PASTURE & CONSTRAINTS ON BEEF PRODUCTION

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ABSTRACT

In the absence of management and conservation techniques, seasonality of pasture production was calculated to reduce capacity to carry beef cows, traditional beef weaners and dairy beef weaners to 30-55% of the capacity suggested by annual total dry matter production. However, comparison of these theoretical values with actual production systems, indicated that in practice, seasonality of pasture production had a considerably smaller effect on animal productivity.

INTRODUCTION

For the purposes of this paper, seasonal fluctuations in feed supply are defined as those fluctuations in pasture growth that are expected to occur within an average year. Variability between years also constrains productivity by encouraging conservative stocking rates and the withholding of feed as drought reserves, but these constraints are not considered here.

Beef production is found throughout the range of grazing lands in New Zealand from alpine regions to first-rate lowland pastures. Not only is the beef industry geographically diverse but it is also diffuse in that beef cattle are seldom found as a sole enterprise; being, instead, intermingled with the sheep, dairy and cropping industries. Thus any consideration in isolation, of the influence of fluctuating feed supply on beef production must be a simplification of the real situation. The sheep and beef farmer, for example, must balance fluctuating feed supplies to fluctuating requirements of ewes, lambs, hoggets, cows, calves and replacement heifers within an economic framework where the relative values of different categories of stock strongly influence his decisions.

Accepting, however, the limitations of a simplified approach, an attempt can be made to quantify the influence of seasonality of pasture growth on three sub-units of the industry up to the farm gate. Although this symposium does not consider the situation beyond the farm gate, there is no doubt that any freezing works manager would be only too aware of the constraints on his unit of the beef industry that arise from seasonality of feed supply. Consideration will, however, be restricted to

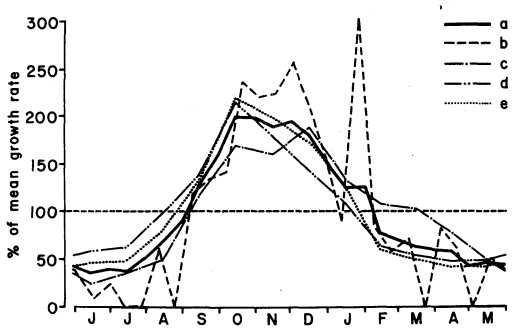
(i) the traditional beef cow enterprise producing weaner steers, replacement heifers, some excess heifers and cull cows;
(ii) the growing and finishing of weaners of traditional beef breeds;
(iii) the growing and finishing of dairy-beef weaners.

BEEF COW ENTERPRISE

Of the 2.1 million breeding beef cows in New Zealand in June, 1975, 73% were in the North Island and of these more than three-quarters were on hill country (NZ Meat and Wool Boards' Economic Service 1977a,b). Thus North Island hill country can be considered typical of the environment for such an enterprise.

Data on the patterns of pasture production for North Island hill country conditions are summarised in Figure 1 where differences in absolute levels of production have been eliminated to illustrate seasonality *per se*.

Figure 1. Pasture growth patterns for improved hill country: (a) Mean of (b) to (e); (b) Baars, J. A. (unpublished data from Te Kuiti); (c) Suckling (1959); (d) Gillingham (1974) – North Aspect; (e) Gillingham (1974) – South Aspect.



Peak levels of pasture growth of 2 to 3 times the yearly average clearly indicate that marked seasonality is a feature of all hill country sites for which data are available. In more practical terms, more than 45% of the year's feed production can occur in a 3-month period.

Although the primary concern of this paper is seasonality, it would be an oversimplification to leave consideration of pasture growth on hill country without reference to the differences in levels of absolute production that have been recorded between closely adjacent sites. Thus Suckling (1959) found large differences in pasture production between stock camps and adjacent hillsides, while Radcliffe (1971), Gillingham (1974) and Radcliffe *et al.* (1976) found smaller but significant differences in annual production (Table 1) as well as differences in seasonal

TABLE 1. Estimated annual production of improved hill country pastures (kg DM ha^{-1})

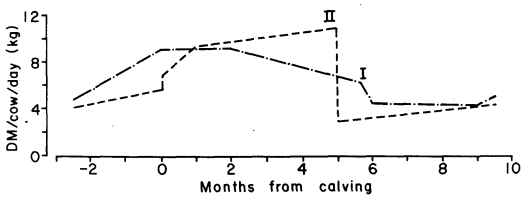
Reference	Site	Sunny (Northern) Aspect	Shady (Southern) Aspect
Suckling (1959)	Te Awa:		
	hillside	9 500	9 000
	stock camp	19 500	20 000
Radcliffe (1971)	Whatawhata*	9 960	9 940
	Te Kuiti	4 530	3 880
	Coopers Creek*	2 370	4 215
Gillingham (1974)	Whatawhata	7 120	6 440
Radcliffe *et al.* (1976)	Coopers Creek	5 020	5 800

* Mean of 2 measurement techniques.

patterns of growth between sunny and shady aspects at the one site. Thus the mixture of aspects and of swampy valleys and dry hilltops found on a commercial hill farm may give a more even spread of pasture growth than is suggested by the data in Figure 1. However, as the balance of such factors will differ from farm to farm, the mean of the pasture production curves (Figure 1) is used.

Optimum liveweights or rates of liveweight change at various times of the year have been only loosely defined for the beef cow so that feed requirements as discussed here are more a reflection of what happens in practice than of some optimum pattern of live weight change. Smith *et al.* (1976) have suggested an annual pattern of requirements for beef cows (Figure 2) with a rising level for the last 3 months of pregnancy, a constant level for 2 months after calving and then a slowly falling level until weaning at 6 months. Smeaton (peronal communication) has proposed a slightly different pattern (Figure 2) with a 5-month lactation. Total annual requirements are close to 2400 kg DM cow^{-1} for both patterns.

Figure 2. Patterns of daily DM requirements per cow relative to time of calving; I as suggested by Smith *et al.* (1976), II as suggested by Smeaton, D., (personal communication).



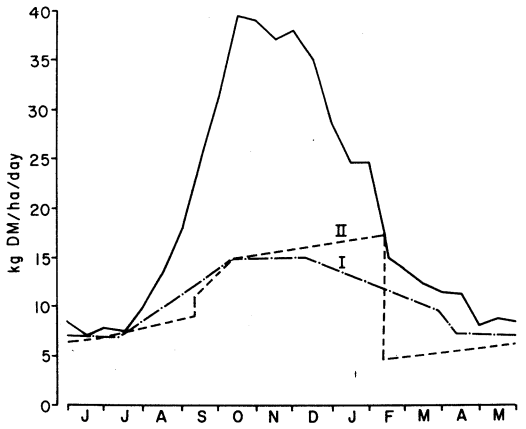
The suggested patterns of feed requirements shown in Figure 2 indicate that although cow requirements fluctuate, they do so to a smaller extent than pasture growth with peak levels being only 150% of the yearly mean requirement. Thus even a cursory comparison of Figures 1 and 2 indicates that rate of feed production (pasture growth rate) will not match rate of feed consumption (animal requirements) throughout the year. There are, however, techniques of pasture and animal management and of conservation and supplementary feeding by which the mismatch between patterns of production and consumption is lessened. These are the subject of subsequent papers in this symposium. However, it is necessary to emphasise here that in a real situation, feed supply to the animal on a particular day is not determined solely by the current rate at which pasture is growing. It is determined by management decisions, some made months earlier, and may also include nutrients stored in the animal's body, as well as in the hay shed or silage stack. Thus even with a set pattern of pasture production, it is possible to create an almost unlimited number of patterns of feed supply to the animal. As such a range of possibilities cannot be examined here, consideration is restricted to the simplified situation where each day's feed supply is determined solely by growth rate of pasture on that day. Adjustment of stocking rate (on an annual basis only) andof time of calving are then the only mechanisms available to match feed supply to feed requirements of the animals.

In Figure 3, daily growth rate of pasture producing an annual total of 7200 kg DM per ha in the average seasonal pattern for hill country (Figure 1), is matched with daily DM requirements of 1.6 cows per hectare (pattern I, Figure 2) and 1.55 cows per hectare (pattern II, Figure 2). These are the maximum stocking rates possible within the constraints imposed and are about 53% of the stocking rate of 3 per hectare that 7200 kg of DM per ha per year could support if it were available as required to meet animal requirements. Thus seasonality of pasture growth could be said to have resulted in a 47% decrease in theoretical carrying capacity.

In practice, several factors operate to give less pronounced fluctuations in feed demand than indicated in Figure 2. There is typically a wide spread in time of calving and a high level of replacement heifers, many of which do not calve until 3 years of age. For example, in July 1975 the average North Island hill farm carried 88 mature cows and 60 cows of 2½ and 1½ years of age (NZ Meat and Wool Boards' Economic Service 1978).

If this ratio of replacement to breeding stock is

Figure 3. Patterns of daily growth rate (kg DM ha^{-1} day^{-1}) of pasture producing 7 200 kg DM $year^{-1}$ in the mean pattern for Figure 1 (——) and of daily DM requirements of 1.6 calving cows ha^{-1} (–·–) (pattern I, Figure 2) and 1.55 calving cows ha^{-1} (– –) (pattern II, Figure 2).



allowed for and first calving occurs at 3 years of age, requirements per cow calving are increased (Figure 4) to an annual total of 3450 kg DM. Theoretical carrying capacity of a pasture producing 7200 kg DM ha^{-1} $annum^{-1}$ is correspondingly reduced to 2.1 calving cows per hectare. Seasonality of pasture production again reduces carrying capacity below this level by about 50% (Table 2).

Figure 4. Patterns of daily DM requirements per calving cow as in Figure 2 together with an allowance for replacement heifers calving first at 3 years of age.

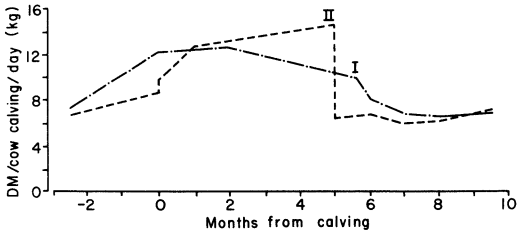


TABLE 2. Capacity of pasture producing 7 200 kg DM ha^{-1} $year^{-1}$ to carry beef cows plus repla ements calving first at 3 years of age (calving cows ha^{-1}; stock units ha^{-1} in parenthesis). (7 200 kg DM = requirements of 2.09 calving cows or 17 stock units).

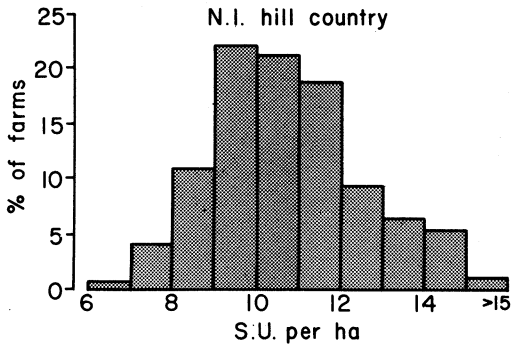
Pattern of pasture growth	Pattern of cow requirements (Figure 4) I	II
Mean (Fig 1)*	1.10 (9.0)	1.00 (8.2)
Mean (Fig 1)+	1.00 (8.2)	1.00 (8.2)

* No restriction on calving date.
\+ Calving before end of September.

These carrying capacities have been converted (Table 2) to stock units using the same conversion factors for cows and replacements as in survey data for North Island hill country (NZ Meat and Wool Boards' Economic Service 1978).

Comparison with the survey data (Figure 5) indicates that practical stocking rates are in general well above theoretical values in Table2. Whilst this may be partly a result of some hill farms producing more than the 7200 kg of DM ha^{-1} used in Table 2, it is also a result of beef cow producers, by management and/or conservation techniques, avoiding some of the hypothetical 50% restriction imposed by seasonality of pasture growth.

Figure 5. Distribution of stocking rates on North Island hill country, July 1975. (New Zealand Meat and Wool Boards' Economic Service, 1978).



BEEF STEER ENTERPRISE

Again for the sake of simplicity, the finishing of steers of traditional beef breeds is examined in relation to one broad situation; in this case the fattening areas of the North and South Island. However it should be noted that these areas probably account for only half of such animals with many of the remainder held on hill country, where their requirements become an additional factor to be considered in management.

Considerably more data on annual growth curves for pasture have been published for fattening areas than for hill country. Reports by Radcliffe and colleagues for 16 dryland sites are used here as all the data were obtained with a standardised technique (Radcliffe, 1974a, 1975a; Radcliffe and Sinclair, 1975; Baars *et al.*, 1975; Radcliffe, 1975b; Baars, 1976a, 1976b; Radcliffe, 1976; Round-Turner *et al.*, 1976; Rickard and Radcliffe, 1976). There must however be some reservations whether such data from mowing trials accurately reflect the fluctuations in growth rate of grazed pastures.

When patterns of growth rate, regardless of absolute levels, were compared, the 16 sites could be grouped as follows:

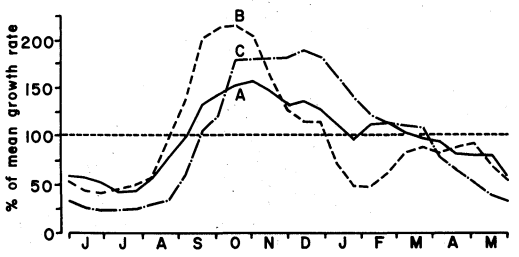
Group "A": Dargaville, Manutuke, Marton, Flock House;

Group "B": Hamilton, Masterton, Maraekakaho, Motueka, Winchmore (dryland);

Group "C": Wairakei (2 sites), Westport, Winton, Mona Bush, Invermay (2 sites).

Sites in Group "A" showed the least seasonality with an average curve (Figure 6) for growth rates lying between 50 and 150% of the yearly mean. Group "B" sites, in contrast, produced a sharp peak of production in October of more than 200% of the yearly mean, followed by a rapid fall with a distinct secondary peak in autumn. Group "C" sites were intermediate in seasonality with a late spring, but a more prolonged period of high relative growth through summer followed by a steady decline in growth rate (Figure 6).

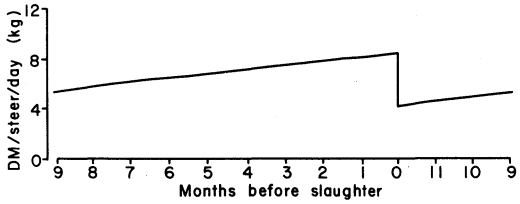
Figure 6. Pasture growth patterns from the data of Radcliffe and colleagues.
A mean of Dargaville, Manutuke, Marton, Flock House;
B mean of Hamilton, Masterton, Maraekakaho, Motueka, Winchmore (dryland);
C mean of Wairakei (2 sites), Westport, Invermay (2 sites), Winton, Mona Bush.



The beef steer is assumed to enter this enterprise at 6 to 8 months of age weighing 170 kg and to be killed at 430 kg 12 months later. National Research Council (1970) feeding standards were used to estimate DM requirements (Figure 7) on the assumption of constant growth rate (0.7 kg day^{-1}) and constant feed quality (net energy for maintenance (NE_m) of 6.70, and for gain (NE_g) of 4.31 M joules kg^{-1} DM). Annual requirements are 2 300 kg DM per animal.

Theoretical carrying capacities of pastures producing 11 500 kg DM ha^{-1} annum^{-1} and growing in the 3 patterns in Figure 6, are presented in Table 3 where, as for the hill country cows, it is assumed that feed requirements must always be met from current

Figure 7. Pattern of daily DM requirements per steer relative to time of slaughter for a traditional beef weaner growing at a constant rate from 170 to 430 kg in 12 months.



growth rates. Seasonality of pasture production in patterns A, B and C reduces carrying capacities to 53%, 42% and 31% respectively of the 5 steers per hectare that 11 500 kg of DM per hectare would support if available as required for feeding. The percentages of the year's total feed production that is produced in excess of requirements from September to December are 28%, 39% and 41% respectively. Carrying capacity was limited by the level of feed needed to maintain a growth rate of 0.7 kg day^{-1} in the period about 9 months before slaughter in two of the three growth patterns. (Carrying capacity of pastures growing in the "B" pattern was largely determined by low January-February growth rates which also dictate a need for early-born calves). Thus acceptance of lower growth rates in June to August presents itself as a management technique to allow a higher stocking rate even within the restrictions of similar overall live weight change and no carryover of feed used in Table 3.

DAIRY-BEEF ENTERPRISE

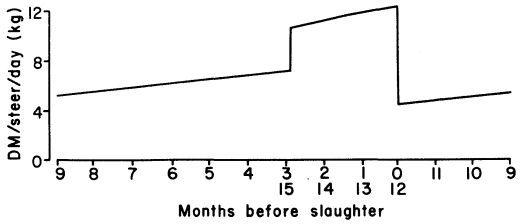
The growing and finishing of beef animals of dairy origins is concentrated in and around the major dairying areas. Patterns of pasture growth are assumed to be as in Figure 6. It is assumed that calves enter the enterprise at 4 months of age, weighing 140 kg and are slaughtered 15 months later at 430 kg. At a constant animal growth rate (0.64 kg day^{-1}) and constant pasture quality (6.70 and 4.31 M joules kg^{-1} DM for NE_m and NE_g), annual feed requirements are estimated at 2600 kg DM per animal (Figure 8).

Theoretical carrying capacities of a pasture producing 11500 kg DM grown in several patterns are shown in Table 4 where time of slaughter is allowed

TABLE 3. Capacity (steers ha^{-1}) of pasture producing 11 500 kg DM ha^{-1} year^{-1} to carry traditional beef steers, resultant live weight gain (kg ha^{-1} year^{-1}) and % of year's feed produced in excess of requirements in September-December (incl.). (11 500 kg DM = requirements of 5 steers gaining total of 1 300 kg).

Pattern of Pasture Growth (Figure 6)	Steers ha^{-1}	Live Weight Gain (kg ha^{-1} year^{-1})	DM produced in excess of requirements (Sept-Dec) (% of year's production).
A	2.65	690	28
B	2.10	550	39
C	1.55	400	41

Figure 8 Pattern of daily DM requirements per steer relative to time of slaughter for a dairy beef weaner growing at a constant rate from 140 to 430 kg in 15 months.



to vary freely to give the best possible fit between pasture growth and animal requirements. Seasonality of pasture growth in patterns A, B and C reduces theoretical carrying capacity to 54, 48 and 33% of the 4.4 animals per hectare that 11 500 kg DM should be capable of supporting. Pasture production in excess of current requirements in the September-December period amounted to 29, 33 and 28% of the year's total production.

If it is assumed that no calves born before July 1 are available, the carrying capacity of pasture growing in pattern B is reduced to 40% of the theoretical maximum with low rates of pasture growth in January-February being the limiting factor.

CONCLUSIONS

A uniform pasture growth rate throughout the year would not necessarily be the most efficient feed supply as each of the beef production enterprises examined (breeding cows, beef weaners and dairy beef weaners), exhibits a seasonal fluctuation in feed demand.

Seasonality of pasture growth is clearly a feature of all sections of the beef industry even when, as in the pasture growth data examined here, much of the variability is lost by averaging over years and over time periods within years.

The effect of such seasonality in the absence of any measures to counter it, should be a reduction of carrying capacity down to 30-55% of possible levels. Whilst documentation of practical performance is difficult to obtain, it is clear that hill country farms, by a combination of methods, are less affected by the limitations of seasonality than is suggested by the artificial situation hypothesised here.

In the case of the two fattening enterprises, data from practical finishing farms are unavailable. The theoretical feed conversion ratios of 8.8 and 9.0 kg of DM eaten per kg of live weight gain are near the middle of the range (6.8 - 11.3) found by Everitt and Ward (1974) for dairy beef bulls in experimental situations. However they reported live weight gains per hectare of the order of 1 200 to 1 700 kg which even when scaled down to account for 16% higher annual pasture production, are well in excess of the 400 to 700 kg live weight gain found in Tables 3 and 4. Brougham *et al.* (1975) likewise reported annual live weight gains (approximately 2 000 kg per hectare) well in excess of these values. In both of these experiments, management and conservation techniques very largely offset the reductions in animal production that seasonality of pasture production should, in theory, have caused.

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TABLE 4. Capacity (steers ha^{-1}) of pasture producing 11 500 kg DM ha^{-1} $year^{-1}$ to carry dairy beef steers, resultant live weight gain (kg ha^{-1} $year^{-1}$) and % of year's feed produced in excess of requirements in September-December (incl.). (11 500 kg DM = requirements of 4.4 steers gaining 1 280 kg).

Pattern of Pasture Growth (Figure 6)	Steers ha^{-1}	Live Weight Gain (kg ha^{-1} $year^{-1}$)	DM produced in excess of requirements (Sept-Dec) (% of year's production)
A	2.40	700	29
B	2.10	610	33
C	1.45	420	28

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