FIBRE DIAMETER DISTRIBUTION CHARACTERISTICS OF THE MERINO FLOCK
DURING BLOODLINE SUBSTITUTION

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SUMMARY
The standard deviation and coefficient of variation of fibre diameter and the percent fibres greater than thirty microns were measured from the mid-side samples of eight Merino bloodlines and their crosses. The mating types examined were purebred, first cross, and backcross combinations of the bloodlines. It is known that average fibre diameter of a bloodline combination can be predicted from the means of the parental bloodlines. The influence of bloodline substitution on fibre diameter distribution traits is not known. It is shown that for fibre diameter distribution traits heterosis was not significant. Those commercial breeders wanting to substitute one bloodline for another are able to predict the fibre diameter distribution from the weighted average of each bloodline in Merino sheep.

Keywords: Merino, sheep, crossing, fibre diameter distribution, wool quality.

INTRODUCTION
Average fibre diameter is the major determinant of wool value and is the most important of the wool quality traits in terms of influence on weight, smoothness and stiffness of the fabric (Stevens 1994). Atkins (1995) examined a number of strategies to reduce the average fibre diameter of the Australian Merino wool clip. Bloodline substitution in commercial flocks was shown to be an appropriate strategy to achieve significant reductions in fibre diameter through genetic change.

For first cross and backcross progeny produced during bloodline substitution, Mortimer et al. (1994) showed that performance in average fibre diameter and some other aspects of wool quality (staple length and style) were fully predicted by averaging of the additive effects of the parental bloodlines. However the impact of bloodline substitution on fibre diameter distribution (FDD) traits is not known. In considering a change of bloodline source, a commercial producer is likely to need such information about the change on wool quality traits. Many wool growers (Love et al. 1987) and ram breeders (Casey and Hygate 1990) emphasise wool quality in their breeding objectives. Furthermore some ram breeders consider fibre diameter variability to be a component of wool quality (Casey 1990). It may also be used as an indirect selection criteria for staple strength (Lewer and Li 1994) and for fleece rot and fly strike (Raadsma et al. 1992). Within normal limits fibre diameter variability has a small influence on spinning performance, with yarn evenness and yarn strength improving with lower coefficient of variation of fibre diameter (Lamb 1992).
This paper is a preliminary report on the effect of bloodline substitution on mean performance of hogget fibre diameter distribution characteristics. Data were derived from the Merino bloodline crossing project conducted at Trangie between 1984 and 1996.

MATERIALS AND METHODS
The source flock is fully described by Mortimer et al. (1994). In brief, purebred, first cross and backcross progeny born between 1992 and 1994 were used for this study. These animals were produced by two contemporaneous types of matings: mating of eight Merino bloodlines in a complete diallel design and matings of the purebred and crossbred ewes produced by the diallel matings to purebred and a restricted range of crossbred ram genotypes. The eight bloodlines were chosen from within the fine-wool (two bloodlines, F1 and F2), medium-wool non-Peppin (two bloodlines, MNP1 and MNP2), medium-wool Peppin (three bloodlines, MP1, MP2 and MP3) and strong-wool (one bloodline, S) strains.

A total of 1001 hoggets (15 months) ewes and rams were observed. These consisted of 235 purebreds, 210 first cross and 570 backcross animals. Midside samples from these animals were measured by Laserscan (IWTO-12-93) for average fibre diameter (FD), standard deviation (SDFD) and coefficient of variation (CVFD) of fibre diameter, and percentage of fibres greater than 30 microns (PF30).

RESULTS
Bloodline effects, shown in Table 1, were highly significant (P<0.01) for all the traits. The fine-wool bloodlines had the lowest FD (19.1 and 19.6 μm), the strong wool bloodline the highest (21.7 μm) and the medium-wool bloodlines intermediate (20.3-21.6 μm). The MP and MNP strains overlapped in FD. Strain differences for the fibre diameter distribution traits followed a similar trend to FD. SDFD increased from 3.5 μm in the fine wool bloodlines (3.40 μm and 3.59 μm) to 4.71 μm in the strong wool bloodline, CVFD from 18% (17.95% and 18.43%) to 21.6% and PF30 from <1% (0.46% and 0.99%) to 6.09% respectively. The non-Peppin and Peppin bloodlines were, on average, intermediate to the fine and strong bloodlines, and similar to each other (SDFD: 4.43 μm vs 4.51 μm; CVFD: 21.1% vs 21.3%; PF30 4.3% vs 4.6%; non-Peppin and Peppin respectively). However within the medium-wool bloodlines, the trend between FD and the FDD traits was not as definite. For example, MNP2 had a lower FD but higher CVFD compared to MNP1 and likewise for MP3 compared to MP2.
Table 1. The bloodline and mating type least squares means and standard errors and heterosis estimates for average fibre diameter and fibre diameter distribution traits

<table>
<thead>
<tr>
<th></th>
<th>FD $^\text{A}$(\mu m)</th>
<th>SDFD $^\text{A}$(\mu m)</th>
<th>CVFD $^\text{A}$ (%)</th>
<th>PF30 $^\text{A}$ (%)</th>
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<tbody>
<tr>
<td><strong>Bloodline effect</strong></td>
<td></td>
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<tr>
<td>F1</td>
<td>19.05 (0.16) $^a$</td>
<td>3.40 (0.07) $^a$</td>
<td>17.95 (0.28) $^a$</td>
<td>0.46 (0.36) $^a$</td>
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<tr>
<td>F2</td>
<td>19.56 (0.18) $^b$</td>
<td>3.59 (0.08) $^a$</td>
<td>18.43 (0.31) $^a$</td>
<td>0.99 (0.40) $^a$</td>
</tr>
<tr>
<td>MNPL</td>
<td>21.55 (0.15) $^c$</td>
<td>4.52 (0.06) $^b$</td>
<td>20.91 (0.25) $^{bc}$</td>
<td>5.13 (0.33) $^b$</td>
</tr>
<tr>
<td>MNP2</td>
<td>20.35 (0.14) $^d$</td>
<td>4.34 (0.06) $^c$</td>
<td>21.25 (0.24) $^b$</td>
<td>3.50 (0.30) $^c$</td>
</tr>
<tr>
<td>MP1</td>
<td>20.33 (0.15) $^d$</td>
<td>4.11 (0.06) $^d$</td>
<td>20.16 (0.25) $^d$</td>
<td>2.67 (0.33) $^c$</td>
</tr>
<tr>
<td>MP2</td>
<td>21.60 (0.15) $^c$</td>
<td>4.42 (0.07) $^{bc}$</td>
<td>20.49 (0.27) $^{cd}$</td>
<td>4.78 (0.34) $^b$</td>
</tr>
<tr>
<td>MP3</td>
<td>21.30 (0.14) $^e$</td>
<td>4.99 (0.06) $^e$</td>
<td>23.31 (0.24) $^e$</td>
<td>6.32 (0.31) $^d$</td>
</tr>
<tr>
<td>S</td>
<td>21.72</td>
<td>4.71</td>
<td>21.60</td>
<td>6.09</td>
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<td><strong>Mating type effect</strong></td>
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<tr>
<td>Purebreds</td>
<td>20.51 (0.08) $^a$</td>
<td>4.24 (0.03) $^a$</td>
<td>20.57 (0.13) $^a$</td>
<td>3.59 (0.17) $^a$</td>
</tr>
<tr>
<td>First crosses</td>
<td>20.76 (0.08) $^b$</td>
<td>4.29 (0.03) $^a$</td>
<td>20.65 (0.13) $^a$</td>
<td>3.72 (0.17) $^a$</td>
</tr>
<tr>
<td>Backcrosses</td>
<td>20.79 (0.06) $^b$</td>
<td>4.25 (0.03) $^a$</td>
<td>20.36 (0.11) $^a$</td>
<td>3.92 (0.14) $^a$</td>
</tr>
<tr>
<td><strong>Heterosis (%)$^b$</strong></td>
<td>1.2</td>
<td>1.1</td>
<td>0.4</td>
<td>3.6</td>
</tr>
</tbody>
</table>

$^A$ Means followed by different superscripts differ significantly (P<0.05).

$^b$ The superiority of the first cross over the mean of the parental bloodlines.

Table 1 also shows the least squares means for the fibre diameter distribution traits corresponding to each mating type and heterosis estimates. There were no significant differences between the mating types for SDFD, CVFD and PF30, whereas differences for FD were significant (P<0.05).

**DISCUSSION**

The hogget average fibre diameter from the 1992 to 1994 drops is slightly higher than that reported for the same flock from 1984-1994 drops, although the ranking is the same (Mortimer et al. 1994), whereas FD, SDFD and CVFD were slightly higher in a study by Taylor and Atkins (1994) on ewes from the larger multiple-bloodline resource flock which provided the bloodlines for the Merino bloodline crossing project.

The results here show that under a similar environment the non-Peppin and Peppin strains were similar for FD, SDFD, CVFD and PF30 while the fine-wool bloodlines showed lower values and the strong-wool bloodline showed higher values for these traits. The significant differences between medium-wool bloodlines within the respective strains, and the lack of significant differences between particular bloodlines across these strains (eg. MNPL vs MP2) suggests that the bloodlines should be better assessed individually rather than by their respective strain. Also important is the change in ranking of MP3 and MP2 between FD and the fibre diameter distribution traits. MP3 had a significantly lower FD than MP2 of 0.3 microns yet had higher values for SDFD, CVFD and PF30.
Fleece weight and fibre diameter are incorporated into the breeding objective of all Merino breeders (Casey and Hygate 1990) and thus all commercial wool growers. For a given micron premium, the commercial grower can identify bloodlines with greater economic merit based on comparative performance in fleece weight and fibre diameter. However, information on bloodline performance in additional wool quality traits, like those associated with diameter distribution, may also be required (Coelli et al. 1996). If heterosis for fibre diameter distribution traits was appreciable, it would need to be taken into account for the accurate determination of the value of an alternate bloodline if it differed significantly in performance to the bloodline on which the commercial grower's flock was based. However, absence of heterosis in fibre diameter distribution traits allows Merino breeders to predict changes to these traits with bloodline substitution as the average of the two bloodlines in the initial cross. Further substitution will result in progressively smaller changes that are also predictable as the weighted average of the bloodlines.

There is a cumulative effect of heterosis on the individual. For example, the number of lambs weaned is the summation of heterosis in fertility, fecundity, and survivability of the lambs. The overall economic impact of this cumulative effect is generally positive in Merinos: lamb survival, weaning weight, and fleece weight are increased (Mortimer 1987), while individuals have improved disease resistance (Gray and Raadsma, 1986). There is little heterosis for fibre diameter (Mortimer et al. 1994), which is fortunate from an economic perspective. The traits of fibre diameter distribution, while not of great influence on economic outcome, are important to this overall cumulative effect. The absence of heterosis in these traits indicates that crossing Merino bloodlines will not result in progeny with greater fibre diameter variability.

ACKNOWLEDGMENTS
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