A simulation model was used to estimate changes in wool production, gross margin/ha and the most profitable stocking rate for breeding ewes, in response to increasing pasture growth rates at different times of the year, delaying the onset of flowering and increasing the digestibility of dead herbage. The model was applied to perennial pastures in western Victoria.

Increases in pasture growth rate throughout the entire year were economically worthwhile if the stocking rate was increased accordingly. However, increased profitability could also be achieved by increasing pasture growth for selected periods. These increases were more valuable in late autumn and early winter than at other times of the year. Profitability could also be increased in the absence of increased stocking rate by introducing later flowering cultivars or increasing the digestibility of dead pasture stubble. Key words: flock simulation, pasture growth, utilization, digestibility.

INTRODUCTION

Pasture growth and utilization have a major effect on the financial viability of pastoral properties. Wool growth rates vary substantially both within and between years, thereby presenting the challenge of economically improving the nutrition of sheep in the seasons of low wool production (Robards 1979). In western Victoria, pasture species and cultivars have been identified which have the potential to improve herbage quality during the hot, dry summer months (Kenny and Reed 1984) and herbage yields during autumn and winter (Reed et al. 1985).

A simulation model of a pasture-sheep production system has been developed at Werribee and tested at the Pastoral Research Institute (PRI), Hamilton, and on Western District farms (White and Bowman 1986). The model was used to estimate the extent to which pasture growth rate, date of flowering and the digestibility of dead pasture limit wool production and financial returns for sheep farms based on perennial pastures in western Victoria.

MODEL STRUCTURE

The model describes a commercial flock of small-framed Merinos grazing a 500 ha property. There are four major components to the model: daily climatic data, an algorithm for simulating pasture growth, an animal production component and a component which allows for an economic evaluation of the production system (White et al. 1983). Price assumptions in the model are described by White and Bowman (1987). The model contains a set of 52 weekly values representing maximum pasture growth rates (kg/ha/day) which in this study define a perennial ryegrass and subterranean clover pasture in the Hamilton District (Fig. 1). These values are derived from the original PRI data of Cayley et al. (1980) and Birrell (1981). Actual growth rates

* Department of Agriculture and Rural Affairs, Victoria, 3030.
are determined by reducing potential values if soil moisture and
temperature are limiting, or if pasture availability is low or
approaching ceiling yield.

EXPERIMENTATION

The model was used to investigate the effects of increasing
maximum pasture growth rate values by 25% for part or all of the year
as may occur through the introduction of a new pasture species or
cultivar or through fertilizing the pasture (Fig. 1). Nineteen years of
climatic data (1965 to 1984) recorded at the PRI were used as input to
each experimental run. An August lambing was selected, since field and
simulated experiments have consistently shown that an autumn lambing
system is less profitable in western Victoria than lambing in winter or
in spring (White et al. 1982).

Changes in wool production and gross margin/ha were noted in
response to these changes in the maximum growth rates of the pasture.
In the first set of simulations, a suboptimal stocking rate of 10
ewes/ha was used because it was typical of many properties in the
Hamilton District of western Victoria (Patterson 1985). The
simulations were then repeated, the most profitable stocking rate
(SRopt, ewes/ha) being identified by iteration.

The model was then used to examine the effects of delaying the
maturation of the pasture species by delaying the onset of flowering by
2 weeks. The introduction of later flowering cultivars into Western
District pastures has the potential to improve herbage quality in late
spring and early summer.

Considerable variation has been observed in the digestibility
of different species and cultivars of grasses after senescence (Ballard
et al. 1987). The model was therefore also used to estimate the value
of increasing the digestibility of dead pasture by 10%. This meant
that immediately after the pasture dried off, the digestibility of dead
pasture was set at 65% rather than 59%.
RESULTS

The outcome of the simulations with 10 ewes/ha and at the most profitable stocking rate for each set of PGR values is shown in Table 1. The most profitable stocking rate based on the original set of PGR values was 11.9 ewes/ha with a gross margin of $125.5/ha. An all-year round increase of 25% in the PGR values enabled the most profitable stocking rate to increase by 12.6% to 13.4 ewes/ha accompanied by a 9.6% increase in gross margin/ha.

TABLE 1. Changes in clean wool production (CWH) and gross margin per hectare (GMH) in response to a 25% increase in maximum pasture growth rates (PGR) for selected weeks assuming (a) the stocking rate is fixed at a suboptimal level of 10 ewes/ha and (b) the most profitable stocking rate (SRopt) is used. Simulation is from 1965 to 1984; values are means for this period.

<table>
<thead>
<tr>
<th>Weeks in which PGR increased by 25%</th>
<th>10 ewes/ha</th>
<th>Most profitable</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CWH (kg/ha)</td>
<td>GMH ($/ha)</td>
<td>SRopt (ewe/ha)</td>
<td>UWH (kg/ha)</td>
<td>GMH ($/ha)</td>
<td></td>
</tr>
<tr>
<td>None (control)</td>
<td>35.3</td>
<td>117.5</td>
<td>11.9</td>
<td>41.3</td>
<td>125.5</td>
<td></td>
</tr>
<tr>
<td>12-23</td>
<td>35.4</td>
<td>118.1</td>
<td>12.7</td>
<td>44.0</td>
<td>131.1</td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>35.4</td>
<td>118.3</td>
<td>12.7</td>
<td>44.1</td>
<td>132.9</td>
<td></td>
</tr>
<tr>
<td>24-32</td>
<td>35.4</td>
<td>117.8</td>
<td>12.3</td>
<td>42.8</td>
<td>130.5</td>
<td></td>
</tr>
<tr>
<td>30-41</td>
<td>35.3</td>
<td>117.7</td>
<td>12.2</td>
<td>42.6</td>
<td>128.1</td>
<td></td>
</tr>
<tr>
<td>36-47</td>
<td>35.3</td>
<td>117.8</td>
<td>12.2</td>
<td>42.0</td>
<td>126.2</td>
<td></td>
</tr>
<tr>
<td>1-52</td>
<td>35.5</td>
<td>118.6</td>
<td>13.4</td>
<td>46.6</td>
<td>137.6</td>
<td></td>
</tr>
</tbody>
</table>

The most valuable response to increasing PGR for a 12-week period of the year was achieved for weeks 18-29 (late April to mid-July). The gross margin increased by less than 1% at the sub-optimal stocking rate of 10 ewes/ha, but it increased by 5.9% when the stocking rate was increased by 6.7% from 11.9 to 12.7 ewes/ha. The response to increasing PGR was least in the spring when the availability of feed was usually not limiting.

Delaying the maturation of the pasture species by delaying the onset of flowering by 2 weeks increased gross margin/ha by 3.3% and 3.1% at 10 and 12 ewes/ha respectively, with virtually no shift in the most profitable stocking rate.

Increasing the digestibility of dead pasture by 10% resulted in a concomitant increase in the consumption of dead herbage by sheep. This was accompanied by increases in wool/ha of 0.8% at 10 ewes/ha and 1.7% at 12 ewes/ha with corresponding increases in gross margin/ha of 6.7% and 8.0%, respectively. SRopt increased from 11.9 to 12.2 ewes/ha.

DISCUSSION

The model demonstrated the value of increasing pasture growth rates throughout the year in terms of a higher SRopt and increased profitability. It also indicated that, within the flock management constraints imposed, increasing pasture growth in late autumn and early winter was more valuable than at other times of the year because it
provided extra herbage during a period of feed deficit. This compares with the lower value of extra growth in late spring when surplus feed was present. The model also illustrated the importance of increasing stocking rate to capitalize on extra pasture growth. A similar conclusion was reached by Morley (1974) who advocated near-optimal stocking rates to ensure worthwhile financial returns to fertilizing pastures.

The increase in gross margin/ha due to delaying the onset of flowering suggests that there is substantial scope for moving to later flowering cultivars (Reed et al. 1985). Likewise, there appears to be economic sense in increasing the digestibility of dead pasture stubble (Ballard et al. 1987). These last two options which improve herbage quality over summer would be preferable to increasing pasture growth rates if a producer did not wish to increase the number of sheep on his property. For many producers, however, adjusting stocking rate to improve the utilization of their pastures will be their most profitable management option (White 1987).

This study makes no attempt to assert that the extra pasture productivity or quality is achievable by particular pasture species or cultivars under grazing. Changes in fibre diameter were not considered although both coarser fibres and 'tender' staples can reduce the value per kg of wool (White and Morley 1977). Nor was there any consideration of the cost of re-establishing or fertilizing a pasture. The study does, however, offer a methodology whereby the potential economic value of pursuing such goals can be reasonably estimated.

ACKNOWLEDGEMENTS

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REFERENCES