Improving the sustainability of milk production systems in Europe through increasing reliance on grazed pasture


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Abstract

A European Union funded research project (Grazemore) has developed a grazing decision support system (DSS) to assist dairy farmers in improving their reliance on grazed grass milk production. Initially, a mathematical model was produced to predict seasonal milk production from forecasted meteorological inputs and knowledge of N fertiliser inputs. A further model was then developed to predict herbage intake of grazing dairy cows, based on a wide range of plant and animal parameters. Finally, a DSS for use on dairy farms has been produced based on a plant/animal interface model derived from the grass growth and intake models. The DSS is currently being validated using data from grazing trials and will also be assessed on dairy farms throughout NW Europe in 2004.

Keywords: grazing, intake, grass growth, decision support, milk production

Introduction

Milk production systems based on a high reliance on grazed herbage offer a number of economic, animal welfare and environmental benefits. However, output from grazed grass on farm level is relatively low, reflecting the fact that full exploitation of the potential of grazed grass requires a knowledge of grass growth rates and effective grass budgeting during the grazing season. In order to encourage and facilitate increased reliance on grazed grass in the European Union, there is a need for reliable decision support systems (DSS) which will enable accurate prediction of grass growth and herbage intake for a range of soil and climatic conditions.

Materials and methods

The project involves 6 partners from 5 countries with personnel drawn from research and systems/extension groups in each country. All partners are represented on a Project Management Group which is responsible for the co-ordination of three major elements of the project:

iii) Integration of the HGM and HIM to produce a grazing management Decision Support System (DSS).
i) Development of herbage growth model
Following a detailed evaluation of three current grass growth models, using test data from throughout Europe, a new model has been developed based on the LINGRA model of Schapendonk et al. (1998). The HGM (Barrett et al., 2004) is a mathematical, predictive model which predicts seasonal herbage production from forecasted meteorological, inputs, in addition to N fertiliser inputs. Herbage production is calculated and iterated on a daily basis, enabling estimation of herbage DM accumulation following a previous grazing or cutting. The model also enables prediction of herbage quality, in terms of organic matter digestibility (OMD) and crude protein (CP) content, as these are important parameters for prediction of herbage intake.

ii) Development of herbage intake model
Whilst a large number of models are available to predict food intake of dairy cows, few models have focussed on intake prediction in the grazing dairy cow. Consequently, a new model has been developed (Delagarde et al., 2004) based on the principle of the INRA Fill Unit System (Dulphy et al., 1989) but adapted for the grazing situation. The new model takes account of a wide range of animal (potential milk yield, liveweight, body condition score, stage of lactation, stage of gestation, body reserves and protein status and plant factors (herbage allowance, pregrazing herbage mass, sward height and access time to grazing).

iii) Development of a decision support system
The overall objective of the DSS (Hetta et al., 2004) is to assist farmers in farming their grazing management through the provision of information on grass growth and intake. The DSS provides prediction of grass growth rates based on data input to the HGM whilst also predicting the extent of grass removal through grazing (via the HGM) Inputs to the DSS include information on meteorological data and fertiliser Nitrogen application, paddock size and animal characteristics and the DSS predicts growth rates, herbage intake and animal performance on a daily basis.

Results and discussion

Validation of Herbage Growth Model
The HGM was independently validated using two data sets based on grass growth monitoring at the Agricultural Research Institute of Northern Ireland and at Wageningen, the Netherlands. Results of the validation are presented in table 1.

<table>
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<tr>
<th></th>
<th>Average growth rate (kg DM ha⁻¹ d⁻¹)</th>
<th>Proportion of MSPE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Predicted</td>
</tr>
<tr>
<td>N. Ireland</td>
<td>50.1</td>
<td>47.5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>44.0</td>
<td>54.0</td>
</tr>
</tbody>
</table>

Detailed analysis of the results indicates reasonably good prediction of overall grass growth rate at both sites, although the model tended to over predict grass growth in the latter part of the season at Wageningen. Nonetheless the precision of the model is sufficiently accurate to enable it to be used in grass budgeting and decision support systems for grassland management.

Land Systems in Grassland Dominated Regions
Validation of Herbage Intake Model
A series of validation tests were undertaken on the HIM and results indicate that the model is particularly sensitive to variations in sward characteristics (herbage mass and nutritive value) but provides accurate prediction of the effect of animal characteristics (milk yield, liveweight etc.) and the interaction between plant and animal factors. For example, substitution rate (reduction in herbage intake with concentrates) increases with increasing herbage allowance from 0 to 0.8 kg herbage kg⁻¹ concentrate dry matter (DM) over the range from 10 to 60 kg herbage DM allowance per cow. The model also predicted lower substitution rates (0.2 is 0.7 kg herbage DM kg⁻¹ supplement DM with concentrates compared to forage supplements. The MM is also able to simulate the evolution of DM intake and milk yield over the complete lactation.

Decision Support System
The grazing management DSS integrates information from the growth (HGM) and intake (HIM) models into a simulated whole farm system. The approach adopted is similar to a series of bank accounts, with the 'accounts' (paddocks) being replenished with grass calculated from individual growth rate ('interest' rates). Removal of grass through cutting or grazing acts as 'withdrawals' from the accounts. The DSS also takes into account the effect of other sources of feed, and the interaction between these sources, in relation to herbage intake and milk production. Initial tests of the DSS against experimental data indicate that the model can accurately simulate the whole farm situation. Further tests on farms throughout Europe are being undertaken during the 2004 grazing season.

Conclusions
A Decision Support System to assist farmers in management of grazing for dairy cows has been developed. The DSS enables farmers to predict grass growth and herbage intake of dairy cows and consequently should enable increased confidence in, and reliance on, grazed grass for milk production. This approach will be increasingly important given the current proposals for the mid term review of the Common Agricultural Policy.

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References