Efficiency of pasture and supplement management in high producing dairy herds

P.V. SALLES, J. HODGSON, P.N.P. MATTHEWS, C.W. HOLMES, and N.M. SHADBOLT
Institute of Natural Resources, Massey University, PB 11 222, Palmerston North

Abstract

In 1998 a three-year dairy farm monitoring programme funded by AGMARDT (Agricultural Marketing and Research Development Trust) was established on twelve dairy farms in the southern North Island of New Zealand where policy had changed from a focus on high production per ha through high stocking rate to a management based on reduced stocking rate and strategic use of supplements to enhance both production per cow and per ha. The project involved a detailed three-year data collection which included measurements of the quantity and composition of pasture and supplements consumed as well as animal perfomance. Analysis of the results of the third year (2000/2001) on nine of these farms with complete data sets identified a range of metabolisable energy (ME) intake (50669 – 70135 MJ ME/cow/yr). Supplementary feed represented on average 24% (21 – 27 %) of the total intake of ME, the main supplements being pasture silage (summer to winter), turnips (summer) and maize silage (autumn and winter) consumed by lactating cows, and grazing off by dry stock. There was a range of milksolids (MS) production per cow (372 – 424 kg/year) and per hectare (921 – 1264 kg/year). The average economic farm surplus per hectare of NZ$3077 (NZ$2425 – NZ$3867) for the case-study farms was approximately 43% higher than the top 25% farms in the Manawatu region. Mean values of return on assets for the case-study farms (12.9%) and top 25% farms in Manawatu (13.0%) were similar.

Good pasture management based on controlled pre- and post-grazing herbage mass targets (mean 2650 and 1900 kg DM/ha, respectively), strategic use of supplementary feed to control pasture deficits, and moderate stocking rates (overall mean 2.7 cows/ha), provided high allowances of high quality herbage (organic matter digestibility ranging from 742 to 845 g/kg DM) and maintained high levels of milk production (411 kg MS/cow and 1100kg MS/ha). The comparison with industry data showed that the case-study farms were highly productive and profitable dairy systems, at least under the conditions of the 2000/2001 season. However, the result indicated the need to improve management skills to limit feed wastage under generous feeding management, and also the limitation of conventional procedures for monitoring pasture consumption in farming systems.

Keywords: animal performance, dairy systems, energy intake, herbage quality, pasture management, profitability

Introduction

The success of New Zealand dairy production has been based on the increased amount of pasture harvested per ha as a consequence of better pasture utilisation resulting from high stocking rates (Matthews 1995) combined with genetic improvement, which has increased milk production and feed conversion efficiency per animal (Holmes & Matthews 2001). However, pasture limitations have restricted animal performance (Matthews 1994). The strategic use of supplements is an important tool to overcome pasture limitations, preventing herbage mass from falling to levels which adversely affect herbage intake, animal performance or pasture growth (Matthews 1995). However, more generous feeding may increase herbage wastage, leading to a conflict between pasture utilisation and forage intake (Hodgson 1990; Matthews 1995).

In 1998 a three-year dairy farm monitoring programme funded by AGMARDT (Agricultural Marketing and Research Development Trust) was established on twelve dairy farms in the southern North Island of New Zealand where policy had changed from a focus on high production per ha through high stocking rate to a management based on reduced stocking rate and strategic use of supplements to enhance production per cow while still maintaining efficient pasture utilisation. The project involved a detailed three-year data collection which included measurements of the quantity and composition of pasture and supplements consumed as well as animal performance. In this paper, the results of the third year (2000/2001) of the project are analysed for nine of these farms for which complete data is available and implications for management of feed resources in high production dairy systems are discussed.

Materials and methods

The nine study farms were located in the Rangatikei, Manawatu and Northern Waiarapa regions. Farm and herd characteristics are summarised in Table 1. The

Table 1 Farm and herd characteristics for the season 2000/2001.

	Mean	Range
Effective farm area (ha)	108	52-213
Peak cow number	287	148-570
Breeding worth (BW)	66	50-91
Production worth (PW)	79	55-112
Liveweight early lactation (kg)	460	425-480
Stocking rate (cows/ha)	2.7	2.4-3.0
Soil Olsen P (µg/ml)	33	29-36
Fertiliser nitrogen (kg/ha)	125	80-150
Rainfall (mm/yr)	1102	840-1600

herds were made up of Holstein-Friesian and Jersey crossbred animals. All farms concentrated calving in August, but in one herd cows were milked through winter to meet winter contract requirements. All properties were used as milking platforms, with no provision for young stock on the farm. Pastures were predominantly perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) under rotational grazing management. Sward targets designed to optimise pasture management were defined as 2500-3000 kg DM/ha and 1500-1800 kg DM/ha pre- and post grazing herbage mass, based on predictions from visual assessment without seasonal adjustment (Matthews 1994, Matthews *et al.* 1999). When necessary, pastures were taken out of the rotation for conservation to maintain sward targets, or controlled by topping, usually restricted to once a year in November/December. Eight of the farms grew turnips as summer forage crop, and all made use of winter grazing off-farm for a proportion of the dairy herd. The main supplements were pasture silage (summer to winter), maize silage (autumn and winter) and turnips (summer). Further details are given in Salles (2002).

Pre- and post-grazing herbage mass (kg DM/ha) were estimated daily by the farmers, using visual assessment (L'Huillier & Thomson 1988; Hodgson *et al.* 1999). Once a month, pre- and post-grazing herbage mass of 15-20 paddocks selected randomly in each farm were measured using the Ashgrove Rising Plate Meter (RPM) (Hodgson *et al.* 1999) and standardised seasonal calibration equations (Hainsworth 1999). Regression analyses were used to derive monthly equations between RPM readings and visual sward assessment for each farm, in order to adjust individual estimations from visual assessment. Apparent herbage intake (kg DM/cow/day) was estimated as the difference between adjusted pre- and post-grazing herbage mass (kg DM/ha) divided by grazing intensity (cows/ha/day), defined as the number of animals grazing divided by the area grazed per 24 hours.

The quantities of all supplementary feeds were recorded by the farmers every time they were offered to the cows. The fresh weights were determined using feed wagons fitted with load cells, or the weight of bales/bags of supplements, and samples of supplementary feed were collected for dry matter determination. Wastage of 5% was assumed for all types of supplements fed on feed pads, and 10% for turnips and supplements fed on the paddocks, based on farmer's assessment. Composite herbage samples were collected every ten days from August 2000 to January 2001 and once a month from February 2001 to May 2001 by hand plucking to grazing height from three paddocks due for grazing. A representative sample of each type of supplement used was collected at the same times. Supplement samples were analysed for metabolisable energy (ME) content using Near Infrared Reflectance Spectroscopy (NIRS) (Corson *et al.* 1999) and herbage samples were analysed for ME, crude protein (CP), acid detergent fibre (ADF), neutral detergent fibre (NDF) and organic matter digestibility (OMD) utilising the same method. Total intake consisted of pasture plus supplements and included both dry and lactating periods.

The quantity of milksolids supplied to the factory was divided by the peak number of cows on farm and by the farm's effective area (ha) to calculate annual milksolids (MS) production per cow and per hectare, respectively. A random selection of 25% of the cows were weighed on four occasions between early lactation and drying off. Theoretical ME requirements for maintenance, pregnancy, milk production and liveweight change were calculated for the period of one year for each farm (Holmes *et al.* 2002). Economic farm surplus (EFS) was calculated as gross farm income less total operating expenses (Shadbolt 1998, 2001) and was then divided by the farm's effective area. Return on assets was calculated as EFS divided by farm's total assets value (Boehlje 1994).

Results and discussion

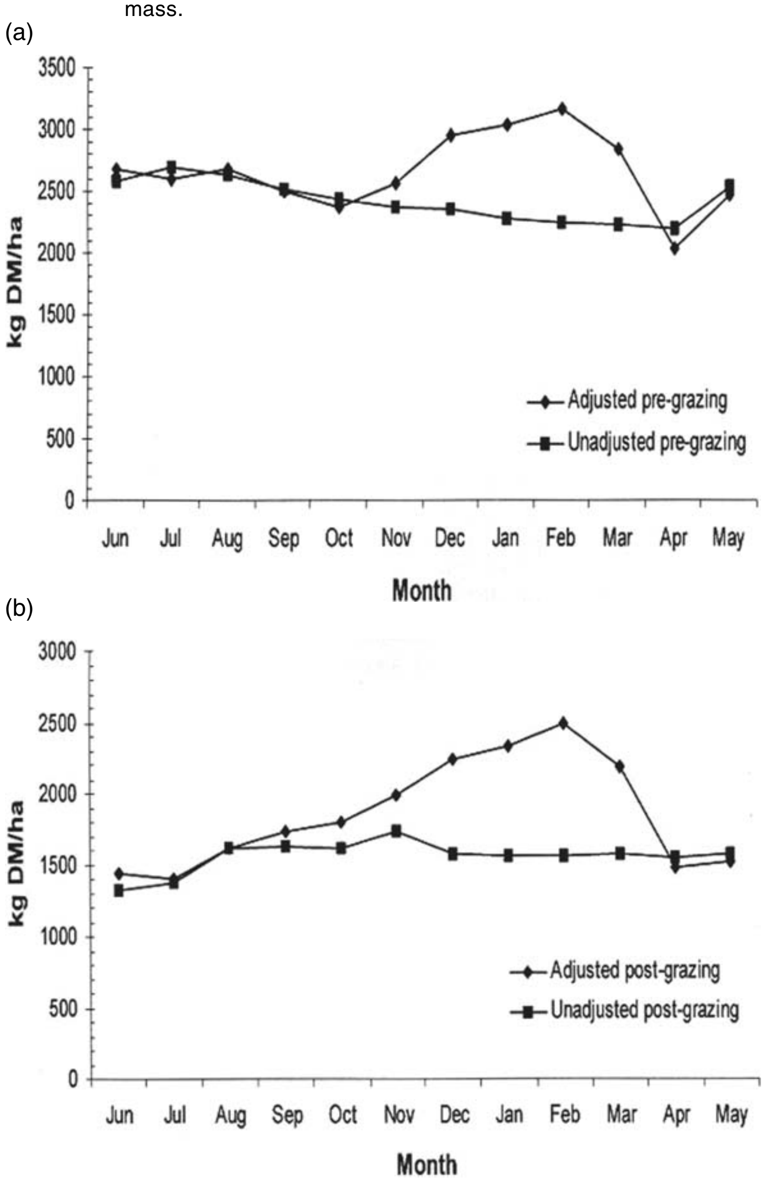
Pasture management

Mean unadjusted (farmers' visual assessment) and adjusted pre- and post-grazing herbage mass values for milking paddocks on all farms for the whole season are illustrated in Figure 1. Mean annual adjusted pre- and post-grazing herbage mass were 2 650 and 1900 kg DM/ha, respectively. The minimum adjusted post-grazing herbage mass value for the case-study farms was approximately 1300 kg DM/ha (Figure 1). In the period between late December and early March (Figure 1), the average adjusted pre-grazing herbage mass value for all case-study farms was higher than the recommended 3000 kg DM/ha.

These values may reflect the greater difficulty of pasture management at this period of the year, caused by the onset of flowering. However, Figure 1 shows that the unadjusted pre- and post-grazing herbage mass values (farmers' visual assessment) were substantially lower than the adjusted values (RPM) at this period of the year, confirming the need for seasonal adjustment of sward dry matter targets linked to seasonal changes in RPM prediction equations (Hainsworth 1999).

The annual averages and ranges of values for components of nutritive value for pasture samples taken to grazing height are illustrated in Table 2, and Figure 2 shows the seasonal variations across farms. Overall, herbage quality (Table 2) compared well with the composition of green leaf herbage (Hodgson & Brookes 1999), and with critical parameters of nutritive value for efficient summer milk production (Holmes *et al.* 2002). The annual averages of ME concentration for the main supplementary feeds were 10.4 MJ ME/kg DM (9.8 – 11.4) for maize silage, 10.5 MJ ME/kg DM for grazing off pastures, 10.8 MJ ME/kg DM (9.7 – 11.9) for pasture silage and 12.5 MJ ME/kg DM for turnips.

Figure 1 Comparison of adjusted and farmers visual assessment (unadjusted) estimates of pre- (a) and post (b) grazing herbage mass.



Energy intake and milk production

The estimated average annual ME intake for all case study farms was 59650 MJ ME/cow (range 50670 to 70140 MJ ME/cow). Supplement intake represented 24% (range 21 % to 27%) of total annual ME consumed, substantially higher than the value of 10% normally assumed for spring-calving dairy herds (Holmes *et al.* 2002). Supplements were fed throughout the year, the main contributions being from pasture silage and turnips in December to March (up to 12% and 20% of total ME intake respectively), pasture silage and maize silage in April and May (up to 6% and 9% of total ME intake, respectively), and grazing-off pasture for dry cows in June and July (up to 40% of total herd ME intake).

Records of MS production/cow and per ha for the case study farms are shown in Table 3. Cow liveweights were 460 kg (range 425 to 480 kg) in early lactation (Table 1) and increased steadily to 523 kg (range 450 to 580 kg) in late lactation. Estimates of total ME intake were 16% greater than requirements predicted from theoretical standards (Holmes *et al.* 2002). The on-farm techniques may have over-estimated actual intakes, though the indications that the rising plate meter under-estimates pre-grazing herbage mass (Thomson *et al.* 2001) suggests a risk of under-estimating rather than over-estimating intake. Alternatively, some wastage of pasture could have occurred. Taking the field estimates of ME intake, calculated values for the efficiency of production of MS for project farms was 6.9g MS/MJ ME (range 6.0 to 7.4g MS/MJ ME) similar to values calculated from Holmes *et al.* (2002) for spring calving, pasture fed cows. Evidence of a decline in feed conversion efficiency with increasing ME intake across the set of nine farms (Salles *et al*. 2003) provides further indication of the risks of feed wastage at high levels of feeding.

The estimates of ME intake on the case-study farms were lower than three out of five estimates derived by Penno (2001), also using pre-minus post-grazing measurements to estimate herbage intake, in farmlet trials with dairy cows under a range of stocking rates (4.41 and 3.35 cows/ha, respectively) and supplement treatments, where mean intakes over three years ranged from 47191 to 65 343 MJ ME/cow/yr. Levels of MS production per cow in the case study farms (372 – 432 kg/cow/yr) and in Penno (2001) (361 – 408 kg/cow/year) were similar. This provides further evidence of the risk of over-estimating herbage intake, substantiating the need for a careful assessment of techniques used to monitor pasture and supplement intakes in case-study farms and farmlet trials (Thomson *et al.* 2001).

Comparative performance

The case study farms produced 28% more MS/ha than the top 25% Manawatu farms at similar stocking rates (Table 3). Similar values of annual MS production/ha were

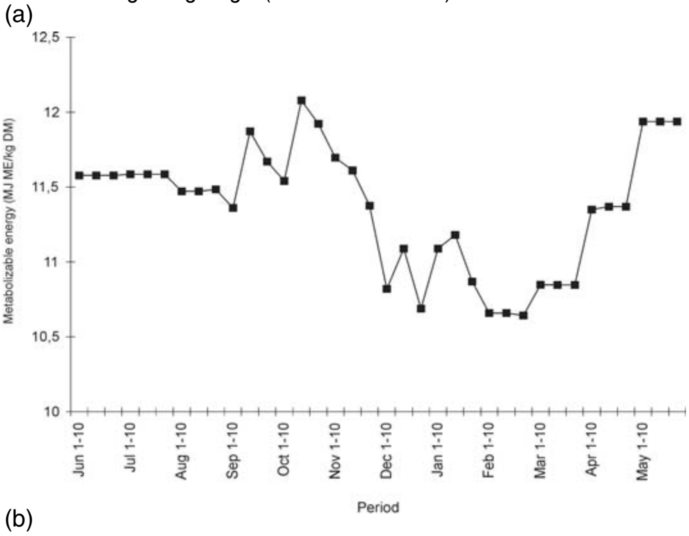
Table 2 Annual averages and ranges of values for estimates of nutritive value of herbage samples from case-study farms, for green leaf samples (Hodgson & Brookes 1999) and critical values for efficient summer milk production (Holmes *et al.* 2002).

	Study farms (overall)	Study farms (summer)	Green leaf samples	Critical values
Metabolisable energy	11.4 [(1)]	10.8		
(MJ ME/kg DM)	10.6 – 12.1 [(2)]		11.5 – 12.0	> 10.5
Crude protein	239	218		
(g CP/kg DM)	185 - 281		250 - 300	> 200
Acid detergent fibre	227			
(g ADF/kg DM)	191 - 262			
Neutral detergent fibre	417	439		
(g NDF/kg DM)	387 - 453		300 - 350	450 - 550
Organic matter digestibility	801	761		
(g/kg DM)	742 - 845		815 - 870	> 700

[(1)] Mean and [(2)] range of values, respectively.

Figure 2 Average metabolisable energy (ME) (a) crude protein, acid detergent fibre (ADF) and neutral detergent fibre (NDF) (b) for all case-study farms, for pasture samples taken to grazing height (season 2000/2001).

(a)



(b)

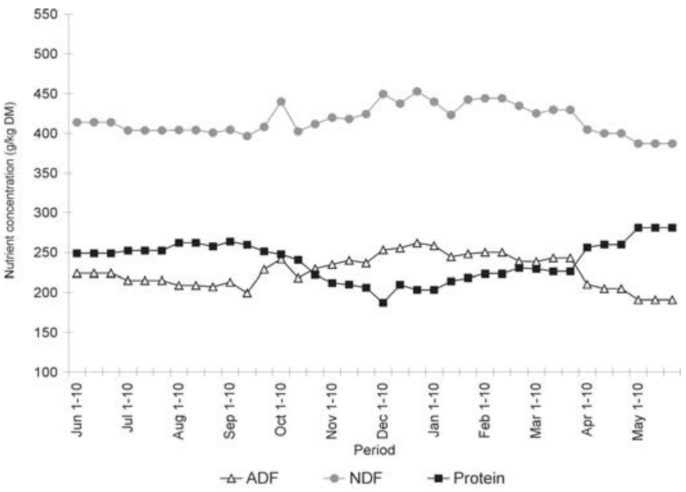


Table 3 Effective area (ha), herd size, stocking rate (cows/ha) and annual milksolids (MS) production per cow (kg/cow/year) and per hectare (kg/ha/year), economic farm surplus ($/ha) and return on assets (%) for the case study farms, top 25% farms in Manawatu and top 10% farms in Waikato and Taranaki (Dexcel 2002 pers. comm).

	Case study farms			Manawatu	Waikato	Taranaki
	Mean	Max	Min	Top 25%	Top 10%	Top 10%
Effective area	108	213	52	144	68	77
Herd size	287	570	148	381	216	231
Stocking rate	2.7	3.0	2.4	2.6	3.2	3.0
MS/ha	1100	1264	921	859	1074	1088
MS/cow	411	432	372	324	340	361
EFS/ha	3077	3867	2425	2153	3235	2879
Return on assets	12.9	14.4	10.0	13.0	11.8	12.8

observed for the case-study farms and top 10% farms in Waikato and Taranaki regions, as a result of 18% and 11% higher stocking rate on these farms, respectively (Table 3). The average economic farm surplus/ha for all case-study farms was approximately 43% higher than the top 25% farms in Manawatu region, 7% higher than the top 10% farms in the Taranaki region and 5% lower than the top 10% farms in the Waikato region (Table 3). The return on assets of 12.9% for the case study farms was similar to the top 25% and 10% farms in Manawatu and Taranaki regions, respectively, but 9% higher than the top 10% farms in Waikato region (Table 3). A detailed financial analysis of the case-study farms is made in Salles *et al.* (2002).

Conclusions

The overall objective of the grazing management of the case-study farms was to maintain high per ha MS production through improved animal performance. Grazing strategies were based on moderate stocking rates and use of pre- and post-grazing herbage mass targets to control supplementary feed inputs and monitor pasture quality. The results indicated that the farmers were able to manage pre- and post-grazing herbage mass levels and pasture quality successfully, and high quality pasture was consistently offered to the cows.

The comparison with the industry data showed that the case study farms were highly productive and profitable dairy systems, at least under the conditions of the 2000/2001 season. However, the focus on high per cow performance represents a new management strategy for these farmers and improvement of management skills is necessary to increase efficiency of the whole system. In particular, on-farm measurements indicate the risk of pasture wastage when generous feeding is the objective, even in circumstances where feeding decisions are keyed to objective pasture targets. However, there is clearly a need to improve pasture monitoring procedures in order to define farm feed flows with greater confidence.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the support of the Agricultural Marketing and Research Development Trust (AGMARDT), Massey University and New Zealand Official Development Assistance (NZODA), which provided the funding for this work. We are extremely grateful to all the farmers who supplied data and forage samples for this study. Special thanks to Fulton Hughes and Melissa Ercolin for their contribution in the project.

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