A SELECTION INDEX FOR CARPET WOOL SHEEP INCORPORATING FLEECE WEIGHT, WOOL QUALITY, LIVESTOCK AND REPRODUCTION

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SUMMARY
Carpet wool sheep are selected for fleece weight, fleece quality, growth rate and reproduction rate. Economic values for these traits were determined using a computer model based on the WOOLPLAN index calculations. This model also shows the gains expected in each trait from the use of an index based on the economic values or from the use of an index produced by variation of these values. In order to maintain an acceptable improvement in fleece quality, a greater weighting must be given to this trait than the value estimated from current economic values alone. For maximum production gain, a single index combining all traits, including fleece quality, is shown to be substantially better than independent culling on fleece quality and an index based on the remaining traits.

Keywords: Elliottdale, carpet wool, selection index.

INTRODUCTION
Carpet wool sheep are dual purpose, so the aims of the breeders include high reproductive rate and fast growing lambs in addition to a high fleece weight of good quality. Objective traits for fleece quality are not as well defined as for apparel wool so subjective gradings are used. Specialty carpet wool should be medullated and of high fibre diameter, but the quality also depends on colour, harshness, length and other subjective characteristics (Calver and Franklin-Backhouse 1988). Different classifiers may put different levels of emphasis on these traits.

Genetic values for carpet wool production traits have been reported (Horton 1991), however, these values have not been previously been combined into a selection index.

METHODS
Economic values for the production traits were estimated by the procedure used to determine the WOOLPLAN index (Ponzoni 1988), with modification where necessary to allow for differences in management.

Fibre diameter measurements are not used by buyers of specialty carpet wool, so fleece grade was used in its place. The fleece grading system is that used at the Elliott Research Station (Sides 1988), but other gradings could be used.

This model assumes that 40% of surplus lambs are sold as weaners (after their first shearing) and the remainder as hoggets (after their second shearing), so both weaning weight and hogget weight are included in the index.

Prices for carpet wool and lambs have fluctuated significantly over recent years, but as in the WOOLPLAN index, average values over several years are preferable to current market prices. The basic assumptions used (where different from those in the WOOLPLAN model) are as follows:

(i) The weaning percentage for maiden ewes is 100%, and for subsequent years is 119%, 125%, 129% and 136%.
(ii) Adult ewe greasy fleece weight (GFW) is 6 kg per year, 75% yield, $A3.25/kg GFW. Lamb fleece is 25% of adult annual fleece weight. Carpet wool sheep are normally shorn at least twice a year, but wool production is expressed in terms of annual adult production for these calculations.
(iii) Lamb plus hogget fleece is 66% of adult annual fleece weight. All fleeces are of similar value per kilogram.

An improvement of 1 unit of fleece grade is worth an extra 20 cents per kg GFW.

(iii) Compared with singles, twins have a 2% reduction in fleece weight, 14% reduction in weaning weight and 4% reduction in hogget weight, but twins do not reduce the dam’s fleece weight.

(vi) Weaners are sold at 33 kg for $20/head; hoggets are sold at 36 kg for $23/head; CFA ewes are sold at 47 kg for $7/head.

(vii) Marketing costs are 6% of liveweight values. Extra feed costs due to increased growth are assumed to be 6 c/extra kg and 5 c/extra kg liveweight for lambs and ewes respectively, as in WOOLPLAN.

A computer model was used to calculate the economic values. This model also estimates the
expected gains in each production trait if these or any other economic values are used in an index. The genetic gains expected from using an index and gains from single character selection are calculated as described by Turner and Young (1969). The estimates are based on the heritabilities and correlations reported previously for Elliottdale carpet wool sheep (Horton 1991). Genetic values for reproduction in carpet wool sheep have not been reported. However, preliminary results (Horton unpublished) suggest a heritability of about 0.1, and a negative correlation between lambs born and fleece weight. Therefore the values used in WOOLPLAN (heritability 0.1, and genetic correlation with GFW of -0.1) were used in this analysis. Other correlations are low and were assumed to be negligible.

The gains actually obtained at the Elliott Research Station for the Elliottdale carpet wool nucleus were results from ewes born from 1979 to 1985 and retained as breeders in the flock. Lifetime values for fleece weight, fleece grade, body weight and reproduction were used, with correction for age and lambing status and regression against year of birth.

The Elliott Research Station nucleus flock consists of 500 breeding ewes and 10 stud rams. After the second, third and fourth lambings 19%, 25% and 30% respectively of the ewes are culled. No ewes are used after their fifth lambing. This gives an average of 4.4 lambs weaned per ewe, resulting in a selection intensity of 0.87 for ewes and a generation interval of 3.4 years. Rams are used only once (selection intensity 2.22, generation interval 2.0 years). All estimates of expected gains were based on this flock structure.

RESULTS

The economic values derived from the basic assumptions are shown in Table 1. The value for fleece weight is based on production of the ewe (average 4.8 years production) plus her lambs to hogget stage (equivalent to 3.9 adult years production) worth $3.50 for each extra kg of wool. The value for an increase of 1 unit in fleece grade is based on the total weight of the equivalent of 8.7 years adult production. The values for weaning weight and hogget weight take into account the proportions of lambs of each type sold. Mature weight has a negative economic value because the extra value from sale of larger cull ewes does not cover the extra costs of feed eaten.

<table>
<thead>
<tr>
<th>Clean fleece weight (CFW)</th>
<th>$30.86 per extra kg CFW per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleece grade</td>
<td>$7.10 per extra unit of fleece grade</td>
</tr>
<tr>
<td>Reproduction</td>
<td>$59.99 per extra lamb per ewe joined</td>
</tr>
<tr>
<td>Weaning weight</td>
<td>$0.74 per extra kg liveweight</td>
</tr>
<tr>
<td>Hogget weight</td>
<td>$1.41 per extra kg liveweight</td>
</tr>
<tr>
<td>Mature weight</td>
<td>$-0.11 per extra kg liveweight</td>
</tr>
</tbody>
</table>

Genetic values (Horton 1991) can be used to obtain Estimated Breeding Values (EBVs) by the usual methods (Falconer 1981). The optimum selection index is the sum of all the EBVs, each multiplied by the relevant economic value (Turner and Young 1969). See Appendix for calculation of EBVs and the recommended index.

Table 2 shows the genetic gains expected in each trait if the recommended economic values are used in a selection index as the sole selection method. The gains are expressed in terms of the percentage of the gain that would be made if single trait selection were used. Alternative selection indices were tested by varying only the economic value for fleece grade to give exactly 50% of the maximum possible gain in this trait, and then increasing this economic value further until the gains in fleece grade exactly matched the gains in fleece weight (as a percentage of the maximum possible gains for each trait). Mature weight has a negligible effect on the index and may be omitted without significantly affecting the economic gains.

The effect of selection using independent culling is also shown in Table 2, based on the assumption that equal emphasis is given to fleece grade and to all other traits combined. The actual gains obtained for the Elliottdale carpet wool nucleus at Elliott research Station are shown based on results from ewes born in the nucleus from 1979 to 1985.

It is seen in Table 2 that if the index is used with the higher economic values for fleece grade then gains can be made in fleece grade with little loss of fleece weight, but improvement in hogget weight and reproduction is markedly reduced.

A common selection method is to select animals on fleece quality without reference to index score.
Table 2. Expected genetic gains (%) in each trait by using various selection indices as the sole selection method

Gains are expressed as the percentage of the maximum possible gain for each trait compared with single character selection, assuming no change in flock structure or selection differential. Independent culling means independent selection on fleece grade and on index (excluding fleece grade) with equal emphasis on each. The actual gains are those found for the Elliotdale nucleus flock at Elliott Research Station.

<table>
<thead>
<tr>
<th>Selection method</th>
<th>Greasy fleece weight</th>
<th>Fleece grade</th>
<th>Hogget weight</th>
<th>Reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic values</td>
<td>82</td>
<td>22</td>
<td>61</td>
<td>42</td>
</tr>
<tr>
<td>Fleece grade $30.80</td>
<td>83</td>
<td>50</td>
<td>43</td>
<td>24</td>
</tr>
<tr>
<td>Fleece grade $75.20</td>
<td>81</td>
<td>81</td>
<td>19</td>
<td>1</td>
</tr>
<tr>
<td>Independent culling</td>
<td>60</td>
<td>61</td>
<td>13</td>
<td>-2</td>
</tr>
<tr>
<td>Actual gains</td>
<td>70</td>
<td>79</td>
<td>46</td>
<td>0</td>
</tr>
</tbody>
</table>

or fleece weight, then independently select on the basis of performance records. This independent culling process is not as efficient as selection based on a single index. Breeders using independent culling will make little or no improvement in hogget weight or reproduction, but will also fall short of the optimum gains in fleece weight.

The actual gains in the Elliotdale nucleus have been very close to the maximum possible, particularly since some culling must always be done on faults not included in the index.

DISCUSSION

The proposed index is relatively straightforward except for the valuation of fleece grading. There is at present little difference in price for carpet wool of different fleece grades. Nevertheless, it is important for breeders to maintain superiority in wool quality over imported carpet wools. Most breeders would not accept the small rate of increase in wool quality resulting from the optimum index, but 50% of the maximum possible gains in fleece grade can be obtained by increasing the value for fleece grade $7.10 to $30.80 per extra unit. Any higher emphasis on fleece grade would be at the expense of gains in growth rate. Some breeders would prefer to put at least equal emphasis on fleece quality and fleece grade (equivalent to a value of $75.20 per extra unit). However, the poor improvement in growth rate could make the sheep uncompetitive for lamb production.

ACKNOWLEDGMENTS

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REFERENCES


APPENDIX

The selection index is calculated as follows:

Step 1. Correct all values for type of birth and rearing (single, twin, etc) and for age of dam using the factors given previously (Horton 1991). Convert fleece weights to annual production by allowing for the time between shearings.

Step 2. Express all values as deviation from the mean of the flock or management group, (i.e. FW is the deviation from the mean annual fleece weight; FG is the deviation from the mean fleece grade; WW is the deviation from the mean weaning weight; HW is the deviation from the mean hogget weight; Rp is the deviation from average number of lambs).

Step 3. Calculate the individual EBVs.
FWEBV = 0.415FW + 0.046FG - 0.007WW - 0.002HW - 0.018Rp
FGEBV = 0.031FW + 0.180FG - 0.004WW - 0.002HW + 0.018Rp
WWEBV = -0.190FW - 0.484FG + 0.208WW + 0.160HW + 0.235Rp
HWEBV = -0.217FW - 0.185FG + 0.411HW + 0.231Rp
RpEBV = -0.048FW + 0.050FG + 0.050WW + 0.010HW + 0.050Rp

Step 4. Calculate the index.
Index = 30.9FWEBV + 30.8FGEBV + 0.74WWEBV + 1.4HWEBV + 60.0RpEBV