Concentrate supplementation and milking frequency in automated milking with grazing

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Abstract

Voluntary movement of cows from paddock to milking yard is an inherent aspect of an automatic milking system (AMS) integrated with grazing. The motivation for the cow to present at the milking yard, during the main grass-growing period, is the trained knowledge that they will be rewarded with fresh grass in a new paddock. In late-lactation concentrate supplementation assists in ensuring the cow receives adequate nutrition. Although the cow decides to present at the milking yard, AMS settings determine when the cow is milked based on milk yield and time since last milking. The aim of this study was to investigate the influence of milking permission and concentrate supplementation on milk production and cow traffic. There were 4 treatments with combinations of milking permissions, 3.2 or 1.8 times per day and concentrate supplementation allowance of either 3 kg or 0.84 kg per day. This study has highlighted strategies to maintain consistent milk production and cow traffic in the latter stages of lactation, through adjusting AMS settings for concentration supplementation and milking permission.

Keywords: milking permission, concentrate supplementation, automatic milking, grazing

Introduction

In Ireland the integration of automatic milking systems (AMS) is relatively new and this is the first study in an Irish context to attempt to define best animal, grass and concentrate supplementation management practices during the latter stages of the grazing season. The successful integration of an AMS with grazing is reliant upon voluntary movement of cows around the farm system and achieving an even distribution of milkings over 24 hours. Lyons *et al.* (2013) compared the use of supplementary feed pre- and post-milking in a grazing system and observed a reduced voluntary return time of cows from the paddock with pre-milking supplementation. Reduced pre-milking waiting time enhances animal welfare and was achieved by providing concentrate at the milking unit in a voluntary robotic rotary system (Scott *et al.,* 2014). In a spring-calving, pasture-based system of farming the availability of grass is a key factor in a farmer's management decisions relating to grass budgeting and concentrate supplementation. During a period when there is a grass deficit, for example as a result of reduced grass growth and quality in the latter end of the year, the dairy system needs to be sufficiently flexible to react to and compensate for the shortage of grass without dramatically impacting on milk production and, in the case of an AMS, on cow traffic. The current study assesses the effects of milking permission and concentrate supplementation in late lactation on milk yield and cow traffic.

Materials and methods

An AMS was located on a 25.2 ha milking platform divided into 3 grazing sections; A, B and C. Cows moved voluntarily to and from the paddock, passing through the milking yard, between the grazing sections. The experiment was divided into a lead-in period of 2 weeks (04/08/14 to 17/08/14) and an 11-week trial period (18/08/14 to 02/11/14). The herd had access to new pasture from 00:00 in A, 08:00 in B and 16:00 in C. Prior to each grazing the herbage mass (HM) (available grass kg dry matter (DM) ha^{-1} above 4 cm) was either estimated visually or by weighing grass DM in a 0.25 m^2 quadrat. The density of grass dry matter (kg m^{-3}), pre- and post grass heights in the area allocated to the herd for grazing were used to determine the grass DM intake for the herd after each grazing. The grazing area was allocated based on the pre-herbage mass and a demand of 18 kg grass DM cow^{-1} day^{-1} which was distributed over the 3 grazing sections in a 24 h period. Pasture management involved strip grazing and only back grazing a grazing area for 1 day if the post grass height was greater than 6 cm from the previous grazing. Pre- and post-grazing heights were measured prior to and after each grazing using a Jenquip rising plate meter (NZ Agriworks Ltd t/a Jenquip, New Zealand). The grass DM removed for each grazing was calculated to estimate the herd daily grass intake. The dairy featured one Fullwood Merlin 225 AMS unit. During the lead-in period all cows received 0.5 kg of concentrate with a milking permission of 2.5 times per day. 65 out of 68 cows milking on the system were randomly allotted to four groups and balanced for breed, lactation, days in milk, previous milk yield and milking frequency. The average days in milk, for the 65 cows on the experiment, was 175 days, ranging between 134 and 214 days in milk. The experimental design was a 2×2 factorial with 2 concentrate levels (3 kg, 0.84 kg) and 2 milking permissions (3.2, 1.8 times per day). The groups consisted of high concentrate (3 kg) with high milking permission (3.2) (HCHP) and low milking permission (1.8) (HCLP) and low concentrate (0.84 kg) with high milking permission (3.2) (LCHP) and low milking permission (1.8) (LCLP). Milking-permission treatments were selected based on previous work carried out in Teagasc Moorepark in a grazing based system with an AMS. Dependent variables included milk production and cow traffic. The statistical model used was a repeated measures ANOVA in SAS with PROC MIXED and Tukey's post-hoc analysis.

Results and discussion

During the trial period, grass budgeting decisions based on a deficit of grass availability resulted in supplementation of silage in a shed instead of 8 hours grazing in B for 9 days and in C for 5 different days. The average pre-grazing available herbage mass across all sections was 1,538±295 kg DM ha^{-1} (A – 1,587±324 kg, B – 1,410±416 kg and C – 1584±333 kg DM ha^{-1}). Of the days where there was a full set of data for A, B and C the total daily grass DM allowance per cow was 20.7±6.2 kg (A – 7.2±3.4 kg, B – 7.1±2.6 kg and C – 6.5±2.3 kg) and daily estimated grass DM intake per cow was 18.1±6.2 kg (A – 6.4±3.4 kg, B – 6.0±2.3 kg and C – 5.8±2.1 kg). The average post-grazing height was 4.9 cm (A – 5.0±1.0 cm, B – 4.9±0.9 cm and C – 4.8±0.9 cm). The results indicated that for the dependent variables of milk production (milk yield per visit and per day) and cow traffic (milking frequency, milking interval per visit, milking duration per day and waiting time per visit) the interaction between milking permission and concentrate was not significant. The main effects of milking permission and concentrate were significant for each dependent variable, except for wait time per day under the concentrate-supplementation treatments. Cows on the high milking permission (HP) and low milking permission (LP) had a milking frequency of 1.9 and 1.3 per day, respectively. Cows on high concentrate (HC) and low concentrate (LC) had an allowance of 3 and 0.84 kg per day, respectively. Cows with lower milking permission (HCLP and LCLP) compared to cows with a higher milking permission (HCHP and LCHP) had a significantly lower milking frequency (P<0.01), longer milking interval per visit (P<0.01), higher milk yield per visit (P<0.01) lower milk yield per day (P<0.01), shorter milking duration per day (P<0.01) and less time waiting to be milked per day (P<0.01) (Table 1). Cows with the lower concentrate level (LCHP and LCLP) compared to cows with the higher concentrate level (HCHP and HCLP) had a significantly lower milking frequency (P<0.05), longer milking interval per visit (P<0.05), lower yield per visit (P<0.01), lower milk yield per day (P<0.01) and a shorter milking duration per day (P<0.01) (Table 2). Decreasing milking permission had a positive impact on cow traffic as cows spent significantly less time waiting to be milked. This effect was not observed by increasing concentrate supplementation; instead an increase in milk yield per visit and per day was achieved.

Conclusions

Reducing milking frequency reduced time spent waiting to be milked, which may benefit lower ranking cows providing them with increased opportunities to access the AMS and also reduce time spent standing on hard surfaces, thereby enhancing cow welfare. This study demonstrated that by implementing appropriate settings on an AMS it is possible to achieve a milk yield response to concentrate

Table 1. Effect of milking permission on milk yield (MY), milking frequency (MF), milking interval (MI), milking duration (MD) and waiting time (WT) per day and per visit.[1,2]

	Milking permission per day								
	3.2				1.8				*P*-value
	HCHP	LCHP	Group		HCLP	LCLP	Group		
	LS Means	LS Means	LS Means	SE	LS Means	LS Means	LS Means	SE	
MY day^{-1} (kg)	16.6	14.9	15.7	0.2	16.0	14.1	15.0	0.2	0.002
MY visit^{-1} (kg)	8.4	7.8	8.1	0.2	11.5	10.7	11.1	0.2	<0.0001
MF day^{-1}	2.0	1.9	1.9	0.0	1.4	1.3	1.3	0.0	<0.0001
MI visit^{-1} (hrs)	10.9	12.4	11.6	0.3	16.2	16.9	16.6	0.3	<0.0001
MD day^{-1} (min)	10.9	10.2	10.5	0.1	8.9	8.2	8.6	0.1	<0.0001
WT day^{-1} (hrs)	1.9	2.4	2.1	0.1	1.5	1.6	1.6	0.1	0.003

[1] Least squares (LS) means and standard error (SE) are represented. Group denotes the combination of two treatments with respect to milking permission and concentrate supplementation.
[2] HCHP = high concentrate/high milking permission; LCHP = low concentrate/high milking permission; LCHP = low concentrate/high milking permission; LCLP = low concentrate/low milking permission.

Table 2. Effect of concentrate supplementation on milk yield (MY), milking frequency (MF), milking interval (MI), milking duration (MD) and waiting time (WT) per day and per visit.[1,2]

	Concentrate per day (kg)								
	3				0.84				*P*-value
	HCHP	HCLP	Group		LCHP	LCLP	Group		
	LS Means	LS Means	LS Means	SE	LS Means	LS Means	LS Means	SE	
MY day^{-1} (kg)	16.6	16.0	16.3	0.2	14.9	14.1	14.5	0.2	<0.0001
MY visit^{-1} (kg)	8.4	11.5	10.0	0.2	7.8	10.7	9.3	0.2	0.008
MF day^{-1}	2.0	1.4	1.7	0.0	1.9	1.3	1.6	0.0	0.022
MI visit^{-1} (hrs)	10.9	16.2	13.6	0.3	12.4	16.9	14.6	0.3	0.012
MD day^{-1} (min)	10.9	8.9	9.9	0.1	10.2	8.2	9.2	0.1	0.001
WT day^{-1} (hrs)	1.9	1.5	1.7	0.1	2.4	1.6	2.0	0.1	0.230

[1] Least squares (LS) means and standard error (SE) are represented. Group denotes the combination of two treatments with respect to milking permission and concentrate supplementation.
[2] HCHP = high concentrate/high milking permission; LCHP = low concentrate/high milking permission; LCHP = low concentrate/high milking permission; LCLP = low concentrate/low milking permission.

supplementation in the latter stages of lactation. This research suggests management strategies involving reduced milking frequency and increased concentration supplementation towards the latter stages of lactation, in an effort to maintain milk yield and reduce pre-milking waiting time.

References

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