

## **Automatic milking and grazing in dairy cattle: effects on behaviour**

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### **Abstract**

Milking dairy cattle with an automatic milking system (AMS) can be a reason for a farmer to minimize pasture time during the grazing season, since it is assumed that it may lead to a decrease in use of AMS capacity and an increase in labour required for fetching cows with long milking intervals from pasture. Previous research in The Netherlands showed that grazing in combination with automatic milking can be successful under various management conditions. Knowledge about cow behaviour may reveal useful information in this respect. The aim of this research was to study the effect of grazing combined with automatic milking on the potentially relevant behavioural aspects of a dairy herd.

A commercial herd of about 60 cows was observed before and during the grazing seasons of 2001, 2002 and 2003. The cows were milked by an AMS which was introduced in September 2000. Access to pasture was restricted and regulated by a selection gate. Locations in the barn and at pasture and standing/lying positions were observed during 48 h periods using scan sampling with 15 min intervals.

Herd behaviour as well as behaviour of 10 selected individual cows showed comparable results. The mean percentage of cows in the AMS was lower during the grazing season than at the end of the winter season, although it was on an acceptable level. No significant differences were found for mean presence in the waiting area in front of the AMS or for the total lying behaviour. These results apply to the management practices used at the farm. Further research on the effect of grazing systems, pasture distances, fetching regimes, cow traffic systems or occupancies of the AMS and their interaction on herd and individual level is needed to optimise the management of dairy cattle offered grazing combined with automatic milking.

### **1. Introduction**

In The Netherlands as well as in other European countries (for example Denmark, Sweden) the number of automatic milking systems (AMS) replacing a conventional milking parlour on dairy farms is increasing substantially. It is often assumed that grazing does not combine well with automatic milking, since it may lead to a decrease in use of capacity of the AMS and an increase in labour required for fetching cows with long milking intervals from the pasture site. However, cow health and welfare as well as the 'green' public image of the dairy industry benefit from giving dairy cattle the opportunity for grazing (see references in Ketelaar-de Lauwere et al., 1999). Therefore, more information on how to combine the use of an AMS with grazing is needed. On experimental scale (24 cows) Ketelaar-de Lauwere et al. (1999) found that grazing combined with use of an AMS on a voluntary basis was possible for restricted -, zero -, and unrestricted grazing. In an observational study involving 25 Dutch dairy farms it was found that grazing in combination with automatic milking is possible under various management conditions while other farmers are less successful (Ruis-Heutinck et al., 2001). Information about herd and individual cow behaviour on commercial dairy farms combining automatic milking with grazing is lacking, however, although this knowledge may reveal which management

practices may be successful and which not. The aim of this research was to study the effect of grazing combined with automatic milking on the potentially relevant behavioural aspects of a dairy herd.

## 2. Material and Methods

### 2.1 Animals, housing and management

The animals were part of a commercial herd of about 60 dairy Holstein Friesian cows at the experimental dairy farm Nij Bosma Zathe in The Netherlands. The lay-out of the housing facility is shown in figure 1. At Nij Bosma Zathe an AMS was introduced in September 2000. In the following 3 grazing seasons (2001, 2002 and 2003) a study of the behaviour of the herd and 10 selected cows within this herd was carried out. The selection of individual cows was semi-random, based on lactation number (1, 2 and 3-or-more) and lactation stage. The latter varied from zero up to about 5 months at the start of the first observation each year.

The cows were milked with a two-units-in-row Galaxy AMS. The minimum milking interval was set at 6, 8 or 10 h depending on production level and days in lactation. In 2001 and 2002 (except for the last observation period) a one-way cow routing system was used, i.e. cows had access to the feeding gate only by passing the AMS. In 2003 free cow traffic was used. Concentrates were supplied in the AMS and in a concentrate feeder (with entrance in the feeding compartment). Maize silage was supplied in the morning and in the late afternoon in 2001 and 2002. In 2003 the supplied roughage was a mixture of grass and maize silage. On average an amount of 7.5 kg dry matter roughage per cow per day was available at the feeding gate. Water was available in two water troughs located at opposite sides of the barn, and at the entrance of the pasture site.

Figure 1 Barn lay-out at Nij Bosma Zathe

### 2.2 Pasture

Pasture sites (about 4 ha each) were located with distances ranging from 50 to 800 m from barn to pasture entrance. Access to the pasture site was regulated by a selection gate at the entrance of the barn. When milking intervals were within two hours before the end of the minimum milking interval, access to pasture was denied. A restricted daytime grazing system was offered (the selection gate allowed cows to go to pasture between 6 am and 5.30 pm) with fetching of the cows at about 8 pm except for the last observation period of 2003 when cows had 24 hour access to pasture. Cows were fetched at 6 am and 4 pm in this system. Sward height varied between the observation periods.

### 2.3 Behavioural observations

In each year the first observation period was scheduled 2-3 weeks before the grazing season started to obtain the behaviour of the animals without having access to pasture as a starting point. During the grazing season 3-4 observation periods were scheduled with intervals of 4 to 8 weeks. Direct observations were conducted during 48 hours using the scan sampling method (Altmann, 1974) with 15 min intervals. Usually one person observed during 8 hours, followed by the next person. In some cases when pasture distance was large or the herd was spread out over pasture as well as in the barn, observations were carried out by two people. All observers were instructed at the beginning of each observation period to minimize subjectivity.

Location of animals and standing or lying position were observed. Locations in the barn were: in the AMS, in the waiting area, in the feeding compartment, at the feeding gate, at the concentrate feeder, by the water troughs, within the first five cubicles on each side near the waiting area, within other cubicles, in the corridor of the lying compartment and the selection gate (see figure 1). The waiting area was defined as the corner area near the AMS entrance. In a pilot observation it was found that in some occasions cows seemed to be part of (and close to) the group waiting for the AMS but not standing in the defined waiting area. It was decided to count those cows as if they were in the waiting area. It also became clear that sometimes cows used the first five cubicles near the AMS to stand in while waiting. Therefore standing (and lying) in these cubicles was scored separately from standing and lying in the other cubicles in the barn. In the analysis it was added to the scores in the waiting area and labelled 'extended waiting area'.

Locations outside the barn were the path to the pasture site, an area of about 10 m around the water trough at the pasture entrance and the pasture site.

All behavioural elements were observed at herd level as well as at individual level. At herd level the number of animals per behavioural element was scored, at individual level the element itself was recorded.

#### 2.4 Technical data

Herd size, average number of AMS visits, pasture time and frequency of going to pasture was recorded by the AMS (and selection gate) management software.

Numbers of fetched cows were recorded by the farm manager daily.

#### 2.5 Analysis and presentation of the results

Behavioural data were analyzed with Genstat (Genstat, 1993). Number of scores per behavioural element or per cow and total number of scores were used in the analysis. Predicted means and standard deviations of these traits were first calculated under the assumption of being normally distributed. The presented percentages represent the mean duration of the behavioural elements per day, as well as the relative number of cows per behavioural element. Differences between percentages of the first observation period (referred to as winter season) and the observation periods during the grazing season were analyzed over years ( $n=3$  for the winter season and  $n=10$  for the grazing season) and per year ( $n=1$  vs.  $n=3$ , 4 and 3 for 2001, 2002 and 2003, respectively for the winter season vs. the grazing season) using the GLM procedure. No block-effect for year was found.

### 3. Results

#### 3.1 Time budget

The number of cows in the herd was 61, 56 and 68 respectively in 2001, 2002 and 2003 in the winter season and on average 59, 62.1 and 63.1 respectively in the grazing season.

The average number of fetched cows during the restricted grazing periods (all except the last period in 2003) was 16.8, ranging from 0-38, and average pasture time of the herd was 7.7, 7.3 and 7.3 hr in 2001, 2002 and 2003, respectively. The average pasture time of the selected cows was 7.5, 7.2 and 7.6 h in 2001, 2002 and 2003, respectively. The average daily frequency of going to pasture was 1.1 in all 3 years. Table 1 shows the mean time budget of the herd in the winter and the grazing season. The time budget of the individual selected cows was comparable with that of the total herd.

Table 1 Mean time budget (%) of the herd in the winter and grazing season

### 3.2 Use of AMS and waiting area

Table 2 shows the mean percentage of the herd in the AMS and waiting area during the winter and the grazing season in 2001, 2002 and 2003. The mean percentage of cows on herd level in the extended waiting area was on average 2% higher than in the waiting area.

Table 2 Mean percentage of the herd in the AMS and waiting area during the winter and grazing season in 2001, 2002 and 2003

Over years the mean percentage of cows in the AMS was significantly higher in the winter season than in the grazing season ( $2.3 \pm 1.2$  vs.  $2.0 \pm 1.4\%$ , respectively;  $P < 0.001$ ). No difference was found for mean presence in the waiting area (respectively  $3.5 \pm 2.9$  vs.  $2.9 \pm 3.6\%$ ;  $P > 0.05$ ). Interactions between year and winter/grazing season were not statistically identified.

The mean percentage of 2.3 vs. 2.0 in the AMS equals a mean of 1.4 vs. 1.2 cows and a total of 17.0 vs. 14.7 hr occupancy of the AMS per unit per day. The mean percentage of 3.5 vs. 2.9 in the waiting area equals a mean of 2.2 vs. 1.8 cows and 50.4 vs. 42.0 min per cow per day.

Data from the AMS showed on average 2.9 and 2.7 milkings per cow per day in the winter season and in the grazing season, respectively. The AMS visiting frequency of the selected cows was in agreement with those on herd level.

During the winter season a peak in mean percentage of cows in the waiting area or visiting the AMS was seen between 7-9 am. In the grazing season no clear peak could be found, but there was an off-peak in AMS visits in the afternoon (between 1-3 pm).

### 3.3 Lying behaviour

Table 3 shows the mean lying behaviour during the winter and the grazing season in 2001, 2002 and 2003. Although not statistically proven, it is interesting to notice the decrease in mean percentage of lying in cubicles in 2003 in favour of lying at pasture. The mean percentage of lying in the cubicles was significantly different ( $P < 0.05$ ) between the winter and grazing season. The sum of the lying duration in cubicles and at pasture did not differ ( $P > 0.05$ ) between seasons on herd level as well as on selection level.

Table 3 Mean lying behaviour during winter and grazing season in 2001, 2002 and 2003

## 4. Discussion

The first observation, referred to as in the winter season, was usually carried out in April/May. In the first experimental year (2001) it was delayed because of the occurrence of Foot and Mouth Disease in The Netherlands till mid June.

On herd level 2.3% of the cows was in the AMS in the winter season compared to 2.0% in the grazing season. This equals 1.4 vs. 1.2 cows or an occupancy of 17.0 vs. 14.7 h per day of the AMS in the winter vs. the grazing season. This indicates that in the system used (2-units-in-row) there was sufficient free time. The difference in

mean percentages between winter and grazing season was in agreement with the AMS data on milking frequencies.

During the winter season cows spent on average 3.5% of their time in the waiting area. In the grazing season this was less, although not significantly. It equalled 50.4 min in the winter season compared to 42.0 min in the grazing season. In the grazing season the number of AMS visits was less than in the winter season, which probably caused this difference. Another reason may have been the forced cow traffic in 2001 and partly in 2002. To get to the feeding gate the cows had to pass the waiting area and the AMS first. In 2003 there was free cow traffic within the barn. Cows were free to move from the lying compartment to the feeding compartment and vice versa, or to go to pasture when milking intervals allowed them to. The mean percentages of lying in cubicles and at pasture in 2001, 2002 and 2003 indicate that with free cow traffic cows seem to prefer lying at pasture, as is found by Ketelaar-de Lauwere et al. (1999). The total mean lying percentage did not differ between winter and grazing season. It was within the range mentioned in other studies (Albright and Arave, 1997, and references therein). Durations of 10.1 to 12.5 h for lying at pasture compared to in a barn were seen. The mean percentage in our study (45.7 vs. 43.7% in the winter vs. the grazing season equals 11.0 vs. 10.5 h lying per day, respectively.

## 5. Conclusions

Herd behaviour as well as behaviour of the selected individual cows showed comparable results. There was a difference in mean percentage of cows in the AMS between the winter and grazing season: it was significantly lower but still on an acceptable level during the grazing season. No significant differences were found for mean presence in the waiting area in front of the AMS or for the total lying behaviour. Cow behaviour was not affected dramatically over the grazing seasons. However, these results apply to the management practices described. Further research on the effect of grazing systems, pasture distances, fetching regimes, cow traffic systems or occupancies of the AMS and their interaction on herd level as well as individual level is needed to optimise the management of dairy cattle offered grazing combined with automatic milking.

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## References

- Albright, J.L. and C.W. Arave, 1997. The behaviour of cattle. CAB International, Oxon UK, p. 38.
- Altmann, J., 1974. Observational study of behaviour: sampling methods. *Behaviour* 49: 229-267.
- Genstat 5 Committee, 1993. Genstat 5 reference manual; version 3. Clarendon Press, Oxford, 796 pp.
- Ketelaar-de Lauwere, C.C., A.H. Ipema, E.N.J. van Ouwerkerk, M.M.W.B. Hendriks, J.H.M. Metz, J.P.T.M. Noordhuizen and W.G.P. Schouten, 1999. Voluntary automatic milking in combination with grazing of dairy cows; milking frequency and effects on behaviour. *Applied Animal Behaviour Science* 64: 91-109.

Ruis-Heutinck, L.F.M., H.J.C. van Dooren, A.J.H. van Lent, C.J. Jagtenberg & H. Hogeveen, 2001. Automatic milking in combination with grazing on dairy farms in The Netherlands. In: J.P. Garner, J.A. Mench and S.P. Heekin (Eds.), Proceedings of the 35<sup>th</sup> International Congress of the ISAE, The Center for Animal Welfare at UC Davis, Davis (CA), USA, p. 188.

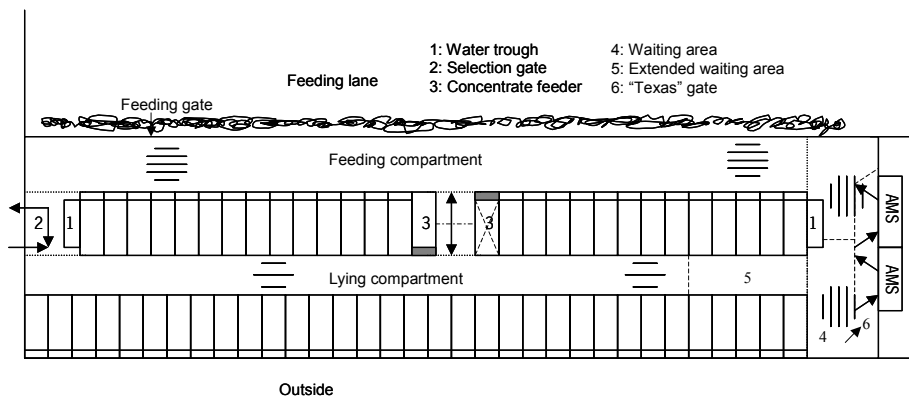


Figure 1 Barn lay-out at Nij Bosma Zathe

Table 1 Mean time budget (%) of the herd in the winter and grazing season

	Winter season	Grazing season
AMS	2.3	2.0
Waiting area	3.5	2.9
Standing in feeding area	7.2	4.1
Near roughage/concentrate/water	21.7	10.6
Standing in lying area outside cubicles	5.5	3.5
Standing in cubicles	14.1	12.1
Lying in cubicles	45.7	30.8
Standing/walking at cow path	0	1.1
Standing in the pasture	0	20.0
Lying in the pasture	0	12.9
TOTAL	100	100

Table 2 Mean percentage of the herd in the AMS and waiting area during the winter and grazing season in 2001, 2002 and 2003

Location	Winter season		Grazing season	
	Mean %	S.d.	Mean %	S.d.
AMS 2001	2.4	1.2	2.1	1.4
AMS 2002	2.6	1.4	2.0	1.3
AMS 2003	2.0	1.2	2.0	1.8
Waiting area 2001	2.9	3.0	3.6	4.7
Waiting area 2002	3.6	3.1	2.3	2.6
Waiting area 2003	4.0	2.4	3.0	3.5

Table 3 Mean lying behaviour during winter and grazing season in 2001, 2002 and 2003

	Winter season		Grazing season	
	Mean %	S.d.	Mean %	S.d.
Lying in cubicles 2001	43.0	3.5	33.4	4.9
Lying in cubicles 2002	47.7	3.0	32.7	5.0
Lying in cubicles 2003	46.3	3.9	25.4	4.7
Lying at pasture 2001	-	-	11.3	2.5
Lying at pasture 2002	-	-	9.6	2.2
Lying at pasture 2003	-	-	18.8	3.8

