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## Comparison of a Calan gate and a conventional feed barrier system for dairy cows: feed intake and cow behaviour

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There is little published information on comparisons of individual and group feeding systems for dairy cows. Twenty-four dairy cows were used in a three-period incompletely balanced, change-over design study, to examine food intake and feeding behaviour of dairy cows offered their food via group-access electronic Calan gates, or via a conventional feed-barrier system. The food offered was in the form of a complete diet, and comprised grass silage and concentrates (60:40 dry matter (DM) basis). With the conventional feed-barrier system a maximum of eight animals were able to feed at any one time, while the Calan-gate system allowed a maximum of three animals to feed at any one time. Method of offering the ration had no effect on daily DM intake. During the 8-h period after animals were given access to fresh food, the mean number of animals feeding at any one time was 5.4 and 3.0 for the conventional and Calan-gate systems, respectively, while total intake over this period was 11.0 and 9.2 kg DM per cow, respectively. When access to feed was restricted by the use of Calan gates, animals responded by increasing their intake rate. It is concluded that total DM intake was unaffected by the use of a group Calan-gate feeding system as animals modified their feeding behaviour to maintain food intake.

*Keywords:* Calan gate; dairy cows; intake

### Introduction

Electronic ‘Calan gate’ type feeding systems were developed to allow the food intake of individual animals to be

measured, and these systems are now common in research institutes worldwide. Some of these systems allow animals to access feed through ‘individual’ gates,

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while others are designed so that a group of animals share a number of gates. With the latter, all animals do not normally have access to food at any one time. While it is generally assumed that food intake is unaffected by the use of Calan gates, few studies have compared the intake of animals offered food via Calan gates and via 'conventional' feeding systems. The results of a 'preliminary' study by Phipps *et al.* (1983), which involved a comparison of dairy cow performance when a complete diet was offered either via individual Calan gates, or via a 'communal manger', were confounded by the experimental design. A second study (Phipps *et al.*, 1987) concerned a comparison of a 'self feed' silage system with individual Calan gates, but self-feed silage systems have now largely been replaced by easy-feed systems which often involve complete diets. In addition, neither of these two studies examined a 'group' access Calan-gate system. The current study was conducted to examine the food intake and feeding behaviour of dairy cows when offered a complete diet, either through a 'group' Calan-gate feeding system or via a conventional feed-barrier system.

### Material and Methods

Twenty-four late lactation (285 [s.d. 26.8] days calved) Holstein-Friesian dairy cows (pre-experimental milk yield, 18.6 [s.d. 2.98] kg/day) were used in a two treatment, three period (period length = 14 days), change-over design study. Animals were divided into two groups (each of 12 animals) at the start of the study, and remained within the same group for the duration of the study. The two groups were housed side-by-side in cubicle accommodation (one cubicle per animal), with the layout of the housing area for each group identical, but 'reversed'. All animals were

offered a complete diet comprising grass silage and concentrates (60:40 dry matter (DM) basis), prepared daily using a mixer wagon. Animals did not have access to food between 0900 and 1100. During this period uneaten food was removed while fresh food was prepared and placed in the appropriate feed boxes. Animals were given access to fresh food at 1100. The ration was offered daily at proportionally 1.1 of the previous day's intake. The ingredient composition of the concentrate (coarse 'meal'), on an air dry basis (g/kg), was as follows: barley 230, wheat 225, sugar beet pulp 300, soya bean meal 245. The silage offered was produced from the primary growth of a perennial ryegrass-based sward harvested in the period 22 to 28 May.

The treatments examined, 'Calan gate' (CG) and 'easy feed' (EF), involved two different methods of allowing animals access to their diet. With CG, animals accessed food via three 'electronic Calan gates' (American Calan; NH, USA), with each gate allowing access to a feed box (length 120 cm, depth 104 cm, width at top 118 cm, width at base 63 cm) mounted on a weigh scale and linked to an automatic cow identification system (Griffith Elder; Bury St Edmunds, UK), as described by Forbes *et al.* (1986). Opening of the Calan gates was controlled via a transponder mounted on a neck collar. All 12 animals on this treatment could access any of the three Calan gates. This system allowed individual food intake to be recorded. With EF, three Calan gates and their surrounding fittings were removed, leaving three feed spaces, each 122 cm long, and separated by upright steel bars. Animals accessed the ration through these three spaces, with the ration being placed in a single feed box (length 385 cm, depth 60 cm, width at top 94 cm, width at base 63 cm). This box rested on two weigh

scales, which allowed the weight of food in the box to be measured, but which did not allow individual food intakes to be recorded. A maximum of eight animals were able to feed from this system at any one time, while the average feed space per animal was 305 mm.

Animals were removed for milking twice daily, at 0600 and 1700. Post-milking, they remained in a collecting yard without access to food, until returned to the cubicle house and given access to food again at 0700 and 1800, following AM and PM milking, respectively.

### *Measurements*

*Daily food intake:* Food intakes were recorded daily during days 8 to 14 of each experimental period. With the Calan-gate treatment, the automatic cow identification system allowed individual cow food intakes to be determined, with a mean daily intake subsequently calculated. With EF, group food intakes were calculated as the difference between the quantity of food offered at 1100 and the uneaten food remaining at 0900 the following day. With both treatments, a mean intake (group basis) for this 7-day period was calculated.

*Hourly food intake:* On day 12 of each period, food consumption by each treatment group was recorded hourly (except during milking), commencing 1200 and continuing until 0900 the following day. With both treatments, these measurements were recorded directly from the weigh scales on which the feed boxes were mounted.

*Group scan:* On day 12 of each period, a group scan was conducted to record the number of animals involved in a range of activities within each group. Commencing at 1105, each group was scanned at 10-min intervals throughout the day (except during 'milking,' and during the 2-h period prior to offering fresh food). Scanning each

group normally took 20 to 40 s, depending on the range of activities observed. Each animal was 'classified' according to one of the following activities: feeding (or with head in feed box), queuing to feed (animal standing within, or partly standing within the 'feed area', defined as the area directly in front of the feed boxes, and extending to a distance of 2.4 m from the boxes), standing/walking (including drinking), and lying. The number of animals 'ruminating' was also recorded. Mean hourly activity was calculated as the mean of the six scans conducted each hour, while the mean activity over the 20-h recording period was calculated as the mean of all scans for each group. Based on the mean number of animals observed to be participating in each activity, the average time (hours and minutes) that individual animals spent in each activity over the 20-h observation period was calculated. Group scan observations were conducted by three operators during each recording period. Operators were located on a raised platform between the two groups of animals, approximately 6.5 m behind the feed boxes.

### *Statistical analysis*

The experimental design was a 2 (group)  $\times$  3 (period) partially balanced change-over, with one group fed on one of the feeding systems (CG, EF) in period 1, changing to the other system in period 2, and finally reverting back to the period 1 system in the third period. As individual intakes were available for the CG animals, but only group intakes for EF animals, group intakes were subsequently calculated for the former treatment. Mean group intake data for the final week of each experimental period, were then analysed by analysis of variance using the Genstat Restricted Maximum Likelihood Analysis (REML) procedure, with a model that included treatment as a fixed effect, and period

and group as random effects. A preliminary analysis of the data indicated that period effects were non-significant. Thus the data were subsequently re-analysed with period effects added into the residual term. Mean hourly group intake data and mean hourly behavioural data based on the data from the 20-h observation period, and mean behavioural data over the entire 20-h observation period, were analysed identically. All analysis were undertaken using Genstat for Windows, Version 8.

### Results

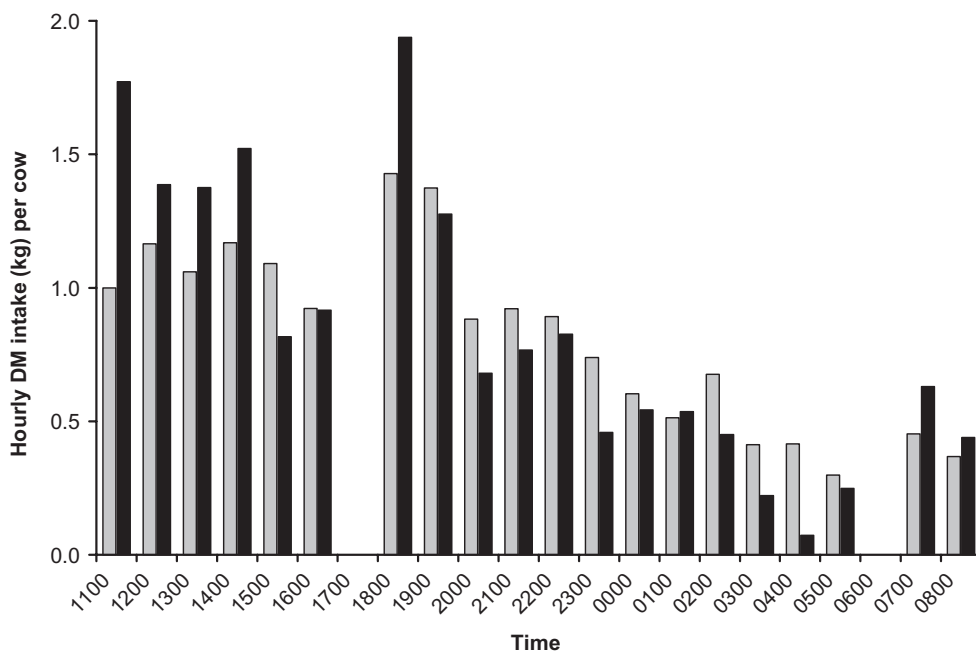
Total DM intake (Table 1) was 15.6 and 15.4 kg per cow daily for treatments CG and EF, respectively. During the 4-h period post access to fresh food, and during the 1-h period post evening milking, hourly food intake was between 0.2 and 0.7 kg greater for EF than CG (Figure 1). The difference in hourly intake was only

**Table 1. Effect of method of offering feed on daily dry matter intake (kg) per cow**

Component	Feeding treatment <sup>1</sup>		s.e.d.
	Calan gate	Easy feed	
Concentrate	6.5	6.4	0.13
Silage	9.1	9.0	0.54
Total	15.6	15.4	0.46

<sup>1</sup>There was no significant effect of feeding treatment.

significant ( $P < 0.001$ ) for the 1100 to 1200 interval. In contrast, food intake for CG was significantly greater ( $P < 0.001$ ) than for EF between 2300 and 0000 and between 0400 and 0500. Mean group scan data for the 20-h observation period are presented in Table 2, and the time calculated for each activity during the 20-h observation period is shown in brackets. During the observation period, the mean number of animals feeding was significantly less for CG, compared to EF, while the reverse was true for the mean number of animals queuing to feed ( $P < 0.001$ ). Feeding



*Figure 1: Mean hourly dry matter intake (kg) by cows on easy feed (■) and Calan gate (▒) feeding systems (time represents the start of each 1-h interval).*

**Table 2. Effect of method of offering food on the mean number of animals observed participating in a range of behaviours during a 20-h observation period**

Behaviour	Feeding treatment		s.e.d.	Significance
	Calan gate	Easy feed		
Feeding	2.44 (4:05) <sup>†</sup>	3.33 (5:32)	0.023	***
Queuing to feed	0.95 (1:35)	0.23 (0:20)	0.023	***
Standing/walking (excluding queuing and feeding)	3.21 (5:21)	3.22 (5:23)	0.270	
Lying	5.38 (8:59)	5.23 (8:45)	0.381	
Ruminating	4.88 (8:08)	4.88 (8:08)	0.159	

<sup>†</sup>Figures in brackets refer to the calculated time each animal spent on that activity during the 20-h observation period (hours:minutes).

system had no significant effect on the mean number of animals participating in any of the other activities recorded. When examined on an hourly basis (Figure 2), significantly fewer animals were observed feeding between 1100 and 2000 on CG compared to EF ( $P < 0.001$ ), while the reverse was true between 0400 and 0500 ( $P < 0.05$ ). In addition, significantly fewer

animals were observed queuing between 1100 and 2000 on EF.

**Discussion**

That there was no difference in food intake between feeding systems in the current study supports the findings of a comparison by Phipps *et al.* (1987), although

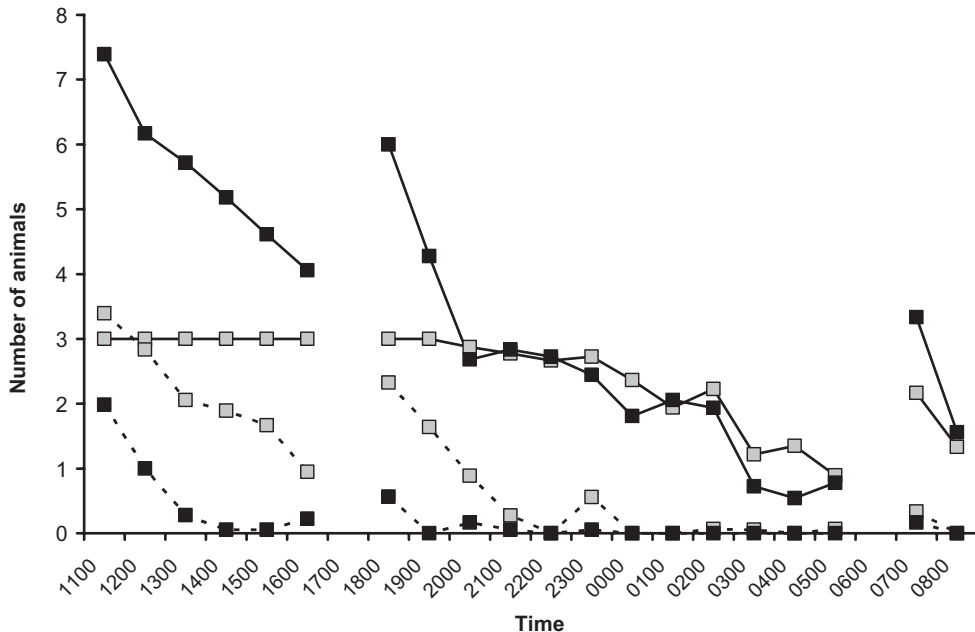


Figure 2: Mean number of animals observed feeding (—) and queuing (---) each hour on the easy feed (■) and Calan gate (■) feeding systems (time represents the start of each 1-h interval).

that study compared a self-feed silage system with individual Calan gates. With the exception of the 'preliminary study' by Phipps *et al.* (1983), there appears to be no other published comparisons of food intake associated with Calan-gate and conventional feed-barrier systems. In the study by Phipps *et al.* (1983), cows consumed 1.5 kg more DM, but milk yields were unaffected, when food was offered via an easy feed type system based on a 'communal manger', than via individual Calan gates. The lack of a milk yield response may have been due to the late stage of lactation of the animals involved. Phipps *et al.* (1983) suggested that the lower food intake by cows on the Calan gate system may have been due to the removal of visual stimulation associated with food, and the lack of competition that exists with individual feeding compared to group feeding. This is important as it has been observed that food intake of cows managed as a group can be 7 to 9% higher than that of those managed individually, while increased energy requirements due to social interaction may be another possible explanation (Coppock *et al.*, 1972). However, the outcome of the study by Phipps *et al.* (1983) may have been confounded due to the comparisons having been made in different buildings. In addition, animals were offered feed from the "communal manger" for a 4-week period, following a 20-week period of feeding via the Calan-gate system. Another key difference between the current study, and the studies by Phipps *et al.* (1983, 1987), is that the current study was based on 'group' Calan gate feeding, with an average of four animals sharing each gate, while the studies of Phipps *et al.* (1983, 1987) were based on 'individual' Calan gates.

While total DM intake was unaffected by feeding system, feeding behaviour, and

the pattern of food intake, differed significantly between the two systems. This can be attributed to the design of the systems, with a maximum of three animals able to feed from the Calan gates at any one time, compared to a maximum of eight animals with the easy feed system. For example, during the 8-h period after animals were given access to fresh feed, the mean number of animals feeding from EF was 5.4 (7.4 during the first hour post feeding), compared with 3.0 for CG. Corresponding mean DM intakes for this period were 11.0 and 9.2 kg, respectively. That intakes were only 16% lower with the Calan gate system, despite the fact that 45% fewer animals were observed to be feeding during this time, was due to the fact that the CG animals responded by increasing their rate of intake. Mean hourly intake rates over this time were 1.15 and 1.38 kg DM for CG and EF, respectively. An increase in eating rate with increased feeding competition has been observed previously. For example, Elizalde (1993) compared the effect of increasing the level of competition with a Calan-gate feeding system, from one to nine cows per gate. When nine cows shared each gate, animals responded by reducing their total daily feeding time, and feeding time per meal, by proportionally 0.70 and 0.81, respectively, but they increased their daily eating rate, and eating rate during their first main meal, by factors of 3.3 and 5.0, respectively.

In addition to an increase in eating rate, Reynolds and Campling (1981) observed an increase in agonistic behaviour as the number of animals sharing each feed space increased. While agonistic behaviours were not formally recorded in the current study, incidences of pushing, head butting and nudging amongst non-feeding animals, and between non-feeding and feeding animals, were observed to be more common with CG than EF. In addition, non-feeding

animals were frequently observed to force feeding animals from the Calan gates, with the greater number of animals queuing to feed with CG likely to be a key contributing factor to the increase in agonistic-type behaviour observed. With EF on the other hand, animals were observed to be involved in much 'social interaction' whilst feeding, especially during the hours after fresh feed was offered. Such 'social interaction' was not possible with animals on CG. As feeding system had no effect on the number of animals involved in any of the other key behaviours recorded (standing/walking, lying or ruminating), it appears that CG animals substituted feeding time with queuing, and at the same time, increased their rate of food intake. While Martinsson and Burstedt (1990) and Martinsson (1991), concluded that giving access to silage-based rations for 8 h/day was inadequate to maximise intake, irrespective of feeding system, animals in the current study spent less than 6 h/day feeding. However, it is important to note that, in the current study, animals on both treatments had access to their food for 20 h/day. This would also be the situation on most farms.

The purpose of this study was to determine if the use of group-access electronic Calan-gate feeding systems, of the type used to measure individual cow intakes within research environments, has an effect on the food intake of dairy cows. When an average of four cows shared each gate, total DM intake was not significantly different between the Calan gate and a conventional easy feed system. While it was not possible to measure milk output, the lack of food intake response suggests that milk output would have been unaffected by feeding system. Nevertheless, it should be noted that although pre-experimental milk yields were 18.6 kg/day, the animals involved in the study were in late lactation, and accordingly, food intake was relatively low. Thus it cannot be

concluded that a similar response would be obtained with early lactation animals at peak food intake. For this reason, it is normal practice at the Agri-Food and Biosciences Institute-Hillsborough, for three animals to share each Calan gate, rather than four, as in the current study. Nevertheless, the present study clearly shows that animals on a CG system modify their feeding behaviour and increase intake rate to maintain total DM intake.

It is concluded that, when compared to a conventional easy-feed system, group Calan-gate feeding systems can be used to measure food intake by individual animals, without affecting total DM intake. When competition for feed space is increased, dairy cows modify their feeding behaviour and increase their intake rate.

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