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GENETIC ESTIMATES FOR ALONG AND ACROSS FIBRE DIAMETER VARIATION AND CORRELATIONS WITH SUBJECTIVE WOOL QUALITY TRAITS IN MERINO SHEEP

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SUMMARY

Genetic and phenotypic correlations were estimated for along and across fibre diameter components measured by the Optical Fibre Diameter Analyser 2000 (OFDA2000) and a range of subjectively assessed wool quality scores. Results demonstrated that greasy wool handle, wool staple structure and wool character were strongly genetically correlated with fibre diameter, overall fibre diameter standard deviation, minimum fibre diameter along the fibre and maximum fibre diameter along the fibre (0.51-0.68). Genetic correlations for across fibre co-efficient of variation with subjective wool quality scores were all low to negligible (<0.40). However, along fibre co-efficient of variation had a moderate favourable genetic correlation with staple structure (0.47±0.11) and greasy wool handle (0.38±0.13). All other correlations were low to negligible. Correlations for fibre diameter, overall fibre diameter standard deviation and overall fibre diameter co-efficient of variation with subjective wool quality scores were generally higher in magnitude than the along or across fibre diameter distribution traits. They were also estimated in a favourable direction with most subjective wool quality scores. Therefore selecting for sheep with less variable fibre diameter will result in correlated improvements in subjective wool quality scores.

INTRODUCTION

The OFDA2000 is utilised to measure fibre diameter and is capable of splitting fibre diameter into along and across fibre components. This provides the opportunity to investigate the genetic relationships between fibre diameter and its components with the suite of visual wool quality scores as well as greasy wool handle. Subjectively recorded traits can be difficult to assess accurately and precisely and determining the estimated correlated response with along and across fibre components may reveal a method of achieving greater genetic gain. Overall fibre diameter co-efficient of variation has been shown to be highly heritable (0.48) (Mortimer *et al.* 2009) with a moderate to strong relationship with greasy wool handle (Roberts 1956; Stevens 1994), wool character (Mortimer *et al.* 2009; Robinson *et al.* 2007), staple weathering (Mortimer *et al.* 1990) and fleece rot (Evans and McGuirk 1983; Watts *et al.* 1981). Estimating the phenotypic and genetic correlations between the visual wool quality wool scores, greasy wool handle and along/across fibre components will further determine if there is any benefit in terms of genetic gain in dividing fibre diameter distribution into its along or across fibre components compared to utilising overall mean fibre diameter coefficient of variation. A previous paper by Preston and Hatcher (2013) provided heritability estimates and variance components for the along and across fibre diameter traits. This paper will report the correlated response of along and across fibre attributes with visual wool quality scores and greasy wool handle.

MATERIALS AND METHODS

Data was obtained from the Information Nucleus Flock (INF) conducted by the Sheep Cooperative Research Centre (Fogarty *et al.* 2007; van der Werf *et al.* 2010). The data used in this study has been previously described by Preston and Hatcher (2013). In addition all progeny were Merino's assessed at yearling age (10-13 months) for a range of subjectively assessed visual wool quality scores (AWI & MLA 2007). Traits assessed in this study included greasy wool colour (GCOL), wool character (CHAR), dust penetration (DUST), staple weathering (WEATH), fleece rot (FLROT) and staple structure (STRUCT). All traits were scored on a 1-5 scoring system with a higher score representing the less desirable expression. GCOL, STRUCT and CHAR were all assessed on the midside of the sheep; while DUST, WEATH and FLROT were assessed along the top-line of the sheep where the expression of the traits was likely to be most pronounced. Textural greasy wool handle (HAND) was assessed according to Casey and Cousins (2010). This involves the textural components of the wool and requires the assessor to rub their finger along the fibre in a base to tip direction and allocated a 1-5 score with a higher score represented a harsher and more abrasive surface. Midside samples were collected and measured at a commercial fleece measurement laboratory (AWTA Limited Melbourne). For OFDA2000 traits, one staple was chosen at random from the midside sample and then cleaved into the formation of smaller micro staples. The micro staples were then placed on the OFDA2000 fibreglass xy slide and measured for fibre diameter. OFDA2000 output included fibre diameter (FD), overall fibre diameter standard deviation (FDSD), overall fibre diameter co-efficient of variation (FDCV), maximum fibre diameter along the fibre (AMAX), minimum fibre diameter along the fibre (AMIN), across fibre diameter co-efficient of variation (ACCV) and along fibre diameter co-efficient of variation (ALCV).

ASReml 3.0 (Gilmour *et al.* 2009) was used to estimate the genetic parameters using general linear mixed model and residual maximum likelihood methods. As described in Preston and Hatcher (2013), a univariate analysis of all traits including the addition of the following fixed effects: flock (8 sites), year of birth (2007, 2008, 2009, 2010), sex (male, female), dam age (2, 3, 4, 5, 6), birth type rearing type (born single raised single, born twin raised single and born and raised as a multiple) and siregroup (ultra/superfine, fine/fine medium & medium/strong) with appropriate two way interactions. A number of models were fitted to each trait which varied in the combination of random effects (i.e. sire.flock and maternal effect) and a means to account for genetic groups (fitted as random or fixed). Genetic groups were allocated according to the obtained pedigree. Progeny from ancestors with a low number of offspring were removed and then merged into groups with insufficient data. The genetic grouping accounted for the differing ewe foundation flocks at each of the Information Nucleus flocks. The most appropriate model for each trait was determined by log likelihood ratio tests. Phenotypic and genetic correlations for each trait were estimated from the appropriate co-variances in ASReml.

RESULTS AND DISCUSSION

The phenotypic correlations between the along and across fibre traits and subjective wool quality traits were all low to negligible (<0.4) (Table 1). This indicates that within flock there is little to no relationships between these traits. ACCV and ALCV had a lower phenotypic relationship with subjective wool traits than FDCV or FDSD.

Genetic correlations were all stronger in magnitude than the corresponding phenotypic correlations and had higher standard errors which may influence the estimates (Table 2). STRUCT and HAND both had strong positive genetic correlations with FD, FDSD, AMAX and AMIN (>0.60). Therefore selection for either finer fibre diameter, less variable fibre diameter distribution, lower maximum or minimum diameter along the fibre will result in wool with smaller fibre bundles that are texturally softer. STRUCT, HAND and CHAR also had low to moderate positive genetic correlations with ALCV (0.47±0.11, 0.38±0.13 and 0.25±0.13 respectively). Genetic correlations with ACCV were much lower in magnitude (≤0.05) inferring that STRUCT, HAND and CHAR are more associated with along fibre diameter components rather than across fibre attributes. FLROT had a low positive genetic correlation with FDCV (0.30±0.08) and ACCV (0.39±0.09), which supports previous reports that fleecerot is linked to fibre diameter distribution

(Evans and McGuirk 1983; Watts *et al.* 1981). All other genetic correlations with FLROT were negligible (≤0.13) including ALCV (0.00±0.13); inferring that greater response to selection will be achieved if ACCV was used. In agreement with Hatcher *et al* (2004), DUST had a negligible genetic correlation with ALCV or ACCV (≤0.02). DUST and GCOL both had favourable low to moderate positive genetic correlation with FD, FDSD, AMAX and AMIN ($0.44 \leq r_g \geq 0.25$). Therefore selection for finer fibre diameter, reduced overall fibre diameter distribution and lower minimum and maximum diameter along the fibre will generate correlated improvements in greasy wool colour (i.e. whiter wool) and reduced dust penetration along the wool staple.

Table 1. Phenotypic correlations (r_p) between OFDA traits and subjectively assessed traits

	GCOL	CHAR	DUST	WEATH	FLROT	STRUCT	HAND
FD	0.15±0.02	0.20±0.02	0.05±0.02	0.04±0.02	-0.08±0.02	0.30±0.01	0.28±0.02
FDSD	0.16±0.02	0.26±0.02	0.05±0.02	0.04±0.02	0.03±0.02	0.29±0.01	0.25±0.02
FDCV	0.08±0.02	0.17±0.02	0.02±0.02	0.02±0.02	0.10±0.02	0.12±0.02	0.09±0.02
AMAX	0.14±0.02	0.19±0.02	0.05±0.02	0.05±0.02	-0.07±0.02	0.29±0.01	0.27±0.02
AMIN	0.16±0.02	0.20±0.02	0.05±0.02	0.03±0.02	-0.06±0.02	0.30±0.01	0.28±0.02
ACCV	0.09±0.02	-0.01±0.02	-0.04±0.02	0.02±0.02	0.13±0.02	-0.03±0.02	-0.04±0.02
ALCV	0.00±0.02	0.07±0.02	0.01±0.01	0.01±0.02	0.00±0.02	0.05±0.02	0.06±0.02

Table 2. Genetic correlations (r_g) between OFDA traits and subjectively assessed traits

	GCOL	CHAR	DUST	WEATH	FLROT	STRUCT	HAND
FD	0.33±0.07	0.51±0.07	0.25±0.10	0.11±0.09	-0.13±0.08	0.68±0.06	0.63±0.07
FDSD	0.44±0.07	0.68±0.06	0.27±0.10	0.22±0.10	0.11±0.09	0.70±0.06	0.61±0.08
FDCV	0.24±0.08	0.39±0.08	0.08±0.11	0.21±0.10	0.30±0.08	0.25±0.09	0.16±0.10
AMAX	0.37±0.07	0.52±0.07	0.27±0.10	0.19±0.09	-0.11±0.08	0.70±0.07	0.68±0.07
AMIN	0.37±0.07	0.53±0.07	0.28±0.10	0.11±0.09	-0.10±0.08	0.67±0.06	0.65±0.07
ACCV	0.24±0.09	0.03±0.10	0.02±0.12	0.26±0.11	0.39±0.09	-0.01±0.10	-0.05±0.12
ALCV	0.13±0.13	0.25±0.13	0.02±0.15	0.22±0.14	0.00±0.13	0.47±0.11	0.38±0.13

Merino breeding programs with a focus on selecting for finer less variable wool will generate correlated improvements in STRUCT, HAND, CHAR, GCOL and DUST. All results had favourable correlations; which suggests that there would be minimal negative effect on visual wool quality scores when producers select for wool with less variable fibre diameter distribution. These results indicate most visual wool quality scores would have a greater response to selection when utilising a overall fibre diameter distribution trait rather then splitting it into its along and across fibre components. Therefore there would be little value in including the latter in a Merino breeding program.

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