

EW E REPRODUCTION STATUS AND ITS IMPACT ON GREASY FLEECE WEIGHT BREEDING VALUES

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SUMMARY

Using industry records (n=12,912), the effect of ewe reproductive status (defined as combined lambing outcomes during previous and current production cycles) on adult greasy fleece weight (AGFW) was estimated for pre-joining and pre-lambing shearing systems. Increasing ewe reproductive output significantly decreased AGFW, by up to 26% over 2 cycles of shearing. Differences in adjustments between shearing systems reflected that AGFW was most affected by the reproductive cycle completed before shearing. Estimated breeding values for AGFW of sires and ewes were little affected by bias due to reproductive status (< 1% for the highly reproductive ewes comprising 36% of the data) and re-ranking of animals was limited. Nevertheless, adjusting AGFW for reproductive status is proposed, but this would be difficult under the current low recording levels.

INTRODUCTION

The recording of lifetime productivity traits in Merino ewes is encouraged by both Sheep Genetics and, more recently, through the activities of the Merino Lifetime Productivity project (Ramsay *et al.* 2019). This follows studies (Brown *et al.* 2013; Swan and Brown 2013) which confirmed that recording of at least 1 measurement of adult greasy fleece weight (AGFW) would increase genetic gains in AGFW and overall selection accuracy for lifetime wool production. These studies used available expressions of AGFW recorded on both males and females from MERINOSELECT flocks. Reproductive level of ewes was not included as a fixed effect in models fitted to AGFW due in part to constraints with the genetic evaluation software at that time.

For a production system where ewes were shorn with a lamb at foot, Waters *et al.* (2000) reported that ewes rearing multiple lambs during the current production cycle had 0.12 kg lighter AGFW than ewes rearing single lambs, but effects due to rearing performance during the previous production cycle were not significant. Richards *et al.* (2018) examined effects of cumulative lifetime reproductive performance on clean fleece weight of Merino ewes, finding generally no significant differences in fleece weight between ewes with higher and lower number of lambs scanned over 3 consecutive reproductive records. As their study used data from 2 commercial flocks, genetic and environmental influences could not be separated, and it was not clear when ewes were shorn in relation to stage of the reproduction cycle.

Using data from the MERINOSELECT database, this study aimed to evaluate the effects on AGFW of ewe reproductive status, defined as the combined lambing outcomes from its previous and current production cycle. The effect of ewe reproductive status was estimated for these consecutive cycles within 2 shearing systems.

MATERIALS AND METHODS

Greasy fleece weights of ewes with known and consecutive reproductive outcomes recorded between their second and fifth adult shearings were extracted from the MERINOSELECT database.

* A joint venture of NSW Department of Primary Industries and the University of New England

The fleece weights were collected under 2 annual shearing systems, where ewes either were shorn pre-joining (dry period) or pre-lambing (mid-gestation). For each shearing system, initially reproductive performance at each ewe's previous and current cycle was described as not pregnant (DRY), single lamb born and lost (S_L), single lamb born and reared (S_S), multiple lambs born and lost (M_L), multiple lambs born but a single lamb reared (M_S) and multiple lambs born and reared (M_M). Ewe reproductive status then was defined by concatenating reproductive performance during the previous and current production cycles (36 levels per shearing system). A total of 12,912 AGFW records from 9,934 ewes across shearing systems were available for previous and current reproductive performances relevant to each fleece weight's production cycle (Table 1).

Analysis of the effect of ewe reproductive status on AGFW was conducted using ASReml (Gilmour *et al.* 2015). The fixed effects fitted included the birth-rearing type of the ewe (3 levels), age of dam (10 levels), age in days at measurement (fitted as a linear covariate), contemporary group (defined as combinations of flock, birth year, date of measurement and management group) and its reproductive status, described above. Random effects included sire and ewe permanent environment, to accommodate repeated records for ewes. Predicted means for greasy fleece weight for the reproduction effects were estimated using solutions from the full model. The impact of fitting reproductive status on BLUP estimated breeding values (EBVs) for AGFW was evaluated using single trait models with and without the effects of reproductive status within shearing system.

Table 1. Descriptive statistics for adult greasy fleece weight (kg) in each shearing system

	Number of records	Number of ewes	Mean (SD)	Minimum	Maximum	Mean ewe age (days)
Pre-joining	6636	5226	5.6 (1.32)	2.2	12.8	1436
Pre-lambing	6276	4708	4.9 (1.58)	1.2	13.8	1267

RESULTS AND DISCUSSION

The predicted means for AGFW were higher for the pre-joining system (5.3 kg for DRY ewes, Table 2), but this difference at least partially reflected a change in the predominant type of ewe: stronger wool ewes tended to be shorn pre-joining, whereas fine-ultra fine wool ewes were mainly shorn during gestation. Within a single shearing cycle, reductions in AGFW from DRY to M_M were 14% within pre-joining and 20% within pre-lambing shearing systems. The high reproductive output of twice M_M ewes (M_M-M_M category) reduced AGFW by 22% and 26% when compared to twice DRY ewes under pre-joining and pre-lambing shearings respectively. For twice S_S ewes, the reduction was 18% and 21% respectively. These highly reproductive ewes (S_S-S_S and M_M-M_M categories combined, Table 2) contributed 36% and 37% of records to the pre-joining and pre-lambing shearing data, respectively. In agreement with the finding of Bunter and Swan (2021), of small unfavourable genetic correlations between reproduction and AGFW, having accurate reproduction records would assist Merino breeders to avoid culling of ewes with lower fleece weight but higher reproductive output, and so improve both fleece weight and reproduction.

Reproductive status had a significant detrimental impact on AGFW, increasing in magnitude with number of lambs reared over more than one annual cycle (Table 2). Ewes with persistently high reproductive performance will have reduced AGFW as a result of competition for limiting nutritional resources during pregnancy and lactation, with lactation taking priority (Corbett 1979). This result was consistent across both shearing systems. However, a difference in timing of shearing relative to lambing and lactation altered which of current or previous reproductive outcome (i.e. lambing was several months before or shortly after the shearing event) influenced AGFW more. The largest effects were evident where the full reproductive cycle (including lactation) was completed prior to shearing. Therefore, current reproduction effects were larger under the pre-joining system

Table 2. Predicted means of adult greasy fleece weight (kg) for ewe reproductive status categories of ewes shorn under pre-joining and pre-lambing shearing systems

Previous reproduction			Current reproduction ¹					
			DRY	S_L	S_S	M_L	M_S	M_M
Pre-joining shearing								
		N	297	347	2901	164	97	2010
Previous reproduction	DRY	468	5.29	4.86***	4.54***	4.68**	4.56***	4.54***
	S_L	441	5.02	4.68***	4.45***	4.45***	4.42***	4.12***
	S_S	3357	5.07*	4.64***	4.36***	4.65***	4.34***	4.21***
	M_L	150	4.89‡	4.70**	4.39***	4.32***	4.34***	4.24***
	M_S	815	5.29	4.73***	4.44***	4.61***	4.34***	4.15***
	M_M	1405	5.22	4.58***	4.36***	4.53***	4.27***	4.10***
Pre-lambing shearing								
		N	421	509	2933	235	744	1434
	DRY	302	3.74	3.40**	3.37***	3.96	3.46	3.68
	S_L	520	2.88***	3.25***	3.14***	3.28**	3.17***	3.25***
	S_S	3725	3.02***	2.96***	2.95***	2.99***	2.98***	3.00***
	M_L	105	3.45	2.83***	3.06***	2.94**	3.15**	3.09***
	M_S	608	2.80***	2.80***	2.81***	2.93***	2.81***	2.96***
	M_M	1016	2.98***	2.89***	2.80***	2.87***	2.84***	2.77***

¹ DRY: not pregnant; S_L: single lamb born, lost; S_S: single lamb born, reared; M_L: multiple lambs born, lost; M_S: multiple lambs born, single lamb reared; M_M, multiple lambs born, reared. ***, $P < 0.001$, **, $P < 0.01$, *, $P < 0.05$ and ‡, and $P \leq 0.10$ tested within each shearing system as a contrast to DRY_DRY predicted mean.

(range of 12-22% reduction in AGFW of M_M ewes within each previous reproduction category), while previous reproduction effects were larger under the pre-lambing system (range of 14-29% reduction in AGFW of M_M ewes within each current reproduction category).

The difference between unadjusted and adjusted EBVs for AGFW of ewes (i.e. bias) was around 2.5% for twice dry ewes, but much less in ewes consecutively bearing and raising singles (S_S) and twins (M_M) (Figure 1A). The large positive bias in AGFW EBVs for twice DRY ewes indicated that their EBVs were overestimated when reproductive status was not accounted for during genetic evaluation. However, very few records for AGFW were available for twice dry ewes (1% of records for both shearing systems), similar to industry flocks where ewes are usually culled if dry once, and so few ewes would have EBVs affected. Across the other reproductive categories, industry recording of AGFW is also low, e.g. industry data used by Bunter and Swan (2021) had 6% of AGFW with known previous reproductive status. For both ewes and sires, EBVs based on models where AGFW was unadjusted and adjusted for ewe reproductive status were highly correlated (correlations > 0.98 ; Figure 1B, D), indicating that little re-ranking of animals on AGFW would occur when reproductive effects are ignored. Independently, the relationship between an EBV for litter size and bias in AGFW for sires was negative and not strong (Figure 1C). While sires with lower EBVs for litter size had higher EBVs for AGFW after adjusting for reproduction status, the overall effect was small as

daughters of sires were spread across all reproductive categories.

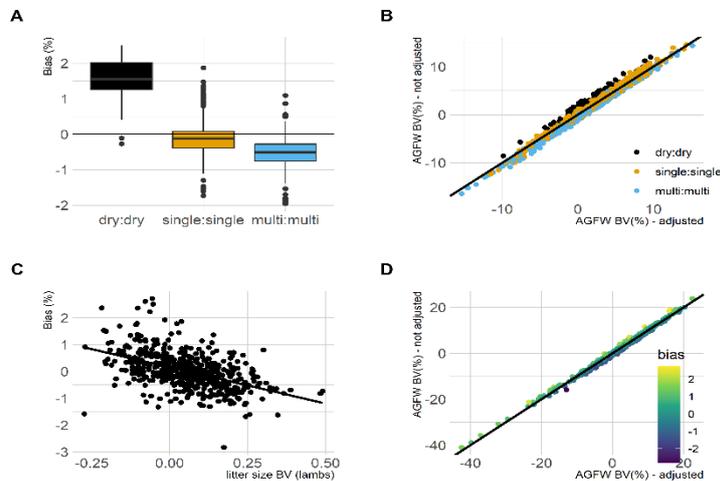


Figure 1. Bias in and impact on estimated breeding values (BV) for adult greasy fleece weight (AGFW) in ewes (A and B respectively) and sires (C and D respectively)

CONCLUSIONS

Ewe reproductive status significantly influenced AGFW, with timing of shearing relative to the reproductive cycle influencing size of the effects. Sire and ewe EBVs for AGFW, though, were little affected by bias due to reproductive status and re-ranking of animals was limited, largely because reproductive status was mainly unknown in industry data. Current low levels of recording for ewe reproductive status make it difficult to apply such adjustments to AGFW. However, it is proposed that applying these adjustments would increase confidence in using EBVs for AGFW by ram breeders and producers. Well-recorded reproductive information is needed to avoid culling of more reproductive ewes with lower fleece weights and for increased selection accuracy of young animals.

ACKNOWLEDGMENTS

This research was made possible through the efforts and support of the Australian sheep industry in submitting data to MERINOSELECT, as well as funding provided by MLA and AWI.

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