PRELIMINARY EVALUATION OF THE IMPACT OF VISUAL TRAITS ON LIFETIME EWE PERFORMANCE

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SUMMARY

Visual traits are considered valuable components within the breeding objectives of many Merino breeders. This paper aimed to estimate genetic and phenotypic correlations between visual traits and growth, body composition, reproduction and survival in adult ewes. The data were derived from Merino Lifetime Productivity (MLP) sites. Heritability estimates were high for body weight, eye muscle depth, fat depth, body wrinkle, breech wrinkle, breech cover and classer grade (0.32 – 0.64), moderate for urine stain (0.21) and legs score (0.23) and low for weaning rate (0.07) and ewe survival (0.06). Low to moderate negative (favourable) genetic correlations were estimated between the visual traits and body weight and composition, reproduction, and survival traits. Phenotypic correlations between the visual traits and adult body composition and weaning rate traits were negative and low. The genetic and phenotypic correlations estimated in this study were generally favourable hence consideration of visual traits in selection and classing may have beneficial effects on adult ewe performance.

INTRODUCTION

Merino sheep are often visually assessed for a range of traits that are not easily evaluated by quantitative measurements (Mortimer *et al*. 2009). These traits contribute to the cost of production, the value of wool and meat and the welfare of the sheep; hence, they are considered valuable components within the breeding objective of Australian Merino sheep. Professional sheep classers and trained technicians currently use standardised scoring systems to visually assess sheep for evaluations by Sheep Genetics and the Australian Merino Sire Evaluation Association (Brown *et al.* 2007; Australian Wool Innovation 2019; https://merinosuperiorsires.com.au/australian-sire-evaluation). Moderate heritabilities and low genetic correlations have been reported in the literature between some visual traits and body composition (Mortimer *et al.* 2009). Walkom and Brown (2016) estimated genetic parameters and relationships among some visual and production traits in the Sheep Cooperative Research Centre Information Nucleus Flocks. However, the association among early visual traits and ewe survival are largely unknown. This study utilised data from the Merino Lifetime Productivity (MLP) project (Ramsay *et al*. 2019) to estimate preliminary genetic relationships between visual classing traits recorded pre-selection and adult ewe measures of body composition, reproduction and survival.

MATERIALS AND METHODS

Data. Data were extracted for 5,916 Merino ewes from the Balmoral, MerinoLink, New England, Macquarie and Pingelly Merino Lifetime Productivity (MLP) project sites (Ramsay *et al.*

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2019). These first generation (F1) ewes were the progeny of 134 sires and 4,266 dams. All sites provided two cohorts of F1 ewes with lifetime data up to seven years of age. Additionally, the sires and sites represent the main wool growing regions in Australia and genotypes found in Australia (Ramsay *et al.* 2019). The data included lifetime records (all repeat records available) for weaning rate (WR), pre-joining adult body weight (AWT, kg), live ultrasound eye muscle depth (AEMD, mm) and live ultrasound fat at the C site (AFAT, mm). The visual traits included body wrinkle, breech wrinkle, breech cover, urine stain, legs score and classer grade, as defined in Table 1. The visual traits were scored on a scale of one to five except for grade, which was scored in categories of tops (1), flock (2) and culls (3). Ewe survival was defined as the ability of ewes to survive from yearling to beyond their fourth year of age (0 or 1). Individual ewes that missed consecutive adult reproduction, body and wool trait measurements due to involuntary culling or culling for welfare reasons were assumed to have been dispersed from the flock and assigned 0 for survival. Outlier measurements beyond four standard deviations across the dataset for body weight, fat and eye muscle measurements were dropped from the analysis.

Table 1. Visual trait descriptions, age stages considered and their standard scoring scale (Australian Wool Innovation 2019)

Trait	Description	Scores
Breech wrinkle (MBRWR)	Degree and quantity of wrinkle on the breech at marking (1 – no wrinkle and 5 – extensive wrinkle)	1 - 5
Body wrinkle (YBDWR)	Degree and quantity of wrinkle on the body at yearling (5 – extensive wrinkles and heavy folds of skin over the entire body)	1 - 5
Breech cover (MBCOV)	Amount of natural bare skin around the perineum and breech area at marking (5 – complete wool cover)	1 - 5
Urine (HURINE)	A score of the extent of breech, hind legs and tail wool stained by urine at hogget (5 – extensive urine)	1 - 5
Legs (PLEGS)	Overall soundness of the front and back leg and feet structure at post-weaning (5 – extreme angulation at the hocks and pasterns of the back legs)	1 - 5
Grade (HGRADE)	Standard of the sheep for visual performance relative to the flock breeding objective at hogget (1 – tops and 3 – culls)	1 – 3

Statistical analysis. Univariate and bivariate mixed linear models were used to estimate variance components and, genetic and phenotypic correlations between the visually assessed traits and body composition traits using the ASReml software package (Gilmour *et al.* 2015). Fixed effects in the models included contemporary group (flock, year of birth and management group, 97 levels), and the interaction between birth and rear type (8 levels). Additive genetic, permanent environmental and genetic group effects (182) were fitted as random. The permanent environmental effect was fitted for adult traits with repeated records. An extended pedigree with 10,546 animals from MERINOSELECT (Brown *et al.* 2007) was used to capture all known ancestors of the animals with data and their parents, and with genetic groups defined for base animals with unknown parents. Ultrasound fat and eye muscle depth records were adjusted for body weight (van der Werf 2004). Variance components and heritability for survival were based on a binomial univariate model. The correlations between muscle and fat and visual traits were post-adjusted for body weight as shown by van der Werf (2004).

RESULTS AND DISCUSSION

Low heritabilities were estimated for weaning rate (0.07) and survival (0.06) (Table 2). Low heritabilities for reproduction (Walkom and Brown 2016; Bunter *et al.* 2019) and survival traits

(Hatcher *et al.* 2009) have been commonly reported for Merino sheep. The heritability for fat, urine stain, leg score, classer grade, body weight, eye muscle depth, body wrinkle and breech wrinkle ranged from 0.21 to 0.64, indicating considerable genetic variation that could be exploited to improve these traits through selection. These parameters were within the ranges of estimates reported by Brown *et al.* (2010) and Walkom and Brown (2016). However, lower estimates for classer grade, body and breech wrinkle and legs scores for front and back legs have been estimated Mortimer *et al.* (2009). Future analysis using threshold models will be considered for the categorical traits.

Table 2. Data summary, genetic groups (σ_{gg}), additive genetic (σ_a), permanent environment (σ_{pe}) and phenotypic (σ_p) variances and heritabilities for body composition, weaning rate (WR), visual traits and ewe survival traits (full trait definitions in Table 1 and in data section)

Trait	Records	Mean (std)	σ^2_{gg}	σ^2_a	σ^2_P	h^2
AWT	15,338	59.06 (11.21)	4.15	19.86	48.93	0.41 (0.04)
AEMD	15,337	24.21 (3.23)	0.30	2.05	5.22	0.39 (0.04)
AFAT	15,331	3.36 (1.70)	0.08	0.43	1.10	0.40 (0.04)
WR	15,298	1.09 (0.67)	0.03	0.03	0.42	0.07 (0.02)
YBDWR	3,318	2.28 (0.84)	0.20	0.14	0.32	0.44 (0.08)
MBRWR	5,771	2.53 (0.95)	0.21	0.48	0.76	0.64 (0.06)
MBCOV	5,771	3.60 (1.11)	0.08	0.17	0.49	0.34 (0.05)
HURINE	2,564	1.71 (0.75)	0.01	0.08	0.41	0.21 (0.06)
PLEGS	3,824	2.08 (0.77)	0.03	0.13	0.54	0.23 (0.05)
HGRADE	5,304	2.00 (0.65)	0.03	0.13	0.41	0.32 (0.05)
Ewe Survival	5,494	0.77 (0.42)	0.01	0.21	3.50	0.06 (0.03)

The genetic relationships between early visual traits and adult body weight (Table 3), indicated that lower wrinkle, barer breech cover, lower urine stain, better legs and/or classer grade scores were all associated with heavier ewes. This relationship supports previous findings by Mortimer *et al.* (2009) and Brown *et al.* (2010). The association between early body and breech wrinkle scores and adult muscle and fat was also favourable, implying that plainer ewes (less wrinkle) were genetically more likely to have higher body condition. Similar results were reported by Walkom and Brown (2016) between wrinkle and joining condition scores, who also observed high genetic correlations between condition scores and muscle and fat. Ewes with more breech cover were genetically likely to have higher body fat. The positive correlation between classer grade and adult muscle and fat implies that classers favour ewes with lower body condition. This may be related to relationships between these traits and others not included in this study (wool traits for example), which is an area for further investigation. Phenotypic correlations followed a similar trend to the genetic correlations except for the positive correlation between urine stain and adult body weight and fat. Bigger and heavier ewes with longer fleece could, therefore, tend to have more urine stain.

Low and favourable genetic relationships existed between weaning rate and body wrinkle, breech wrinkle and leg scores showing that ewes with lower wrinkle and good legs would tend to wean more lambs. The relationship between urine stain and leg scores with weaning rate should be treated cautiously due to the high standard errors. The genetic correlation between classer grade and weaning rate was also negative, indicating a favourable relationship between classing and reproduction. Low phenotypic correlations were estimated between the visually assessed traits and weaning rate. Negative and moderate genetic correlations were estimated between survival and the wrinkle traits. These results suggest that plain bodied ewes with low breech cover score (barer breech) at an early age are likely to survive longer in the flock. The genetic correlations estimated between survival and breech cover, urine stains, legs and classer grade were considered not significantly different to 0. The phenotypic correlations between survival and the visual traits were also close to zero or not significantly different from zero. Further analysis of survival is required to better understand the impact of other traits.

Table 3. Genetic and phenotypic correlations between welfare traits at yearling, post-weaning or hogget stage and lifetime adult production

	Trait	AWT	AEMD	AFAT	WR	Ewe survival
Genetic	YBDWR	-0.18 (0.05)	-0.06 (0.05)	-0.12 (0.06)	-0.15 (0.08)	-0.43 (0.26)
	MBRWR	-0.09 (0.03)	-0.11 (0.03)	-0.08 (0.03)	-0.22 (0.06)	-0.46 (0.19)
	MBCOV	-0.33 (0.04)	0.02 (0.04)	0.11 (0.04)	-0.05 (0.08)	-0.01 (0.21)
	HURINE	-0.35 (0.08)	-0.14 (0.08)	-0.03 (0.08)	-0.21 (0.13)	-0.03 (0.29)
	PLEGS	-0.36 (0.07)	-0.11 (0.06)	0.06 (0.06)	-0.23 (0.10)	0.04 (0.27)
	HGRADE	-0.53 (0.04)	0.16 (0.04)	0.21 (0.05)	-0.24 (0.08)	-0.01 (0.20)
Phenotypic	YBDWR	-0.12 (0.02)	-0.04 (0.02)	-0.17 (0.03)	-0.07 (0.02)	-0.01 (0.02)
	MBRWR	-0.06 (0.02)	-0.13 (0.02)	-0.15 (0.02)	-0.10 (0.02)	-0.03 (0.01)
	MBCOV	-0.26 (0.02)	0.05 (0.02)	0.01 (0.04)	-0.03 (0.02)	-0.03 (0.01)
	HURINE	0.21 (0.03)	-0.11 (0.03)	0.01 (0.03)	0.03 (0.03)	-0.04 (0.02)
	PLEGS	-0.16 (0.02)	-0.06 (0.02)	-0.01 (0.03)	-0.03 (0.02)	-0.01 (0.02)
	HGRADE	-0.42 (0.02)	0.05 (0.02)	0.01 (0.02)	-0.05 (0.02)	-0.00 (0.01)

CONCLUSION

The genetic and phenotypic correlations estimated in this study were generally favourable hence emphasis on visual traits prior to first selection of maiden ewes into the breeding flock may have beneficial effects on adult ewe performance. This was a preliminary analysis and after data collection is completed a more comprehensive analysis will be conducted.

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