DAIRY PRODUCTION IN NEW ZEALAND AND THE ROLE OF SUPPLEMENTARY FEEDING

A.M. BRYANT*

SUMMARY

About 90% of the 6600 million litres of milk produced annually in New Zealand is processed into milk products and 88% of these are exported. Returns to the farmer are dependent on export prices and are 30-50% of those in many countries, This determines that low costs of production are essential and the use of feedstuffs other than pasture is generally not profitable. The important nutritional factors that determine farm productivity are pasture production, stocking rate, cow quality, length of lactation and grazing management. Developments in these areas enable productions of up to 18000 kg FCM/ha during a lactation of about 260 d.

INTRODUCTION

New Zealand has an area of 27 million hectares of which 13 million hectares are in pasture. Half of this is steep high country growing native grasses of low productivity. The remainder is sown pasture divided equally between hill and flat to rolling country. The flat to rolling country is about as twice as productive per hectare as the hill country and twenty times that of the high country. Dairying is confined to about one million hectares of the flat and rolling country.

THE DAIRY INDUSTRY

Of the two million cows milked, 93% are in the North Island, 65% of than being in the northern half. These cows produce annually 6600 million litres of milk containing 4.9% milkfat. About 90% of this milk is processed into milk products and 88% of these are exported. These exports earn 20% of NZ foreign exchange.

Production of liquid milk for local consumption involves about 1400 farms and is an industry separate from the manufacture of "factory supply" industry and is not considered in this paper.

All manufacturing of dairy products is by companies that are co-operatively owned and controlled by the farmers who supply the milk. There are 36 such companies. The NZ Dairy Board buys and then markets the output from the dairy companies and returns the net profit to the dairy companies. These in turn deduct their costs and distribute the remainder amongst their suppliers on the basis of the quantity and quality of milkfat supplied. Payouts vary among dairy canpanies depending on their costs and product mix, ranging in the 1981/82 season for example, from $3.11 to $3.63/kg milkfat

In 1981/82 there were 14600 factory supply farms, nearly all either operated by the owner (68%) or by a sharemilker (27%). Effective farm area was 60 ha on which 133 cows were milked for 250 days to yield 144 kg fat or 3600 ℓ FCM/cow. Herd size on 75% of the farms was 80-200

* Ruakura Animal Research Station, Hamilton, New Zealand

cows, reflecting that the family unit is the basis of the industry. Only 200 herds were in excess of 300 cows.

Cows are rotationally grazed on pasture the whole year with hay and silage, conserved on the farm, providing less than 10% of annual feed requirements. Farm operations are closely related to seasonal pasture growth. Calving is during July-September, about the time of onset of spring growth. Time from start to end of calving is 6-14 weeks. The herd is dried off in April-May (autumn) or earlier when summer is dry.

The extreme seasonality of production is reflected in the processing of milk. Factories have to be large enough to process peak milk flow. About 55% of the total milk processed is during the four months of September to December. No milk is processed for 3-6 weeks during June and July.

The dominating feature of the dairy industry is that the price the 'factory supply farmer receives for his milk depends almost entirely on export prices. Returns fran selling on the export market are considerably lower than what can be obtained from internal markets. Because of this, returns to the NZ farmer are about 40% of those in the USA and UK (Scott 1982). In support of this, Buxton and Frick (1976) concluded that the NZ milk products could be landed in the US East Coast at 56-65% of the price of US products at their manufacturing plants.

Average milkfat price received by the farmer for the 1982/83 season will average about \$3.60/kg, equivalent to UK 6 p/ℓ, \$USA 4.10/100 lb milk and \$Aust 2.70/kg fat. Some examples of approximate costs for the same year are replacement cows \$500, cull cows \$300, urea \$400/t, superphosphate \$135/t, concentrates \$250/t, and hay \$3/20 kg bale. Dairy farm prices have doubled in the last 2-3 years and are presently up to \$8000/ha, equivalent to about \$20/kg milkfat.

SUPPLEMENTARY FEEDING

The relatively low returns received by the NZ dairy farmer severely limits the use of expensive inputs and has encouraged the development and adoption of those that reduce costs of production. Nowhere is the limitation on the use of expensive inputs so evident as in the use of supplementary feedstuffs. Their greatest potential use is either in early or in late lactation. Feed shortages can occur in early lactation because of factors like delayed spring growth or bad winter management. In late lactation, they are invariably because of unusually low summer rainfall.

Bryant and Trigg (1982) reviewed Australasian data on the effects of supplementation in early lactation on the performance of cows offered limited grazing, Average response for 15 comparisons was an extra 530 g of milk and 21.g milkfat for each 1.0 kg DM of supplement eaten.

An example of these effects are given in Table 1.

The trial was for 28 d starting when the 60 cows involved had been in milk for an average of 21 d. Wilted (28% DM) pasture silage (11.5 MJ ME/kg DM) was used, the highest level of feeding being that amount that resulted in refusals of about 5% of the amount offered.

TABLE 1 Effects of supplementing cows in early lactation with wilted pasture silage

	Treatment				
	1	2	3	4	SED
Pasture allowance (kg DM/day)	46	14	15	15	0.50
Intake (kg DM/cow/day)					
Pasture	13.3	8.8	8.1	7.1	0.08
Silage	0	0	2.1	4.0	-
Residual herbage mass (kg DM/ha)	1910	1000	1170	1390	25
Milk yield (kg/day)	21.7	17.7	18.3	19.5	0.60
Fat yield (kg/day)	1.03	0.86	0.92	0.95	0.03
LW change (kg/day)	-0.80	-1.15	-0.80	-0.05	0.17

Average response was about 26 g fat or 640 g FCM/kg supplement DM.

Since use of supplements during underfeeding of pasture in early lactation also reduces both liveweight loss and severity of grazing, subsequent benefits in a farm situation may be greater than observed in trials of a few weeks duration. Limited evidence from farmlet trials (Bryant and Trigg 1982), suggests that this is not the case. Despite this evidence fran farmlet trials, there is good evidence that under-feeding of cows in early lactation affect their subsequent production (Broster and Thomas 1981). If it is assumed there are residual effects in a grazing situation and that these amount to 50% of the immediate effects (Bryant and Trigg 1982), then total response to supplements used in early lactation, will be 32 g fat/kg DM. At a milk price equiva-lent to $3.40/kg milkfat, costs of using supplements will be met if they do not exceed $0.07-$0.11/kg DM. With hay costing about $0.15/kg DM and concentrates about $0.30/kg DM, the economics of supplementary feeding are not attractive. The best policy fran an economic point of view during pasture shortages in early lactation is therefore to let the cows go hungry.

Even the use of hay and silage made on the farm is of doubtful profitability. Highest profit results from high stocking rates and limited conservation equivalent to 150-300 kg DM/cow (Scott and Dawson 1981).

The response to extra feed during dry summers has not been extensively investigated, It is certain however that the response is less than in early lactation (Bryant 1978, 1982; Wilson and Davey 1982). During dry summers, the farmer has little option but to use what hay and silage he has available, reduce stocking rate by early culling, and progressively dry off the herd. Variation between years in summer rainfall is therefore reflected as variation in both milk production and length of lactation (Scott 1978).

Economic considerations therefore dictate that the profitability of milk production in NZ depends largely on the full and effective utilisation of pasture directly by the grazing cow. Of the multiplicty of factors that determine farm productivity and profitability, there are probably only five nutritional factors of real importance in the

NZ scene. They are feed production, stocking rate, grazing management, cow quality and length of lactation. These are briefly considered below.

FEED PRODUCTION

The feed supply of a herd is constrained by economics to mainly the pasture grown on its farm. Pasture production is therefore a major determinant of farm productivity.

Annual production of the predominantly ryegrass-white clover pastures is up to 18 t DM/ha. Of this about 10% is grown during the winter, 70% during spring and summer and 20% in the autumn.

As the conversion on an annual basis of pasture to milkfat is 25 kg DM /kg fat (Hutton 1971) , where 18 t DM/ha are harvested, attainable milk yields are the equivalent of 720 kg of milkfat, 2000 kg milk solids, or 18000 ℓ of FCM for each grazed hectare. Most importantly, yields of milk solids close to the probable potential set by pasture production are being achieved on sane research and commercial farms (Hutton 1978; Campbell *et al.* 1977; Fowler 1977; Davis *et al.* 1979; Bryant 1983a).

Undoubtedly scope exists in same areas for increasing potential yields of milk through increasing feed production. These include lucerne (Mace and Peterson 1979), irrigation (Hutton 1978) , and use of crops (Campbell et *al.* 1978). It is also certain that, for many years to come, most of New Zealand's dairy production will be obtained without widespread adoption of these inputs. Even in the case of nitrogen fertiliser, the experimental evidence (Bryant 1983a) is that its extensive use does not invariably result in profitable increases in milk production. Some data from an experiment over three years at Ruakura involving 212 cows, eight herds and 52 ha are in Table 2. The design was a 2x2x2 factorial, the factors being stocking rate, calving date and N fertiliser.

TABLE 2 Effect of N fertiliser on farm productivity

	1979/80		1980/81		1981/82	
	-N	+N	-N	+N	-N	+N
Urea applied (kg N/ha)	0	86	0	137	0	56
Days in milk	252	252	251	246	244	242
Fat - kg/cow	170	175	155	163	171	179
- kg/ha	657	677	634	668	699	732
Pasture yield (t DM/ha)	16.25	16.11	16.97	18.08	15.34	16.22
Supplement used (kg DM/cow)	220	206	245	245	209	209

The average response of 0.31 kg fat/kg N applied, equivalent to about 8 ℓ FCM/kg N, was not profitable since about 0.38 kg fat/kg N is required to cover costs. Certainly its use by farmers is limited, being restricted in the spring of 1980 to 17% of farms. On average these farms used 1.1 t N/farm (NZ Dairy Board 1981-82).

In the interests of achieving high pasture production, drainage, application of phosphate and potassic fertiliser (O'Connor and Feyter 1980), control of pasture pests (Pottinger 1981), and use of improved pasture cultivars (Lancashire 1982), must be given high priority.

STOCKING RATE

The dominating importance of stocking rate in determining animal output per hectare was recognised by McKeekan 25 years ago and has since been repeatedly confirmed. In 16 stocking rate comparisons with dairy cows in New Zealand milkfat per hectare was greater at the higher stocking rate on 15 occasions and equal on the remainder (Davis *et al.* 1979; Holmes and Macmillan 1982). These data indicate that an increase in stocking rate of one cow per hectare increases milkfat by about 70 kg/ha.

A feature of farms with high output per hectare is the high stocking rate employed relative to the district average. This is shown by survey data (Clifford 1967; Hutton 1977; NZ Dairy Board 1979) and by ICI award winners (Scott and Dawson 1981). The discrepancy between possible and average stocking rates in all areas emphasises the tremendous scope for increasing dairy production by lifting stocking rates and thereby harvesting a greater proportion of the feed grown.

COW QUALITY

The NZ Dairy Board assumed responsibility for effecting herd improvement by recording production of individual cows ("herd testing") in 1936. Its commercial artificial breeding service started in 1950. The measure of cow quality presently in use is breeding index (BI). This index, which has a base of 100 shows the percentage by which the genetic value of an animal for milk or fat yield is estimated to differ from that of the average animal in the early 1960s. Work to determine how and to what extent cow quality influences the conversion of pasture to milk is in progress at both Ruakura and Massey University. Considerable information has accumulated on the comparative performance of cows with breeding indexes of about 125 (HBI) and 100 (LBI) (Davey and Grainger 1980; Bryant and Trigg 1981; Bryant 1981, 1983b). A dominant feature is that the higher milk production of cows is associated with a higher food intake. The extent that the observed differences are reflected in farm production is currently being measured at Ruakura. Eight farmlets are involved, four stocked with HBI and four with LBI cows. Annual feed requirements are estimated to be about 4200 and 3500 kg DM/cow for HBI and LBI cows respectively. This means that if 15000 kg DM/ha are harvested annually, "optimum" stocking rates for HBI and LBI cows are 3.5 and 4.3 cows/ha respectively. Because of this, the stocking rates range from 2.8 to 4.3 cows/ha for the HBI farms and from 3.8 to 5.3 cows/ha for the LBI farms. In both cases the increase is in increments of 0.5 cows/ha.

Some data for the first season for herds at a common stocking rate are shown in Table 3. The HBI cows resulted in fat productions that were about 25 kg/cow and 100 kg/ha higher than those of the LBI [illegible]. These data demonstrate a large effect of cow quality on farm production and emphasise the importance of identifying the poor producers in a herd, culling these and replacing them with genetically superior stock. Recognition of the importance of cow quality is

TABLE 3 Performance of HBI and LBI herds at common stocking rates (1981/82)

	Stocking rate (cows/ha) 3.75		4.28	
	HBI	LBI	HBI	LBI
Fat kg/cow	175	151	151	126
kg/ha	656	566	646	539
Fat %	5.8	5.8	5.6	5.4
Condition score				
Calving	5.8	6.6	6.0	6.2
Drying off	3.6	5.7	3.4	4.5
Silage made (kg DM/cow)	263	497	86	338

reflected in 54% of national herd being inseminated with semen from Dairy Board bulls in 1981. Average BI of these bulls was 136 (NZ Dairy Board 1981-82). Other artificial breeding enterprises probably accounted for a further 15-20%. The high quality of Dairy Board bulls by world standards has been recently demonstrated (Jasiorowski et *al.* 1983).

LENGTH OF LACTATION

Characteristic of the national herd is a lactation of about 250 days. Drying off is in May or earlier in the interests of maintaining cow condition and accumulating pasture for winter feeding (Hutton 1972; Campbell et *al.* 1977). A lactation that finishes in May and the uncertainties of summer rainfall emphasise the importance of obtaining high milk production per hectare before summer. To achieve this requires full and efficient use of pasture when cow efficiency, growth and quality of pasture are near maximum. It ensures that cows are capable of capitalising on good summer growth should this occur; it provides the best and least expensive insurance against the possibility of it 'not occurring.

From a nutritional view point, the amount of milk produced before summer is a function of three factors; stocking rate, which reflects the level of soil fertility and pasture production; daily fat, determined by cow quality, autumn-winter management, and level of feeding in early lactation; and days in milk, a function of calving date and calving spread. A conflict arises therefore between calving before the onset of spring growth in'the interests of a longer lactation, and delaying calving to coincide with spring growth so high levels of feeding apply around calving.

Arising from the work of Hutton (1968) , the advantages of delaying calving has received particular emphasis in the last 10-15 years.

Certainly there has been a trend, 'at least in the Auckland Livestock Improvement Association, towards later mating. The date on which the maximum number of inseminations were made was 22/10 in 1973

29/10 in 1979 and 4/11 in 1980. When expressed as a percentage of the number of inseminations made on the peak day, the number of inseminations made on 1st October in each of the years was 32%, 18% and 11% respectively .

This trend has undoubtedly aided improved cow nutrition around calving. It has also magnified the seasonality of milk production (Paul 1982). Its contribution to increased total production is less certain.

Since 1978/79, the amount of milkfat processed on the peak day by the NZ Co-operative Dairy Company has steadily increased from 448 to 543 tonnes. Total fat for the season has remained constant at about 98000 tonnes. This has been so despite the number of cows serviced by the Company increasing fran 618000 to 659000 during the five years. Clearly the massive increase by suppliers in production at the peak has not been accompanied by anequivalent increase in total production.

The significance of calving date and spread was overlooked in the debate (Campbell et *al.* 1977; Karlovsky 1977; Middleton 1977; Jury 1977; Campbell 1977) about the reasons why milk production on the Ruakura No. 2 Dairy was about twice the district average. Macmillan and Phillips (1983) compared calving statistics of this herd with those of 35 nearby farms. The data are summarised in Table 4.

TABLE 4 Calving statistics for Ruakura No. 2 Dairy and 35 Waikato farmers

	No. 2	Waikato survey	
		Mean	Range
Planned start	15 July	5 Aug.	23 July - 18 Aug.
Planned start to mid point (days)	14	17	11-24
Mid point to end (days)	31	52	21-89
Total (days)	45	69	36-112

Not only was the planned start of calving for the *No.* 2 herd about 20 days earlier than the survey average, but calving was also *more* concentrated. The combined effect of these two factors contributed to that herd of 196 cows achieving 11400 kg FCM/ha during the 150 d lactation to end of December.. Total lactation was 257 d for a total FCM production of 4675 kg/cow and 17300.kg/ha solely on pasture grown on the farm.

This and other information suggests that compared to surrounding farmers, the advantage accruing to the No. 2 Dairy herd through its earlier, more concentrated calving and associated managxnent amounts to

15-20 kg milkfat per cow.

Later calving has undoubtedly been an important factor in assisting farmers to achieve high daily fat production in early lactation. For those who have achieved this, there are now gains in total production to be obtained by reducing calving spread and calving earlier while still maintaining levels of feeding comparable to those being achieved with later calving.

GRAZING MANAGEMENT

Campling (1974) reviewed systems of grazing management for dairy cattle and concluded that no single system was markedly superior. This result is perhaps no surprise when obtained in an environment where stock are housed for much of the winter and extensive use of N fertiliser and supplementary feed can be made to overcome any deficits in pasture supply. By contrast, where both high stocking rates and grazing during the winter are practised, careful rationing of autumn-winter growth by rotational grazing offers considerable advantages. McMeekan and Walshe (1963) concluded that optimum stocking rate with set-stocking is reached at a 5 to 10% lower level than with rotational grazing. When set-stocking in winter was attempted on two-thirds of a farmlet stocked at 4.9 cows/ha, the "folly" of this was apparent after one month (Hutton 1966). More convincing perhaps, than the limited research data is that probably every dairy farmer in NZ uses some system of rotational grazing.

The interval of grazing during winter may also be important. Thus Bryant and Cook (1980) demonstrated over two successive winters that for a stocking rate of 4.31 cows/ha, a slow rotation system that established a Pasture supply averaging about 2000 kg DM/ha in June and July resulted in 10 to 15% more milkfat during the subsequent lactation than a system resulting in an average of 1300 to 1700 kg DM/ha at that time. A more comprehensive investigation of the effects of autumn-winter management on farm productivity is presently in progress at Ruakura. In involves eight farms -each of 6.48 ha and stocked with 24 cows.

Current belief is that grazing management during autumn and winter has three objectives of decreasing priority; the accumulation of sufficient high quality pasture to ensure high levels of feeding in early lactation; achieving conditions to enhance the cool season growth of improved pasture species; and imposing feeding levels that minimise feed used while replacing live weight lost in late lactation so that cows calve in reasonable condition.

Optimum early lactation management has not been defined. It is well established that the milk yield of cows at this time increases with herbage allowance in an asymptotic manner (Le Du *et al.* 1979; Bryant 1980). A consequence is that lenient grazing is required for high initial milk yields since residual herbage mass also increases with increasing herbage allowance. Other evidence however (see Holmes and Macmillan 1982; Bryant 1982) suggests that in the interests of maintaining high pasture growth and quality further into the summer, factors like severity of grazing, topping, conservation, calving date and stocking rate should be manipulated so that only moderate herbage allowances occur in early lactation. The many ramifications of this apparent conflict and the role of the various possible management inputs is an area requiring further investigation.

There is overwhelming evidence from plot trials that increasing the interval between harvests increases DM production substantially, particulaly during summer. Despite this, farmlet trials with milking cows have shown that differences in fat yields due to grazing interval during lactation are minor (Bryant and Parker 1971; Miller 1971; McFeely et *al.* [illegible] . Advantages of rotationally grazing established ryegrass-white clover swards during later lactation may be primarily as an aid to recognizing feed surpluses.

Management that achieves many of these objectives is summarised in Table 5 using data from a research farm stocked the whole year with 3.86 cows/ha. Calving is over 6 weeks starting mid July and the herd is dried off about the end of April. During the last 2-3 weeks of lactation

TABLE 5 Seasonal changes in some pasture parameters fran a dairy farm stocked at 3.86 cows/ha (1980/81)

		Month (season)			
		May (Autumn)	July (Winter)	October (Spring)	February (Summer)
Pasture growth	(kg DM/ha)	38	18	82	42
Area of farm grazed	(%/d)	1.04	1.23	3.85	3.13
Stocking density	(cows/ha/d)	371	314	101	126
Herbage mass	(t DM/ha)				
Farm mean		2.1	1.4	2.3	3.0
On area grazed		2.7	3.1	3.1	3.8
Residual		0.8	1.0	1.5	2.1
Degree of defoliation	(%)	70	67	50	45
Herbage allowance	(kg DM/cow/d)	7.9	9.8	30.4	30.1
Intake	(kg DM/cow/d)	5.6	6.6	15.2	13.6

the area grazed by the herd each day is restricted, the good pasture growth that occurs following autumn rain is used to increase the amount of pasture on the farm, and the herd is dried off according to body condition. About 100-150 kg DM/cow as hay or silage may be used to maintain intake at about 10 kg DM/cow/day. High stocking densities and a high degree of defoliation are characteristic of management at this time. Herbage mass on the area grazed may achieve 3500-4000 kgDM/ha. As winter proceeds feed supply reduces since herd requirements, which gradually increase as calving approaches exceed pasture growth. Following calving liberal feeding is achieved by grazing a greater area each day, Grazing intervals of 10-15 days may be used in September increasing to 25-30 days during the remainder of lactation. During summer, high DM material accumulates in the base of sward resulting in high residual herbage masses. Increased stocking density in autumn enhances disappearance of this largely senescent material.

CONCLUSIONS

Dairy farming practices in NZ are continually changing. As soil fertility improves and better pasture species become dominant, both the amount of feed grown and its seasonal distribution changes. Recent work shows that the highly improved cow of today differs from that of yesterday in many respects. To exploit these improvements requires management practices to also change. Some farmers may continue to seek higher farm production by means of late calving and relatively high stocking rates. For some, there is considerable scope for higher production by means of more modest stocking rates but longer lactations by reducing calving spread, earlier calving, and adopting the necessary grazing management. Overshadowing all are the uncertainties and low returns of the export market. More than any other factors, these will continue to determine the activities of the farmer, his advisors, and supporting scientists.

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