Application of a neck-collar mounted sensor for recording feeding and grazing behaviour

Anwendung eines Halsbandsensors zur Erfassung von Fress- und Graseverhalten

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Summary

During the grazing season 2014 a herd consisting of 60 HF/FH cows, milked with an automatic milking system, was subjected to a strip grazing regime on the experimental research station Dairy Campus in Leeuwarden, The Netherlands. During part of the day cows had access to pasture for grazing. The main focus of the research was on the application of a commercial sensor for registration of eating and grazing time (Nedap, Smarttag Neck). The sensor recordings during grazing in pasture and eating at the feeding gate in the barn showed good similarities with 10-min scan observations. For grazing the correlation between the sensor recorded eating time and the observed eating time was 98 %. For eating at the feeding gate in the barn the correlation was 84 %, which was very likely due to a lower accuracy of the 10-min scan observations.

Eating sensor data from all cows showed a mean daily eating time of 5.75 hrs per cow per day, 3.29 hrs thereof were spent with grazing and 2.47 hrs with eating at the feeding fence in the barn. Older cows (3rd of higher parity) had significantly lower eating times than younger cows (parity 1 and 2). These differences were mainly caused by the eating times at night in the barn; grazing times differed less between parities.

Zusammenfassung

Auf dem Versuchsbetrieb „Dairy Campus“ in Leeuwarden (Niederlande) erhielt eine Herde, bestehend aus 60 HF-Kühen, die mit einem automatischen Melksystem (AMS) gemolken wurde, täglich für eine bestimmte Zeit Zugang zur Weide. Die Zuteilung der Weide erfolgte im Rahmen einer Portionsweide. Das Hauptaugenmerk der Untersuchung lag auf der Anwendung des handelsüblichen Sensors (Nedap, Smarttag Neck) zur Erfassung der Fress- und Grasedauer. Die Sensordaten zeigten während der Beweidung und dem Fressen am Fressgitter im Stall gute Übereinstimmungen mit den 10-Minuten-Beobachtungen. Bezüglich des Graseverhaltens lag die Korrelation zwischen der mit dem Sensor erhobenen und der beobachteten Grasedauer bei 98 %. Im Hinblick auf die Futteraufnahme am Fressgitter im Stall konnte eine Korrelation von 84 % berechnet

werden, wobei dies sehr wahrscheinlich mit einer geringeren Genauigkeit der 10-Minuten-Beobachtungen zusammenhängt.

Im Mittel lag die tägliche Fressdauer laut Sensordaten bei 5,75 Stunden pro Kuh und Tag, 3,29 Stunden für das Grasen und 2,47 Stunden für die Futteraufnahme am Fressgitter. Ältere Kühe (3. oder höhere Laktation) fraßen signifikant kürzer als junge Kühen (1. und 2. Laktation). Die Ursache hierfür lag vor allem an den nächtlichen Fresszeiten, die Grasedauer variierte weniger zwischen den Altersgruppen.

1 Introduction

Partly due to the increased use of automatic milking systems (AMS) 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. For economic reasons a high milk production per cow is desired. That is only possible if the cows consume sufficient high quality feed. In order to achieve high productions also a good health status of the cows is a prerequisite. Health problems may arise if the animal is not able to meet the needs arising from the realized milk production. It is therefore desirable to get an indication of the recorded feed quantities in an as early as possible stage. In practice it is technically and economically not feasible to register the feed intake of individual animals. For research purposes a few systems are available with which eating and grazing durations per cow can be captured (Bikker et al. 2014, Nielsen 2013, Ueda et al. 2011, Nydegger et al 2010). A new sensor, the Nedap Smarttag Neck (Nedap 2014), was introduced in practice in 2013. The application of this commercial sensor for registration of eating and grazing time is evaluated in this paper.

2 Materials and methods

2.1 Daily milking and eating (grazing) management

During the summer of 2014 a herd consisting of in average 60 HF/FH dairy cows was subjected to a strip grazing regime on the experimental research station Dairy Campus in Leeuwarden, The Netherlands. This herd was milked with a DeLaval automatic milking system (VMS) located in a barn with cubicles, feeding fence and concentrates feeding station.

The herd was kept in the barn during the night (17:00 h till 6:00 h) and fed with 8.4 kg dry matter conserved forage (mixture of grass and maize silage) per cow and day. This feed was available from 17:00 h. Any feed remains at the feeding fence were removed at 6:00 h. Starting from 6:00 h, cows that were recently milked, could leave the barn to graze. The distance from barn exit to the pasture strips varied between 150 and 750 m. Cows in pasture were free to return to the barn for visiting milking robot, concentrate feeder or water trough, and the cycle repeated. Twice a day, at 6:00 and 12:30 h a new strip of grass was made available in the pasture. 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. Cows still in the pasture at 17:00 h were fetched to the barn for the night. In the milking robot or in a concentrates feeding station in the barn cows received additional concentrates on an individual basis.

All individual cow data regarding milk production (yield and frequency) were recorded by the VMS. Eating behaviour data were recorded with the Smarttag Neck sensor system. Information collected by the sensor is made available for daily management. This covers both information on herd and individual animal level.

2.2 Evaluation of the Smarttag Neck sensor

The Smarttag Neck system registers the position and movements of the head of an animal by a sensor at the neck of the animal. The sensor consists of a 3d accelerometer, which provides data on head position (height) and movement. This information is used by software in the tag that estimates the time spent eating for each 15 min period in 24 hours. The most recent 24 hour data (96 quarters) is sent to the base station and process controller every 15 minutes, which, assuming the animal is within tracking distance at least once daily, produces continuous data sets. These are further analysed and used to inform the farmer about deviations in eating behaviour. For proper operation, the tag should hang below the neck, attached to a collar that is applied snugly to the neck. The process controller in the tag will provide a warning if it is applied incorrectly or shifts to a poor position.

The sensor system was evaluated during grazing as well as during eating at the feeding fence by recording the behaviour of 20 cows with 10 minute scan observations.

Grazing observations were carried out during 7 three-hour-periods in the morning (from 8:00 till 11:00 h) and 4 three-hour-periods in the afternoon (from 13:00 till 16:00 h). The distinguished behaviours in the pasture were “grazing”, “lying”, “standing” or “walking”.

The observations in the barn took place in 4 two-hour-periods and 1 three-hour-period all between 17:00 and 20:00 h. In the barn the recorded behaviours were “at feeding fence” (cow stayed with head through feeding fence), “in concentrate feeding station”(cow stayed in feeding station) and “in VMS” (cow stayed in VMS); all other behaviours were recorded as “others”. The behavioural information obtained during the various periods of observation in the pasture as well as the barn was merged per cow. Information about the grazing or eating time during the same observation periods were obtained from the Smarttag Neck sensor system and also merged per cow. Multiple regression analyses were run (GenStat Seventeenth Edition, VSN International Ltd.) to find out which variables statistically significantly predicted sensor eating time. The tested variables for eating time in the pasture were grazing, lying, standing or walking and for eating in the barn staying at feeding fence, in concentrate feeding station or in VMS.

2.3 Analysis of milk yield and eating time

Effects of parity on milk yield, milking frequency eating time (grazing in pasture and eating at feeding fence) were analysed. Data originated 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 term "parity" on milk and eating parameters were analysed by the REML algorithm using GenStat Seventeenth Edition, VSN International Ltd. Cow number, lactation stage and week of year were used as random model terms.

3 Results

3.1 Evaluation of the Smarttag Neck sensor

Table 1 gives an overview of the mean behaviour results of 20 cows for pasture and barn observations based on 10 min scans; feeding time information recorded by the sensor is given in the last column.

Tab. 1: Means of behaviour of cows (20) during observations in pasture and barn
Tab. 1: Mittelwerte des Verhaltens der Kühe (20) während Beobachtungen auf der Weide und im Stall

Location	Duration obs. [min]	% grazing	% lying	% standing	% walking	% eating (sensor)
Pasture	1236	43.1	33.9	19.2	3.7	44.7

Location	Duration obs. [min]	% at feeding fence	% in feeding station	% in VMS	% eating (sensor)
Barn	633	48.3	1.7	1.7	47.0

The 10-minute scan observations in the pasture were in total carried out during 11 three-hour-periods. The total duration of all observation periods was 33 hours or 1980 minutes. During these periods the cows were more or less free to choose between pasture and barn. This meant that not always all 20 cows, that potentially could be observed were present in the pasture during the observation periods. In average cows were during 62 % (1236 minutes) of the observation time present in the pasture. The total period a cow was observed varied between 610 and 1660 minutes.

The overall mean of the duration of the observations in the barn was 633 minutes; 16 cows were present during all observation periods (660 minutes) and 4 cows were missing during the last 3-hour-observation period (left the herd) resulting in a total observation duration of 480 minutes.

During the pasture observations cows spent in average 43.1% of the time or 539 minutes grazing. This is about 3% less than the mean eating time of 557 minutes recorded by the sensors. During the barn observations cows were staying at the feeding fence for in average 48.3 % of the time or 305 minutes. The mean eating time recorded by the sensors was 296 minutes. So in the barn the observed eating time was 3 % higher.

For the pasture data a multiple linear regression (GenStat Seventeenth Edition, VSN International Ltd.) showed that the terms lying, standing and walking time as well as the constant did not add significantly (p > 0.1) to the prediction. The only significant term left was grazing time with an estimated coefficient of 1.0268 (p < 0.001). The final model accounted for 95.2 % of the variance.

For the barn data a multiple linear regression showed that the terms staying in concentrate feeding station or in VMS as well as the constant did not add significantly (p > 0.1) to the prediction. Staying at the feeding fence was the only significant term with an estimated coefficient of 0.9564 (p < 0.001). The final model accounted for 71.3 % of the variance.

3.2 Feeding time management information

As an example the eating (grazing) pattern of cow NL 485623206 on August 13, 2014 is shown in Figure 1.

On August 13 this cow spent four rather long periods grazing; in the barn the time spent eating was much lower. This information from each individual cow is in real time available for the farmer. Also graphical presentations of total daily eating times of individual cows in the last 10 days in comparison with the herd average can be displayed as management information.

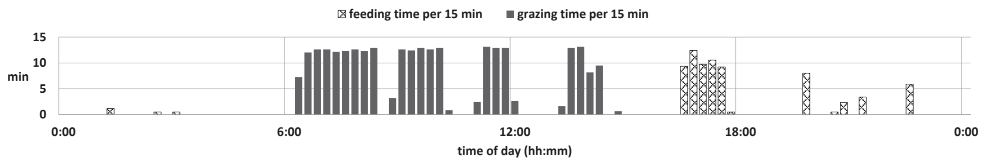

Fig. 1: Feeding (grazing) pattern of cow NL 485623206 during August 13, 2014
Fig. 1: Fress(Weide)verhalten der Kuh NL 485623206 am 13. August 2014

3.3 Milk yield and eating/grazing time

The predicted mean milk yield was 26.0 (s.e. 0.90) kg per cow per day. As could be expected, milk yields differed between parities (Tab. 2).

Tab. 2: Effect of parity on milking and feeding parameters of cows in a stripgrazing regime
Tab. 2: Effekt der Parität auf Melk- und Fressparameter der Kühe in einer Portionsbeweidungstrategie

Parameter	Parity		
	1	2	≥ 3
Milk yield [kg/d]	20.9[a]	26.3[b]	30.8[c]
Milking frequency [milkings/d]	2.42	2.31	2.41
Total eating time [h/d]	5.99[a]	6.07[a]	5.19[b]
Eating time day [h/d]	3.28[ab]	3.46[a]	3.12[b]
Eating time night [h/d]	2.72[a]	2.61[a]	2.08[b]

a, b, c: different letters within the same parameter row mean a significant difference (*P* < 0.05)

In automatic milking, daily milking frequencies could potentially affect milk yields. In this research milking frequencies did not differ between lactation numbers. The predicted mean for total eating time was 5.75 (s. e. 0.151) hrs per cow per day. The total eating time was significantly lower for cows in 3rd or higher parity (Table 2); first and second parity cows did not differ significantly. For eating time during the day (grazing) and eating time during the night (in the barn) the predicted means were respectively 3.29 (s. e. 0.109) and 2.47 (s. e. 0.087) hrs per cow per day. Table 2 shows that the differences in total eating time are mainly caused by the differences in eating time during the night in the barn.

4 Discussion and conclusions

At the pasture observations the sensor recorded eating (grazing) time was about 3 % (coefficient was 1.0268) larger than the observed eating time. If we take into account that the 10-min scan observations will have led to a certain inaccuracy of the observed eating (grazing) times than we can conclude that with 95.2 % of accounted variance the sensor recorded eating time and the observed eating time were largely in line.

At the observations in the barn the observed staying duration at the feeding fence overestimated the sensor registered eating time by about 4 %. This can be explained by the fact that at the barn observations just the presence of a cow at the feeding fence was recorded. Obviously a certain part of the time at the feeding fence was not spend eating. This larger inaccuracy of the barn observation method also explains the lower percentage of 71.3 % of the accounted variance.

The information provided by the Smarttag Neck sensor system offers good possibilities to check the eating and grazing performance for individual cows as well as for the whole herd.

Because higher parity (≥ 3) cows produced more milk they will need more feed. However, total eating time was significantly lower in these cows, which implies that these cows should have had a higher feed intake rate. Striking was that the differences in eating time between the parities is mainly caused by the night eating times.

Literature

The literature can be requested from the author.

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