number of lambs conceived over the 2 years was also included in the model to test whether it added any further information beyond that of effects due to reproductive performance in the current year alone.

Results

Reproductive performances

The percentage of ewes within each age group that were scanned as dry, single lamb or multiple lambs is shown in Table 1.

The interaction between property and year for fertility was significant (P<0.05), such that on the South-West Slopes fertility was similar between years (89.2% and 88.3%), but higher in year 2 on the Central West Plains (85.3 and 90.8%, in years 1 and 2 respectively). Overall, there was no significant main effect due to age, year or property on conception rate (P>0.05).

Fecundity (lambs/100 pregnancies) increased with age (P<0.001), being 9.3 ± 3.7, 14.3 ± 3.9 and 21.6 ± 5.2 more lambs in 4, 5 and 6 year-old ewes, respectively, more than 3 year-old ewes. In year 2, fecundity was 13.2 ± 2.9 lambs/100 pregnancies higher (P<0.001) than in year 1. Fecundity tended to be higher on the Central West Plains property (P=0.061).

Table 1 Effects of age on fertility and fecundity (expressed as a proportion of ewes joined at each age) of flocks of Merino ewes on the South-West Slopes and Central-West Plains of NSW.

	Age	Year 1			Year 2		
Scanning:		Dry	1	Multiples	Dry	1	Multiples
				South-West Slopes			
	3	0.117	0.543	0.340	na	na	na
	4	0.103	0.484	0.381	0.105	0.320	0.575
	5	0.100	0.420	0.480	0.142	0.304	0.554
	6	na	na	na	0.103	0.368	0.655
				Central-West Plains			
	3	0.142	0.480	0.378	na	na	na
	4	0.162	0.399	0.439	0.058	0.319	0.623
	5	0.136	0.331	0.532	0.118	0.291	0.591
	6	na	na	na	0.111	0.200	0.689

Fat scores

At scanning across both years and sites, fat scores (Table 2) of multiple-bearing ewes tended to be higher than that of single-bearing ewes, who were higher than dry ewes (P=0.12). The effect of age on fat score differed between the properties such that older ewes at the Central West Plains site were lower in condition. At the South-West Slopes site there was an increase or little difference in fat scores with increasing age.

Table 2 Predicted mean fat score by pregnancy status at scanning for each age group from flocks on the South-West Slopes and Central-West Plains of NSW

	Year 1			Year 2		
Age	Dry	Single	Twins	Dry	Single	Twins
			South-West Slopes			
3	3.05	3.09	3.13	na	na	na
4	3.23	3.26	3.30	3.39	3.42	3.47
5	3.24	3.27	3.32	3.40	3.43	3.48
6	na	na	na	3.32	3.35	3.40
			Central-West Plains			
3	3.33	3.36	3.40	na	na	na
4	3.39	3.43	3.47	3.36	3.39	3.44
5	3.12	3.16	3.20	3.09	3.12	3.17
6	na	na	na	2.71	2.74	2.79

Immediately after weaning, ewes that had borne a lamb(s) were lower in body condition than dry ewes (P<001), with single-bearing ewes in a little better condition than those that had

borne multiple lambs (Table 3). The effects of pregnancy status were greater in year than year 2 (P<0.001). Although fat scores tended to decline with increasing age this effect was small and not significant (P=0.09).

Table 3 Predicted mean post-weaning fat score by pregnancy status for each age group from flocks on the South-West Slopes and Central-West Plains of NSW

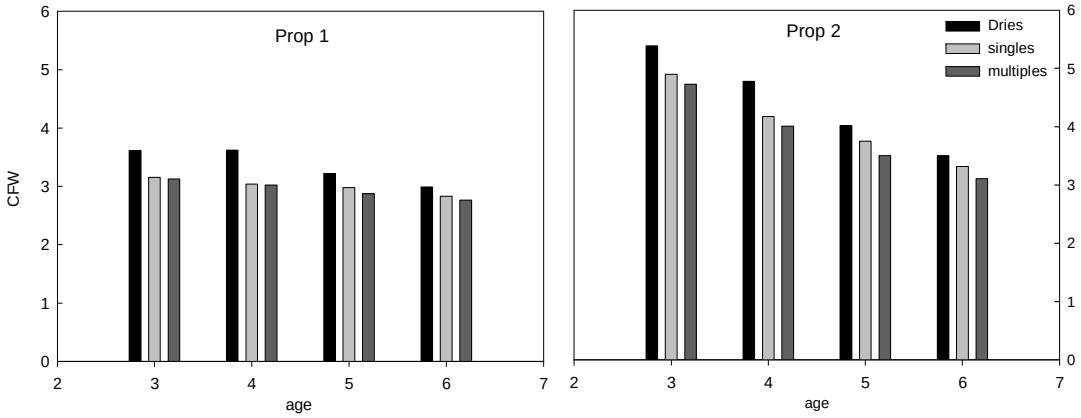
	Year 1			Year 2		
Age	Dry	Single	Twins	Dry	Single	Twins
			South-West Slopes			
3	4.14	3.21	2.93	na	na	na
4	4.13	3.20	2.92	3.80	3.22	3.08
5	4.02	3.08	2.81	3.69	3.10	2.97
6	na	na	na	3.64	3.06	2.92
			Central-West Plains			
3	4.13	3.20	2.92	na	na	na
4	4.12	3.19	2.91	3.53	2.94	2.80
5	4.01	3.07	2.79	3.41	2.83	2.69
6	na	na	na	3.37	2.78	2.64

Fleece traits

Fleece weight. The main effects for property, age and scanning status, together with their first-order interactions each significantly (P<0.05) influenced clean fleece weight (Table 4). Fleece weights were lower at the South-West Slopes site, as was the magnitude of the negative effects of both age and scanning status (Figure 1). However, the magnitude of effects of scanning status (pregnancy and the number of lambs carried) declined with age (P<0.05).

The effect of year on clean fleece weight was not significant (P>0.05).

Figure 1 Predicted clean fleece weights (kg) by age and pregnancy status of Merino ewes on the South-West Slopes (Prop 1) or Central-West Plains (Prop 2).



Fibre diameter. Overall, the fibre diameters (Table 4) of ewes on the South-West Slopes tended to increase with age, while on the Central-West Plains the trend was reversed (P<0.001). The scanning status effects were greater in ewes at the South-West Slopes site (P<0.001), these ewes were also much finer overall (4.88 ± 0.20 µm, P<0.001). The magnitude of age effects differed between years, particularly on the South-West Slopes (Figure 2).

Fibre diameter was the only fleece trait for which the total number of lambs conceived over 2 years and the current year's reproductive performance were both significant. Ewes that carried 2-4 lambs over the years were 0.24-0.50 µm finer than ewes conceiving only 1 lamb and 0.60-0.87 µm finer than ewes dry in both years.

Table 4 Predicted mean fleece characteristics as affected by scanning performance, age and year in Merino ewes at two sites in NSW

	Age	Year 1			Year 2		
Scanning:		Dry	1	Multiple	Dry	1	Multiple
				South-West Slopes			
Clean fleece wt	3	3.61	3.15	3.13	na	na	na
(kg)	4	3.62	3.05	3.03	3.61	3.03	3.02
	5	3.23	2.98	2.88	3.22	2.97	2.87
	6	na	na	na	3.00	2.84	2.77
Fibre diameter	3	17.62	17.15	17.05	na	na	na
(µm)	4	17.98	17.51	17.42	18.11	17.64	17.54
	5	17.85	17.38	17.29	18.53	18.06	17.96
	6	na	na	na	18.53	18.06	17.96
Staple strength	3	45.79	44.74	42.42	na	na	na
(N/ktex)	4	44.30	44.45	43.82	41.12	41.28	40.64
	5	40.60	44.66	43.00	37.42	41.48	39.83
	6	na	na	na	41.61	44.36	39.92
Staple length	3	96.01	91.19	90.57	na	na	na
(mm)	4	89.69	84.86	84.25	91.25	86.43	85.81
	5	86.98	82.15	81.53	88.54	83.72	83.10
	6	na	na	na	87.05	82.23	81.61
				Central-West Plains			
Clean fleece wt	3	5.38	4.89	4.72	na	na	na
(kg)	4	4.78	4.18	4.02	4.76	4.16	4.00
	5	4.03	3.76	3.51	4.01	3.74	3.50
	6	na	na	na	3.51	3.32	3.11
Fibre diameter	3	22.49	22.55	22.33	na	na	na
(µm)	4	22.67	22.73	22.51	22.79	22.85	22.63
	5	21.84	21.90	21.68	22.52	22.58	22.36
	6	na	na	na	21.44	21.50	21.28
Staple strength	3	42.10	38.30	29.51	na	na	na
(N/ktex)	4	38.69	36.10	29.00	45.52	42.94	35.83
	5	33.64	34.96	26.83	40.47	41.79	33.67
	6	na	na	na	40.62	40.63	29.72
Staple length	3	105.97	103.68	105.00	na	na	na
(mm)	4	99.65	97.35	98.68	90.35	88.05	89.38
	5	96.93	94.64	95.96	87.63	85.34	86.66
	6	na	na	na	86.14	83.85	85.17

Figure 2 Predicted fibre diameter (µm) by age and pregnancy status of Merino ewes on the South-West Slopes (Prop 1) or Central-West Plains (Prop 2), in each of 2 years.

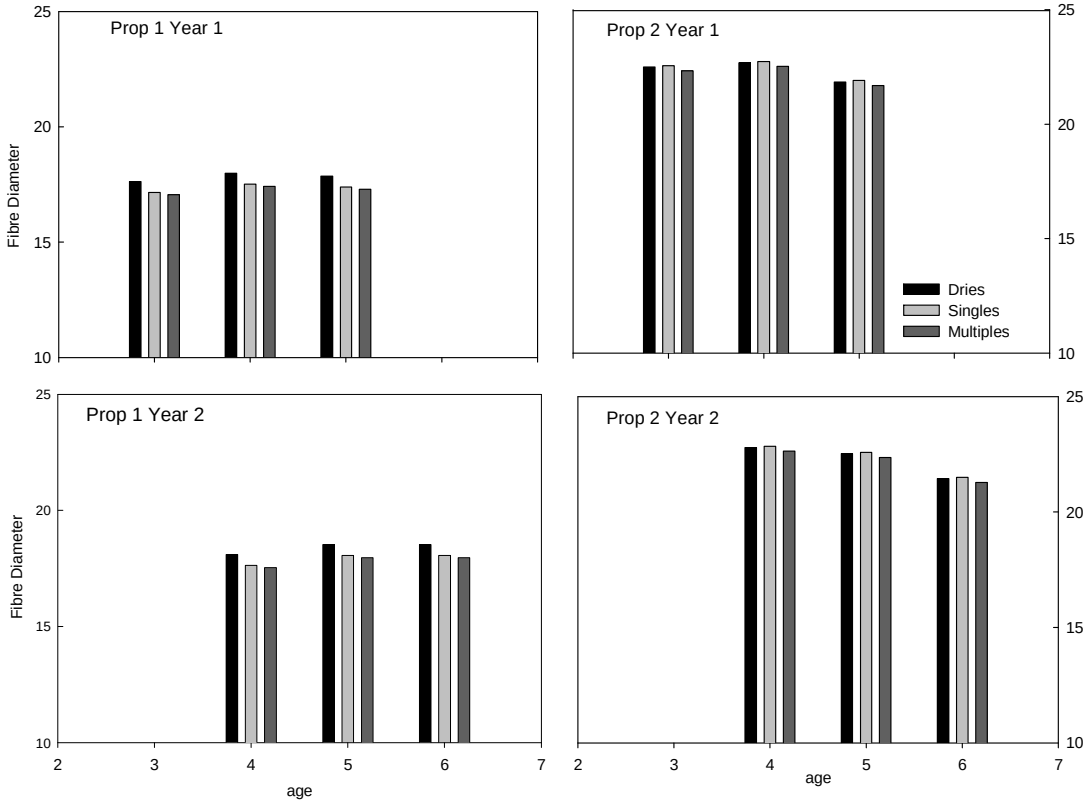
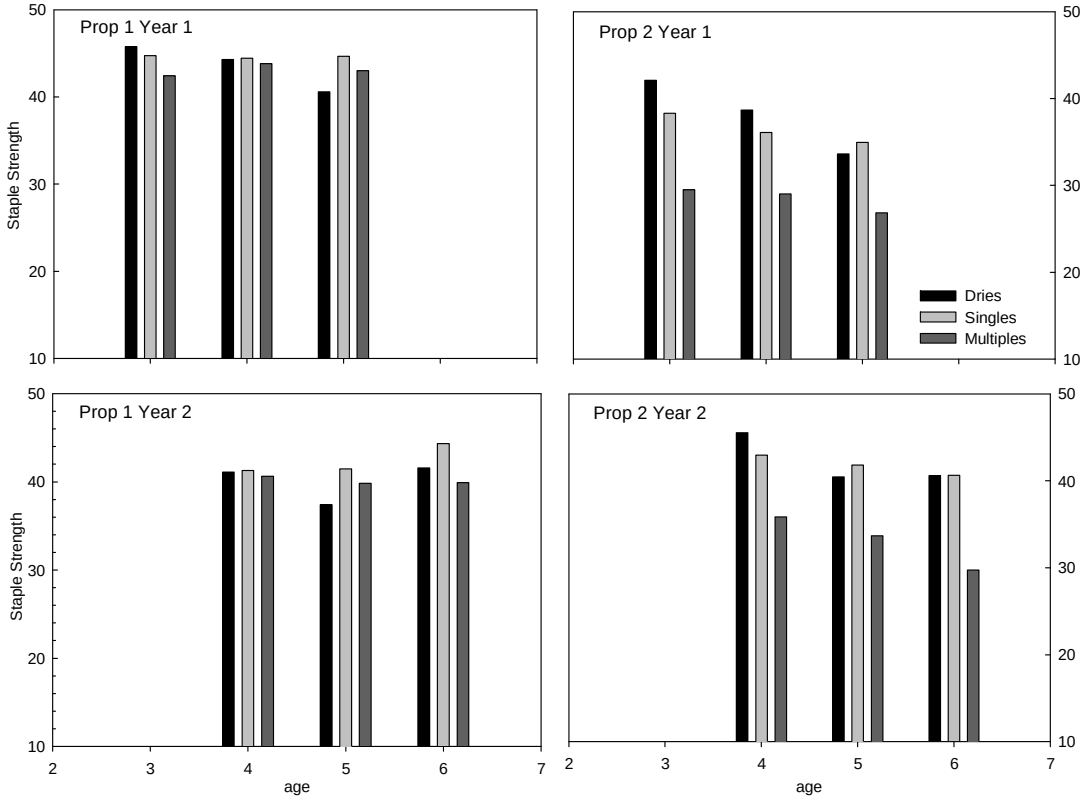


Figure 3 Predicted staple strength (N/ktex) by age and pregnancy status of Merino ewes on the South-West Slopes (Prop 1) or Central-West Plains (Prop 2), in each of 2 years.



Staple strength. Means for the fleece traits measured in each of the scanning and rearing categories are shown for the Central-West Plains site in Table 4.

Property (P<0.001), scanning (P<0.001), year (P<0.05) and age (P<0.05) main effects all had significant effects on staple strength.

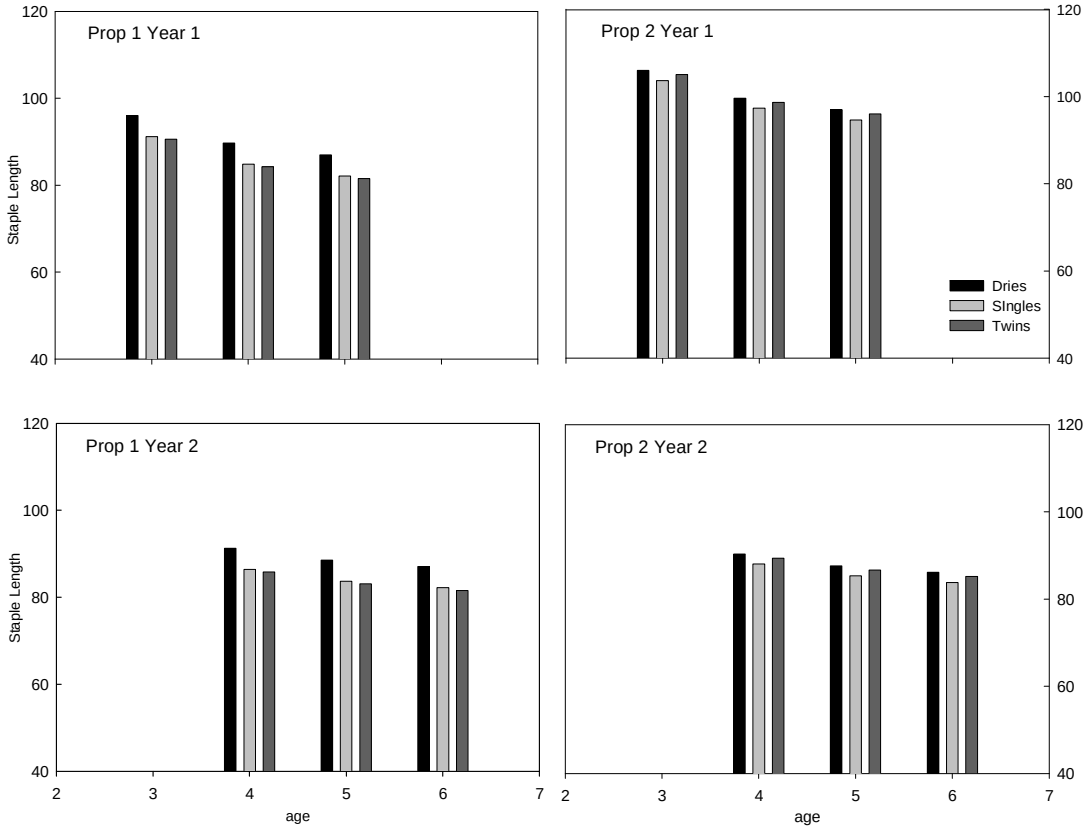
Year effects on staple strength were evident but the magnitude of year effects differed between the sites (P<0.001). At the South-West Slopes site staple strengths were higher in year 1, while at the Central-West Plains site staple strengths were higher in year 2.

The effects of both scanning status (P<0.001) and age (P<0.05) also differed between the sites. Scanning effects were greater at the Central-West Plains site, particularly for multiple-bearing ewes which were significantly weaker than both dry and single bearing ewes. The effect of age (a trend to decline with age) was also greater, and more consistent, in ewes at the Central-West Plains site (Figure 3).

The interaction of age and scanning status approached significance (P=0.058). The magnitude of scanning status effects tended to decline with age, and in 5- and 6-year-old ewes the staple strength of single bearing ewes was similar or greater than that of dry ewes.

Staple length. In general terms, the staple lengths (Table 3) of fleeces of single- and multiple-bearing ewes were shorter than those of ewes dry at scanning (P<0.001), shorter (P<0.05) in the flock at the South-West Slopes site and declined with increasing age (P<0.001).

Figure 4 Predicted staple length (mm) by age and pregnancy status of Merino ewes on the South-West Slopes (Prop 1) or Central-West Plains (Prop 2), in each of 2 years.



The interaction of property and scanning status was significant (P<0.01), with the effects of reproduction being greater at the South-West Slopes site and the staple length of single-bearing ewes being tending to be shorter than both dry and multiple-bearing ewes at the Central-West Plains site (Figure 4).

Ewe census data

The proportions of the original ewes still present in the flocks at the two sites are presented in Table 5 for each age and initial age cohort. Compared with the differences between years, age differences were small.

Table 5. Proportion of the ewes, within each age cohort by age, present at weaning in two Merino flocks at two sites in NSW

	Actual Age (yrs)			
Initial Age (yrs)	3	4	5	6
		South-West Slopes		
3	95.3	89.5	na	na
4	na	97.5	84.7	na
5	na	na	98.0	88.1
		Central-West Plains		
3	95.9	89.9	na	na
4	na	93.2	81.1	na
5	na	na	97.4	79.9

Conclusions

In this study all ewes (at each site) ran together as one flock throughout the year with no particular emphasis on managing different age groups. Although site (property) effects confound environmental and genetics, the effects on all the wool traits of interactions of year and/or of site with age and reproductive performance show that environmental effects influence the extent of age and reproductive effects on production of older ewes. Fat scores also were particularly affected by age in the harsher of the two environments (the Central-West Plains). These imply the importance of the management of productive older ewes, particularly ewe nutrition. The recovery (or lack thereof) of body condition from reproductive effects did not appear to greatly influence fertility or fecundity in the age groups studied, but is likely to have influenced the value of their wool production in conjunction with reproductive costs. This is an area of research which has received little serious attention. The role of genotype on longevity and fitness in older ewes also requires further investigation.

There was no evidence to indicate that ewes having a higher level of reproduction over 2 years differed in the quantity or quality of their fleece (other than the effect on fibre diameter) beyond the effect of only the current year's performance on the fleece. Therefore in selecting ewes to retain past the normal culling age, the criteria of reproductive performance and fleece characteristics will not be antagonistic. However, the data do suggest that the fibre diameter of ewes which consistently conceive will be more affected by reproductive costs than ewes that do not conceive every year.

The use of on-farm census data from commercial flocks to derive mortality rates is unreliable without much more intensive supervision than has been possible in this study. Factors contributing to this situation include the movement of animals "through" fences (both ways), incomplete musters and lost tags. The large difference between years, with only 2 years data, makes it particularly difficult to estimate age effects *per se*.

Had more financial resources been available, problems of limited accessing of the Pedigree Matchmaker system by ewes (and lambs) may have been overcome especially at the South-West Slopes site.

References

ABARE (2008) Farm survey data for the beef, slaughter lambs and sheep industries. *http://www.abare.gov.au/ame/mla/mla.asp*

Clutton-Brock TH, Stevenson JS, Marrow P, MacColl AD, Houston AI, McNamara JM (1996) Population fluctuations, reproductive costs and life-history tactics in female Soay sheep. *Journal of Animal Ecology* **65**, 675-689.

Gilmour AR, Gogel BJ, Cullis BR, Thompson R (2006) 'ASReml User Guide Release 2.0.' (VSN International Ltd: Hemel Hempstead, HP1 1ES, UK).

Hamel S, Côté SD, Gaillard J-M, Festa-Bianchet M (2009) Individual variation in reproductive costs of reproduction: high-quality females always do better. *Journal of Animal Ecology* **78**, 143-151.

Lee GJ, Atkins KD (1995) Consequences of reproduction on the liveweight, fat depth, wool growth, and intake of grazing Merino ewes in the short and long term. *Australian Journal of Experimental Agriculture* **35**, 153-159.

Lee GJ, Atkins KD, Sladek MA (2009) Heterogeneity of lifetime reproductive performance, its components and associations with wool production and liveweight of Merino ewes. *Animal Production Science* **49**, 624-629.

Richards JS, Atkins KD (2007) Determining pedigree by association in Merino flocks. *Proceedings of the Association for the Advancement of Animal Breeding and Genetics* **17**: 403-406.

Scaramuzzi RJ (1988) Reproduction research in perspective. *Proceedings of the Australian Society of Animal Production* **17**, 57-73.

Turner HN, Brown GH, Ford GH (1968) The influence of age structure on total productivity in breeding flocks of Merino sheep. I. Flocks with a fixed number of breeding ewes, producing their own replacements. *Australian Journal of Agricultural Research* **19**, 443-475.

Weladji R, Loison A, Gaillard J-M, Holand Ø, Mysterud A, Yoccoz N, Nieminen M, Stenseth N (2008) Heterogeneity in individual quality overrides costs of reproduction in female reindeer. *Oecologia* **156**, 237-247.