Within-year variation in pasture quality has implications for dairy cow nutrition

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Abstract

Within-year variation in herbage nutritive parameters (digestibility (DOMD), crude protein, soluble carbohydrate and fibre fractions) are described for pasture samples collected from four dairy farms with different soil and pasture characteristics. Samples were collected at 2- to 4-weekly intervals to reflect material likely to be consumed by cows and analysed after freeze drying by near infrared spectrophotometry (NIRs). Results show large seasonal variations for most of the nutritive parameters (e.g., digestibility (65–80%), crude protein (13–32%), ADF (22–36%)). At times these values exceeded or were inadequate to meet the requirements of lactating cows. The implications of pasture quality data for dairy farm management and dairy cow productivity are discussed.

Keywords: carbohydrate, dairy cows, digestibility, fibre, pasture quality, protein

Introduction

Historically much of New Zealand's dairy production research has concentrated on managing the amount of pasture made available to cows. Surprisingly little research has been carried out on pasture quality and its seasonal variation and scant attention has been paid to formally incorporating this information into dairy farm feed management (Parker & Edwards 1994). It is well known, however, that diet components and their relative proportions significantly influence animal production (Muller 1993). Thus, while well-managed pastures provide a high quality feed, they do have a number of deficiencies which limit milk production (Ulyatt & Waghorn 1993).

Variation in parameters of pasture quality on dairy farms over a full year are described in this paper in order to identify opportunities to enhance the diet quality, and hence productivity, of dairy cows. In this paper pasture quality is interpreted largely in relation to nutrient and mineral composition. Linn (1992), however, provided a more encompassing definition of feed quality which included parameters of nutritive value, palatability and animal health effects. These additional aspects of quality are also important in a grazing situation where animals can exercise preference, and hence choose components of the sward (e.g., leaf vs stem) then may enhance or depress performance, or consume material that results in animal health problems (e.g., grass staggers, facial eczema).

Materials and methods

Case farms

Four dairy farms were selected for the study. These provided contrasting soil fertility, sward types and pasture growing conditions. Two farms were located in the Manawatu; Massey University's No. 1 and No. 4 dairy farms, and two properties were situated in south Waikato (near Te Awamutu). Pasture was sampled over a 2-year period for the University farms and one of the Waikato properties. The second Waikato property was sampled fortnightly for 1 year.

Pasture sampling and analysis

During the 1992193 season two representative paddocks at each of the No.1 and No.4 dairy farms were sampled at approximately monthly intervals. Samples were not collected when paddocks were closed for silage or within 1 week after grazing. During the 1993/94 season (commencing from July) sampling was modified to include a third paddock on each farm, which was offered to cows for grazing on the day following sampling. The inclusion of this paddock in the sample set allowed a more complete picture to be obtained of changes in pasture quality during the year.

The Waikato samples were collected every 2 weeks from caged sites. The caged site allowed sample collection even if the cows had just grazed thc paddock. The sample material collected was visually similar to that about to be grazed by cows. After sample collection the cage was moved to a new site that represented pasture left by the herd after their last grazing.

Herbage was cut from within the cage site or from different parts of the paddock (where the paddock was about to bc grazed) in a manner that reflected how the cows would have consumed pasture if they were grazing the paddock at the time of sampling. The fresh sample was stored immediately in crushed ice to stabilise the material until it was deep frozen. Samples were subsequently freeze dried, ground through a 1 -mm screen Wiley Mill and analysed by near infrared spectrophotometer (NIRs) analysis at the University of Sydney for *in vitro* digestibility (DOMD), crude protein (CP), total soluble carbohydrates (CHO), acid detergent fibre (ADF), neutral detergent fibre (NDF), pectin and minerals (Mg, Ca, P, K).

Results, except for the mineral analyses (not reported), are presented in graphical form to show seasonal variation and the 95% confidence interval. Curves were fitted to the data aggregated across farms using the Flexi 2.2 Bayesian smoothing software (Upsdell 1994).

Results

The values for *in vitro* DOMD (Figure 1) ranged from 65 to 80%, with the highest values in spring and autumn, corresponding to periods when new pasture growth is usually greatest. Crude protein values mirrored those for DOMD and were also highest in spring and autumn (Figure 2). Autumn levels of CP were higher than those for spring on the two Massey University farms. In April and May of 1994 this may have been associated with the application of diammonium phosphate at 200/kg ha.

The NDF values (Figure 3), which reflect the cellulose, hemi-cellulose and lignin components of the fibre in pasture, exceeded NRC (1989) recommended levels of 35–40% in the DM for lactating dairy cows during the summer months especially. The range in ADF concentrations was much lower than that for NDF, with the highest levels recorded in the summer months (Figure 4). Concentrations of soluble carbohydrates (CHO) (Figure 5) were highest in late autumn, winter and spring.

Figure I Seasonal variation in crude pasture (CP) in the dry matter (DM) of pasture samples collected from four dairy farms. For all figures; Massey farm 1 0, Massey farm 4Δ, to farm 2 ●, Waikato farm 3 ▲.The 95% confidence interval is shown by a dotted line about the mean concentration, and the recommended NRC (1989) minimum (and upper) level for high producing cows is shown by the horizontal line.

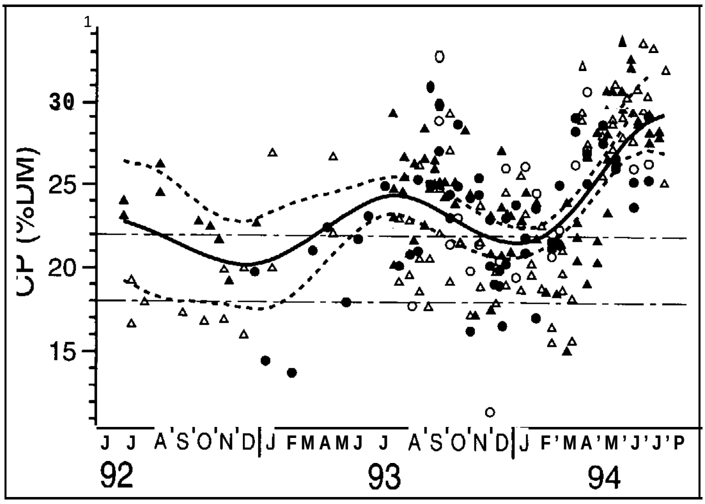
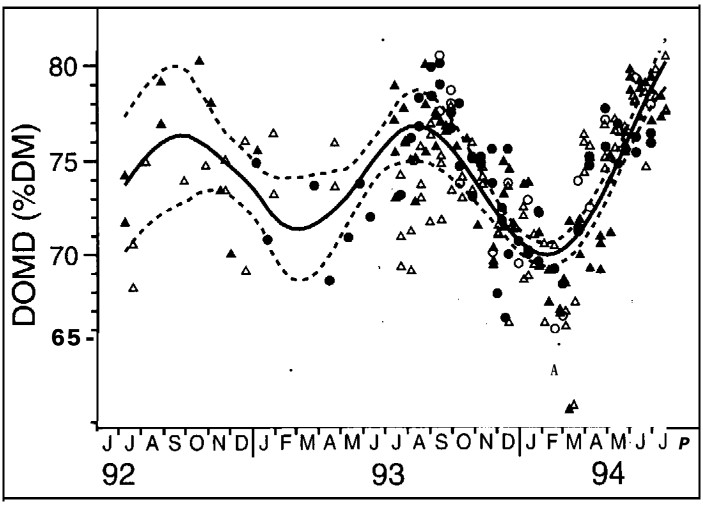


Figure 2 Seasonal variation in the digestible organic matter in the dry matter (DOMD) of pasture samples collected from four dairy farms (see Figure 1 caption for explanation of symbols and lines).



Discussion

Distinct seasonal patterns could be discerned for the pasture quality variables measured. Based on known requirements for dairy cows (e.g., NRC 1989), concentrations of some nutrients were either inadequate or in excess of recommended feeding levels for dairy cows at some times of the year, particularly if relatively high (>25 milk/cow) milk yields arc sought (Muller 1993; Ulyatt & Waghorn 1993). For example, high producing cows need approximately 17-18% CP in the

Figure 3 Seasonal variation in the neutral detergent fibre (NDF) concentrations in the dry matter (DM) of pasture samples collected from four dairy farms (see Figure 1 caption for explanation of symbols and lines).

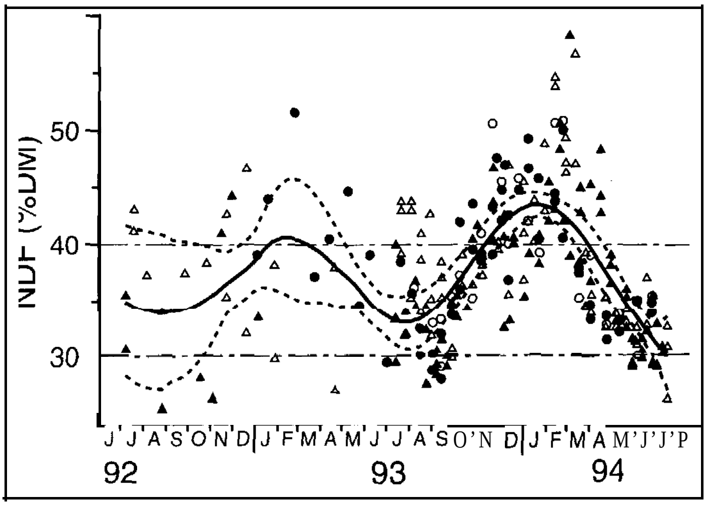
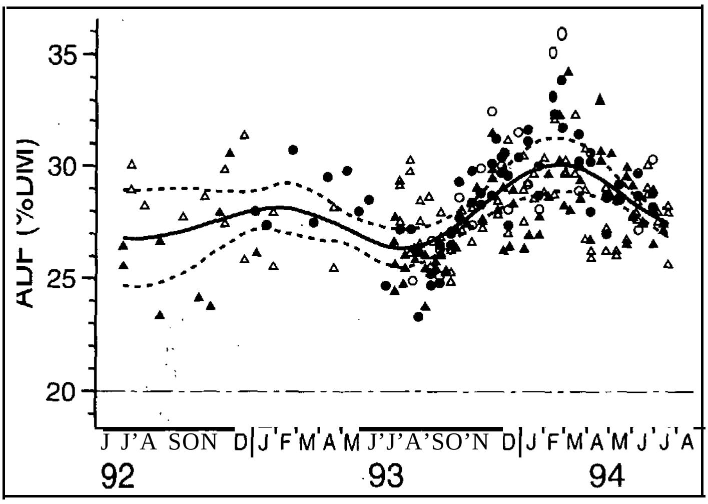


Figure 4 Seasonal variation in the acid detergent fibre (ADF) concentrations in the dry matter (DM) of pasture samples collected from four dairy farms (see Figure 1 caption for explanation of symbols and lines).

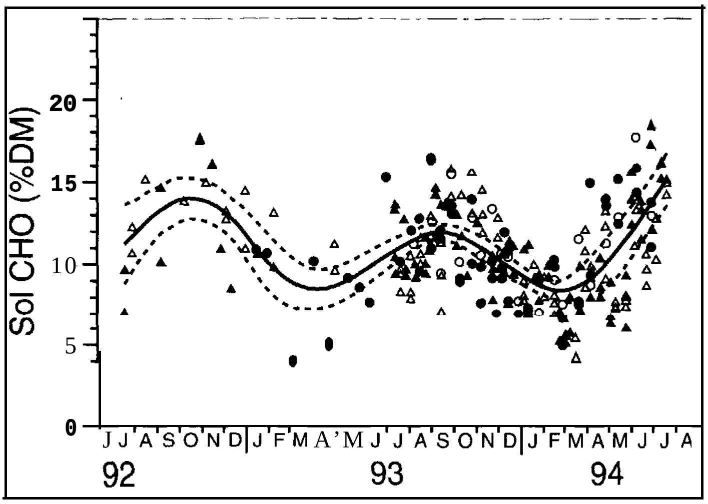


DM they consume (NRC 1989). While high CP levels are found mainly in spring and autumn pasture (Figure 1) they are likely to create a "protein penalty" since the cow must use energy to clear urea from the bloodstream, which could otherwise be used for milk synthesis (Danfaer 1980; Satter *et al.* 1992; Beever 1993). In contrast, protein levels in summer pasture were sometimes below 15% in the DM, and under these circumstances cows may select diets with insufficient protein to sustain high levels of milk production. Adding a low protein supplement (e.g., poor quality and pasture, silage, maize silage, hay, some fodder crops) to this type of summer pasture would exacerbate the pasture protein deficiency.

Pasture management strategies (e.g., clover enhancement; short, fresh ryegrass) can help to maintain summer protein levels above the recommended dietary concentration. Alternatively, farmers could consider establishing forage crops which have high levels of protein (and possibly tannin) and low levels of fibre (e.g., chicory, turnips) to supplement the pasture. However, while both of these options may effectively provide adequate dietary protein for dairy cows during the summer-autumn, they are subject to climatic variation and therefore do not necessarily remove the risk of sub-optimal feeding of the dairy herd. Alternatively, a small quantity of by-pass protein could be added to "inexpensive" supplements that often have low protein levels (e.g., sweet corn silage or apple pomace) (Edwards & Parker 1995). For all feeding strategies caution should be exercised to avoid supplement effects on milk flavour or manufacturing qualities (Keen 1993).

The ADF and NDF analyses show that hemi-cellulose increased over the summer (i.e., NDF - ADF = hemi-cellulose). Minimum ADF levels for high milk production per cow are 20-21% in the DM (NRC 1989). Elevated NDF values in summer may reduce the DM intake of cows (Mertens 1984) unless low pasture allowances are already restricting DM intake (e.g., owing to dry conditions). The addition of high fibre supplements (e.g., pasture silage) in summer may exacerbate any intake depression due to high levels of NDF already being provided by pasture. On the other hand, rapidly grown pasture with high protein, but low hemi-cellulose, or soluble sugars concentrations, such as the spring and autumn pastures in this study, may not provide sufficient energy for optimal rumen bacterial function (Satter *et al.* 1992; Muller 1993), especially if this coincides with high levels of soluble protein in the diet. The application of

Figure 5 Seasonal variation in the soluble carbohydrate (CHO) concentrations in the dry matter (DM) of pasture samples collected from four dairy farms (see Figure 1 caption for explanation of symbols and lines).



nitrogen to enhance growth rates, or short grazing rotations which allow cows to consume immature leafy pasture, may exacerbate this problem (Moller *et* al. 1995), particularly if overcast weather conditions are also reducing photosynthetic activity at the same time.

Values for DOMD showed a similar pattern of seasonal change as the protein, ADF and NDF values. High proportions (20–25% DM) of clover in the sward will increase DOMD and CP values, but will likely decrease overall NDF concentrations in the diet. Pasture digestibility is positively linked to DM intake (Ulyatt & Waghorn 1993), so high DOMD should increase milk production through greater energy consumption, other things being equal. However, high quality pastures have a mismatch in the energy: protein ratio (Satter *et* al. 1992; Muller 1993). Adding a suitable CHO energy source (e.g., maize silage) to balance plant protein digestion, should theoretically assist rumen bacteria to assimilate ammonia, and improve energy and protein utilisation. Because of the highly soluble nature of pasture protein, the addition of some under-graded protein with the soluble CHO supplement is likely to enhance the milk production response (Satter *et* al. 1992). The spring split-herd farm trial reported by Moller & McKay (1994), and the initial yield response reported by Edwards & Parker (1995) for autumn pastures, both suggest that milk production responses to by-pass protein can be obtained. However, more formal experiments, or a larger number of split-herd farm trials, are required to confirm these findings.

It should be emphasised that the pasture samples collected in this study may not-exactly mimic the pasture selected by cows during grazing, although a comparison of samples from the paddock about to be grazed and the fixed sites on the Massey farms (results not shown) suggests the difference is small. The problem of sampling pasture to exactly replicate that which is consumed by cows is almost impossible to overcome in practical terms (oesophageal fistulated cows are not a viable option at the farm level), and this will always have some impact on the interpretation of pasture quality values, particularly in situations where cows can exercise a high degree of selectivity.

The dairy farms sampled could be classified as being "well managed" with relatively high stocking rates, improved pastures and above-average levels of fertiliser inputs. As such they may not represent seasonal variation on dairy farms with poorer quality land and lower fertiliser inputs. They do, however, represent farms which are achieving above-average levels of milk production and are therefore in the group of farms most likely to benefit from the application of ration balancing principles (Edwards & Parker 1994).

Conclusions

This study provides further understanding of the factors that may limit the milk production of cows on pasture-only diets. Pasture quality information provides a basis from which feeding and pasture management strategies can be devised to enhance the nutrient value of pasture diets so that they more closely match those known to elevate milk production (Muller 1993). The use of NIR analysis for the diagnosis of pasture quality has demonstrated its potential role as a decision-aid for farmers and nutrition consultants (Parker & Edwards 1994). Rapid turn-around, low-cost results from NIRs should enhance feed management decisions and this in turn should lead to increased milk output per cow (and hectare) and more cost-effective nutrient use on pastoral dairy farms.

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