DUST PENETRATION IS NOT GENETICALLY AND PHENOTYPICALLY THE SAME TRAIT AS DUST CONTENT

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SUMMARY

Breeders use dust penetration as a measure of dust content when selecting indirectly for higher yielding wool and better style wool. Merino wool from 1053 ewe and wether hoggets was used to estimate genetic parameters of dust and wool production traits. Dust penetration and dust index had a moderate genetic correlation (0.54), but a low phenotypic correlation (0.32) with each other. Dust index was moderately heritable (0.36), while the heritability of dust penetration was low (0.21). It was concluded that dust penetration and dust content are genetically distinct therefore dust penetration should not be used as a measure of dust content. Breeders would make faster genetic gain in reducing dust content by selecting animals for higher yield rather than dust penetration. Style grades might get worse as the wools would look dirtier but have better yields.
Keywords: Wool, Merino, heritability, dust, yield

INTRODUCTION

Western Australian farmers have been faced with the long-standing issue of their wools being labelled "dirty" (Anonymous 1832). Dust content, along with wax, suint (sweat) and vegetable matter, is a non-wool component that lowers the yield of raw wool fibre. The average yield of WA wools is about 3% below the national average (Couchman *et al.* 1992). Couchman *et al.* (1992) estimated that a yield increase of 5% would be worth $1 million to Western Australia. Therefore it is integral to Western Australian wool farmers that they increase yield of their wool.

Lowering dust content is a priority for increasing yield in Western Australia's dusty Mediterranean environment. Dust content is measured by a dust index, which is the amount of dust expressed as a percentage of clean, dry wool. Currently, estimations of dust content are made using the penetration of dust into the staple as an indicator that is based on the general assumption that dust penetration is highly correlated with dust content. This assumption has been challenged by Charlesworth (1970) and Schlink and Murray (unpublished) who both found a moderate phenotypic correlation between dust penetration and dust content. Despite these studies, dust penetration is still used as a measure of dust content to class wool and for breeding purposes to improve yield and style grade. We hypothesise that dust penetration and dust content are only moderately correlated. Since dust penetration is the only dust measurement included in style, and we expect dust penetration and dust content to be moderately correlated, it is unlikely that selection for better styles will reduce dust content and improve yield efficiently.

Swan *et al.* (1997) found the heritability of dust penetration to be low (0.01) which indicates that breeding for lower dust penetration would not be very successful. However, yield is a highly heritable trait (Atkins 1997; Greeff and Schlink 2002; Rose and Pepper 1999) while its component traits, wax and suint are both moderately heritable (0.40) (Mortimer and Atkins 1993). As dust content is a non-wool component, similar to wax and suint, and directly affects yield, it is hypothesised that dust content may also be moderately heritable and therefore a potentially desirable trait for breeders to include in their breeding programmes.

MATERIALS AND METHODS

This study was carried out on the Merino Resource flocks of the Department of Agriculture of Western Australia at Katanning. This flock is fully pedigreed. Fifty-two sires of different Merino strains were used to produce 1053 progeny born in June/July 2000 and reared under normal commercial conditions. The animals were shorn as lambs and again as hoggets with 12 months wool growth. Mid-side wool samples were collected and analysed for yield, wax, suint and dust content.

Wax, suint and dust content were determined using a modification of the column extraction method outlined by Hemsley and Marshall (1984). Weight loss instead of centrifugation was used to determine the content of wax, suint and dust. Yield was expressed as the proportion of clean fleece weight relative to conditioned greasy fleece weight. Wax, suint and dust content were expressed as percentages of clean, dry wool and termed wax, suint and dust indexes. Dust penetration was objectively assessed by measuring the depth of dust into 10 wool staples with a ruler. These measurements were averaged, and expressed as a percentage of staple length.

Phenotypic variances, heritabilities, and phenotypic and genetic correlations were all determined using ASREML (Gilmour *et al.* 1999). An animal model was used. Age of the dam, type of birth and group were fitted as fixed effects. As males and females were managed separately, sex was confounded with group. All first order interactions were fitted but none were found to be significant and therefore left out of the final model. In addition animal was fitted as a random effect apart from error.

RESULTS AND DISCUSSION

The genetic and phenotypic correlations between dust penetration and dust index are not as high as normally assumed ($r_p = 0.32$, $r_g = 0.54$) and therefore not phenotypically or genetically the same trait. Consequently, if breeders select against dust penetration to reduce dust content and to improve yield in their wool, they will make slow genetic progress. The phenotypic correlation is lower than reported by Schlink and Murray (unpublished) and Charlesworth (1970). This is not surprising because Charlesworth's experiment was carried out in drought conditions when it is possible that a higher than normal correlation might be expected. The experiment by Schlink and Murray (unpublished) was carried out in various areas of WA, some of which are likely to be dustier than Katanning.

Dust index was moderately heritable (0.36) as hypothesised, while the heritability of dust penetration was low (0.21) (see Table 1). This high heritability makes dust content a desirable trait to use to select indirectly for higher yield. However, dust content may be hard to estimate visually especially considering it has only a moderate correlation with dust penetration.

Table 1 Mean values, coefficient of variation (CV), phenotypic variances (Vp) and the heritability (h^2) for yield related wool traits

Trait	Mean	CV	Vp	h^2
Dust index (%)	10	39	15	0.36
Dust penetration (%)	28	20	33	0.21
Yield (%)	70	7	26	0.75
Suint index (%)	11	30	11	0.72
Wax index (%)	24	32	58	0.61

Yield has a high heritability and phenotypic variance (0.75, 26). However, yield is difficult to estimate on farms and is expensive to measure on a large scale. Therefore, it could be more desirable for farmers to select for increased yield by indirectly selecting against wax, suint and dust index, as these traits are genetically highly correlated with yield (Table 2).

Table 2 Phenotypic (r_p) and genetic (r_g) correlations between yield (%) and non-wool components

	Yield (%)			
Non-wool components	$\mathbf{r_p}$	± se	$\mathbf{r_g}$	± se
Wax index (%)	**-0.73**	± 0.02**	**-0.90**	± 0.04**
Suint index (%)	**-0.63**	± 0.02**	**-0.86**	± 0.06**
Dust index (%)	**-0.47**	± 0.03**	**-0.71**	± 0.11**
Dust penetration (%)	**-0.03**	± 0.04	**-0.01**	± 0.21

* Statistically significant from zero at the 5% level
** Statistically significant from zero at the 1% level

As expected high phenotypic and genetic correlations were found between yield and the non-wool component traits wax (-0.73, -0.90), suint (-0.63, -0.86), and dust index (-0.47, -0.71). However, the phenotypic and genetic correlations between yield and dust penetration were non-significant (-0.03, -0.01).

Dust index had a positive genetic correlation with wax index (0.37), while dust penetration had a negative genetic correlation of -0.40 with wax index (Table 3). This indicates that selecting for lower amounts of wax in the fleece will lower dust index while increasing dust penetration. It appears wax acts as a barrier to dust penetration but its sticky nature attracts dust to the tip of the staple therefore increasing dust index (Henderson 1968).

Suint had positive phenotypic and genetic correlations (0.23; 0.51) with dust index and therefore its sticky nature will also attract dust (Table 3). Positive phenotypic correlations between suint and dust index are also reported by Charlesworth (1970) and Schlink and Murray (unpublished). Therefore high levels of suint reduce yield and increase dust index, as well as enhancing the likelihood of fleece rot. Suint contributes to yellowing of the wool which lowers style and therefore farmers should endeavour to keep suint to a minimum.

Table 3 Phenotypic (r_p) and genetic (r_g) correlations of dust index and dust penetration with wax and suint indexes

Trait	Dust index (%)				Dust penetration (%)			
	$\mathbf{r_p}$	± se	$\mathbf{r_g}$	± se	$\mathbf{r_p}$	± se	$\mathbf{r_g}$	± se
Wax index (%)	**0.39**	± 0.03**	**0.37**	± 0.17*	**-0.17**	± 0.03**	**-0.40**	± 0.20*
Suint index (%)	**0.23**	± 0.03**	**0.51**	± 0.16**	**0.11**	± 0.04**	**0.19**	± 0.20

* Statistically significant from zero at the 5% level
** Statistically significant from zero at the 1% level

CONCLUSION

Dust penetration is a poor indicator of dust content in Merino wool and therefore should not be used in breeding programs to reduce dust content and improve yield.

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REFERENCES

Anonymous (1832) *Western Australian Chronicle*, pp. 6.
Atkins K.D. (1997) The Genetics of Sheep. (Eds L Piper and A Ruvinsky) pp. 471 - 504. [CAB International: UK]
Charlesworth D.H. (1970) A study of dust contamination in Merino wool in low rainfall areas. MSc thesis, University of NSW.
Couchman R.C., Hanson P.J., Stott K.J., Vlastuin C. (1992) Management for Wool Quality in Mediterranean Environments. Perth, WA. (Eds P.T. Doyle, J.A. Fortune and N.R. Adams) pp. 1- 23. [Western Australian Department of Agriculture]
Greeff J.C., Schlink A.C. (2002) *Wool Tech. Sheep Breed.* **50**, 6 - 10.
Gilmour A.R., Cullis B.R., Welham S.J. and Thompson R. (1999). ASREML manual. NSW Agriculture Biometric Bulletin No.3.
Hemsley J.A., Marshall J.T.A. (1984) *Wool Tech. Sheep Breed.* **Dec/Jan**, 145 - 163.
Henderson A.E. (1968) 'Growing Better Wool.' [A.H. & A.W Reed: Wellington, N.Z.]
Mortimer S.I., Atkins K.D. (1993) *Aust. J. Agric. Res.* **44**, 1523 - 1539.
Rose M., Pepper P.M. (1999) *Proc. Assoc. Adv. Ani. Breed. Gene.* **13**, 114 - 117.
Swan A.A., Purvis I.W., Hansford K., Humphries (1997) *Proc. Assoc. Adv. Ani. Breed. Gene.* **12**, 153 - 157