GENETIC PARAMETERS FOR OBJECTIVELY MEASURED STYLE TRAITS OF MERINO FLEECES.

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SUMMARY
Genetic parameters are presented for style traits as measured by The Style Machine. Most style traits were moderately to highly heritable and all should respond to selection. Selection to simultaneously improve mean fibre diameter and clean fleece weight should result in improvements in most style traits.

Keywords: Merino, wool, style.

INTRODUCTION
The value of Merino wool is determined in part by the wool trade’s assessment of style. In the case of Merino combing fleece wools, style is currently determined by subjective appraisal of a suite of characteristics including crimp definition and uniformity, staple tip weathering, dust penetration and greasy colour (Winston 1989). The application of image analysis technology to the measurement of the components of style has culminated in a prototype instrument (The Style Machine) developed to provide pre-sale objective measurements of these characteristics (Humphries 1994). The instrument may also find application in the measurement of these traits on individual sheep for use as selection criteria in Merino breeding programs. The relative emphasis applied to style characteristics in current breeding programs may be considerable given the importance assigned to traditional wool quality by stud Merino breeders in NSW (Casey 1990). The efficient use of all or any of the measured style traits in Merino breeding programs requires reliable estimates of genetic parameters for each candidate trait and between them and other economically important traits such as fleece weight and mean fibre diameter. Genetic parameter estimates have been published for the Merino breed for some of these traits based on subjective appraisal (Gregory 1982a and b, James et al 1990, Lax et al 1995). This paper presents preliminary estimates based on objective measurements of Merino fleece samples by The Style Machine.

METHODOLOGY
The sheep and wool metrology. Fleece samples of 12 months wool growth were taken from the mid-side location of two drops of fully pedigreed 16 month old ewes (n = 1,312) of the Fine, Medium-Peppin and Broad wool Merino strains. The ewes are the progeny of 971 ewes and 69 rams sampled directly from or on the recommendation of parent studs of each strain and are part of the base population from which the selection lines within the QPLUS Project were established. The project is being conducted at Trangie ARC in central NSW and is described by Taylor and Atkins.

(In press). Fleeces including belly wool were weighed prior to skirting. Sub-samples from the mid-side were aqueous scoured to derive an estimate of yield and clean fleece weight (cfw) and were minicored and measured using Laserscan to derive estimates of mean fibre diameter (mfd). Ten staples from each mid-side sample were measured using The Style Machine to provide mean values for each ewe of the following characteristics, staple tip length (tipl) - from apex of staple tip down to 75% of mean staple width, staple tip weathering (tipw) - the length of staple above the upper margin of the dust band, crimp frequency (crfreq), - the average number of crimps per cm along the length of the staple, crimp irregularity (irreg), - the standard deviation of crimp frequency across the face of the staple, dust penetration (dust), - the depth from staple tip to the lower margin of the dust band, yellowness (yellow), - Y - Z (tristimulus values) of the staple below the lower margin of the dust band.

(Note: These measures are not necessarily of the form intended for pre-sale specification of sale lots.)

Statistical methods. Square root transformations were applied to tipl, irreg and dust and a log transformation applied to crfreq to rectify departures from normality and/or heterogeneity of variance across strains. Least squares analyses of variance were used to identify significant fixed effects for each variable. Variance components were estimated from an animal model by restricted maximum likelihood using ASREML (Gilmour et al 1996) fitting strain, year, strain by year, birth/rearing status and date of birth as fixed effects and direct genetic and maternal environment as random effects. Maternal environmental effects were significant for cfw, tipw and yellow. For subsequent bivariate analyses covariance due to maternal environment was estimated for these traits only.

RESULTS

Genetic parameters for each trait are given in Table 1. All traits were moderately to highly heritable with the exception of irreg and yellow and all exhibit considerable phenotypic variance. Between-sheep variation was particularly high among the style traits with coefficients of variation ranging from 14% for dust to 42% for irreg. The phenotypic correlations among style traits were generally negligible to weak, the exceptions being the positive correlations between tipw and tipl and between dust and tipl, tipw and yellow. In contrast the genetic correlations indicate moderate to strong association among most style traits, although the genetic correlations of irreg with tipw and dust and of yellow with crfreq and tipw were negligible. The phenotypic correlations between cfw and mfd and style traits were also low except that crfreq and irreg had moderate negative associations with mfd. Crfreq also had a strong negative association with cfw. The genetic correlations between mfd, cfw and the style traits were generally moderate to strong, the exceptions being between mfd and yellow and between cfw with tipl and dust.

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Table 1. Genetic parameters (+ se) for mfd, cfw and some objectively measured style traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>mfd (µm)</th>
<th>cfw (kg)</th>
<th>tip1 (mm)</th>
<th>crfreq (no/cm)</th>
<th>irreg (no/cm)</th>
<th>tipw (mm)</th>
<th>dust (mm)</th>
<th>yellow (Y-Z)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>21.09</td>
<td>4.28</td>
<td>4.89 #</td>
<td>3.82 #</td>
<td>0.45 #</td>
<td>10.80</td>
<td>45.10 #</td>
<td>5.72</td>
</tr>
<tr>
<td>*phenotypic</td>
<td>1.35</td>
<td>0.57</td>
<td>1.17*</td>
<td>0.54*</td>
<td>0.19*</td>
<td>3.95</td>
<td>6.16*</td>
<td>1.88</td>
</tr>
</tbody>
</table>

**bold, r_p above, r_# below diagonal. * = back transformed, " = approximate. Standard errors for r_Ps range from 0.02 to 0.03.**

**DISCUSSION**

Based on the parameter estimates presented we anticipate worthwhile improvements in all style traits in response to single trait selection. Assuming that 5% of rams and 50% of ewes are selected, with a generation interval of 3.5 years, response per year is expected to be in the order of 2.0% (tip1), 2.2% (crfreq), 1.6% (irreg), 4.6% (tipw), 2.4% (dust) and 0.7% (yellow). This compares favourably with predicted responses in mfd and cfw of 1.9% and 1.7% respectively. The relatively low heritability of irreg and yellow is compensated to some extent by the high phenotypic variance exhibited by these traits (between-sheep coefficients of variation of 42% and 33% respectively).

In terms of simultaneously improving the suite of style traits, the generally weak phenotypic correlations indicate that fleeces regarded highly for one style trait will not necessarily be superior for others. A notable exception is the strong phenotypic protagionism between dust and tipw and the weaker but favourable association between these and tip1. At the genetic level, however, the magnitude and sign of the correlations indicate excellent potential to improve most style traits in response to selection for any one. The exception to this is the antagonism evident between tip1 and irreg. Although not strictly a style trait, crfreq also exhibits genetic antagonism with irreg and tipw.

The parameters indicate that selection to improve cfw and/or mfd will result in improvements in most style traits. The phenotypic correlations indicate that heavy fleeces will generally exhibit low crfreq but no obvious association with other style traits. The quite strong and favourable genetic correlations indicate that selection to increase cfw will result in improvements in all style traits except tip1 which should not change. Fleeces of low mfd will, on average, display increased crfreq
and irreg, reduced tipw and dust and little association with tip1 or yellow. The genetic correlations indicate that selection to reduce mfd will result in improvements in tip1, tipw and dust, an increase in crfreq, a deterioration in irreg and a small increase in yellow.

The deterioration anticipated in crfreq, irreg and to a lesser extent yellow in response to selection to reduce mfd will be moderated to some extent in breeding programs focused on increasing cfw as well. Predictions of the net change in these style traits will depend on the relative emphasis applied to mfd and cfw in the breeding objective. The 3%, 8% and 15% micron premium selection lines established within the QPLUS Project (Taylor and Atkins in press) will demonstrate changes in style traits in response to a range of selection emphases on mfd relative to cfw.

At present the economic incentive to improve style is relatively small. Over the last three years, across all fibre diameter categories, variation in style grade has accounted for only 2.6% (range by financial quarter 1.3% - 4.0%) of the variation in price paid at auction for Merino combing fleece wool (IWS 1994 - 1996). There are clear indications, however, that the importance of style as a determinant of price increases as mean fibre diameter is reduced. For the same period, price differentials between Spinners grade (now MF3) and Average Topmaking (now MF6) ranged from 10.8% for fleece wools in the 18.6 - 20.5\(\mu\)m category, through 5.1% for the 20.6 - 22.5\(\mu\)m categories to 1.8% for fleece wools in the 22.6 -24.5\(\mu\)m category. This implies that breeders contemplating a reduction of mfd in their broad or medium wool flocks may need to focus some attention on style traits in future. The parameters presented here suggest that breeders implementing within-flock selection to simultaneously reduce mfd and increase cfw should also anticipate some correlated improvement in most style traits.

ACKNOWLEDGMENTS
Support for this project was provided by Australian woolgrowers and the Australian Government through the Australian Wool Research and Promotion Organisation. Approval by CSIRO Division of Wool Technology to measure these samples using The Style Machine is gratefully acknowledged. Thanks also to Mr Jason Lobb who operated The Style Machine.

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