

NUTRITIONAL PROBLEMS IN SOUTH ISLAND DAIRYING

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Introduction

This discussion is based on a simple assumption about the South Island dairy industry: the trend towards large herd size (>650 cows) and greater milk solids (MS) production is not going to abate in the near future. That being so, there are emerging features of herd nutrition management of these larger, higher producing herds that are both interesting and poorly described to date, and recent research by Lincoln University Animal Science, including the South Island Dairy Lameness (SIDL) project (2005-09), is relevant to some of these. In this paper, some aspects of the rumen impact of typical grazing strategies used for pasture management in lactation and for kale crops in winter on these large, high producing herds will be discussed.

Pasture management

The consistent factor in improved MS production from grass based systems is achieving higher daily intakes of metabolisable energy (ME). Higher quality pastures supply more ME/ kg DM, and also increase daily intake of DM. Pasture quality has been increasing steadily in recent decades under the stimulus of consistent industry reinforcement of the value of better pastures to overall profit. It has been achieved by a combination of research and industry application, in both plant genotype selection and improved pasture management (Lambert et al., 2004; Woodfield and Easton, 2004). An argument can be made that larger, higher producing, grass based farms such as those in the SI are often more proactive and focused on excellent pasture management, perhaps because they are acutely aware of the primary impact this has on the bottom line – profit. The ‘immediate pre-grazing’ pasture samples collected from farms in the SIDL project – approximately 2000 across all seasons and regions, and in four consecutive years – support this argument, as they demonstrate the quality of the pastures at grazing on the participant farms was consistently high (mean monthly ME \approx 11-12 MJ/kg DM).

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There are however, several identifiable features associated with the patterns of pasture intake in these larger, high production herds. First, larger herd size requires more hectares to graze, which means longer average walking times (often an average of >30 minutes to and from the shed). Larger herds often also spend more time in the yards each milking (for the SIDL project farms, the typical 'cups on to cups off' time at peak milk was 120-150 minutes, and in April was 90-120 minutes). Together, these 'non-grazing' periods can account for 25% of the day in a milking herd of 650 cows, or greater milked twice daily. Second, because excellent pasture management requires very careful attention and judgement, large herds often have a single fresh break daily, after afternoon milking. This is driven by two practical concerns: it is easier to assess and make grazing judgements on post grazing residuals, a driving factor in maintaining high quality pastures, in the daylight hours compared to darkness; and because pasture management has to take account of many dynamic factors (weather influence, cow preferences, surface water/pugging etc), twice daily breaks are significantly more difficult to manage. As one very experienced 'super' producer put it, twice daily breaks 'just give you two opportunities a day to make mistakes instead of one'. In addition, there is an industry position that the quality of the evening break is better on account of the higher sugar content at that time of day.

So, to put these features side by side, you have higher intake cows that spend longer periods each day either not grazing (on the tracks and yards – up to 25% of the day), or grazing lower quality and cover pasture as they 'clean up' last night's break to achieve satisfactory residuals (usually between morning to afternoon milking, and then beyond this as required – approximately 25% of the day). This pattern of management leaves the cows with the evening break – typically of high quality - to achieve their higher intakes. Given cows are quick to adapt to routine, this establishes a diurnal grazing pattern of relatively hungry cows having very high rates of intake of high ME grass across this period, particularly the first four hours, then low intake rates for the remainder of the day – the 'feast and famine' effect.

There is Australian research (Dobos et al., 2009) that reports >70% of the daily intake was achieved in 4 hours after this break. There is however, little research on the effect of this grazing pattern on rumen function. The SIDL rumen function experiments at Lincoln University Dairy Farm (LUDF) included recording diurnal grazing behaviour in association with rumen pH, and although rate of intake was not measured, the observed grazing patterns broadly support a similar proportion of daily intake occurring in the evening. High MS production cows in this study were observed grazing continuously from afternoon milking to after midnight, and rumen pH profiles typically mirrored that time sequence, and neither the extended grazing behaviour, or the rumen pH response, was repeated any other time of the day.

This episodic rumen ‘loading’ of energy and nitrogen is a new and unintended development in grazing systems of large herds. Intake patterns of marked diurnal fluctuations can potentially leverage an effect at two different levels in the cow – on rumen function, and the systemic physiology beyond the rumen. In this discussion, rumen pH and bloat will be considered as examples of the former, and urinary nitrogen excretion as an example of the latter.

The robust MS production, generally good reproductive performance and low rates of disease observed in South Island large herds all suggest it is unlikely that the ‘feast and famine’ intake pattern is automatically of major concern. In total mixed ration (TMR) systems overseas, however, managing intake patterns to achieve a consistent intake – termed ‘bunk management’ – is an important concern (Pritchard and Burns, 2003). In these systems, the most powerful driver for this is the risk on starch based diets of fluctuating intakes inducing rumen acidosis (Stone, 2008). This can cause subsequent temporary reductions in rumen stability and intake, and therefore lost production, and sometimes downstream animal health issues.

Given this, it is reasonable to ask if similar risks are also present in the high production, large herd scenario sketched out above. For rumen pH, the SIDL rumen research on LUDF 2005-09 suggests the short answer would be ‘no’. In the high intake cows of a grass based system like LUDF, the rumen pH profile is substantially different to that of starch based TMR systems, with important differences in the size and correspondence of pH responses after feeding, rapidity of pH changes, and the impact of lower pH values (Gibbs et al., 2007). Due to these differences, there are good reasons to be cautious in using international studies on TMR systems as suitable rumen benchmarking for grass based systems. In terms of the effect of ‘feast and famine’ grazing intake patterns on rumen pH, the SIDL rumen research suggests while there is considerable diurnal fluctuation in pH linked to grazing management and intake pattern, there are not the associated negative rumen impacts commonly attributed to these in TMR systems overseas (Marie Krause and Oetzel, 2006).

Another rumen issue of some interest where high quality pastures and fluctuating intake patterns are relevant is bloat. For bloat, the features commonly associated with high production large herds previously detailed above – low residuals and fluctuating intakes across the day – are potential risk factors. Low residuals open up the sward, encouraging strong clover growth in season, and high clover content is associated with bloat risk. Also, larger ‘meals’ are encouraged by the high quality pastures and the ‘feast and famine’ intake pattern encourages rapid intakes when first on the break, both of which are risk factors. There is no formal research

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on this, but anecdotal reports from a number of high production SI farms suggest bloat control is once again rising as an identifiable grazing management challenge in these systems.

Beyond the rumen, patterns of fluctuating intake are also of interest with nitrogen excretion. The degradation of pasture protein in the rumen is generally rapid, and nitrogen containing substrates - particularly ammonia – are released to the rumen environment for use by the microbe population. The amount of nitrogen present that is surplus to prompt use by the microbes for protein synthesis is passed to the systemic circulation. Much of that is then later recycled through the rumen, but a proportion is lost through excretion via urine. The urine volume (Figure 1) and daily total urinary nitrogen excreted broadly rises with increasing crude protein content in the diet, but the urinary nitrogen concentration is also responsive to rumen loading over shorter intervals. For example, in a recent Canterbury trial by this research group, urine was collected from cows grazed under a typical SI management approach to produce a ‘map’ of urine total nitrogen concentration every 2 hours for the 24 hour period. Urinary nitrogen concentrations were clearly associated with grazing, rising sharply within two hours of first grazing the evening break, then declining after the grazing bout, and a similar diurnal pattern was evident with the rumen ammonia concentrations measured in the trial.

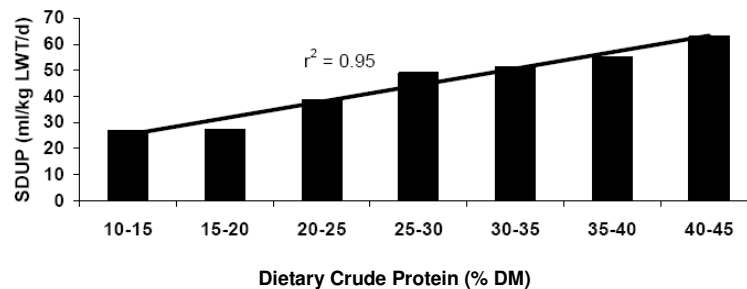


Figure 1. The mean, stratified daily urine production (SDUP: millilitre/ kilogram liveweight/ day) of cattle fed forage and mixed forage/ supplement diets. The SDUP values represent the means of all urinary output measured in individual 7 day total urine collections (n=684) from diets arranged into groups according to the crude protein content (% dry matter) (Gibbs, unpublished data)

As there is limited available research on rumen metabolism or nitrogen balances with high quality pastures and high intake cows at present, it is difficult to extrapolate directly from international work in other systems how influential grazing behaviour could be on the physiology beyond the rumen in nitrogen excretion, so the significance of intake patterns to either protein nutrition or nitrogen excretion is uncertain. As it is a topical point of discussion for the industry and the subject of ongoing research, in the future it may become clearer if intake patterns have any functional role in management of nitrogen losses.

Kale

In addition to the pasture management features discussed above, large herds in the South Island also have a strong tradition of winter crop feeding. Kale is the most common winter crop in the South Island dairy industry (Beare et al., 2006). It is popular as a palatable feed that can be grown relatively inexpensively (15-20 cents/ kg DM) to yields of 7-20 tonnes/ hectare in June, with an ME typically of 12 MJ/ kg DM, a crude protein content above 15%, and a sugar content above 25% (de Ruiter et al., 2007). These factors, and the efficient use of land area, have contributed to the popularity of kale with large herds in the SI. Typically, it is fed behind a wire moved once daily, at about 8kg DM/ cow, with 2-3kg of straw/ silage fed out first. This feed management also generally establishes an intake pattern of rapid feeding for the several hours it takes to finish the available kale, then a longer interval without feeding, or with some nibbling on leftover straw, until the next daily straw/ silage deposit and opening of the break. So it can be seen that this intake pattern has some similarities with that discussed for pasture in large, high production herds above. Although a proportion of graziers shift more than once daily, again there are practical reasons why it is the less common option with larger herds. That is, each break has to be cut in the crop, and someone is required on each paddock twice daily to open the break.

The cow health problems usually associated with kale feeding are toxicities (nitrate, S-methyl cysteine sulphoxide, glucosinolates), trace element deficiencies (Cu and I), and mineral excesses (Ca and S). While attentive management usually eliminates issues with the trace element and minerals Cu, I, Ca or S, the toxicities are sometimes more unpredictable and can be difficult to control. Nitrate poisoning occurs when the rumen microbiota converts nitrate to nitrite at a rate beyond the formation of ammonia, and the rate of nitrite production is a function of the rumen 'loading' of nitrates. Nitrate accumulation is not an uncommon feature of kale, on account of the rapid growth and high nitrogen requirement. S-methyl cysteine sulphoxide (SMCO) is the aetiological agent for a potentially fatal haemolytic anaemia caused by the production of dimethyl disulphide from SMCO by the rumen microbiota, and it is present in kale. For reasons that are as yet incompletely described, SMCO levels fluctuate between paddocks, seasons, regions and years, and can cause significant problems with little warning.

However, both nitrate and SMCO toxicities can also be viewed as 'rate of intake' issues, as both are a consequence not only of the plant constituents, but also the overwhelming of the

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rumen capacity to further inactivate the toxic compounds produced. As detailed above, the typical management of kale feeding, which can encourage rapid intakes at the opening of the break, is therefore a contributing factor to the risk of these toxicities. This has traditionally been a primary driver for the use of straw with kale crops, fed prior to the fresh break of kale being opened to reduce appetite and slow the rate of intake. Straw feeding is generally effective when used for this, if the cows eat it, and experience suggests not every cow will do so.

Straw is also included by some graziers to prevent rumen acidosis, on the basis kale typically has relatively high sugar content, often has a low neutral detergent fibre (NDF) content (25-30%), and a relatively low DM (13-18%) (de Ruiter et al., 2007). Although kale is widely suggested to promote low rumen pH in cattle because of this structure and composition, research demonstrating this or investigating other aspects of rumen function in contemporary kale fed cows is very scarce. In trials over the last several years by this research group, LUDF rumen fistulate cows wintering on kale and straw fed once daily were used to measure rumen pH during this period by continuous monitoring with indwelling probes. In addition, to assess the protein and energy nutrition of the diet, the digestibility of the industry standard kale and straw diet was measured using rumen fistulate cattle in feeding crates, while the rumens were also monitored for pH, and 'mapped' for rumen volatile fatty acid and ammonia concentrations across the day.

In a brief summary of these results, the energy nutrition of this diet appeared sound, with the estimated ME values of kale were in line with industry expectations (≈ 12 MJ/ kg DM). There was an identifiable rumen pH response after the daily break, but not as marked as seen in cows on pasture on a single evening break. In addition, there was no evidence of acidosis, as the industry standard kale and straw diet produced a relatively high rumen pH, particularly when compared to previous observations of the same cows on pasture. However, the protein nutrition of the diet was less clear. There were marked fluctuations in the rumen metabolite concentrations observed, particularly ammonia, relative to feeding time, and this may be of significance in describing the protein nutrition of kale diets fed once daily. Follow up work is underway to directly assess rumen protein metabolism on these diets, but there may be opportunities for improving overall protein supply with more frequent feeding.

Conclusions

As any livestock system develops new methods will be used, and there are likely to be research questions that arise as these are put into use. The large, high production dairy herd based on highly managed and high quality pastures, as seen in the South Island, is a relatively recent system, and it has features of herd nutrition and downstream physiology about which little is known. The intake pattern produced by the large herd size and high intake is of particular interest, and there are interesting similarities to the industry standard feeding of kale.

For both of these, although there is insufficient research in the area to date, the preliminary work suggests that contrary to existing research findings for TMR systems, this intake pattern does not seem to negatively impact the energy nutrition of the rumen. Any possible effect on rumen protein nutrition is currently uncertain, but given the increasing research in rumen function in grass based dairy systems and the potential relevance to nitrogen excretion management, it should be a valuable line of enquiry for future studies in both areas.

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