Management decision rules to optimise milksolids production on dairy farms

K.A. MACDONALD AND J.W. PENNO.

Dairying Research Corporation, Private Bag 3123, Hamilton.

ABSTRACT

A review of grazing management research has provided a series of decision rules for the management of seasonal calving pastoral dairy farm systems. These rules have been used at the DRC No. 2 Dairy to remove subjectivity from the management of farm systems research. Cows are dried off with sufficient time for second calvers and mixed age cows to achieve condition scores of 5 and 4.5 by 1 June. Target pasture average herbage mass at calving is 2200 kg DM/ha. Optimum grazing management during autumn/winter, spring and summer has been shown to increase milksolids production by 29, 70 and 41 kg MS/ha, respectively. Grazing management during late spring must meet the dual objectives of generously feeding the herd, while maintaining pasture quality. Conserved pasture supplements should be fed in late autumn/early winter to meet cow condition, grazing management, and herbage mass objectives. Substantial increases in animal productivity can be achieved by sound farm management during periods of feed deficit.

Keywords: dairy production; pasture; grazing management; stocking rate; rotational grazing.

INTRODUCTION

McMeekan (1956) concluded that extremes in grazing management were associated with only small changes in per hectare yield of animal products from pasture. In contrast, McMeekan (1961) also concluded "that no more important force exists for good or evil than the control of stocking rate (SR) in grassland farming". Survey data continue to demonstrate the importance of SR in determining dairy farm production and profitability (Deane, 1993).

By the early 1960's it was recognised that dairy production of most farms was limited by pasture utilisation rather than the amount of pasture grown on the farm (McMeekan, 1961). In an attempt to increase feed utilisation average SR has increased from 2.1 to 2.5 cows/ha in the 10 years from 1981 to 1991 (LIC, 1997). Farmers trying to increase production were often simultaneously increasing SR and adopting earlier calving dates (Bryant & Macdonald, 1983). While feed utilisation certainly increases with higher SR's and earlier calving, there is no doubt these systems become more difficult to manage during periods of feed deficit.

High SR's are often cited as the cause of poor per cow performance, yet the highest stocked dairy farms often achieve the highest per cow production (Deane, 1993). During the last 15 years a series of simple management decision rules based on the results of previous trials have been established. These decision rules aim to optimise per cow performance at SR's which are sufficiently high to achieve high rates of pasture utilisation and are primarily used to ensure dairy herds are treated consistently both within and between years during farmlet trials. Because their application requires many of the variables within the dairy farming system to be quantified, human subjectivity is removed from management decisions. This paper will specify a series of decision rules, review the research from which they are derived, and briefly discuss their application.

DECISION RULES FOR SEASONAL DAIRY SYSTEMS

1.0 **Drying off**

1.1 Empty and cull cows (to a maximum of 20% of the herd) are removed when the average dry matter intakes (DMI) of the herd is less than 10 kg DM/cow/day after 15 January (Bryant, 1990).

1.2 Individual heifers and cows must be dried off with sufficient time to attain a condition score of 5.0 and 4.5 the end of May, respectively, when offered the same pasture allowance as the milking herd (Grainger & McGowan, 1982; McDougall, 1993).

1.3 Individual cows with daily milksolids (MS) production of less than 0.5 kg MS/cow/day for two consecutive weeks in autumn are dried off (Lacey-Hulbert *et.al.*, 1995).

1.4 Individual cows are dried off 50 days before their expected calving date (Coppock *et al.*, 1974).

1.5 Once 50% of the individual cows in a herd are dry, the remainder of the herd is dried off.

2.0 **Autumn/winter grazing management**

2.1 When herd feed requirements are expected to exceed winter pasture growth rates from 15 May to 15 July the daily grazing area shall not exceed 1/30th, 1/40th, 1/50th and 1/100th of the total farm area during March, April, May, and June, respectively (Bryant & L'Huillier, 1986).

2.2 When winter pasture growth rates are expected to exceed herd feed requirements from 15 May to 15 July the daily grazing area shall not exceed 1/20th, 1/30th, 1/40th and 1/60th of the total farm area during March, April, May, and June, respectively (Bryant & L'Huillier, 1986).

3.0 **Spring grazing management**

3.1 From the planned start of calving until the date pasture growth is expected to exceed requirements the daily

grazing area of the herd increases linearly from the smaller of 1/80th of the total farm area or the winter daily grazing area, to 1/20th of the total farm area (Bryant, 1990).

3.2 Grazing area can be increased beyond that calculated in (3.1) if the average herbage mass of the farm increases for two consecutive weeks.

3.3 After pasture growth exceeds herd requirements, pasture conservation is used to maintain a post grazing herbage mass of 1500, 1750, 2000 kg DM/ha, in September, October, and November, respectively (Hodgson, 1982).

3.4 Total grazing area is manipulated to match expected pasture production with herd feed requirements. Individual paddocks with a pre-grazing herbage mass exceeding that required to meet herd feed requirements and (3.3) are harvested for conservation 30 - 60 days after last grazing (Wrenn & Mudford, 1996; Macdonald, 1997).

4.0 **Summer grazing management**

4.1 If pasture growth rates are expected to be less than 80% of herd requirements from 1 January to 31 March, the daily grazing area will not exceed 1/35th of the total farm area from 15 January until 31 March (Penno *et al*., 1995a).

4.2 Irrespective of feed requirements and previous management, at the conclusion of a summer moisture deficit exceeding 250 mm from 1 November to 28 February, daily grazing area shall not exceed 1/35th of the total farm area (Bryant & Macdonald, 1987).

5.0 **Use of conserved pasture supplements.**

5.1 When herd feed requirements are expected to exceed winter pasture growth rates from 15 May to 15 July, and sufficient pasture is conserved within the farm system, a minimum of 150 kg DM/cow is offered between 1 April and 15 June.

5.2 When winter pasture growth rates are expected to exceed herd feed requirements from 15 May to 15 July, or more than 150 kg DM/cow is conserved the priorities for it's use are: i) Immediately after a summer moisture deficit to achieve (4.2) (Bryant & Macdonald, 1987). ii) In autumn to maintain cow condition and DMI to extend lactation (Penno & Clark, 1997). iii) In spring to prevent post grazing herbage mass falling below (3.3) if sufficient has been carried over from the previous season.

6.0 **Mating management**

6.1 All cows are tail painted at calving and all observed oestrus recorded.

6.2 Cows who have not been observed in oestrus 7 days prior to the planned start of mating (PSM) are treated for anoestrum (Taufa *et.al.,* 1997).

6.3 Cows due to calve more than 42 days after the planned start of calving (PSC) are induced to calve within the first 21 days of the PSC (Verkerk *et al.,* 1997).

DISCUSSION

Within the seasonal dairy farm systems there are a few key variables that have a major influence on the output whole farm system. Cow condition provides a measure of the amount of energy stored as body fat on cows within the herd. Likewise, average herbage mass provides a measure of the amount of feed energy available within the farm systems at any given time. Meeting the required cow condition and average herbage mass targets is more important in spring than at any other time of the year as severe underfeeding at this time can impair herd performance for the remainder of the season. The target calving condition score for all herds at No. 2 Dairy is 4.5 for older cows, and 5.0 for 2 and 3 year old cows. One body condition score has been shown to increase production by 15 kg MS/cow (Grainger & McGowan, 1982) and reduce the number of anoestrus cows at the planned start of mating (McDougall, 1993). The target average herbage mass for calving is 2200 kg DM/ha.

Achieving cow condition targets are of higher priority than herbage mass targets. Meeting condition score targets relies on drying off thin cows with sufficient time and available pasture to regain condition. Assuming 1 condition score is equal to 25 kg liveweight (Macdonald and Macmillan, 1993), a cow needs to consume approximately 170 kg DM, above maintenance, to gain each condition score (Holmes & Wilson, 1987). Within the system this will take approximately 60 days of feeding 3 kg DM/cow/day above maintenance. Based on these calculations individual cows are dried off according to the schedule contained in Table 1.

TABLE 1: Condition Score Drying Off Criteria (individual cows)

Dry off on condition score	Heifers	Cows
Early March	3.0	2.5
Mid March	3.0	3.0
Start April	3.5	3.5
Mid April	4.0	4.0
End April	4.5	4.0
Mid May	All	All

Large increases in somatic cell count occur in 60% of cows not infected by mastitis pathogens immediately before drying off (Lacey-Hulbert *et al.,* 1995). Many of these cows were producing less than 5 litres of milk/cow/day at drying off. Therefore, low producing cows are dried off in autumn to maintain milk quality and udder health. Cows which maintain sufficient body condition and milk yield can be milked until 50 days prior to their expected calving date after which insufficient dry time can detrimentally effect the subsequent lactation (Coppock *et al*., 1974). Once half of the cows in a herd have been culled or dried off, the remainder are dried off to maintain sufficient average herbage mass on the farm.

Winter grazing rotation length controls DMI by altering the pasture allowance of the dry herd. Therefore, longer rotations result in more pasture being available at the end of winter (Bryant 1990). Bryant and L'Huillier (1986) demonstrated that each additional 10 days average rotation length from April to July resulted in an additional

150 kg DM/ha average pasture mass in July. This increase in late winter pasture mass resulted in an extra 3.3 kg MS/cow being produced during early lactation for each additional 10 days in winter rotation length. However, as rotation was extended in late autumn, a 2 kg MS/cow penalty was incurred for each additional 10 days in winter rotation length. Over all, a 100 day winter rotation resulted in an additional 29 kg MS/ha relative to a 40 day winter rotation.

To achieve high pasture utilisation in early spring, a concentrated calving is required before the onset of spring growth. Bryant (1986) showed from survey data that the No.2 Dairy herd had an earlier PSC and more concentrated calving than surrounding farms. The combined effect of these two factors amounted to about 25 more days in milk for each cow, right at the start of the season. Anoestrus and poor heat detection are the primary cause of poor fertility in NZ dairy herds and anoestrus cows must be identified and treated 1 week before the PSM (Macmillan, 1997). Tail painting has been recommended as a cheap and effective aid to heat detection. To enable a compact calving spread (6 weeks) it is necessary to ensure that 95% of the herd is inseminated within 21 days of the PSM.

Feed requirements generally exceed pasture production for several weeks after calving. Therefore, the aim of spring grazing management must be the allocation of pasture to optimise pasture and milksolids production. Average rotation lengths from calving (15 July) to 14 September of 64, 39, 25, and 19 days resulted in milksolids production to 2 March of 260, 286, 283, and 274 kg MS/cow, respectively, and an average October pasture mass of 1966, 1659, 1405, and 1355 kg DM/ha, respectively (Bryant 1990). Short rotations initially increased DMI and animal performance but reduced average herbage mass and net herbage accumulation, compromising subsequent DMI and late spring average herbage mass. At the other extreme, very long spring rotations penalised initial DMI to a greater level than was compensated for by additional pasture mass and DMI in late spring. At the optimum grazing rotation of 39 days, an additional 70 kg MS/ha was produced relative to a very short, or very long spring rotation (Bryant 1990).

From when pasture growth exceeds herd requirements in spring, surplus pasture must be removed from the grazing area to maintain appropriate post grazing herbage mass, pasture quality and subsequent milksolids production (Hodgson, 1982). At the same time the herd must be generously fed to maximise milksolids production, and meet reproductive performance objectives (Macmillan, 1997). To ensure pasture quality is maintained, and the herd properly fed, surplus pasture is identified and harvested according to the formula described by Macdonald (1997).

Summer dry periods detrimentally effect pasture production in most dairying regions of New Zealand. This results in feed requirements exceeding pasture growth from mid January until autumn rains allow a flush in pasture growth. During the early summer, average pasture mass is generally high because pasture growth has exceeded requirements for the preceding months. Extending rotation length (grazing interval) from a short (16 day) to a long (40 day) rotation reduces herbage allowance and forces the herd to remove all available pasture. While this results in an immediate reduction in DMI and animal performance, it utilises old pasture material that will otherwise senesce and decay. Changing from a short to a long summer rotation in mid January at a stocking rate of 3.7 cows/ha resulted in an additional 1700 kg DM/ha net herbage accumulation from 15 December to drying off on 29 April. This additional pasture production increased milksolids production over the same period from 130 kg MS/cow to 141 kg MS/cow. The long rotation also resulted in an additional 400 kg DM/ha pasture mass and 0.3 additional cow condition at the end of April (Penno *et al.*, 1995a).

A previous trial investigated extended grazing rotation of herds stocked at 3.5 cows/ha from a 10 to 40 day rotation in late January after 122 mm rainfall had resulted in the break of a dry period. Over the subsequent 8 weeks, there was no difference in total milksolids production. However, at the end of the experiment in late March, the long rotation herd was producing an additional 0.2 kg MS/cow/day, and average pasture mass was 400 kg DM/ha higher than that of the short rotation farmlet (Bryant & Macdonald, 1987).

Supplementary feeds are of greatest benefit when the carry-over effects of substituted pasture mass, and spared cow condition are captured within the system (Bryant & Trigg, 1982). This is most likely to occur when extra feed is offered immediately before a period of feed deficit (Penno & Clark, 1997). Further, the immediate effect of supplementary feed will provide the largest benefit at the time of greatest underfeeding (Penno *et al.*, 1998). In a seasonal dairying system the period of greatest feed deficit is invariably late autumn/early winter when pasture growth is declining, rotation length is being extended and the potential lactation length of many cows is unmet (Penno *et al.*, 1995b). Bryant and Macdonald (1987) demonstrated large benefits from using supplements to extend the grazing rotation immediately after summer rains. Responses to supplementary feed in spring are only likely to be of benefit when supplements are offered early during a period of severe underfeeding (Clark, 1993; Thomson, 1997).

CONCLUSIONS

While it is probably true that grazing management has little effect on per hectare output of animal products while pasture supply exceeds requirements, substantial increases in animal productivity can be achieved by sound grazing management during periods of feed deficit. Application of these simple decision rules can ensure limited pasture feed resources are utilised to best advantage within the grazing system. An optimum grazing strategy for high stocked dairy farms can be complied using the reviewed experiments. It is reasonable to assume that the additional herbage mass available in autumn after a long summer rotation will negate the negative effects of establishing a long winter rotation. Therefore a highly stocked dairy farm utilising a long (100 day) winter rotation, a moderate

early spring rotation (39 day) and re-establishing a long (<35) day rotation in early summer will produce as much as 182kg MS/ha more than a system using short winter, spring and summer rotations.

REFERENCES

Bryant, A.M. 1986. Major determinants of milk production from grazed pasture in New Zealand. *Bulletin of International Dairy Federation*. **199:** 3-6.

Bryant, A.M. 1990. Optimum stocking and feed management practices. *Proceedings of Ruakura Farmers Conference* **42:**55-59.

Bryant, A.M.; L'Huillier, P.J. 1986. Better use of pastures. *Proceedings of Ruakura Farmers Conference* **38:** 43-51.

Bryant, A.M.; Macdonald, K.A. 1983. Relationships between amount of feed on the farm, autumn-winter grazing management and dairy cow performance. *Proceedings of the New Zealand Society of Animal Production* **43:** 93-95.

Bryant, A.M.; Macdonald, K. A. 1987. Management of the dairy herd during a dry summer. *Proceedings of Ruakura Farmers Conference* **39:** 53-56.

Bryant, A.M.; Trigg, T.E. 1982. The nutrition of the grazing dairy cow in early lactation. Dairy Production from Pasture. Eds. K.L. Macmillan and V.K. Taufa. pp 185-207. Clark and Matherson Ltd, Hamilton, NZ.

Clark, D.A. 1993. Silage for milk production. *Proceedings of the Ruakura Farmers Conference,* **45:** 41-46

Coppock, C.E.; Everett, R.W.; Natzke, R.P.; Ainslie, H.R. 1974. Effect of dry period length on Holstein milk production and selected disorders at parturition. *Journal of Dairy Science* **57:** 712 -718

Deane, T.H. 1993. The relationship between milkfat production per hectare and economic farm surplus on New Zealand dairy farms. *Proceedings of the New Zealand Society of Animal Production* **53:** 51-53.

Grainger, C.; McGowan, A.A. 1982. The significance of pre-calving nutrition of the dairy cow. Dairy production from pasture. *New Zealand Society of Animal Production* 134-171.

Hodgson, J. 1982. Influence of sward characteristics on diet selection and herbage intake by the grazing animal. *Nutritional Limits to Animal Production from Pastures.* ed. J.B. Hacker. pp. 153-166. Commonwealth Agricultural Bureau, Farnham Royal, UK.

Holmes, C.W.; Wilson, G.F. 1987. *Milk Production from Pasture, Butterworths.* New Zealand.

Lacey-Hulbert, S.J.; Woolford, M.W.; Bryant, A.M. 1995. End of season milk. *Proceedings of Ruakura Farmers Conference* **39:** 71-77.

LIC 1997. Dairy Statistics, 1996-97. Livestock Improvement Corporation.

Macdonald, K.A.; Macmillan, K.L. 1993. Condition score and liveweight in Jersey and Friesian cows. *Proceedings of Ruakura Farmers Conference* **45:** 47-50.

Macdonald, K. A. 1997. Profitable Dairying. *Occasional publication. NZ Rural Press.* September 1997.

McDougall, S. 1993. Stocking rate, breed, condition score and anoestrum. *Proceedings of Ruakura Farmers Conference* **45:** 51-56.

Macmillan, K.L. 1997. Why don't cows cycle. *Proceedings of Ruakura Farmers Conference* **49:** 52-56.

McMeekan, C.P. 1956. Grazing management and animal production. *7th Int. Grasslands Congress* 146-156.

McMeekan. C.P. 1961. The pros and cons of high stocking rate. *Proceedings of Ruakura Farmers Conference* 184-190.

Penno, J.W.; Bryant, A.M.; Carter, W.A.; Macdonald, K.A. 1995a. Effect of nitrogen fertiliser and summer rotation length on milk production in a dry Waikato summer. *Proceedings of the New Zealand Society of Animal Production* **55:** 64-66.

Penno, J.W.; Thomson, N.A.; and Bryant, A.M. 1995b. Summer milk - Supplementary feeding. *Proceedings of the Ruakura Farmers Conference* **47:**17-24

Penno, J.W.; Clark, D.A. 1997. Silage for milk production and profit. *Proceedings of the Massey Dairy Farmers Conference* **49:** 50-57

Penno, J.W.; Holmes, C.W.; Macdonald, K.A.; Walsh, B.J. 1998. The effect of stage of lactation and season on milksolids response to supplementary feeding of dairy cows. *Proceedings of the New Zealand Society of Animal Production* **58:** In Press

Taufa,V.K; Macmillan, K.L.; Nation, D.P.; Day, A.M.; Ashcroft, M.J. 1997 *Proceedings of the New Zealand Society of Animal Production* **57:** 241

Thomson, N.A.; Hainsworth, R.J.; Clough, J.S.; McCallum, D.A. 1997. *Proceedings of the New Zealand Society of Animal Production* **57:** 172-176

Verkerk, G.A.; Goble, G.; McDougall, S.; Woods, M.; Clark, B. 1997. *Proceedings of the New Zealand Society of Animal Production* **57:** 231-233

Wrenn, N.R.; Mudford, C.R. 1996. Making quality silage. *Proceedings of the Ruakura Farmers Conference* **48:** 50 -57