SELECTION FOR LOW WOOL SULPHUR CONCENTRATION IN ROMNEY SHEEP

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SUMMARY
It has been known for some 30 years that wool sulphur concentration decreases as a correlated response to selection for high wool production in Merino sheep. This same phenomenon was also noted in Romney sheep nearly 10 years ago. There is a significant research effort directed at either modifying the chemical composition of wool or the metabolic pathways of sheep in an effort to either produce wool more efficiently or to modify wool quality traits. This paper reports on the establishment of a low wool sulphur concentration selection line in Romney sheep at Massey University. In time, sheep from these lines may provide a useful resource for studies involving the keratin gene family. Initial screening of ram lambs produced a male selection differential of -0.38% (2.2σ, relative to unselected rams, a random sample of whom were used to found a control line. Direct response to selection in the first generation of lambs will be presented at the conference. The selected ram lambs were 5.0kg lighter than the unselected population.

Keywords: Wool sulphur concentration, wool growth.

INTRODUCTION
For a majority of sheep farmers producing wool, an increase in the quantity of wool per animal would result in an increase in net farm profit, providing wool quality attributes, reproduction, health and longevity were not adversely affected to a greater extent than the value of the gain in wool quantity. A variety of single-trait selection experiments based on weight of wool produced at 12 months of age (eg Pattie and Barlow, 1974; Turner and Jackson, 1978; Blair et al., 1984; Johnson et al., 1995), and investigations of the genetic variance using collateral relatives (e.g. Baker et al., 1979), have shown that the heritability of 12 month wool production is most likely between 0.2 and 0.3.

A number of trials have shown that the concentration of sulphur in wool from genetically high wool-producing sheep is reduced compared to the concentration of sulphur in randomly-bred or genetically low wool-producing sheep (Piper and Dolling, 1966; Reis et al., 1967; Antram et al., 1991; Sun et al., 1991). Interestingly, high line sheep also yield a greater total amount of sulphur in their fleeces over a constant time period (McGuirk, 1979 and Antram et al., 1991). To achieve this, either less sulphur must be allocated to other bodily functions, and/or sulphur must be retained with greater efficiency from the diet. Finally, sheep with greater genetic potential for wool production can increase wool growth to a greater extent when supplemented with sulphur-containing amino acids than can either genetically low wool-producing sheep or control animals (Williams et al., 1977; Harris et al., 1990; McClelland, 1990).
The above information suggests that reduced wool sulphur concentration might be a useful indirect predictor of wool production in sheep. If this trait can be measured in lamb wool, this would enable the generation interval for both ewes and rams to be reduced. However, the accuracy of selection and effects on other production traits have yet to be determined. The purpose of the current trial is to examine the potential of wool sulphur concentration in lamb wool to act as an indirect indicator for lifetime wool production. After several generations of selection, the correlated responses in other wool characteristics and body traits will be examined. This paper reports on the results of an initial screening of ram lambs.

MATERIALS AND METHODS
In 1994, 226 Romney ram lambs had a mid-side sample of wool collected in early January, some two weeks after lamb shearing. These rams were randomly chosen from a total pool of 544 animals. Rearing rank (RR), date-of-birth (DOB) classified into early and late groups and weaning weights were also available.

Wool samples were scoured, and then analysed for sulphur (S) concentrations using the technique explained by Antram et al. (1991). Four ram lambs with the lowest wool S concentrations were chosen for use as mating sires in 1995. A further 4 ram lambs were chosen at random to establish a control line.

Two hundred mixed age ewes were purchased from a commercial breeder in the Wairarapa region. These ewes were randomly split, within age, into two lines of 100 ewes each. Each of the 8 rams was mated to a randomly assigned group of 25 ewes. At lambing, lambs were identified by tagging and their dam, sex, date of birth and birth rank recorded. Apart from the mating period, ewes were all grazed together under commercial conditions on the Massey University Sheep and Beef Cattle Research Unit.

Data were analysed by ANOVA (using REG, Gilmour, 1985) applying RR, sex, DOB and weaning weight as fixed effects or covariates as appropriate.

RESULTS AND DISCUSSION
The mean wool sulphur concentration of samples collected from 226 randomly chosen rams from a commercial flock was 2.86% (CV = 5.9%), while 48 mixed sex lambs averaged 2.37% (CV = 6.3%), see Table 1. These values are in the same range as those obtained from the Massey University fleece-weight selection and control lines reported by Antram et al. (1991) and Sun et al. (1991). Values rose steadily from c.2.4% at 4 months of age to c.2.8% at about 9 months of age in the study by Antram et al. (1991). Three to six month old lambs in the study of Sun et al. (1991) had values between 2.3% and 2.6%, while 14 month old rams had concentrations of c.2.8%. Sheep in the current trial were about 4 months old.

Analysis of the 1994 data showed that date of birth significantly affected S concentrations (P = 0.2%). The early DOB group had higher S concentrations than the late DOB group (early = 2.86 ± 0.015%; late = 2.77 ± 0.034%). Rearing rank did not significantly affect variation in S concentrations (P = 34.8%). Weaning weight had a highly significant effect on variation in S
concentrations ($P<0.01\% \quad b = 0.0150 \pm 0.0030/\text{kg})$. Thus, lighter rams at weaning tended to have reduced S concentrations. Sex and RR had no significant control over variation in S concentrations in the 1995 lamb data. DOB (fitted as covariate due to having actual date-of-birth), controlled a significant proportion of variation ($P = 4.32\% \quad b = -0.0050 \pm 0.0034\%$/day).

Thus, the only non-genetic factor to significantly affect variation in S concentrations was DOB, with early-born lambs having higher S concentrations levels than later-born lambs. Antram et al. (1991) found that DOB affected S concentrations in only 2 (both at about 12 months of age) out of the 11 samplings analysed (4 to 13 months of age). In both instances, early-born hoggets had lower S concentrations than later-born hoggets. Antram et al. (1991) also found that rearing rank did not effect variation in S concentrations.

The positive relationship between S concentrations and weaning weight has apparently not been previously recorded, although several authors have noted that higher feed intake is associated with increased S concentration (e.g. Reis, 1965). However, the Massey University fleece-weight selection experiment between line differences are suggestive of a negative relationship, because selection for fleece-weight has increased live-weight, and hence surface area. The underlying genetic nature of the relationship between S concentrations and live-weight should be resolved as correlated responses are observed in the current experiment.

Table 1. Means (± standard deviations) for wool sulphur concentration (tag 1994 and 1995) and weaning weight (tag 1994) in unselected and selected ram lambs

<table>
<thead>
<tr>
<th>Tag 94 ram lambs</th>
<th>Wool sulphur concentration</th>
<th>Weaning weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>All rams (n=226)</td>
<td>2.86 ± 0.17%</td>
<td>29.0 ± 3.92kg</td>
</tr>
<tr>
<td>Selected rams (n=4)</td>
<td>2.48%</td>
<td>24.0kg</td>
</tr>
<tr>
<td>Selected - all</td>
<td>-0.38%</td>
<td>-5.0kg</td>
</tr>
<tr>
<td>Tag 95 ewe and ram lambs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All lambs</td>
<td>2.37 ± 0.15%</td>
<td>na</td>
</tr>
</tbody>
</table>

The mean value for the 4 rams with the lowest S concentrations was 2.48\%, giving a difference of 2.2 $\sigma_p$ units between the selected ram team and the overall ram population. The selected rams were also 5.0kg lighter at weaning than the overall population.

The 1995 lambing was unproductive with just 71 control (C) line lambs and 15 sulphur minus (S-) lambs being born and only 39 C line and 9 S- lambs being present at wool sampling. The effect of selection line was not examined and weaning weights were not recorded due to the small numbers involved. The ram lambs used in 1995 were used again in the 1996 mating and some 250 lambs have been generated from 200 ewes. Results from the 1996 wool samples will be presented at the 1997 conference.
As knowledge accumulates regarding the molecular basis and mode of action of genes involved in wool synthesis, there will be opportunities to utilise animals generated in this selection experiment to investigate the interaction of such genes with other performance traits. Studies involving the keratin family of genes have already been underway for several years (e.g. Rogers, 1995). If sufficient divergence in S concentrations can be generated between the S' and C lines in this new trial, there will be opportunities to investigate which polymorphisms of these keratin genes are being favoured by quantitative selection. Such information may assist scientists working at the molecular genetic level to make more informed decisions regarding gene manipulations.

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