CONCENTRATE SUPPLEMENTS FOR PASTURE-FED COWS IN NORTHERN VICTORIA

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SUMMARY

Three experiments are described in which cows were offered irrigated pasture and several levels of concentrate. Responses in milk and milk solids production at various stages of lactation, and with pasture and concentrates of different quality have been measured. The significance of these data to irrigated dairying in northern Victoria is considered.

INTRODUCTION

A third of Victoria's dairy cows are in the irrigated areas of northern Victoria. Dairyfarming in these districts is unique with respect to patterns of feed supply and the quality of that feed (Stockdale 1983). This is caused by low winter temperatures, high summer temperatures, the species present in the pastures and a guaranteed supply of water in summer. Feed production and quality in spring and autumn are similar to those of the temperate seasonal rainfall districts; however, in summer high temperatures ensure good growth of low quality paspalum-dominant pastures. In winter, grazing is often on annual pastures based on sub-clover and ryegrasses.

Traditionally hay supplements have been offered at times of feed shortages. However, the generally poor response of dairy cows to hay supplements (King and Stockdale 1981; Stockdale *et al.* 1981) has resulted in renewed interest in the use of high energy concentrates as supplements for lactating cows.

Many factors my influence the magnitude of responses of grazing cows to supplementary feeds. Of these, quality of the pasture and supplement, levels of feeding of pasture and supplement and stage of lactation are the most important. The following experiments form part of a series of trials designed to quantify responses of cows in the irrigated areas of northern Victoria to variations in these factors.

MATERIALS AND METHODS

Three experiments were conducted at the Animal and Irrigated Pastures Research Institute, Kyabram, in 1982 in which high energy concentrates were offered to pasture-fed cows. The type and duration of each experiment are given in Table 1 together with the numbers of cows and their stage of lactation. A description of the productivity of the cows and some characteristics of the feedstuffs are also given in Table 1

Treatments

Experiment 1 - the cows were allocated to eight groups and offered one of two levels of pasture (Table 2). At each pasture allowance, each group of cows was offered an amount of pellets ranging fran 0 to ad libitum.

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Experiment 2 - cows in either early or late lactation were offered 6.5 kgDM/cow/day of good quality pasture (Lolium perenne/Trifolium repens) and this was supplemented with pellets ranging from 0 to ad libitum (Table 3). These cows were individually fed both pasture and pellets in stalls.

Experiment 3 - was also a stall-feeding experiment and the cows in this experiment were fed 7.0 kgDM/cow/day of good quality pasture or 7.1 kgDM/cow/day of poor quality pasture (Paspalum dilatatum-dominant) (Table 1). The pasture was supplemented with quantities of pellets or wheat ranging from 0 to ad libitum (Table 4).

TABLE 1 Details of the yield (kg/cow/day), composition (%) and live weight (kg) of the cows used in each experiment, and of the in vivo digestibility, (DMD) Kjeldahl nitrogen content (N) and neutral detergent fibre (NDF)(% of dry weight) of the pasture and concentrates offered.

Variable		Experiment No.			
		1	2		3
Type of experiment		Field	Stall-feeding		Stall-feeding
Period of the year		March/April	Sept/Oct		Nov/Dec
Duration (days)		22	15		15
Cows					
Number		26	13	7	29
Stage of lactation		late	early	late	mid
Milk yield		10.3(±0.2)†	25.3(±4.9)	13.8(±0.3)	20.4(±4.0)
Fat content		5.0(±0.6)	4.1(±0.8)	4.9(±1.1)	4.1(±0.6)
Protein content		3.5(±0.2)	3.3(±0.3)	3.6(±0.4)	3.3(±0.3)
Live weight		427(±49)	459(±77)	475(±35)	438(±56)
Pastures					
Ryegrass/clover	-DMD	-	73.9		73.7
	-N	-	3.31		3.25
	-NDF	-	30.6		36.6
Paspalum	-DMD	N/M	-		61.3
	-N	1.26	-		2.02
	-NDF	68.5	-		50.8
Concentrates					
Pellets	-N	2.23	2.50		2.67
	-NDF	14.9	13.0		14.1
Wheat	-N	-	-		1.67
	-NDF	-	-		6.9

N/M Not measured
† Standard deviation about the mean is in parenthesis

Management

In Experiment 1, each group of cows was given a fresh strip of pasture once daily, immediately after the morning milking. Each group was confined to its allocated area and backgrazing was prevented. Pellets were individually fed to the cows immediately after each milking prior to their return to the pasture. Feeding of pellets occurred at approximately 08.00 and 16.00 h.

In Experiments 2 and 3, the pasture and concentrate requirements of each cow were split between two feeding times. The first feed commenced at 08.00 h, immediately after the morning milking. All cows were offered their pasture first and then concentrates after the pasture was finished. The process was repeated after the afternoon milking, commencing at 16.00 h. Cows being offered ad libm concentrates had continuous access to their concentrates.

Effects of treatments on cows were assessed by regression of covariate adjusted data. Milk yield and composition for nine days prior to each experiment were used as covariates.

Prior to the collection of data three weeks were allowed for the cows fed concentrates to adjust to new diets. The quantity of concentrates was gradually increased until the projected level. of feeding was achieved. Both during this period, and subsequently, drenching with sodium bicarbonate was used as a curative procedure for acidosis; regular dosing for prophylaxis was not practiced.

Measurements

Milk yield was recorded at each milking, the fat content was measured daily and the protein content once each week. All cows were weighed daily, immediately after the morning milking.

In Experiment 1, pre7 and post-grazing pasture yields were measured with a rising plate meter (Earle and McGowan 1979) using a double sampling procedure. Daily pasture intake was calculated from the differences between the estimated yields before and after grazing. Intakes in Experiments 2 and 3 were measured from samples of the pasture and concentrates offered and rejected, after drying these at 100°C for 24 h

Samples of all feedtuffs in all experiments were collected daily for the determination of Kjeldahl nitrogen content and neutral detergent fibre (Goering and Van Soest 1970). These were dried at 60°C for 72 h.

Estimates of the in vivo digestibility of the pastures used in Experiments 2 and 3 were made using wethers and collecting faeces for ten days.

Statistical analysis

Regression analysis relating animal productivity to concentrate intake was used. In Experiment 1, group data were used while in Experiments 2and 3, the data from individual cows were used.

RESULTS

Experiment 1

The mean pasture allowances were 15.4 and 26.2 kgDM/cow/day and the range in pellet intake was the same at both allowances (0 to 6 kgDM/cow/day). Pasture intakes and the post-grazing yields associated with the various combinations of pasture allowances and pellet intakes are given in Table 2. Rates of substitution of pellets for pasture depended on pasture allowance (Table 2); at the low pasture allowance, substitution was evident only when pellets were offered ad libitum, while at the higher pasture allowance, substitution was at its greatest at the lowest of pellets on offer and diminished thereafter.

TABLE 2 Effect of the intake of feedstuffs (kgDM/cow/day) on the production of milk products (kg/cow/day), milk composition (%) and liveweight change (kg) of cows in late lactation offered two levels of pasture (kgDM/cow/day). Pasture availability and residual pasture (tDM/ha) and the substitution rate (kg reduction in pasture intake/kg concentrate eaten) have also been presented.

Variable	Treatment No.							
	1	2	3	4	5	6	7	8
Feeds								
Concentrate intake	0	1.8	3.6	6.3	0	1.8	3.5	6.2
Pasture allowance	15.3	16.0	14.9	15.2	25.9	25.8	26.6	26.3
Pasture available	5.01	4.90	4.86	4.97	5.08	4.99	4.99	4.97
Residual pasture	2.33	2.38	2.22	2.79	2.94	3.22	3.22	3.27
Pasture intake	8.0	8.1	8.0	6.5	10.6	8.9	9.1	8.7
Substitution rate	-	0	0	0.23	-	0.94	0.43	0.30
Animals								
No. of cows	4	2	3	4	4	3	4	2
Milk yield	7.4	10.3	10.2	11.8	8.6	10.8	11.5	12.0
Fat content	5.35	5.14	5.76	4.61	5.18	5.11	5.03	4.94
Fat yield	0.40	0.53	0.55	0.52	0.45	0.55	0.58	0.60
Protein content	3.65	3.94	3.90	4.17	3.83	3.67	3.93	4.22
Protein yield	0.28	0.41	0.40	0.42	0.33	0.38	0.44	0.48
Liveweight change	-8	+11	+10	+21	+7	+5	+15	+8

Levels of animal production are given in Table 2. Milk (r^2=0.76; rsd=0.86) and protein (r^2=0.71; rsd=0.076) yield increased linearly with level of supplementation, but the response in milk fat yield (r^2=0.96; rsd=0.019) was curvilinear; peak fat yield occurred at 4-5 kgDM/cow/day of pellets fed. The marginal returns from feeding a kg of pellets were 0.6 kg milk and 0.030 kg fat, from feeding up to 5 kg DM/cow/day of pellets. Live weight of the cows also significantly increased as more pellets were eaten (r^2=0.48; rsd=6.4).

The different pasture allowances significantly influenced fat yield only; however, while the lower allowance tended to reduce milk and protein yields, these were not significant.

Experiment 2

When ad libitum pellets were offered mean intake of pellets approached 10 kgDM/cow/day for cows in early lactation and 6 kgDM/cow/day for cows in late lactation (Table 3). Levels of production at these two stages of lactation are also given in Table 3. Milk (r^2=0.91; rsd=1.59) and protein (r^2=0.88; rsd=0.059) yield, and liveweight change (r^2=0.72; rsd=6.5) all increased linearly with intake of pellets. The marginal returns from feeding a kg of pellets were 0.9 and 0.7 kg milk for cows in early and late lactation, respectively. The response in fat yield to feeding extra pellets was significantly curvilinear (r^2=0.56; rsd=0.093) and maximum yield again occurred at about 4-5kgDM/cow/day of pellets fed regardless of stage of lactation. This was associated with a marked reduction in the fat content of the milk among those cows offered ad libitum pellets; (2.75 and 3.51% for cows in early and late lactation, respectively).

TABLE 3 Effect of concentrate intake (kgDM/cow/day) on the production of milk products (kg/cow/day), milk composition, and liveweight change (kg), of cows offered 6.5 kgDM/cow/day of pasture in early and late lactation.

Variable	Treatment								
	Early lactation					Late lactation			
	0	2	3	6	Ad lib.	0	2	4	Ad lib.
Concentrate intake	0	1.8	2.7	5.4	9.6	0	1.8	3.6	6.1
Milk yield	14.3	16.8	19.3	18.4	24.3	8.7	11.0	11.5	13.1
Fat content	3.93	4.38	4.10	4.00	2.75	5.49	4.89	5.42	3.51
Fat yield	0.59	0.69	0.76	0.76	0.65	0.50	0.53	0.61	0.46
Protein content	2.51	2.88	2.84	3.02	3.23	3.10	3.36	3.75	3.42
Protein yield	0.36	0.49	0.55	0.55	0.78	0.27	0.37	0.44	0.47
Liveweight change	-3	-3	-3	-1	+21	-7	+9	+8	+14

Experiment 3

Maximum intake of pellets and wheat when offered ad libitum were approximately 9 and 6 kgDM/cow/day respectively (Table 4). The effects of concentrate feeding on the productivity of the cows offered pasture of contrasting quality are also given in Table 4.

TABLE 4 Effect of concentrate intake (kgDM/cow/day) on the production of milk products (kg/cow/day), milk constituents (%), and liveweight change (kg) of cows fed either ryegrass/white clover pasture (7.0 kgDM/cow/day) or paspalum dominant pasture (7.1 kgDM/cow/day).

Variable	Treatment				
	0	Wheat		Pellets	
		4	Ad lib.	4	Ad lib.
Ryegrass/white clover pasture					
Concentrate intake	0	3.6	5.6	3.6	8.7
Milk yield	10.3	15.2	16.0	16.4	19.4
Fat content	4.69	4.92	3.94	4.29	3.42
Fat yield	0.45	0.68	0.64	0.65	0.60
Protein content	2.84	3.00	3.41	3.06	3.28
Protein yield	0.27	0.44	0.53	0.48	0.61
Liveweight change	+4	+3	+15	+5	+17
Paspalum/dominant pasture					
Concentrate intake	0	3.6	6.1	3.6	9.0
Milk yield	7.4	12.4	11.6	12.2	17.6
Fat content	4.67	4.36	4.42	4.79	4.27
Fat yield	0.38	0.57	0.51	0.61	0.76
Protein content	2.76	3.04	3.49	2.86	3.25
Protein yield	0.22	0.36	0.43	0.37	0.53
Liveweight change	+2	+5	+13	+11	+15

Higher levels of productivity were generally obtained from cows offered good quality pasture compared to those offered poor quality pasture. However, there were interactions associated with the type of concentrate fed. Response in milk (r^2=0.79; rsd=1.73), fat (r^2=0.58;

rsd=0.085) and protein (r^2=0.82; rsd=0.060) yield obtained from both pellets and wheat when used to supplement good quality pasture were similar to those reported for feeding pellets in Experiments land 2. Milk and protein yield responses were linear (marginal returns from feeding a kg of concentrates were 1.0 kg milk and 0.040 kg protein, respectively) while the response of fat yield to concentrates was curvilinear. Maximum yield again occurred at about 5 kgDM/cow/day of concentrates fed. This was associated with a depression in fat test at high concentrate intakes (Table 4) although this was not as severe as in Experiment 2.

Production of milk solids fran cows offered poor quality pasture indicates an interaction of concentrates with pasture quality at high levels of intake (Table 4). Supplementing poor quality pasture with pellets gave the same response in milk yield as that recorded for good quality pasture. However, use of wheat supplements resulted in a large reduction in milk yield at high concentrate intakes (r^2=0.88; rsd=1.30). While fat depression was obvious when wheat was the supplement, this was not the case when pellets supplemented poor quality pasture(r^2=0.77; rsd=0.077). Although the response to extra pellets was curvilinear, the best fed cows had still not achieved peak yield.

DISCUSSION

Production responses from feeding concentrate supplements to grazing dairy cows can readily be measured as immediate or carry-over effects on milk yield and/or composition. Less obvious are responses associated with changes in partitioning of nutrients to or from body tissue or those involved with substitution of concentrates for pasture.

Many good reviews describe the qualitative effects of supplementary feeding concentrates to dairy cows. (eg., Rook 1961a,b; Leaver et al. 1968; Broster, et al. 1978) . However, quantitative production data from pasture-fed cows are few and generally of little value because they are then complicated by substitution effect or refer only to a single set of circumstances.

The experiments described in this paper provide information useful for the nutrition of dairy cows that graze pastures typical to tne irrigation areas of northern Victoria. While meaningful changes in body condition could not be estimated and liveweight change data in these short-term trials are of doubtful value, the responses in animal products have been determined without the confounding effect of substitution, with the exception Of Experiment 1.

Stage of Lactation

Responses in milk yield to increasing levels of concentrate supplementation at all stages of lactation were within the range of those summarised by Leaver et al. (1968) and Bryant and Trigg (1982). Maximum response to supplementation of milk yield was in early lactation when cows also ate the most concentrates. This difference in response can be attributed to an alteration in energy partitioning to favour increased tissue synthesis, due to an altered acetate : propionate ratio with increasing concentrate intake. The effect on partitioning of progressing stage of lactation is also implicated.

Regression analysis showed that maximum butterfat production, at all stages of lactation, occured when cows ate approximately 4-5 kg concentrate. Fat depression was greatest in the cows fed the highest levels of concentrates. Levels of concentrate intake achieved in early lactation were more than 50% greater than in late lactation, however, the relative magnitude of the depression was greater in late compared with early lactation.

The literature contains many reports of the dependance of milk fat content on dietary roughage (eg., Kesler and Spahr 1964; Broster et al. 1978) and low total N.D.F. in our rations (Table 1) suggest that low fibre had a major influence on this result.

Quality of Pasture

Pasture quality did not influence the marginal response of milk production to concentrate supplementation though the difference in total productivity did reflect the contrasting quality of the pasture.

The much greater reduction of milk fat test of the cam offered high levels of concentrates with ryegrass/white clover pasture compared with those offered paspalum reflect the lower levels of dietary NDF in the former (average NDF: ryegrass diets 24%; Paspalum diets 32%).

The interaction between pasture and concentrate quality on milk fat yield, such that those cows offered paspalum plus wheat supplement produced less butterfat than similar cows offered paspalum and pellets or ryegrass/white clover based diets, was related at least partially to nitrogen content of the diets. Total crude protein content in the RG/WC diets was 18.4 and 17.0% for cows supplemented with the higher level of pellets and wheat respectively. Equivalent data for paspalum diets was 14.8 and 11.6% suggesting nitrogen was limiting in the latter diet. That other nutrients may be involved cannot be discounted.

Of interest also is the maximum level of concentrate eaten they were on offer without restriction; more pellets than wheat were eaten, irrespective of pasture type. The possibility of a greater buffering capacity of pellets compared to wheat cannot be discounted as pellets contained both more N.D.F. than wheat plus 20% limestone of unknown buffering rapacity.

Substitution

The variations in the levels of substitution measured in Experiment 1 indicate that a number of factors may influence the rate of substitution of concentrates for pasture.

Broster and Thomas (1981) have previously outlined many factors affecting substitution rate in lactating cattle. These include forage digestibility, type andlevelof concentrate, and chemical composition of the forage. Experiment 1 suggests that with grazing cows the quantity of pasture on offer is also of major importance. Obviously, rate of substitution requires further definition particularly in view of the pasture types that exist in northern Victoria (Stockdale 1983).

The effect of increasing level of concentrate supplementation on residual pasture was not large in this trial which is in contrast to that reported by Stockdale (1981). This may have occurred because of the very poor quality pasture used in Experiment 1. Any sparing effect on the level of residual pasture can be critical in times of pasture shortage.

Conclusion

The major contribution of this work has been to quantify some effects of increasing levels of concentrate supplementation on productivity of cows fed pasture differing in quality or at different stages of lactation. Further quantitative work defining the effect of changing levels of concentrate is indicated. In addition, factors affecting the magnitude of substitution effects together with the influence of nutritive value of the supplement on intake and productivity, are critical to the definition of cow responses to supplementation.

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