A model to aid decisions regarding feeding of concentrates to dairy cattle

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PREFACE

The impetus for this work came from the dairy farming community of Tasmania. Constant questioning by individuals and argument at discussion groups as to the value of concentrates in a pasture based system, prompted the investigation. Factors affecting responses, especially in the long term are not well recorded. It was therefore considered useful to try and bring as much information together as possible and put it in a format to aid decisions regarding feeding concentrates. The process has been a most rewarding one and I trust readers will find what follows both interesting and valuable.

Peter Neaves
ACKNOWLEDGEMENTS

First, thanks are due to my supervisors, Professor Warren Parker and Associate Professor Colin Holmes, whose thoughtful criticism and comment has been invaluable. Their very rapid return of drafts with comments has been greatly appreciated.

Thanks also to the Dairy Research and Development Corporation of Australia, for making it all possible with their initiative in funding a scholarship and the Department of Primary Industries and Fisheries (Tasmania) for giving me the time to accept the opportunity.

To the other students of the Department of Agricultural and Horticultural Systems Management thanks for useful suggestions, laughs and camaraderie throughout the 12 months.

Lastly, thanks to Kate Mirams, my dear friend and companion, who has supplied not only help with layout but much needed support at a time when both of us were struggling to finish our theses. How we have remained (apparently) emotionally unscared is beyond me.
# GLOSSARY OF TERMS

<table>
<thead>
<tr>
<th>Abbr</th>
<th>Description</th>
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<tbody>
<tr>
<td>BI</td>
<td>Breeding index, a measure of cow genetic merit used in New Zealand.</td>
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<tr>
<td>CS</td>
<td>Condition Score, a measure of cow fat cover where 2 is very thin and 7 is very fat.</td>
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<tr>
<td>Conc</td>
<td>Concentrate feed.</td>
</tr>
<tr>
<td>CP</td>
<td>Crude protein.</td>
</tr>
<tr>
<td>dig</td>
<td>Digestibility.</td>
</tr>
<tr>
<td>DM</td>
<td>Dry matter.</td>
</tr>
<tr>
<td>FCM</td>
<td>Fat corrected milk (4% milk fat).</td>
</tr>
<tr>
<td>kg/c/d</td>
<td>Kilograms per cow per day.</td>
</tr>
<tr>
<td>l</td>
<td>Litres.</td>
</tr>
<tr>
<td>LIC</td>
<td>Livestock Improvement Corporation.</td>
</tr>
<tr>
<td>LW</td>
<td>Liveweight.</td>
</tr>
<tr>
<td>ME</td>
<td>Metabolisable energy.</td>
</tr>
<tr>
<td>MF</td>
<td>Milkfat.</td>
</tr>
<tr>
<td>MJ ME</td>
<td>Megajoules.</td>
</tr>
<tr>
<td>MS</td>
<td>Milksolids.</td>
</tr>
<tr>
<td>NE</td>
<td>Net energy.</td>
</tr>
<tr>
<td>NDF</td>
<td>Neutral detergent fibre.</td>
</tr>
<tr>
<td>OM</td>
<td>Organic matter.</td>
</tr>
<tr>
<td>P</td>
<td>Protein.</td>
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ABSTRACT

A model to aid decisions regarding the feeding of concentrates to dairy cows was constructed. The literature regarding milk and liveweight responses to concentrates, pasture growth, nutrient effects on reproductive performance and modelling methods, was reviewed to establish important relationships and a process for model development. The milk response to concentrate supplementation is largely influenced by the substitution rate and marginal energy partitioning to milk and liveweight gain. Substitution rate increases with pasture intake, because as cows approach their intake limit there is reduced scope for further increases in intake. At lower pasture digestibilities substitution rate is also lower and when high fibre concentrates are fed there is less substitution because rumen fermentation is not affected to the same extent as when high carbohydrate concentrates are used. Concentrate feeding level per se, stage of lactation and season of the year do not appear to affect substitution rate in any consistent way.

Marginal nutrient partitioning describes what happens to the extra energy consumed. Total energy intake is negatively related to marginal partitioning to milk. Cows of low condition score partition more energy to liveweight gain than cows of similar genetic merit of higher condition score. High genetic merit cows tend to converge to a lower condition score than cows of low genetic merit, thus genetic merit has an indirect effect on marginal nutrient partitioning. Concentrate intake level was not important until intake levels reached approximately 50% of the diet and/or fibre intake decreased below a critical level. Stage of lactation does not affect marginal nutrient partitioning in any consistent way.

Pasture growth rate was estimated to increases by 2.6 kg DM/ha for each 100 kg DM extra remaining after grazing at least up to a residual pasture mass of 1800 kg DM/ha and possibly beyond this. Therefore, one outcome of substitution is likely to be increased pasture growth. The utilisation of the extra pasture growth and hence its financial value, can be estimated from the feed supply and demand on the farm.

Nutrition in early lactation and specifically energy balance, affects reproductive performance. A complex relationship between cow condition, milk production and intake exists. Cows in low condition score (< 4.3) and losing weight are most likely to benefit from extra feed in the period prior to mating. The benefit may be as high as 12 kg MS/cow through earlier calving in the following lactation if all cows in the herd improve reproductive performance.

A stepwise decision framework was chosen to model the decision problem. A paper model using a set of graphs, tables and calculations to represent the information described above was developed to predict both short-and long-term financial benefit of feeding concentrates to pasture fed dairy cows. Preliminary field testing revealed the model was time consuming and difficult to use for scenario analysis. A spreadsheet version of the model was therefore developed, however it has less value as an educational tool for farmers. It was concluded that it provides a useful framework for analysing decisions regarding concentrate feeding in the field.