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CAN ALONG AND BETWEEN FIBRE DIAMETER VARIATION MAKE A CONTRIBUTION IN MERINO BREEDING PROGRAMS?

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SUMMARY

The Optical Fibre Diameter Analyser 2000 (OFDA2000) model allows coefficient of variation of fibre diameter (CVFD) to be separated into a between fibre diameter variation component and an along fibre diameter variation component. Both traits are heritable (0.4 and 0.20, respectively) but not as heritable as CVFD on a minicored sample (0.67). Only CVFD between fibres is genetically strongly (-0.7) correlated with SS to nearly the same extend as CVFD (-0.65). It is more effective to use CVFD of wool samples as an indirect selection criterion to improve SS. In addition this will also result in a reduction in the propensity of FD to blowout along the staple.

Keywords: Genetic parameters, fibre diameter variation, staple strength, micron blowout.

INTRODUCTION.

It has been shown that coefficient of variation of fibre diameter (CVFD) is an inexpensive and valuable indirect selection criterion (Greeff *et al*. 1995) to improve staple strength (SS). It is commonly used in Merino breeding programs as it has a medium to high heritability and it is moderately to strongly genetically correlated to SS. CVFD is a composite trait consisting of the between and along fibre diameter variation of fibre diameter. Brown *et al*. (1999) reported genetic differences in fibre diameter profile characteristics at both the individual sheep and bloodline level. It has therefore been suggested that changing the fibre diameter profile could improve SS and reducing fibre diameter variation along the staple could also reduce fibre diameter blowout (FD blowout) during the growing season. Yamin *et al.* (1999) estimated the heritability of CVFD along the staple using individual wool snippets on mature Merino ewes. They estimated the heritability of CVFD along the staple to be between 1 and 20 % and found a low to moderate phenotypic correlation of 0.15 to –0.43 with SS.

The Optical Fibre Diameter Analyser 100 model (OFDA100) measures FD and CVFD on 2mm wool snippets under controlled conditions in the laboratory. This machine was recently adapted to the OFDA2000 to obtain measurements of FD and CVFD on a single greasy wool staple outside the laboratory (Brims *et al.* 1999). This new OFDA2000 is also able to provide measurements of the between and along fibre diameter variation of a greasy wool staple. This paper reports on the genetic value of these measurements (CVFD between and along the staple) in hogget animals to improve SS or to restrict FD blowout along the staple.

MATERIALS AND METHODS

The dataset consisted of 1756 records of Merino hoggets born in 1998 and 1999 in the Katanning Merino resource flocks. The original flock was established in 1982 and consists of animals bought from 12 different studs. In 1986, four additional flocks were added from the performance testing ram breeding groups. Ewe replacements were randomly selected from within each stud from the resource flock, while replacement rams were bought from each individual stud as described by Lewer *et al.* (1992).

The animals in the dataset were born from 1102 ewes that were single-sire mated to 100 sires in 1998 and 1999. Complete pedigrees were available for all animals. The animals were shorn in spring in 1999 and 2000 with 12 months wool growth. Midside wool samples were collected. SS was measured on 10 staples from each fleece and the values averaged. The midside wool samples were minicored into 2mm snippets, that were washed and tested for fibre diameter (FD minicore) and CVFD (CVFD minicore) on the OFDA100 in the laboratory. FD (FD staple) and CVFD (CVFD staple) were also measured on a greasy wool staple with the OFDA2000. As the OFDA2000 measures FD across the staple every 5 mm along the greasy staple, this process also provides the FD profile of the staple from which the minimum FD (FD minimum) and maximum FD (FD maximum) along the staple was obtained. The number of measurements along the staple were standardized to 25 per staple and an average FD calculated (FD staple). The CVFD along the staple (CVFD along) was calculated from the average FD measurements along the staple. The CVFD between fibres (CVFD between) was calculated by averaging the CVFD measured at every point along the staple.

James (1998) has shown that the difference between FD measured at different times (micron blowout) could result in a non-zero heritability due to a difference in the genetic variances of FD recorded at the different ages. Hill *et al.* (1999) recommended that genetic parameters between a trait and the two fibre diameter traits used to estimate micron blowout, be calculated after standardising the fibre diameter measurements to a common genetic variance. Thus FD measured at the minimum and maximum FD along the staple was standardized according to the method proposed by Hill *et al.* (1999) to calculate standardised FD blowout along the staple. The data were analysed with ASREML (Gilmour *et al.* 1999). An animal model was fitted with age of the dam, birth status, sex and shearing year as fixed effects and date of birth was fitted as a covariate. All two way interactions were fitted and the non-significant effects deleted from the model. As the animals were managed within sex groups, sex and management group were completely confounded. Only significant ($P<0.05$) effects were kept in the model.

RESULTS AND DISCUSSION

Table 1 shows that the wool was part tender (under 33N/Ktex). The average minimum FD was 16.6 ìm in late autumn, that increased to 22.1 ìm in spring which resulted in an average increase of 5.5 micron along the staple within the production year. The CVFD at the minimum and maximum FD was virtually the same at 9 %. The average FD of the minicored midside sample agreed reasonably well with the average FD tested on the staple with a correlation of 0.82, while CVFD of the midside sample was slightly higher than that measured on the staple with a correlation of 0.72. The average CVFD along the staple was 3.4 % compared to 22.4 % for CVFD between fibres in the staple.

Genetic parameters. The heritability of SS (Table 2) agreed with previously published estimates (Greeff et al. 1995), while the heritability of FD measured on the minicored midside sample and on the wool staple were estimated at 0.77 and 0.71, respectively. The values for minimum and maximum FD along the staple agreed very well with published estimates, but were lower than that of FD measured on the midside and on the wool staple.

Table 1. Means and variances of the wool traits

Trait	Mean	Variance
Staple strength (N/Ktex)	30.6	71.4
Standardised FD blowout (ìm)	5.5	1.0
FD minicore (ìm)	19.8	2.21
FD staple (ìm)	19.2	2.58
Minimum FD (ìm)	16.6	2.23
Maximum FD (ìm)	22.1	3.98
CVFD minicore (%)	22.4	8.8
CVFD staple (%)	21.8	5.05
CVFD along (%)	3.4	3.08
CVFD between (%)	22.4	10.8

The heritability of the standardised FD blowout along the staple was 0.20. Yamin *et al.* (1999) reported a heritability of 0.1 to 0.20 for different FD blowout traits. This confirms that there is a genetic component to FD variation along the staple. Hickson *et al.* (1995) and Hill *et al.* (1999) have also reported low heritabilities but on micron blowout from one shearing to the next shearing.

Table 2. Genetic parameters (with standard errors) for staple strength and standardised fibre diameter blowout of hogget wool

Trait	Heritability	Staple strength		Standardised FD blowout	
		Genetic correlation	Phenotypic correlation	Genetic correlation	Phenotypic correlation
Staple strength	0.38 ± 0.07	---	---	---	---
Standardised FD blowout	0.20 ± 0.06	-0.41 ± 0.16	-0.27 ± 0.02	---	---
FD minicore	0.77 ± 0.07	0.28 ± 0.11	0.25 ± 0.02	0.18 ± 0.14	0.13 ± 0.08
FD staple	0.71 ± 0.07	0.32 ± 0.11	0.29 ± 0.02	0.04 ± 0.15	0.08 ± 0.02
Minimum FD	0.61 ± 0.08	0.41 ± 0.11	0.38 ± 0.02	-0.17 ± 0.15	0.32 ± 0.02
Maximum FD	0.57 ± 0.08	0.17 ± 0.13	0.15 ± 0.02	0.29 ± 0.14	0.45 ± 0.02
CVFD minicore	0.67 ± 0.08	-0.65 ± 0.07	-0.45 ± 0.02	0.23 ± 0.14	0.16 ± 0.02
CVFD staple	0.49 ± 0.08	-0.72 ± 0.07	-0.50 ± 0.02	0.29 ± 0.15	0.32 ± 0.02
CVFD along	0.25 ± 0.06	-0.20 ± 0.16	-0.18 ± 0.02	1.00 ± 0.03	0.77 ± 0.01
CVFD between	0.40 ± 0.07	-0.70 ± 0.10	-0.36 ± 0.02	0.09 ± 0.19	0.02 ± 0.02

CVFD of the minicored midside sample had a significantly higher heritability (twice the standard error) than that estimated on the wool staple (0.67 versus 0.49). The reason for this is unclear but may be related to the fact that the minicored sample is washed before testing. Whatever the reason, CVFD of the minicored sample measured on the OFDA100 gives a more accurate indication of the breeding value of CVFD than CVFD measured on a greasy wool staple with the OFDA2000.

CVFD along the staple had a significantly lower heritability (0.25 versus 0.40) than CVFD between fibres within the staple. This agrees with the result reported by Yamin *et al*. (1999) for CVFD along the staple.

FD measured on a minicore midside sample, or on a wool staple, or at the minimum or maximum point along the staple had a positive genetic and phenotypic relationship with SS. However, FD blowout had a negative genetic and phenotypic relationship (-0.41 and -0.27) with SS. This implies that selection for increased SS will result in a reduction in the propensity of FD to blowout along the staple. Similarly CVFD estimated on a minicore midside sample, or on a wool staple, or at different places along the wool staple, has a negative genetic and phenotypic relationship with SS. In general, this relationship was strong (less than -0.6) except for CVFD along the staple, which was genetically weakly to moderately correlated to SS. This indicates that this CVFD along the staple would be less effective as an indirect selection criterion to improve SS and again confirms the results of Yamin *et al.* (1999). The fibre variability traits had a small positive relationship with FD blowout except CVFD along the staple which is genetically the same trait (r_g=1.0) as FD blowout within a growing season.

CONCLUSION

Selection for low values of any of the measures of CVFD will result in an increased SS. There would be no advantage of selecting for CVFD along the staple or CVFD between fibres. Faster genetic progress would be achieved by using CVFD tested on either a minicore midside sample or on an intact wool staple because of their higher heritability and genetically stronger relationship with SS. In addition, this will result in a small positive correlated response in FD blowout mainly because CVFD along the staple is genetically the same trait as FD blowout.

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