Proc. Assoc. Advmt. Anim. Breed. Genet: 24: 259-262

THE IMPORTANCE OF EARLY ENVIRONMENTAL EFFECTS ON MERINO FLEECE TRAITS ACROSS TWO SHEARINGS

K.L. Egerton-Warburton[1], J.L. Smith[2], S.I. Mortimer[3], A.A. Swan[4], and B.C. Hine[2]

[1] NSW Department of Primary Industries, Orange, NSW, 2800 Australia
[2] CSIRO, Agriculture and Food, F.D. McMaster Laboratory, Armidale, NSW, Australia
[3] NSW Department of Primary Industries, Armidale, NSW, 2351 Australia
[4] Animal Genetics and Breeding Unit*, University of New England, NSW, 2351 Australia

SUMMARY

The importance of early environmental effects, and their estimates, on yearling and adult fleece traits recorded in 2 flocks managed under Lifetime Ewe Management (LTEM) guidelines were evaluated. Significance and overall influence of the effects of birth type and rear type were generally consistent with previous reports. However, estimates of the size of effects were generally larger than those previously reported, with the specific context of LTEM and impacts of management on early environmental effect estimates requiring further investigation.

INTRODUCTION

In breeding programs, we seek to disentangle the effects of genes from environment to obtain accurate estimates of the genetic merit of individuals and maximise genetic progress. To do so, adjustment factors are applied in the MERINOSELECT genetic evaluation system (Brown *et al.* 2007) to account for environmental influences such as age of dam, birth type, rear type, and date of birth or age at trait assessment. For example, classer grades are known to be influenced by birth/rearing type (Clarke and Thompson 2021; Mortimer *et al.* 2009) and age of dam (Mortimer *et al.* 2009). From the earliest genetic studies of Merino sheep, summarised by Turner and Young (1969), it is established that most fleece traits are influenced by early environmental effects, with later work showing these effects to be important across a range of ages (e.g. Huisman *et al*. 2008). Genetic evaluation systems in Australia generally use 'multiplicative' adjustments to account for different levels of performance across breeds and sites when accounting for fixed effects (Graser *et al.* 2005; Gilmour 1993).

The Lifetimewool project established that improving the nutritional management of Merino ewes during pregnancy and lactation resulted in their progeny having heavier, finer fleeces across several shearings (Thompson *et al.* 2011). Guidelines from this project underpin the Lifetime Ewe Management (LTEM) program (http://www.lifetimewool.com.au/), providing recommendations for base ewe management in sire evaluation flocks (AMSEA 2018). This paper reports the importance and persistence of early environmental effects (birth/rearing type, dam age) on measured fleece traits assessed at 2 ages (yearling, and first adult shearings) and at 2 locations in progeny from dams managed to LTEM targets.

MATERIALS AND METHODS

Data used in these analyses were from 2 shearings of the F1 ewe and wether progeny of the Merino Lifetime Productivity (MLP) project conducted at the Macquarie (MCQ) and New England (NE) sites. The design of the MLP Project has been described previously by Ramsay *et al.* (2019). Assessment data were collected according to the AMSEA guidelines (AMSEA 2018). Dams of the

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

progeny were managed in line with Lifetimewool regional guidelines, with multiple bearing ewes managed differentially to single bearing ewes (http://www.lifetimewool.com.au/guidelines.aspx).

F1 progeny at the MCQ site were born in May-June, whilst F1 progeny at the NE site were born in late August/early September of each year. At each site, a yearling (Y, 300 to 400 days age) and an adult (A, 540 days or older) fleece assessment were completed. Shearing at the MCQ site occurred in late February (Y) and mid October (A), whilst shearing at NE occurred in August (Y) and July (A). Greasy fleece weight (GFW, kg), clean fleece weight (CFW, kg) and fibre diameter (FD, µm) data were analysed.

For each data source (MCQ or NE site), analyses were performed using R (R Core Team 2020). Significance of early environmental effects was tested in models that fitted a random effect of sire. For both sites, the fixed effects examined included birth type (BT: single, twin, triplet), rearing type (RT: single, twin, triplet) and age of dam (DAGE: 2, 3, 4, 5, 6 and 7 years old at mating), as well as a contemporary group effect defined by year of birth, management group, ewe bloodline source and sex. Interactions among the BT, RT and DAGE were tested but were found to be not significant for these traits and therefore were not fitted in the final models. Age at observation was fitted as a linear covariate. Table 1 summarises the data available at each site for each trait.

Table 1. Descriptive statistics for selected fleece traits (including number of records, n)

		YGFW	AGFW	YCFW	ACFW	YFD	AFD
Macquarie	Mean[1]	3.8	7.6	2.4	4.7	17.2	18.8
		(0.75)	(1.30)	(0.51)	(0.89)	(1.38)	(1.46)
	n	2013	961	2013	961	2015	961
	Range	1.6 - 6.2	3.4 - 12.0	1.0 - 4.2	1.4 - 7.8	13.1 - 22.1	15.0 – 24.4
New England	Mean	2.7	4.5	2.0	3.3	15.2	16.1
		(0.66)	(0.68)	(0.47)	(0.53)	(1.05)	(1.26)
	n	2170	2151	2170	2151	2175	2152
	Range	1.2 - 5.6	2.7 - 7.3	0.8 - 4.2	1.9 - 5.5	11.4 - 19.9	12.5 - 21.0

[1]Standard deviations shown in brackets below the mean

RESULTS AND DISCUSSION

All Y and A fleece weight traits examined were influenced significantly by BT (Table 2). The lighter fleeces of multiple-born animals relative to single-born animals were still evident at their first adult shearing, consistent with effects on fleece weights of yearlings, hoggets and adults reported previously by Huisman *et al.* (2008). Rearing type (RT) was significant for Y and A fleece weight traits at the NE site, but only significant for the Y fleece weight traits at the MCQ site. Early environmental effects were not significant for FD at either Y or A stage at the MCQ site; only BT was significant for YFD and AFD at the NE site. In general, the significance of the effects of RT and dam age declined with stage. The significance of the BT effect on fleece weight traits was maintained across the two shearings, although the size of the effect generally tended to decrease. Age at shearing was only significant for the Y fleece weights at the NE site ($P < 0.0001$).

The results of this analysis contrast with those of Huisman *et al.* (2008) who reported that the RT effects on Y fleece weights were approximately half of those of BT effects. Additionally, when effects are converted to a 'multiplicative' basis (Table 2), the adjustments for BT≥2 are larger than published estimates for sheep (Gilmour 1993), but do decline with stage. The size of the estimate of the BT and RT effects on fleece weight at these MLP sites are large in comparison with those reported by Thompson *et al.* (2011), on a site in Victoria across annual shearings from 15 months of age. Our results are consistent with Thompson *et al.* (2011) with respect to fleece weight (e.g. their estimate had twin-born animals producing 0.19 kg less wool than single-born animals), but do not in general support their effects reported for FD (twin born animals had 0.26 µm broader fibres).

Table 2. Significance of fixed effects[1] and their estimates[2] and multiplicative adjustments[3] for greasy fleece weight (GFW, kg) clean fleece weight (CFW, kg) and fibre diameter (FD, µm) at yearling (Y) and adult (A) assessments

		Macquarie				New England					
Effect	Level	YGFW	AGFW	YCFW	ACFW	YGFW	AGFW	YCFW	ACFW	YFD	AFD
Birth type	Twin	-0.46***	-0.45**	-0.37***	-0.17*	-0.23***	-0.22***	-0.18***	-0.20***	0.11**	0.14***
	Triplet	-0.61***	-0.49**	-0.47***	-0.26*	-0.42***	-0.37***	-0.32***	-0.29***	0.24*	0.62***
Rear type	Twin	-0.34***		-0.22***		-0.33***	-0.11**	-0.27***	-0.11***		
	Triplet	-0.41**		-0.32**		-0.18	-0.03	-0.18*	-0.13		
Age of dam	3					0.08*	0.07‡	0.07**	0.09*		
(years)	4	0.13‡				0.10**	0.09*	0.09***	0.10**		
	5	0.03				0.14***	0.18***	0.12***	0.16***		
	6	0.03				0.11‡	0.07	0.10*	0.10‡		
	7	-0.07				0.09	-0.01	0.14	-0.003		
Age	Linear					0.018***		0.013***			
Multiplicative	2:1	1.12		1.16		1.08	1.05	1.09	1.06		
(BT:RT)	2:2	1.23	1.06	1.28	1.04	1.22	1.08	1.26	1.10	0.99	0.99
	3:1	1.17		1.21		1.15	1.09	1.18	1.09		
	3:2	1.29		1.34		1.32	1.12	1.38	1.14		
	3:3	1.32	1.07	1.42	1.06	1.24	1.09	1.30	1.14	0.98	0.96

[1] ‡, $P < 0.10$; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; level of significance based on t-test between estimates

[2] Estimates expressed as: birth type as the deviation from estimates for single animals of estimates for twin and triplet animals; rearing type as the deviation from estimates for single animals of estimates for twin and triplet animals; age of dam as the deviation from estimates for youngest dams (2 year olds) of estimates for older dams. Where cells are blank the effect was not significant.

[3] Multiplicative adjustments: calculated from marginal means of BT and RT expressed relative to BT:RT 1:1 (single born, single reared)

This is an important observation considering that the intent of the differential management of multiple bearing ewes under LTEM is to provide optimal nutrition to offset any lifetime effects of BT and RT. Further investigation of this finding could be achieved by extending this analysis to other MLP sites, especially the Balmoral site whose environment and sheep type are most similar to the Victorian site at which data were collected and reported by Thompson *et al.* (2011). In addition to MLP sites where LTEM management is known to be applied, identifying the size of these effects in the wider MERINOSELECT database is also necessary.

This exploratory study will also be expanded to examine other measured and visual wool traits at the two sites reported herein, and later stages of assessment (third adult and later shearings).

CONCLUSIONS

This study of the importance of early environmental effects, and their estimates, on yearling and adult fleece traits recorded in two flocks managed under Lifetimewool guidelines found the significance and overall influence of the effects of birth type and rear type were generally consistent with previous reports. Estimates of effects were generally larger than those previously reported, but the specific context of LTEM and impacts of management on early environmental effect estimates requires further investigation.

ACKNOWLEDGEMENTS

The Merino Lifetime Productivity Project is being undertaken in partnership between the Australian Merino Sire Evaluation Association Incorporated (AMSEA) and Australian Wool Innovation (AWI). AMSEA and AWI acknowledge those entities who also contribute funding: woolgrowers through sire evaluation entry fees, site hosts, site committee in-kind contributions, and sponsors of AMSEA. The MLP Macquarie site gratefully acknowledge the generous financial support provided by the site host NSW Department of Primary Industries. The MLP New England site gratefully acknowledges the generous financial support provided by the site host, CSIRO.

Projects ON 536 (MCQ site) and ON 511 (NE site) also provided data for this study, and we gratefully acknowledge AWI for their co-investment. Staff and Site Committee volunteers at the respective MLP sites are also thanked for their contributions to data collection.

REFERENCES

AMSEA (2018) 'Merino Sire Evaluation Site Requirements'. Version 180831.

Brown D.J., Huisman A.E., Swan A.A., Graser H-U., Woolaston R.R., Ball A.J., Atkins K.D. and Banks R.G. (2007) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **17:** 187.

Clarke B.E. and Thompson A.N. (2021) *Anim. Prod. in Aust*. **33:** clii

Gilmour A.R. (1993) 'BVEST: A multiple trait animal model Best Linear Unbiased Predictor breeding value estimation program'. NSW Agriculture, Orange, Australia.

Graser H-U., Tier B., Johnston D.J. and Banks R.G. (2005) *Aust. J. Exp. Ag.* **45**: 913.

Huisman A. E., Brown D.J., Ball A.J. and Graser H.-U. (2008) *Aust. J. Exp. Ag.* **48**: 1177.

Mortimer S.I., Robinson D.L., Atkins K.D., Brien F.D., Swan A.A., Taylor P.J. and Fogarty N.M. (2009) *Anim. Prod. Sci.* **49**: 32.

R Core Team (2020) R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Ramsay A.M.M., Swan A.A. and Swain B.C. (2019) *Proc. Assoc. Advmt. Anim. Breed. Genet.* **23**: 512.

Thompson A.N., Ferguson M.B., Gordon D.J., Kearney G.A., Oldham C.M. and Paganoni B.L. (2011) *Anim. Prod. Sci.* **51**: 794.

Turner H.N. and Young S.S.Y. (1969) 'Quantitative Genetics in Sheep Breeding'. Macmillan of Australia, Melbourne.