FLEECE WEIGHT / FIBRE DIAMETER RATIOS FOR MERINO SHEEP ARE NOT INDEPENDENT OF ENVIRONMENTAL INFLUENCES

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SUMMARY

We used data from three sources to examine the hypothesis that a clean fleece weight (CFW) / fibre diameter (FD) cubed ratio (CFW/FD^3) is independent of environmental effects on wool production. Heritability for CFW/FD^{3}estimated from the Katanning Base Flocks, comparison of CFW/FD^3 in identical twin hoggets after differing fetal nutrition and comparison of wether trial data before and after adjustment for environmental effects all failed to provide support for the hypothesis.
Keywords: w/d^3, L:D ratio, wool, breeding

INTRODUCTION

It is well known that nutrition has a large influence on both the quantity and fibre diameter of wool produced by Merino sheep. It has also been observed that the length and diameter of individual wool fibres change at a similar rate in response to nutritional changes with the result that fibre length (L) to diameter (L/FD) ratio varies less than either L or FD (Downes and Sharry 1971). L/FD^2 and L/FD^3 have been found to be more repeatable than L/FD (Cottle 1987). CFW/FD^3 forms the basis of the selection index used by the Australian Merino Society.

It has also been suggested that CFW/FD^3 is independent of environmental effects (Ferguson 1981) and is sufficiently robust to allow comparison between flocks in different environments or across years (Swan 1997). This study used three sources of data to test the hypothesis that CFW/FD^3 is independent of environmental effects on wool production.

MATERIALS AND METHODS

Genetic parameters for CFW, FD and CFW/FD^3 were estimated on 6,686 records collected from 237 sires over a six year period (1987 – 1992) in the Katanning resource flocks. These flocks were described by Lewer *et al* (1992). The data were analysed with ASREML (Gilmour *et al.* 1997) fitting an animal model that included stud as an additional random effect, and year of birth, sex, birth status, age of the dam and management group as fixed effects.

CFW/FD^3 were compared for identical twin hoggets (n=35) produced by embryo splitting and subjected to differing levels of maternal nutrition (Kelly *et al.* 1996). Paired t-tests were used to compare means and linear regression to determine the degree of relationship between CFW/FD^3 in genetically identical pairs.

Data from wether trial teams (Clarke and Windsor 1999) were used to examine whether correction for environmental effects altered the CFW/FD^3 ratio. Raw data for CFW/FD^3 (n=75) and CFW/FD^3 for the same teams after correction for site effects using BLUP were compared by regression analysis. The relationship between CFW/FD^3 and predicted farm profit for wether trial teams (Windsor and Young 1999) was also examined by linear regression.

RESULTS AND DISCUSSION

The heritabilities for CFW, FD, CFW/FD^3 and the phenotypic and genetic correlations between these traits are shown in Table 1.

Table 1. Genetic and phenotypic parameters for CFW, FD and CFW/FD^3 in the Katanning flocks

Trait	CFW	FD	CFW/FD^3
Phenotypic variance	0.28	3.09	0.97×10^{-8}
Genetic variation (studs)	9.6 %	28.3 %	20.7 %
CFW	**0.40** ± 0.06	0.25 ± 0.05	0.32 ± 0.05
FD	0.22 ± 0.05	**0.49** ± 0.06	-0.81 ± 0.02
CFW/FD^3	0.29 ± 0.05	-0.85 ± 0.02	**0.53** ± 0.05

Heritabilities (bold) on, phenotypic correlations above and genetic correlations below the diagonal

The heritabilities of CFW and FD compare very well with accepted heritability estimates (Mortimer, 1987). The heritability estimate of CFW/FD^3 is slightly higher than FD which indicates that this ratio should respond to selection. The phenotypic and genetic relationship between CFW and FD of 0.25 and 0.22, respectively, also falls within the accepted estimates. The phenotypic and genetic correlation between CFW and CFW/FD^3 were moderately low (0.32 and 0.29) whereas the correlations between FD and CFW/FD^3 were negative and very high (-0.81 and –0.85). This indicates that selection for CFW/FD^3 will produce a large correlated response in FD. Anecdotal evidence from long term phenotypic trends from individual AMS flocks have shown that in some cases fibre diameter decreased dramatically while fleece weight stayed relatively constant. The heritability of CFW/FD^3 is not so high as to suggest that the trait is independent of environmental influences.

Mean CFW/FD^3 values differed ($P<0.05$) between identical twin hoggets whose recipients were fed at maintenance (0.46 $g\mu m^{-3}$) or low (0.41 $g\mu m^{-3}$) levels during pregnancy. Figure 1 shows the relationship between CFW/FD^3 for twin pairs. Differences in CFW/FD^3 between low treatment animals explained only half the variation observed in their genetically identical high treatment counterparts. This demonstrates that environmental effects during late pregnancy which affect the activity of the wool follicle population can alter CFW/FD^3 later in life. Ferguson (1981) assumes that changes in L and FD control CFW while the density of wool producing follicles remain constant. In fact Merino sheep shut down up to 30 % of their wool follicles under of nutritional stress (Thompson *et al.* 1998).

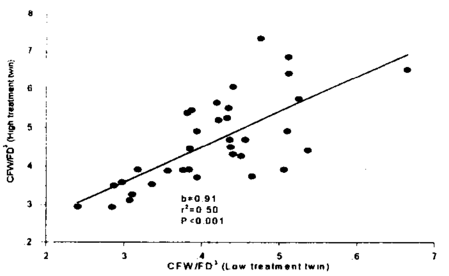

Figure 1. Effect of fetal nutrition on CFW/FD^3 (gμm^{-3}) in identical twin hoggets.

The proposition that CFW/FD^3 is independent of environmental differences between sites or years (Swan, 1997) and can be used as an index of flock profitability is based upon the strong relationship between CFW/FD^3 and gross margin/Ha in the bloodline comparisons of Coelli *et al* (1996). It ignores the fact that this data is corrected for environmental differences between sites. The relationship between CFW/FD^3 values for WA wether trial teams before and after correction for site specific environmental differences is shown in Figure 2. CFW/FD^3 in the raw team data is an extremely poor predictor of CFW/FD^3 for the same teams after correction for environmental effects. This illustrates both the large effect which environmental differences exert on the CFW/FD^3 ratio and the inadvisability of using the ratio to compare flocks or individuals running in different environments.

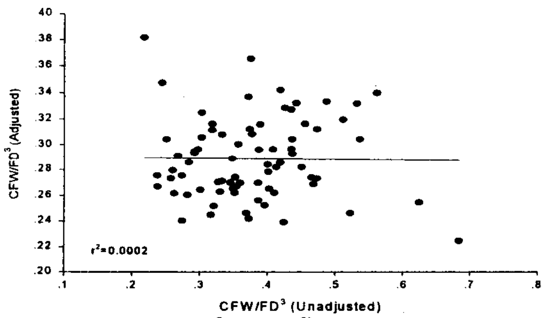

Figure 2. Relationship between CFW/FD^3 (gμm^{-3}) for wether trials teams (n=75) before and after adjustment for site effects.

This point is further illustrated by Figure 3 that shows the relationship between CFW/FD^3 for wether trial teams and predicted whole farm profit. As with the bloodline data of Coelli *et al* (1996) there is a strong relationship between flock economic performance and CFW/FD^3 in the environmentally corrected data. There is no relationship between CFW/FD^3 and farm profit in the raw data.

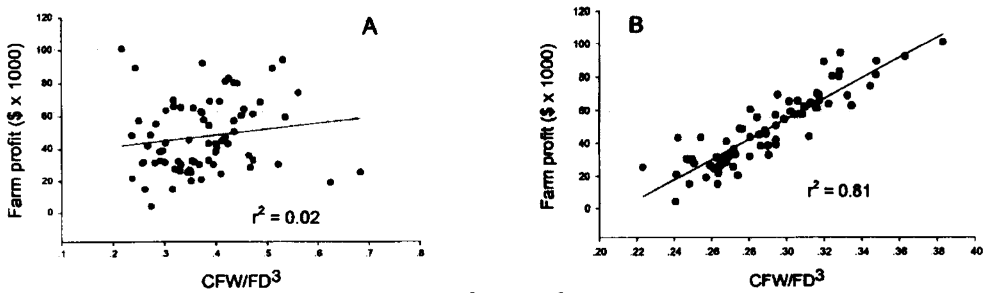

Figure 3. Relationship between CFW/FD^3 (gμm^{-3}) and farm profit for wether trial teams before (A) and after (B) correction for environmental site effects.

In conclusion, this study confirms that CFW/FD^3 is a heritable trait and will respond to selection. However we found no evidence to support the hypothesis that CFW/FD^3 is independent of environmental effects on wool production. These data suggest that the use of CFW/FD^3 as a tool to compare the economic merit of flocks across sites or years without genetic links to correct for environmental effects is not advisable.

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