International Conference of Agricultural Engineering
AgEng 2014 Zurich 6–10 July

Influence of Different Feeding Frequencies on the Rumination and Lying Behaviour of Dairy Cows

Anne Grothmann[1], Lara Moser[2], Franz Nydegger[1], Adrian Steiner[2], Michael Zähner[1]

[1] *Agroscope Reckenholz-Tänikon Research Station ART, Tänikon, CH-8356 Ettenhausen, Switzerland*

[2] *Ruminant Clinic, Vetsuisse Faculty, University of Berne, CH-3012 Berne, Switzerland*

Abstract

The purpose of this study was to analyse the effect that feeding at more frequent intervals with automatic feeding systems (AFS) had on the feed intake, feed ingestion behaviour, ruminating activity, lying times and lying duration of dairy cows. The trials took place on the experimental farm at the Agroscope Research Station in Tänikon, Switzerland. Six different feeding frequencies used in conjunction with an automatic feeding system supplied by the Finnish Pellon Group were examined with a view to determining their influence on animal behaviour.
The results showed that a high number of feed distributions had a significant influence on feed intake and no significant influence on either feeding and ruminating behaviour, or the lying behaviour of dairy cows.

Keywords: automatic feeding, feed intake, feeding behaviour, rumination, lying behaviour

Introduction

Automatic feeding of upgraded mixed rations and total mixed rations is gaining more and more importance in dairy-cattle farming. This feeding system makes it possible to implement a fully automatic distribution of the basic feed ration or mixed rations consisting of roughage and concentrates with the help of feeding belts and rail-mounted or self-propelled feeding robots. This means that different rations and more-frequent feed distribution are possible without increased working-time requirements or workload. More-frequent feed distribution is also said to ensure natural feeding behaviour and thus promote animal health.

The aim of the trial is to analyse the effect of increased feeding frequency on feed intake as well as on feed ingestion behaviour, ruminating activity, and lying times and duration.

Materials and methods

Feeding frequencies of one, two, six, eight, ten and twelve times daily in two trial sessions were compared. Once- and twice-daily feeding (FF1 and FF2) is the equivalent of using a diet feeder, and serves as a reference. Feeding twelve times a day (FF12) represents roughly the highest feed frequency, whilst the six (FF6) and eight times a day (FF8) are the most frequently used feeding frequencies in practice (GROTHMANN and NYDEGGER, 2009). With feeding ten times a day (FF10), a larger quantity of feed was distributed after each milking. According to previous studies, this corresponds to the feed ingestion behaviour demonstrated by cows when fed *ad libitum* in the housing system (SAMBRAUS, 1978).

Groups of animals comparable in terms of mean lactation number and day as well as milk yield were set up for trials using a 'crossover' design. Each trial block started with an introductory week aimed at habituating the animals to a change in feed-distribution system. Trial 1 with two, six and eight feed distributions a day took place in October and November 2010, whilst Trial 2 with one, ten and twelve feed distributions a day was held in February and March 2011.

In order to determine feed intake, the amount of feed left over from the upgraded mixed ration was weighed every 24 hours. The quantity of feed distributed was determined in the feeding system by means of automatically compiled lists. Together with daily dry-matter samples of the individual ingredients, the mixed ration and the feed residues, it was possible to calculate the daily feed intake. In addition, milk yield was recorded individually for each animal at each milking. On two days in each of the trial blocks, milk samples were taken from the animals involved in the trial with a view to determining the constituents of the milk.

To determine the influence of feeding frequency on feeding behaviour and ruminating activity, the ART-MSR noseband sensor was used (**Fehler! Verweisquelle konnte nicht gefunden werden.**). With this sensor, the movement of the cow's jaw causes a change in pressure in a silicone tube which is displayed on a logger with a frequency of 10 Hertz (NYDEGGER et al., 2011). This also makes it possible to record the number of chews per ruminal bolus in addition to the duration of rumination and feeding. Evaluation and classification of the sensor pressure data were undertaken using the RumiWatch System algorithm.

To enable lying behaviour to be recorded, an MSR logger was worn as a position sensor. The loggers were secured to the cannon bone of one rear leg using self-adhesive bandages (**Fehler! Verweisquelle konnte nicht gefunden werden.**). The measuring variable used was three-axis acceleration. The logger position was defined within a three-dimensional space at 30-second intervals. As part of an evaluation routine, standing and lying were calculated on the basis of the individual values. This allowed us to obtain information on the overall duration of lying, as well as on the number and start-times of the lying bouts and their duration.

Fig. 1: Cow with an ART-MSR noseband sensor (left) and position sensor (right)

Results

For FF2, the result was 16.6 kg of dry matter/animal/day. Feed intake with a feeding frequency of FF6 was 17.0 kg of dry matter per animal and day or, where FF8 was used, daily feed intake was 7.2 kg of dry matter per animal and day. With an increase in the number of feed distributions, feed intake was 600 g higher in terms of dry matter.
Where one-off feeding was the norm, the animals consumed a quantity of dry matter amounting to 20.0 kg of the mixed rations per animal and day. Where feed was distributed ten times daily, consumption per animal was 20.8 kg of dry matter; where twelve distributions were made per day, consumption fell to 20.7 kg of dry matter. The difference in consumption between once-daily and 12-times-daily feeding is 800 g of dry matter per animal and day. The effect of feeding frequency on feed intake was significant in both trials.

For the average daily duration of feeding and rumination for the various feeding frequencies, see Table 1. The frequency of feeding had a negligible effect on the duration of both feeding and rumination. Nevertheless, feeding tended to be protracted where a higher frequency of feeding was the norm, whilst the duration of rumination declined in most cases. The exception here was FF1. In any case, overall differences were slight. The longest duration of feeding observed here was in the case of FF10, and the longest duration of rumination was for FF6.

Table 1: Duration of feeding and rumination

Feeding frequencies	Duration of rumination [min / 24h]	Duration of feeding [min / 24h]	Chews/ruminal bolus [i]
FF2	486.5 ± 120.5	396.1 ± 61.3	54.1 ± 6.5
FF6	508.4 ± 97.2	402.7 ± 88.8	56.3 ± 5.7
FF8	473.8 ± 87.4	386.1 ± 63.9	54.1 ± 8.0
FF1	469.8 ± 93.3	398.2 ± 79.1	54.2 ± 7.5
FF10	478.5 ± 91.2	416.8 ± 67.8	55.1 ± 7.3
FF12	465.2 ± 69.3	424.1 ± 69.6	54.1 ± 6.8

The number of chews and the number of chews per bolus behaved in a similar manner to the duration of feeding and ruminating. Here too, the differences were not significant.

Frequency of feeding influenced the overall duration of lying over a 24-hour period (**Fehler! Verweisquelle konnte nicht gefunden werden.**). In Trial 1, the animals lay for 21 minutes longer than was the case with FF8 (total 733.4 minutes). Lying duration per bout was highest with FF6, and lowest with FF8 (78.0 minutes).
The animals which lay for longest were those in FF10 in the second trial (692.5 minutes). As regards one-off feeding, the animals averaged 677.1 minutes, whilst, in the case of FF12, lying duration fell to 656.3 minutes per day. In the same way, the lying duration per lying bout was longest in the case of FF10 and shortest with FF1.

Table 2: Resting behaviour

Feeding frequencies [n]	Lying duration [min / 24h]	Number of lying bouts [n / 24h]	Lying duration/lying bout [min]
FF2	733.4 ± 108.6	9.4 ± 2.7	84.2 ± 25.3
FF6	729.0 ± 93.1	8.4 ± 1.7	90.3 ± 19.2
FF8	712.1 ± 204.5	10.0 ± 4.4	78.0 ± 25.9
FF1	677.1 ± 126.2	9.2 ± 2.5	79.4 ± 25.6
FF10	692.5 ± 129.3	8.7 ± 2.5	85.8 ± 28.2
FF12	656.3 ± 126.5	8.7 ± 2.9	81.9 ± 26.8

There was hardly any change in the number of individual lying bouts, which was highest with one-off feeding and somewhat lower with higher feeding frequencies.

Discussion

In both trials, this was shortest with the highest feeding frequencies (FF8 and FF12), and longest for FF10. The number of lying bouts was at its highest for FF8, with ten lying periods per day. At the same time, however, six to eleven lying bouts per day were observed for dairy cows in other trials (DeVRIES et al., 2011; FRIEND et al., 1977; MATTACHINI et al., 2011; SAMBRAUS, 1978). At between 78.0 minutes for FF8 and 90.3

minutes for FF6, lying duration in relation to the various feeding frequencies varied by a maximum of 12.3 minutes. Trials conducted by DeVries et al. (2011), Friend et al. (1977) and Ito et al. (2009) resulted in lying times of between 80.1 minutes and 88.0 minutes per lying bout. This means that the current results are comparable with the results of other studies in terms of lying behaviour. Even the effect on the duration of feed intake and rumination was only slight. Numerous trials concerning feeding and rumination time for dairy cows gave feeding durations of 299.4 minutes to 330 minutes and ruminating times of 413 minutes to 511 minutes per day (DADO and ALLEN, 1993; FRIEND et al., 1977; HANCOCK, 1954; MATTACHINI et al., 2011; METZ, 1975). Similarly, the number of chews per bolus between feeding frequencies varied only to a very small extent.

Conclusions

The results show that a massive increase in feeding frequency from once a day to a total of twelve times daily had no significant effect on feed intake or on the behaviour of the cows. The only significant change was in the lying duration over 24 hours. It therefore appears that increasing the feeding frequency when automatic feeding systems are used is unlikely to have an acute effect on animal behaviour.

References

Dado, R. G.; Allen, M. S. (1993): Continuous Computer Acquisition of Feed and Water Intakes, Chewing, Reticular Motility, and Ruminal pH of Cattle. Journal of Dairy Science 76, pp. 1589-1600

DeVries, T. J.; Deming, J. A.; Rodenburg, J.; Seguin, G.; Leslie, K. E.; Barkema, H. W. (2011): Association of standing and lying behavior patterns and incidence of intramammary infection in dairy cows milked with an automatic milking system. Journal of Dairy Science 94, 8, pp. 3845-3855

Friend, T. H.; Polan, C. E.; McGilliard, M. L. (1977): Free Stall and Feed Bunk Requirements Relative to Behavior, Production and Individual Feed Intake in Dairy Cows. Journal of Dairy Science 60, 1, pp. 108-116

Grothmann, A.; Nydegger, F. (2009): Automatische Fütterung von Rindvieh - Ergebnisse einer Erhebung zum Stand der Technik (Automatic Feeding of Beef Cattle - Results of a Survey of State-of-the-Art Technology) Conference Proceedings, 9th Conference on Construction, Engineering and Environment in Livestock Farming 2009, (9. Tagung Bau, Technik und Umwelt in der landwirtschaftlichen Nutztierhaltung 2009) 21.-23.09.2009, Berlin, KTBL, pp. 280-285

Hancock, J. (1954): Studies of grazing behaviour in relation to grassland management. 1st Variation in grazing habits of dairy cattle. J. Agric. Sci., Cambridge, 44, pp. 420-433

Ito, K.; Weary, D. M.; von Keyserlingk, M. A. G. (2009): Lying behavior: Assessing within- and between-herd variation in free-stall housed dairy cows. Journal of Dairy Science 92, 9, pp. 4412-4420

Mattachini, G.; Riva, E.; Provolo, G. (2011): The lying and standing activity indices of dairy cows in free-stall housing. Applied Animal Behaviour Science 129, 1, pp. 18-27

Metz, J. H. M. (1975): Time patterns of feeding and rumination in domestic cattle. Dissertation, Veenman, Wageningen
Nydegger, F.; Keller, M.; Gygax, L.; Egli, W. (2011): Ruminating sensor for dairy cows: Automatic recording of mastication and feeding activity for purposes of health monitoring ART-Bericht 748, p. 1-8

Sambraus, H. H. (1978): Farm Animal Ethology 1. ed., Paul Parey Publications, Berlin