Comparison of feeding time in barn and pasture under a given grass allowance in a system with robotic milking and strip grazing by using collected sensor data

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Abstract

In the Autograssmilk project funded by the EU-FP7 programme an experiment was conducted with the objective to study the potential of using new technologies for the optimisation and integration of automatic milking with cow grazing. Data were collected during the 2014 grazing season from a 60-cow herd. The herd was kept in the barn during the night (16:00-6:00) where 8.4 kg dry matter (DM) per cow per day of conserved forage was fed. During the day (6:00-16:00) the herd had access to a strip of grass with approximately 8 kg DM per cow per day. Cows were free to return to the barn for visiting the milking robot. Automatic milking-system visits and milk yields were collected per cow. The average milk yield was 26.1 kg milk per cow per day. Feeding time was measured with a sensor attached to the neck of each cow. The cows spent an average of 346 minutes per day for feeding/grazing. For forage fed in the barn, cows spent an average of 6.7 minutes feeding time per kg of milk, while for grazing 8.8 minutes per kg of milk was spent. Older cows were significantly more efficient than heifers in their feeding time in the barn, whereas for grazing the differences were smaller.

Keywords: grazing, sensor, feeding, milking robot

Introduction

Partly due to the increased use of automatic milking systems in the dairy sector of the EU, grazing of cows is decreasing (Van den Pol-van Dasselaar *et al.*, 2008). However, it is seen as desirable by both society and science that cows spend the summer in the pasture, as this increases animal health, improving, for example, hoof and leg condition (Autograssmilk, 2014). Additionally, cows can express normal behaviour on pasture which also increases their welfare. The EU-supported Autograssmilk project has the overall aim to stop the decline in grazing. For this purpose this project also pays attention to possibilities of new technologies on behalf of animal and grassland management when combining automatic milking and grazing. In this paper the main focus will be on feeding information collected with a commercial sensor; the objective is to study the effect of lactation number and lactation stage on feeding time and efficiency. If effects are clear, a next step could be the implementation of sensor techniques in daily grassland management.

Materials and methods

On the 'Dairy Campus' experimental farm in Leeuwarden, the Netherland, milking, feeding and grazing information was gathered for a herd of 60 cows. This herd was milked with a DeLaval automatic milking system located in a barn with cubicles, feeding fence and concentrates feeding station. The herd was kept in the barn during the night (16:00 till 6:00) and fed with 8.4 kg dry matter (DM) of conserved forage (mixture of 30% grass and 70% maize silage on DM basis) per cow per day. In the milking robot or in a concentrate feeding station located in the barn, cows received additional concentrates on an individual basis. The herd had access to a pasture between 6:00 and 16:00. Starting from 6:00, cows that were recently milked could leave the barn to graze. Cows in the pasture were free to return to the barn for visiting the milking robot, concentrate feeder or water trough. At 12:00, cows that not returned to the

barn voluntarily were then fetched. The cycle was repeated for an afternoon grazing session. Cows still in the pasture at 16:00 were fetched to the barn.

In the pasture a strip of grass was made available for grazing twice a day (in the morning and afternoon). The size of the strips was attuned to the grass height and the number of cows so that about 8 kg of DM were available per cow and per day.

Individual cow data regarding milk production (yield and frequency) were collected at the automatic milking system. Feeding information was collected by a sensor (Nedap, 2014) on the neck of each animal. The sensor determines feeding (grazing) time in 15-min periods.

Milking and feeding data collected during the experiment were summarized for further processing in terms of average values per cow and per week of lactation. For analysing the feeding efficiency, feeding time was expressed in minutes per kg of produced milk. Data originate from a total of 68 cows (22 in 1st, 17 in 2nd and 29 in 3rd or higher lactation) and 657 weeks of lactation (approximately 10 weeks of lactation per cow). The effects of the fixed interaction terms 'lactation number' and 'lactation stage' on milk and feeding parameters were analysed by the REML algorithm using GenStat® Release 13 (Payne *et al.,* 2013). Cow number and week of year were used as random model terms.

Results and discussion

The predicted mean milk yield was 26.1 (standard error (s.e.) 0.90) kg per cow per day. As could be expected, milk yields differed between lactation numbers and lactation stages (Table 1). In automatic milking, daily milking frequencies could potentially affect milk yields. In this research milking frequencies did not differ between lactation numbers. Nevertheless, milking frequencies were, across all lactation numbers, significantly lower with advancing lactation stage. The predicted mean for total feeding time was 346 (s.e. 9.2) minutes per cow per day; for feeding time during the day (grazing) and feeding time during the night (in the barn) these figures were respectively 198 (s.e. 6.7) and 149 (s.e. 5.2) minutes per cow per day. Table 1 shows that total feeding time and feeding time at night in the barn were in general significantly shorter for older cows (in 3rd or higher lactation). The effects of lactation stage on total feeding time were small. Differences in grazing times (pasture) between lactation stages and lactation numbers were even smaller.

On average, cows needed 15.5 (se. 0.70) minutes feeding time per kg of milk. In the barn where conserved forages were fed, cows spent, on average, 6.7 minutes feeding time per kg of milk, while for grazing they spent 8.8 minutes per kg of milk. In all the lactation stages the older cows (3rd or higher lactation) were significantly more efficient than younger cows. Differences in feeding time per kg of milk between heifers and older cows were larger in the barn, where a silage mixture was fed, than with grazing in the pasture. In the barn the feeding time per kg of milk for the older cows was about 50% of the heifer feeding time; in the pasture the grazing time for the older cows amounted 60% of the heifer grazing time.

Conclusions

Especially for the high yielding dairy cows, grazing requires greater effort to provide sufficient feed for a high production. This research demonstrated that it is easier for the cows to consume food at the feeding gate rather than gathering their feed by grazing. In grazing, cows needed about 30% more time for feeding.

Table 1. Predicted means for effects of lactation number and lactation stage on feeding and milking parameters of cows in a strip-grazing regime.

Parameter	Lactation number[1]	Lactation stage (d)[2]		
		<100	100-200	200-300
Milk yield (kg per day)	1st	22.3^{A}	21.3^{A}	20.1^{A}
	2nd	28.6^{Ba}	27.0^{Ba}	23.54^{Ab}
	3rd or higher	32.8^{Ca}	30.2^{Bb}	29.4^{Bb}
Total feeding time (minutes per day)	1st	348^{Aa}	361^{Aab}	373Ab
	2nd	359^{A}	371^{A}	365^{AB}
	3rd or higher	298^{Ba}	306^{Ba}	336^{Bb}
Feeding time day (grazing) (minutes per day)	1st	186^{a}	193^{ABab}	212^{b}
	2nd	195	216^{A}	215
	3rd or higher	177^{a}	184^{Ba}	203^{b}
Feeding time night (barn) (minutes per day)	1st	163^{A}	169A	163A
	2nd	161^{A}	157^{A}	152^{AB}
	3rd or higher	122^{Ba}	122^{Ba}	134^{Bb}
Total feeding time per kg milk (minutes per day)	1st	16.37^{Aa}	19.89^{Ab}	23.09^{Ac}
	2nd	13.24^{Aa}	13.81^{Ba}	20.42^{Ab}
	3rd or higher	9.45^{Ba}	10.65^{Ca}	12.52^{Ba}
Feeding time day per kg milk (minutes per kg)	1st	8.80^{Aa}	10.69^{Ab}	13.09^{Ac}
	2nd	7.25^{ABa}	7.85^{Ba}	12.17^{Ab}
	3rd or higher	5.57^{Ba}	6.30^{Bb}	7.46^{Bb}
Feeding time night per kg milk (minutes per kg)	1st	7.58^{Aa}	9.14^{Ab}	9.95^{Ab}
	2nd	5.95^{Ba}	6.00^{Ba}	8.20^{Bb}
	3rd or higher	3.91^{Ca}	4.30^{Ca}	4.94^{Cb}

[1] Different uppercase letters within the same parameter column mean a significant difference ($P<0.05$).

[2] Different lowercase letters within the same parameter row mean a significant difference ($P<0.05$).

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