COMPARISON OF UDDER AND TEAT TRAITS IN MERINO EWES RECORDED AT LAMBING AND WEANING

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SUMMARY

In Australia, there is currently no standard system for assessing ewe udder traits for genetic improvement. The aim of this study was to provide preliminary genetic parameter estimates of four visually scored udder and teat traits recorded at lambing and weaning, to inform recommendations about how and when to record udder and teat traits. Udder depth, teat size and teat placement were moderately heritable at both lambing and weaning (0.23 ± 0.08 to 0.36 ± 0.09) and the traits recorded at the two stages showed high genetic correlations (udder depth 0.75 ± 0.14; teat size 0.79 ± 0.12; teat placement 0.70 ± 0.16). Udder cleft, showed lower heritability, and lower genetic correlation across the two stages, with increased phenotypic variance from lambing to weaning. These results suggest that either stage is appropriate for recording udder depth, teat size and teat placement for genetic improvement of Australian Merinos.

INTRODUCTION

Neonatal lamb mortality is the most significant health issue of Australian sheep with substantial economic, welfare and sustainability implications (Shephard *et al.* 2022). In Australia, neonatal mortalities are mainly caused by dystocia/birth injury and the starvation/mismothering/exposure (SME) complex, each contributing to approximately 40% of neonatal deaths (Hinch and Brien 2014). Starvation mortalities are typically regarded as multifactorial, however poor udder and teat conformation of the dam have been implicated (Jordan and Mayer 1989). Mortality rates in lambs born to ewes with defective udder function have been shown to be more than double that observed in lambs born to ewes with sound udder conformation (Hayman *et al.* 1955; Griffiths *et al.* 2019). Smith *et al.* (submitted) showed that udder and teat conformation traits of Australian Merino ewes are heritable, with estimates ranging from 0.09 to 0.56 across visually scored and measured traits, and that overall udder soundness was associated with lamb survival. Further, (Smith *et al.* submitted) observed that in some instances udder conformation issues noted at birth were not readily discernible at weaning, which was consistent with the findings of Griffiths *et al.* (2019). The objective of this study was to build on earlier work, providing preliminary genetic parameter estimates of udder and teat traits assessed at birth and weaning, to inform recommendations regarding the optimal time for their assessment.

MATERIALS AND METHODS

Data source. The study was conducted during 2022 using ewes from the New England Merino Lifetime Productivity (MLP) flock (Ramsay *et al.* 2019), maintained by CSIRO at the FD McMaster Laboratory, Chiswick, Uralla NSW, Australia, according to MLP project protocols (AMSEA 2020). The flock was generated by artificial insemination in 2017 and 2018 from 28 genetically diverse Merino and Poll Merino sires (15 sires per year with 2 sires used across years for genetic linkage). In 2022 ewe progeny per year-sire group ranged from 27 to 57 ewes. The flock comprised 619, 4 year old (yo) (born 2018) and 638 5 yo (born 2017) ewes, however, only those ewes that lambed in 2022 (number lambs born, NLB>0) and reared at least one lamb to weaning (number lambs weaned, NLW>0) were included in the statistical analysis (n=1,105). The ewes were natural syndicate mated within age groups for 35 days (d) commencing 28th March (d0). Lambing took place from d142-187. Lambs from the 4yo and 5yo ewes were weaned on d248 (median age 89d) and d252 (median age d93) respectively. Udder and teat traits were recorded on the ewes at lambing during lambing rounds (twice-daily), and on the days following weaning (d248-249 and d252-254 for the 4yo and 5yo ewes, respectively). Experimental procedures conducted on animals were approved by the CSIRO Armidale Animal Ethics Committee (Animal Research Authority no. 21/24).

Udder and teat appraisal. Ewes were visually scored (1-5) while in a standing position for 4 udder and teat traits at lambing (L) and weaning (W). Traits assessed were udder depth (UD, size of the udder in relation to the hock, 1=smallest to 5=largest, udder floor below hock); udder cleft (UC, reflects udder symmetry, strength of the medial ligament and attachment to the abdomen, 1=well defined cleft (strong medial ligament), 2=evident cleft, 3=flat udder floor or 'broken' (weak) ligament, 4=asymmetric but both halves functioning; 5=asymmetric with one half involuted); teat size (TS, combination of teat width and length, 1=smallest to 5=largest) and teat placement (TP, position of teat relative to horizontal, 1=high on udder, horizontal, 3=45° from vertical, 5=vertical). Score 3 is considered optimal in terms of productivity and ewe health for all traits, except UC where score 1 is optimal. At lambing, ewes were assessed by 1 of 4 trained operators during lambing rounds, and at weaning by a single operator (1 of the initial 4) in a classing crate.

Statistical analysis. Univariate mixed animal models were applied using ASReml software package (Gilmour *et al.* 2021) for determination of significant fixed effects and covariates on the udder and teat traits, and to estimate (co)variance components and heritability. The maternal environmental effect was tested, but determined by likelihood ratio testing to be non-significant and was not considered further. All traits approximated normality and no interactions among fixed effects were considered. Phenotypic and genetic correlations among the udder and teat traits were estimated from pairwise bivariate models. Fixed effects tested for both the lambing and weaning-stage traits were dam source (3 levels, reflecting the genetic background of the MLP Base ewes) and contemporary group (CG, 4 levels, combined ewe birth year and management group at/following lambing). Assessor of the lambing-stage traits was confounded with lambing management group. For the lambing-stage traits, number of lambs born in 2022 (NLB, 3 levels) and total NLB up to and including 2022 (TotNLB, 10 levels) were also tested, along with bodyweight and condition score pre-mating (pmWT and pmCS) and at late-pregnancy (lpWT and lpCS), all as linear covariates. For the weaning-stage traits, number of lambs weaned in 2022 (NLW, 2 levels), total NLW up to and including 2022 (TotNLW, 8 levels) and day of assessment (ie. from weaning, DoA, 3 levels) were also tested. Linear covariates tested on the weaning-stage traits were days of lactation (DoL), pmWT, pmCS, lpWT, lpCS, as well as weight and condition score at weaning (wWT and wCS).

RESULTS AND DISCUSSION

Phenotypes and heritabilities. The majority of ewes exhibited udders of moderate size with a defined udder cleft and moderately sized teats positioned at or near 45° from vertical (Table 1). The udder and teat trait heritabilities estimated here ranged from 0.09 ± 0.05 to 0.36 ± 0.09 among the two stages. These estimates were higher than those estimated previously by Smith *et al.* (submitted) in the same ewe population and for the same traits at weaning (0.01 to 0.17), but similar to those estimated by McLaren *et al.* (2018) in a terminal breed (0.14 to 0.35). The differences observed in the MLP flock across the different studies may be attributable to some refinements to the scoring system, exclusion from the current study of the ewes that were not lactating at weaning, and age of the ewes. The heritability estimates for UD and TP were consistent across the stages (Table 2). The heritability of TS was higher at weaning than lambing, and UC was lower at weaning than lambing. The phenotypic variance of UC doubled from lambing to weaning which suggests deterioration in UC during the lactation period, with increased expression of udder asymmetry at weaning.

Table 1. Descriptive statistics, significance of fixed effects and phenotypic variance (Vp) for ewe udder depth (UD), udder cleft (UC), teat size (TS) and teat placement (TP) at lambing (L) and weaning (W)

	LUD	LUC	LTS	LTP	WUD	WUC	WTS	WTP
Mean	2.99	2.21	2.70	2.87	3.17	1.97	2.75	3.08
Sd	0.68	0.69	0.68	0.55	0.48	1.00	0.54	0.37
Range	1 - 5	1 - 5	2 - 5	1 - 5	1 - 5	1 - 5	1 - 5	2 - 5
CG	***	***	***	***	ns	*	*	ns
NLB22	**	ns	*	*	-	-	-	-
NLW22	-	-	-	-	***	**	ns	***
DoA	-	-	-	-	***	***	**	***
Vp	0.35±0.02	0.45±0.02	0.42±0.02	0.27±0.01	0.21±0.01	0.96±0.04	0.29±0.01	0.13±0.01

n=1,105 for all traits; CG=contemporary group, NLB22=number lambs born 2022, NLW22=number lambs weaned 2022, DoA=day of assessment after weaning; *** P<0.001, ** P<0.01, * P<0.05, ns not significant, '-'=not tested; dam source, Total NLB, Total NLW, and days of lactation were ns effects on all traits, and ewe weight and condition scores pre-mating, late pregnancy and weaning were mostly ns (not reported here)

Table 2. Heritability (bold, diagonal), phenotypic correlations (above diagonal) and genetic correlations (below diagonal) (all ±s.e.) for ewe udder depth (UD), udder cleft (UC), teat size (TS) and teat placement (TP) at lambing (L) and weaning (W)

Trait	LUD	LUC	LTS	LTP	WUD	WUC	WTS	WTP
LUD	**0.29±0.09**	0.12±0.03	0.29±0.03	0.03±0.03	0.21±0.03	0.02±0.03	0.11±0.03	0.10±0.03
LUC	0.52±0.23	**0.17±0.07**	0.04±0.03	0.07±0.03	0.06±0.03	0.13±0.03	0.06±0.03	0.03±0.03
LTS	0.37±0.22	-0.24±0.25	**0.24±0.08**	0.42±0.03	0.11±0.03	0.26±0.03	0.31±0.03	0.28±0.03
LTP	-0.61±0.22	-0.59±0.23	0.55±0.18	**0.23±0.08**	-0.05±0.03	0.00±0.03	0.14±0.03	0.27±0.03
WUD	0.75±0.14	0.67±0.18	0.21±0.22	-0.60±0.19	**0.28±0.08**	-0.11±0.03	0.14±0.03	0.07±0.03
WUC	0.04±0.31	0.31±0.34	0.02±0.32	-0.03±0.34	0.00±0.30	**0.09± 0.05**	0.05±0.03	0.06±0.03
WTS	-0.04±0.21	0.22±0.25	0.79±0.12	0.34±0.21	0.19±0.20	-0.23±0.28	**0.36±0.09**	0.33±0.03
WTP	-0.16±0.24	-0.20±0.26	0.69±0.15	0.70±0.16	0.04±0.23	-0.65±0.23	0.60±0.16	**0.24±0.08**

Phenotypic and genetic correlations. Within stages, phenotypic correlations among the udder and teat traits were low to moderate (0.04 ± 0.03 to 0.42 ± 0.03 at lambing, and -0.11 ± 0.03 to 0.33 ± 0.03 at weaning). Phenotypic correlations between individual traits across the two stages were also generally moderate ranging from 0.13 ± 0.03 (UC) to 0.31± (0.03) (TS). At lambing, the genetic correlations between UD and UC (0.52 ± 0.23) and between UD and TP (-0.61 ±0.22) indicate that increasing UD is associated with deteriorating UC and high/horizontal TP, but at weaning those correlations were not different from zero. At both lambing and weaning UC and TP were unfavourably correlated genetically (-0.59 ± 0.23 and -0.65 ±0.23 respectively), indicating well-defined UC was associated with more vertical TP. Moderate positive genetic correlations between TS and TP at both lambing (0.55 ±0.18) and weaning (0.60 ± 0.16) imply that large teats tend to be placed vertically. In general, the genetic correlations estimated here are consistent with those of Fernandez *et al*. (1997). Scores for UD (0.75 ±0.14), TS (0.79 ± 0.12) and TP (0.70 ± 0.16) at lambing and weaning were highly correlated genetically. While these genetic parameter estimates have high associated errors and should be interpreted with caution, they do suggest that for UD, TS and TP there would be minimal re-ranking between lambing and weaning. UC at lambing and weaning was not significantly correlated genetically and the estimate had a high error (0.31 ± 0.34).

Implications. Ewe udder soundness, which encompasses aspects of udder and teat conformation has been shown to impact neonatal lamb survival (Hayman *et al.* 1955; Griffiths *et al.* 2019; Smith *et al.* submitted). Genetic improvement of ewe udder conformation may be a means of reducing lamb mortality. The phenotypic and genetic parameters estimated here suggest that for UD, TS and TP, there could be similar genetic gain through trait recording at either lambing or weaning. However, there are likely trade-offs relating to data collection logistics of scoring udder traits at lambing or weaning. Breeders who do not conduct birth records are likely to favour udder scoring at weaning. This may be advantageous for the UC trait, for which deleterious levels may not become evident until weaning. For those who already collect birth records, additional udder scores are likely a minor imposition and may offer better selection outcomes in terms of future lamb survival. Where a lamb dies as a neonate due to an udder issue of the dam, the problem would likely be identified if udder scoring were conducted at birth. If udders were not assessed until weaning, the issue may not be identifiable because the udder will go through involution returning to a dry state. In the current study, DoL was a non-significant effect on weaning udder scores, which is in contrast to Smith *et al*. (submitted), and therefore requires further investigation. However, DoL can only be accurately calculated with knowledge of the date of birth, adding support to udder scores at lambing. Further, assessor of udder traits at lambing was confounded with management group, and at weaning DoA was a significant effect, so both of these factors require consideration in udder trait data collection.

CONCLUSION

Udder depth, teat size and teat placement scored at lambing and weaning on Merino ewes was moderately heritable. For these three traits, the genetic correlations between records at lambing and weaning were high. This indicates that among ewes that have reared a lamb(s) to weaning, there would be minimal re-ranking of ewes across those stages. Udder cleft had lower heritability and lower genetic correlations from lambing to weaning than the other three traits. The phenotypic variance of udder cleft increased from lambing to weaning, suggesting that udder cleft issues develop during lactation and therefore may be more accurately assessed at weaning.

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