ENVIRONMENTAL EFFECTS ON POST WEANING FLEECE TRAITS OF A MERINO SIRE EVALUATION FLOCK

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SUMMARY

Significance of environmental and ewe bloodline effects, and their estimates, on post weaning (PW) fleece traits recorded in a central test sire evaluation flock were investigated. The findings that heavier fleeces were produced by single-born or single-reared or older animals, were generally similar to those reported for yearling expressions of clean and greasy fleece weights. Apart from sex significantly influencing each of the fleece quality traits, mean and coefficient of variation of fibre diameter, staple length and staple strength were largely unaffected by the environmental effects. Significant ewe bloodline and sire x ewe bloodline effects indicate that sire x genotype interactions are important for early age fleece traits. At present, these interactions are partially accounted for by fitting sire x flock interactions in the methodology applied in the MERINOSELECT genetic evaluations.

INTRODUCTION

A gradual decline in the average age at recording of performances in Merino fleece traits is evident in the MERINOSELECT database (D.J. Brown *pers. comm*). Therefore, understanding the importance of age effects on genetic parameters for fleece traits and the role of assessments in young Merinos in breeding programs designed to improve lifetime performance is of continuing interest. Performance recording of fleece traits by ram breeders is occurring more often now in an age range of 7 to 10 months (post weaning, PW), which offers ram breeders the opportunity to supply rams more in line with the needs of their commercial clients. As no published information is available on the genetics of Merino PW fleece traits, including the importance of environmental effects, this preliminary study sets out to estimate environmental effects on PW fleece traits recorded at a central test sire evaluation (CTSE) site, as well as the impact of ewe bloodline effects on these traits.

MATERIALS AND METHODS

Data for this study were available from the progeny of the Macquarie (Trangie) CTSE site, which is conducted according to the requirements of the Australian Merino Sire Evaluation Association (Casey *et al*. 2009). The site is hosted at the Agricultural Research Centre, Trangie. Briefly, the progeny were born in 2012 and 2013 following annual AI matings of 12 industry sires (with one sire in common across years) to base ewes sourced from commercial flocks representative of 2 Merino bloodlines (GRASS: dual purpose type, fleece weight emphasis; Karbullah: dual purpose type, fertility emphasis) and a commercial flock managed at the centre (progeny of ewes mated to Centre Plus rams: dual purpose type, wool, fertility and growth emphasis, 2013 mating only). Approximately 50 ewes were inseminated per sire. To achieve a spread of lambing in each year similar to that from natural mating, AI matings were conducted in 2 programs per year: 13 days apart in 2012 and 29 days apart in 2013. At their first mating, all ewes were maidens (aged 2 years old in both years, as well as 3 year old ewes in 2012) and were randomly allocated to each sire, balanced across the ewe bloodlines and AI programs within a year. Before lambing, the base ewes were allocated to a lambing paddock according to their AI sire and program (24 lambing paddocks per year). During daily lambing rounds, lambs were tagged and their date of birth and sex were recorded. Lambs were weaned at an average age of 92 days in 2012 and 115 days in 2013. Sire pedigree was confirmed and maternal pedigree assigned through DNA testing of blood samples from sires, dams and progeny conducted through the CRC for Sheep Industry Innovation. Birth type and rearing type of the progeny were derived from lambing paddock records, the DNA parentage testing results and dam's pregnancy scanning status.

Animals were first shorn at assessment of the PW fleece traits, which occurred at average ages of 8 months (2012 drop) and 8.6 months (2013 drop). Traits included greasy fleece weight (GFW, kg), clean wool yield (YLD, %), clean fleece weight (CFW, kg), mean fibre diameter (FD, micron), coefficient of variation of FD (FDCV, %), fibre curvature (CURV, degrees/mm), staple length (SL, mm) and staple strength (SS, N/ktex). Data analyses were performed using ASReml (Gilmour *et al*. 2014). Significance of fixed effects was first tested in models that fitted a random effect of sire. The fixed effects examined included ewe bloodline (3 levels), AI program group (4 levels), sex (ewe, wether), birth type (single, twin), rearing type (single, twin) and dam age (2, 3 and 4 year old matings). Age at observation was fitted as a linear covariate within each birth year. The importance of the interaction of sire with ewe bloodline was tested by fitting it as an additional random effect in a second model for each trait. The interaction effect was considered significant ($P<0.05$) if its inclusion with the sire effect resulted in a significant increase in the log-likelihood between models. Table 1 summarises the data on each trait.

Table 1. Descriptive statistics for post weaning fleece traits

Trait	Mean	SD	Range	Trait	Mean	SD	Range
GFW (kg)	3.4	0.73	1.4 - 6.0	FDCV (%)	18.1	1.89	13.0 - 25.7
YLD (%)	68.7	4.67	52.6 - 81.0	CURV (°/mm)	90.4	7.62	65.7 - 117.5
CFW (kg)	2.3	0.53	0.9 - 4.2	SL (mm)	66.6	9.15	40 - 96
FD (micron)	17.1	1.25	13.6 - 23.0	SS (N/ktex)	35.4	14.09	10.1 - 73.5

RESULTS AND DISCUSSION

Environmental effects. All PW fleece traits were significantly influenced by sex of the animal, with wethers having heavier (0.27 kg, greasy; 0.18 kg clean) and finer fleeces (0.26 micron) of slightly lower FDCV and CURV and with shorter staples of lower strength than ewes (Table 2). This contrasts with the study of Asadi Fozi *et al*. (2005), where no significant differences between ewes and wethers were found for GFW and CFW at 10 months of age of a multiple-bloodline fine wool flock; however, significant differences between the sexes were reported for YLD, FD, FDCV and SS. Earlier, Young *et al*. (1965) also observed no significant difference between rams and ewes in GFW at 5-6 months of age in a medium wool flock.

Age at observation significantly affected both fleece weights and SL, with older animals tending to produce more wool. The direction of the minor effect on SL varied with year of birth such that 2012-born animals (from a lambing period of 22 days) produced 0.09 mm shorter staples per day as age increased while 2013-born animals (from lambing period of 41 days) produced 0.33 mm longer staples per day (Table 2). In agreement with the current study, previous studies have reported significant effects of age at observation on GFW and CFW across a range of Merino wool types at 10 months of age (multiple-strain flock: Brash *et al*. 1997; multiple bloodline broad wool flock: Hill 2001; Asadi Fozi *et al.* 2005) and yearling age (industry flocks: Huisman *et al*. 2008) and SL (10 months of age: Hill 2001; yearling age: Huisman *et. al* 2008). However, these studies did show significant age effects on FD (Brash *et al*. 1997; Hill 2001; Asadi Fozi *et al*. 2005; Huisman *et al*. 2008) and SL (Hill 2001; Huisman *et al*. 2008).

Twin-born and twin-reared animals had significantly lighter PW GFW (0.19 and 0.26 kg respectively) and CFW (0.14 and 0.18 kg respectively; Table 2), which agrees with the significant effects on fleece weights previously identified in young Merinos due to birth type and rearing type

Table 2. Significance of fixed effects[1] and their estimates[2] for post weaning fleece traits and percentage of phenotypic variation accounted for by sire x ewe bloodline interaction

	GFW	YLD	CFW	FD	FDCV	CURV	SL	SS
Sex	***	**	**	***	**	***	***	*
	0.27	-0.78	0.18	-0.26	-0.31	-0.24	-4.09	-1.57
	(0.07)	(0.26)	(0.05)	(0.07)	(0.11)	(1.01)	(0.78)	(0.79)
Age	***	‡	***	n.s.	n.s.	n.s.	**	n.s.
2012	0.008	-0.27	-0.002				-0.09	
	(0.015)	(0.14)	(0.011)				(0.26)	
2013	0.034	-0.06	0.022				0.33	
	(0.006)	(0.05)	(0.004)				(0.10)	
Birth type	*	n.s.	*	n.s.	*	n.s.	n.s.	n.s.
	-0.19		-0.14		-0.74			
	(0.08)		(0.06)		(0.30)			
Rearing type	**	n.s.	**	n.s.	*	n.s.	n.s.	n.s.
	-0.26		-0.18		0.76			
	(0.08)		(0.06)		(0.29)			
Dam age	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.
3				-0.45				
				(0.16)				
4				-0.49				
				(0.22)				
Ewe bloodline	*	n.s.	*	***	*	***	***	n.s.
Karbullah	-0.09		-0.06	0.35	-0.32	-3.10	3.15	
	(0.03)		(0.02)	(0.08)	(0.12)	(0.51)	(0.73)	
Commercial	0.08		-0.02	-1.25	-0.19	0.43	-2.44	
	(0.09)		(0.07)	(0.21)	(0.34)	(1.42)	(1.99)	
Sire x ewe bloodline (%)	0 n.s.	0 n.s.	0 n.s.	4.0 *	2.8 *	1.6 n.s.	2.5 *	2.9 *

[1] ‡, $P < 0.10$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; n.s., not significant ($P \geq 0.10$).
[2] Estimates expressed as follows: ewe bloodline as the deviation from GRASS estimate of estimates for each of the Karbullah and Commercial bloodlines; sex as the deviation from ewe estimate of the wether estimate; birth type and rearing type as the deviation from estimates for single animals of estimates for twin animals; dam age as the deviation from estimates for 2 year old matings of estimates for later matings.

(Young *et al*. 1965; Brash *et al*. 1997; Huisman *et al*. 2008) and a combined birth-rearing type (Hill 2001; Asadi Fozi *et al*. 2005). While in the current study the estimates for rearing type effects on the fleece weights were as least as large as those for the birth type effects, Huisman *et al*. (2008) reported that the rearing type estimates for yearling fleece weights were approximately half those for birth type effects (-0.078 versus -0.193 for GFW and -0.074 versus -0.130 for CFW). It is possible that rearing type may have greater impacts on fleece weights recorded at the PW age than at yearling and later ages, but this needs to be confirmed by further study. FDCV was reduced significantly in fleeces of twin-born animals but was significantly higher in fleeces of twin-reared animals, as reported by Husiman *et al*. (2008). The remaining traits were not influenced by birth type or rearing type, results which are consistent with earlier findings for CURV (Huisman *et al*. 2008), SL and SS (Hill 2001; Huisman *et al*. 2008). However, birth type had influenced significantly FD in the studies of Brash *et al*. (1997) and Huisman *et al*. (2008), as well as a combined birth and rearing type effect in the studies of Hill (2001) and Asadi Fozi *et al*. (2005).

Except for FD, there were no significant differences between dam ages for the PW fleece traits, likely due to the ewes being no more than 4 years old at their second lambing opportunity. Based on published reports of significant estimates for fleece weights at 5-6 (Young *et al*. 1965) and 10-

12 (Hill 2001; Asadi Fozi *et al*. 2005; Huisman *et al*. 2008) months of age, it is expected that dam age effects could influence PW fleece weights. However, it is likely that these effects would be relatively small and less noticeable than effects of the other early environmental effects. This may also be the case for FD and FDCV, for which significant dam age effects, though small, have been reported (Hill 2001; Huisman *et al*. 2008).

Ewe bloodline effects. Ewe bloodline had a significant effect on all PW traits, except YLD and SS, with ranges of difference in performance across the ewe bloodlines used in this study of 0.17 kg for GFW, 0.06 kg for CFW, 1.6 micron for FD, 0.32% for FDCV and 5.59 mm for SL (Table 2).The sire x ewe bloodline interaction was significant only for FD, FDCV, SL and SS, accounting for 2.5 to 4.0% of the phenotypic variation in these traits and suggesting that non-additive genetic variance, or heterosis, may be influencing these traits. These results contrast with Mortimer *et al*. (1994) who found non-additive genetic effects to be significant for hogget GFW and CFW, but not hogget FD. From data drawn from industry studs and CTSE sites, Atkins *et al*. (1998) concluded that possible non-additive effects could be influencing yearling fleece weight, based on a significant sire x genetic group effect and the lesser importance of a sire x location effect following decomposition of a sire x management group interaction. Taken together, the evidence suggests that sire x genotype interactions are important for early age fleece traits, though further studies to estimate these effects are needed using suitable data. Currently, this interaction is in part being accounted for as a component of a sire x flock interaction that is fitted by the methodology used in MERINOSELECT genetic evaluations (Li *et al*. 2015).

Conclusions. Although to be verified by estimates from larger data sets, preliminary estimates of environmental effects on PW fleece traits are generally similar to those available for yearling fleece traits. The influence of sire x genotype interactions on early age fleece traits warrants further investigation using data sets structured without confounding of sire and other effects.

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