PASTURE CONSTRAINTS ON DAIRY PRODUCTION

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ABSTRACT

Many major pasture constraints upon dairy production have been overcome by modifying management so as to circumvent or reduce their impact. Thus, New Zealand's highly seasonal factory supply dairying system, geared to the annual curve of pasture production, circumvents the major constraint of the seasonal nature of pasture feed supply.

Constraints do however clearly remain in the drought-induced summer feed deficiency and its effect on milkfat production from February onwards; in the winter low-growth period and its potential effect on cow condition at calving; and probably also in the late spring digestibility decline (especially under poor pasture utilisation) and the effect of this on peak lactation and persistence of peak lactation.

Nevertheless, the major remaining constraint is the physiologically attainable yield of pasture digestible dry matter. The use of high yielding crops may be the only means of making further progress.

However, the static nature of dairy farm production, at a level far below what is technically and practically attainable, lead one to question whether the removal of agronomic or nutritional constraints alone is likely to improve national production.

INTRODUCTION

The proposed subject by the Conference organising committee for this paper presented the authors with some profound philosophical problems. Such as, "When is a constraint on production no longer a constraint?".

If, for example, by modifying stocking rate and management in all its aspects, as has been done at Ruakura and on some private farms over the past 30 years, one can produce very close to the theoretically possible maximum of milkfat from the pasture grown, have the constraints not then been largely overcome by management expertise? In a sense they have, and hence they cease to be constraints. The major constraint remaining is then the physiological limitation to pasture productivity.

Again, both the nature and magnitude of such constraints as do exist differ widely between a farmer carrying, say, 2.5 cows per hectare and another carrying 3.5. From whose point of view should one examine the problem?

At the lower stocking rate the constraints will be those of declining digestibility as pastures mature and become rank, and of the inevitable decomposition of unutilized pasture so that absolute shortages of feed can still arise in dry summers and in early spring. Clearly all that is required to overcome this problem is to breed a grass which does not decay and which maintains the same high nutrititve value from tiller emergence right though to senescence.

Whose constraints then should we examine? We have chosen to look at those confronting the highly stocked (above 3 milking cows ha^{-1}) factory supply dairy farmer. If nothing else this will make the paper idealistic because the average NZ dairy farmer is still stocked at the level of the Ruakura No. 2 Dairy in 1945.

But before discussing these constraints it is necessary first to say that, quite clearly, the seasonal nature of factory supply dairying and the general concordance of its feed requirements with the seasonal curve of pasture growth automatically minimises the greatest constraint imposed by pasture as a feed source in town supply dairying, namely its variability from season to season.

PRE-CALVING AND EARLY LACTATION

Dairy farming, like other forms of animal production, is a cyclical operation in which management decisions and feed supplies many months before will affect responses to current feed and management inputs.

This is particularly so for the dairy cow should underfeeding occur one or two months on either side of calving. The effects of underfeeding at this time are evident not only as reduced peak milk yield but also as a decrease in total lactation production (Broster, 1971, 1972; Broster and Strickland, 1977).

Avoiding underfeeding after calving requires both adequate preparation of the cow prior to calving as well as near-full feeding after calving.

Adequate preparation of the cow for lactation involves the provision of sufficient feed to meet the demands of daily maintenance, the developing calf, and the accumulation of sufficient energy reserves as body fat for use in early lactation. This has to be achieved at a time when pasture growth is at or near a minimum, and without prejudicing feed supplies for after calving.

For a given farm with a predetermined calving date, attaining target live weight or condition at calving, which are the criteria for determining adequacy of preparation, depends primarily on winter management and time of drying-off. Drying-off is one of the most critical decisions at high stocking rates. It determines the extent of loss in condition in late lactation and, therefore, the amount of feed required during the dry period to replace that condition. It determines the time available not only to make good that condition but also to accumulate pasture reserves for use before and after calving.

Milking on in late lactation at the expense of body condition can have other effects. It may lead to the need for excessive and expensive conservation in early summer with consequent underfeeding at that time, in order to provide more hay or silage for better winter feeding. Thus the determinant of when to dry-off is not current level of per cow production but rather cow condition, existing and expected feed supplies, and length of the dry period.

Satisfactory preparation of the cow for calving however achieved will only ensure that the cow can perform to her potential after calving. Realisation of that potential requires feeding to appetite for at least the first two and preferably three months of lactation. Full feeding is essential if the cows are to produce 0.9 kg milkfat day^{-1} or better within two months of calving. These productions cannot be achieved unless tissue reserves are available to meet the demands of milk production in early lactation because food intake does not reach a maximum until 12-16 weeks after calving whereas there is an earlier peak in milk production. Thus energy going out for maintenance and in the milk is greater than is available from the feed which the cow is able to ingest and she has to draw on body reserves. This negative energy balance in early lactation occurs irrespective of the amount or type of feed offered.

The importance of achieving high levels of production from the herd in early lactation through the combined effects of adequate preparation for calving and full feeding in early lactation cannot be over-emphasised. It ensures, more than any other input, the full and efficient use of pasture at a time when cow efficiency, pasture growth rate and quality are at or near maximum. It ensures that cows are capable of capitalising on good summer growth should this occur; and it provides the best and least expensive insurance against the possibility of it not occurring.

With appropriate adjustments to drying-off date, autumn-winter management of both pastures and animals, fertilizer policy, calving date and stocking rate both adequate preparation for lactation and near-full feeding in early lactation can be achieved. Thus, by capitalizing on the adaptability of the animal and the flexibility of management, pasture constraints at this time need not be of major importance.

MID LACTATION

From mid-September to the end of January quantitative feed restrictions are seldom important except perhaps for the "conservation pinch" at high stocking rates. Thus Young (1966) at 4.1 cows per ha compared the closure of 16 and 33% of total farmlet area for hay and found a detrimental effect of the higher conservation level on seasonal fat production and live weight at drying off.

But the "conservation pinch" can at least be reduced if not entirely eliminated by adopting drying-off and wintering strategies which do not call for large amounts of conserved fodder to recoup condition on thin cows prior to calving (Campbell *et al.*, 1977). At a low stocking rate it will certainly be better to conserve at this time rather than let pasture decay, and a high proportion of conservation will help to maintain feed quality on the grazed area of the farm. But the objective of a high stocking rate is to consume the pasture as it grows at this time rather than to conserve it, and to adopt strategies later in lactation which call for a minimum of conserved fodder.

Qualitative constraints at this stage of lactation may well be important, but our understanding of what constitutes quality and how it is improved by management is so meagre that it is necessary swiftly to leave fact behind and rely on speculation. The fact is that grasses decline rapidly in digestibility immediately before and after flowering.

One interesting feature of the lactation curves of cows at No. 2 Dairy is that while they seldom rise to a very high peak (perhaps a reflection of a quantitative constraint) not above one kg fat cow^{-1} day^{-1}, they do persist over a period of 12 to 14 weeks at a level of about 0.95 kg fat cow^{-1} day^{-1}. Such long persistence is unusual in the industry generally. Is this flat-topped curve a function of high genetic merit in these cows? Is it a function of good milking technique? Or is it, at least in part, a function of the high stocking rate maintaining pastures in a more vegetative and digestible state for longer?

DECLINING LACTATION

There is no doubt that the data allow us to identify and quantify pasture constraints on production from February to the end of lactation more clearly than at any other season.

In the past 10 years at No. 2 Dairy, during which the stocking rate of the control, grass-fed Jersey herd has been maintained constant at 4.13 cow equivalents ha^{-1} (ie. 3.46 milking cows plus 25% replacements). the coefficient of variation of per cow production has been five times higher from February 1 to drying off date than it was from calving to January 31. Scott (1978) has produced similar data for tested herds within the Auckland Livestock Improvement Association.

The conclusion is clear. Quantitative and qualitative aspects of summer nutrition have a major influence on whole lactation production. The quantitative restriction imposed by summer drought is a major constraint leading as it can to premature ending of lactation.

Whether this can be ameliorated by the use of cultivars such as Nui or Ellett's ryegrass or economically overcome by the use of maize or Sudax crops are matters for conjecture and research (Campbell *et al.*, 1978). Bryant (1978a) has suggested that even though silage can be profitably used to reduce the impact of dry summers the quantities required can be so large as to jeopardise spring production through the operation of the "conservation pinch".

The variability in occurrence of summer drought can make irrigation unprofitable in major dairying areas (Miller, 1957; Hutton, 1978). And lucerne, at least in areas where ryegrass/white clover pastures grow well for nine months of the year, may have its own shortcomings (Campbell 1967).

The current research answer is by highly stocking from calving to January to get maximum production in these six months - at No. 2 Dairy this has averaged 81% of the annual total, and 450 kg ha^{-1}, over the past ten years - and thereafter, play it by ear. Or, more accurately, play it by eye, because observable cow condition will dictate when to end lactation, especially under a system and at a stocking rate which permits only limited spring conservation.

THE DRY PERIOD AND WINTERING

Once cows are dried off and their feed requirements, in consequence, approximately halved they will gain body weight under conditions where a

continuation of lactation would result in body weight loss (Bryant 1978b). The next nutritional challenge comes with the onset of autumn rain. The roughage decays and although the quality of the "autumn flush" may be high, its quantity is, for a few weeks at least, deficient and cow weight and condition again slump.

A built-in resistance to decay of herbage at this time could be useful and fungicide treatment to "rot-proof" roughage in autumn has been considered in order to reduce the impact of this final insult upon the body condition of the milking cow. But to date the research answer has been to dry cows off before they become too thin (about grade 3.5 on a 0-10 scale of condition grades) so that they can withstand this final feed limitation and yet not decline so far in condition that acceptable pre-calving live weights are unattainable. This inevitably involves judgement and compromise.

The No. 2 Diary Jersey herd shows significant ($p \leqslant 0.02$) associative correlation over 10 years of 0.72 between mean herd weigth immediately pre-calving and fat yield in the first 28 days after calving. Again across years, Scott (1978) found a significant, positive, 0.63 correlation between autumn milk fat production of one year and spring fat production of the next and would argue that the autumn feed supply which permitted good fat production also allowed cows to calve down in good condition next spring. But these are all matters which merit further study so that the interactions and carry-over effects can be clarified and quantified.

Some research has shown (Brougham, 1960) that more grass can be grown over winter by more frequent grazing than by longer spells between grazings, but the evidence is contradictory (Campbell, 1969; M. J. Byford pers. comm.). Dairy farmers on the other hand like to see a bank of feed built up for newly calved cows in July, August and September. However, if a faster rotation at least does not grow less feed a more relaxed wintering method involving a faster rotation around the whole farm may either, by growing more feed or by utilizing more of what is grown, enable better cow condition to be attained at calving, but at the expense of the post-calving feed supply. On which side the balance of advantage will lie is again a matter for research to determine.

CONCLUSION

The orchestration of all the biological interactions of plants and animals in order to maximise animal production per hectare is a scientific endeavour of some complexity. Every management decision interacts with production far into the future. For example, the condition of cows at drying off in one season may affect their condition at mating the next season, the spread of calving the following season and hence the scope for selection of herd replacements upon which production three and more years hence ultimately depends. The ramifications of a single decision can be widespread, but few such interactions have been the subject of the long term study necessary to quantify their consequences. The more immediate cause and effect relationships are easier to work with and observe and measure in isolation from the longer term consequences.

So far as current pasture constraints on immediate production are concerned it is possible to identify the drought-induced summer feed deficiency as being an important one. It has clear immediate effects in truncating lactation, and there is a suggestion of longer term effects upon the following year's production. If these longer term effects are mediated through body condition at calving it implies the need for improving winter nutrition either through the use of more winter-active species or by improving winter pasture growth through better winter management, or the introduction of additional feed from an extraneous source. The possibility of impaired digestibility and the effect of this on lactation peak and persistence in spring where pasture is poorly utilized has been alluded to, but requires verification by research.

While the effects of these pasture constraints to milk production can be minimised by good management, it remains as true today as it was 40 years ago that the major constraint to animal production is the attainable yield of pasture digestible DM. The physiological limits of pasture yield set the ceiling on animal production, and plant breeders around the world seem now to be accepting this (van Bogaert, 1977). If this is so, for future progress we must turn our attention to high yielding crops, with all the economic constraints which they will inevitably impose (Campbell *et al* ., 1978).

Fortunately, on a national basis at least, it would seem we have time to develop new cropping technologies. The milkfat production gap between the highest producing farms (including research farms) and the average dairy farm is fairly steady at about 300 kg fat ha^{-1}.

This being so, we may justifiably ask if the truly important constraints to improved animal production are agronomic, nutritional and managerial or are they advisory, educational, sociological, financial or fiscal? For we may beat our agronomic, nutritional and managerial brains out to no purpose if these are not the important constraints in the eyes of the dairy farmer.

REFERENCES

Broster, W.H. 1971. The effect on milk yield of the cow of the level of feeding before calving. *Dairy Science Abstracts 33:* 253-270.

Broster, W.H. 1972. Effect on milk yield of the cow of the level of feeding during lactation. *Dairy Science Abstracts 34* (4): 265-288.

Broster, W.H. and Strickland, M.J. 1977. Feeding the dairy cow in early lactation. *ADAS Quarterly Review 26:* 87-105.

Brougham, R.W. 1960. The effects of frequent hard grazings at different times of the year on the productivity and species yields of a grass-clover pasture. *New Zealand Journal of Agricultural Research 3;* 125-136.

Bryant, A.M. 1978a. Increasing dairy cow performance by supplementary feeding in summer. *Proceedings of the Ruakura Farmers' Conference Week.* (In press.)

Bryant, A.M. 1978b. Once daily milking. *Proceedings of the Ruakura Farmers' Conference Week.* (In press.)

Campbell, A.G. 1967. Liveweight gains from lucerne. "The Lucerne Crop." Ed. R.H.M. Langer. A.H. &

A.W. Reed, Wellington 261-271.
Campbell, A.G. 1969. Grazing interval, stocking rate, and pasture production. *New Zealand Journal of Agricultural Research 12:* 67-74.
Campbell, A.G., Clayton, D.G. and Bell, B.A. 1977. Milkfat production from No. 2 Dairy, Ruakura. How it is attained: what it is worth. *New Zealand Agricultural Science 11:* 73-86.
Campbell, A.G., Clayton, D.G. and Macdonald, K.A. 1978. Maize/pasture rotations for dairying. *Proceedings of the Ruakura Farmers' Conference Week.* (In press.)
Hutton, J.B. 1978. Irrigation: its potential for increasing dairy production and profit in South Auckland. *Proceedings of the Ruakura Farmers' Conference Week.* (In press.)
Miller, J.M. 1957. The economics of spray irrigation. *Proceedings of the New Zealand Grassland Association. 19:* 37-43.
Scott, J.D.J. 1978. Dairy production in the summer. *Proceedings of the Ruakura Farmers' Conference Week.* (In press.)
van Bogaert, G. 1977. Scope for improving the yield of grasses and legumes by breeding and selection. *Proceedings International Meeting on Animal Production from Temperate Grassland, Dublin.* 29-35.
Young, P.W. 1966. Levels of spring conservation in relation to stocking rate. *Annual report of the Research Division 1965-66. New Zealand Department of Agriculture 23.*