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Validação de sistema de monitoramento individual de consumo e comportamento alimentar para bovinos

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Resumo: O objetivo deste estudo foi validar um sistema eletrônico (Intergado® Ltda, Minas Gerais, Brasil) para monitorar individualmente o comportamento alimentar e o consumo de bovinos. Dados de comportamento alimentar foram registrados em 12 vacas da raça Holandesa ao longo de cinco dias, utilizando o sistema de Intergado e comparados à gravações simultâneas em vídeo. As vacas receberam um brinco contendo transponder passivo e tiveram acesso irrestrito a 12 cochos eletrônicos. O sistema registrou automatizadamente a duração de cada visita e o consumo, o número de identificação do animal, o número do cocho, os tempos inicial e final e a diferença de peso do cocho entre o início e final de cada visita alimentação. Os dados recordados eletronicamente de comportamento alimentar foram comparados com os dados observados por vídeo durante o mesmo período. Uma balança externa foi utilizada para medir manualmente o consumo em cada visita ao cocho. Os dados observado em vídeo e por pesagem manual foram regredidos nos dados de comportamento alimentar e ingestão registrados pelo sistema eletrônico para avaliar a precisão do sistema de monitoramento. O sistema Intergado apresentou valores elevados de especificidade (99,9%) e sensibilidade (99,6%) para a detecção do animal. A duração da visita e consumo de ração por visita coletados usando o sistema de monitoramento eletrônico foram semelhantes aos dados de vídeo e pesagem manual, respectivamente. A diferença entre a ingestão de alimento medida manualmente e a soma da ingestão de alimento registrada eletronicamente foi inferior a 250 g. Em conclusão, o sistema Intergado é uma ferramenta precisa para monitorar o comportamento alimentar e consumo de vacas leiteiras alimentadas em sistema de *free-stall*.

Palavras–chave: Comportamento alimentar, Gado de Leite, Validação, Pecuária de Precisão

Validation of a system for monitoring individual feeding behavior and individual feed intake in cattle

Abstract: The objective of this study was to validate an electronic system for monitoring individual feeding behavior and feed intake (Intergado® Ltd., Minas Gerais, Brazil). Feeding behavior data were recorded for 12 Holstein cows over 5 days using an Intergado system and time-lapse video. The cows were fitted with an ear tag containing a unique passive transponder and provided free access to 12 feed bins. The system documented the visit duration and feed intake by recording the animal identification number, bin number, initial and final times, and the difference of feed weight at start and end for each feed bin visit. Electronic data on animal behavior were compared with video data collected during the same evaluation period. An external scale was used to manually measure and validate the electronic system's ability to monitor dairy cow feed intake for each feed bin visit. Video and manual weight data were regressed on the electronic feeding behavior and feeding intake data to evaluate the precision of the monitoring system. The Intergado system presented high values for specificity (99.9%) and sensitivity (99.6%) for cow detection. The visit duration and feed intake per visit collected using the electronic monitoring system were similar to the video and manual weighing data, respectively. The difference between the feed intake measured manually and the sum of the electronically recorded feed intake was less than 250 g (25,635 ± 2,428 g and 25,391 ± 2,428 g estimated using manual weighing and the electronic system, respectively). In conclusion, the Intergado system is a reasonable tool to monitor feeding behavior and feed intake for free stall housed dairy cows.

Keywords: Dairy cattle, Feeding behavior, Precision Livestock, Validation.

Introduction

Feed intake and feeding behavior data on dairy and beef cattle has been traditionally collected using intensive research procedures, such as direct observation, time-lapse video recording and manually measuring feed refusal. The methods are labor intensive, which limits their use over long time periods and for many animals. Moreover, most research has been performed under conditions that may not reflect the behavior of animals housed in groups, such as individual pens, tie-stalls or feed bins that limit animal access via barrier gates.

The increasing demand for a large database with feed intake as a phenotype feature for dairy and beef cattle breeding programs as well as the potential research on precision livestock farming has motivated technological development of tools for monitoring behavior and feed intake data on individual cattle in large groups. The Intergado monitoring system (Intergado® Ltd., Minas Gerais, Brazil) determines individual feeding behavior and feed intake in cattle; however, no data have been published that validate this system for lactating dairy cattle. The objective of this study was to validate the feeding behavior (bin visit duration) and feed intake data collected from the Intergado system by comparison to time-lapse video recordings and manual feed intake measurements.

Material e Methods

All animal care and handling procedures were approved by the Embrapa Dairy Cattle Animal Care and Use Committee (Juiz de Fora, Minas Gerais, Brazil). Twelve Holstein lactating cows were provided access to a sand-bedded free stall equipped with 12 electronic feed bins at the Embrapa Dairy Cattle research farm (Coronel Pacheco, Minas Gerais, Brazil). The cows were fed ad libitum a TMR consisting of 60% corn silage and 40% concentrate on a DM basis (DM: 47.8±1.25%; CP: 16.8±1.05% of DM; NDF: 45.8±2.67% of DM; ADF: 34.5±2.86% of DM and NEL: 1.6 Mcal/Kg; analysis based on AOAC International, 1990). The animals were fed daily at approximately 0600 and 1530 h and milked daily at approximately 0600 and 1530 h.

Each cow was fitted with an ear tag containing a unique passive transponder (FDX – ISO 11784/11785; Allflex; Joinville, SC, Brazil) in the right ear. The cows were also identified by symbols dyed on their heads and received a numbered ear tag in their left ear. Brackets designed to hold a video camera (Car Rear View Camera ¼" OV136 CCD; Cyberkin; California; EUA) were positioned at the midpoint between each set of two adjacent feed bins; the cameras were connected to a video recorder (DVR Stand Alone H.264; SPYA Express; São Paulo, Brazil). Fluorescent lamps (100 W) were located approximately 6 m above the bins to facilitate video recording at night. The clocks on the video recorder and Intergado monitoring system were synchronized.

The Intergado monitoring system (AF – 1000 MASTER) includes an RFID antenna embedded in a rubberized mat that lines the neck bars and load cells to measure feed intake. After the cow steps on a mat located in front of the neck bars, the antenna is read upon activation of a mechanical switch with an integrated infrared presence sensor. The bin load cells included a 100 kg weighing capacity with a ±25 g accuracy. For each bin visit, the system recorded the animal number, bin number, initial and final times and weight, and it calculated the duration and feed intake. These data were continuously recorded using a data collector via network cable and transferred to the Intergado web software via a general packet radio service (GPRS). The system included a backup battery with up to five hours of energy when the main power fails. The feed bins were 0.80 m wide, 1.00 m long and 0.40 m deep.

The cows were continuously monitored for 5 consecutive days to evaluate the feed bin visit duration. The time-lapse video recordings were assessed by three trained observers. The animals were scored as present or absent at the feed bins when their head passed over the neck bars.

The system's ability to monitor feed intake per visit, on as fed basis, was validated for each feed bin by removing and weighing the feed using an external scale (Model 2096 DO/IV, Toledo, São Paulo, Brazil) at the beginning and end of 153 cow visits. For each single bunk visit, the TMR was manually removed and weighed; the feed bin was refilled thereafter. The feed intake was estimated using the monitoring system and then compared with the manually estimated feed intake (initial weight minus final weight, which were determined using an external scale).

To discern cumulative errors, beginning immediately after a fresh feed delivery, the total feed intake was manually recorded over a 4-h period for 3 different days using an external scale and subtracting the weight of any remaining orts in the bin from the amount of feed provided. This value was then compared with the sum of the feed intake recorded by the monitoring system for each cow visit during the same time period.

Feeding behavior and feed intake data generated by the Intergado monitoring system (dependent variable) were regressed onto those from direct observation (independent variable), and 95% confidence limit of PROC REG CLI option of SAS 9.4. (SAS Inst. Inc., Cary, NC, 2014) was used for testing slope equals one and intercept equals zero. The difference between the electronically registered and manually measured cumulative feed intake as well as feeding duration over a 4-h period were analyzed using the SAS 9.4 MIXED procedure (SAS Inst. Inc., Cary, NC, USA), fitting method (observed or recorded) as fixed effects, and the feed bin as random effect.

Results and Discussion

The manually measured average feed intake per visit (1,998±138 g) was similar to the monitoring system measurements (1,979±138 g).

The regression slope for the manually weighed feed intake per bin visit on feed intake per bin visit estimated using the monitoring system did not differ significantly ($P < 0.05$) from 1, which indicates similarity between the methods. The monitoring system accurately measured the feed consumption. A 15 g systematic error was detected, but this error is lower than the load cell accuracy and can be considered small.

The total feed that disappeared from each feed bin over a 4-h period was compared with electronic measurements over the same period and differed by 244 g (25,635 ± 2,428 g and 25,391 ± 2,428 g estimated through manual weighing and using the electronic system, respectively).

During the observation period, the electronic system detected 2,756 cow visits to the feed bins, whereas 2,764 visits were detected using video recording. In 10 events, a cow was present and detected by video recording but not by the monitoring system, which indicates 99.64% sensitivity. In 2 events, a cow was considered absent from the feed bin using video recording, but the monitoring system considered the animal present; thus, the monitoring system specificity is 99.93%.

On 2 occasions, the animals moved the head away from of the feed bin, but they were detected by the presence sensor. Therefore, the animal was considered absent from the feed bin based on the video analysis, but the monitoring system indicated that the animal was present.

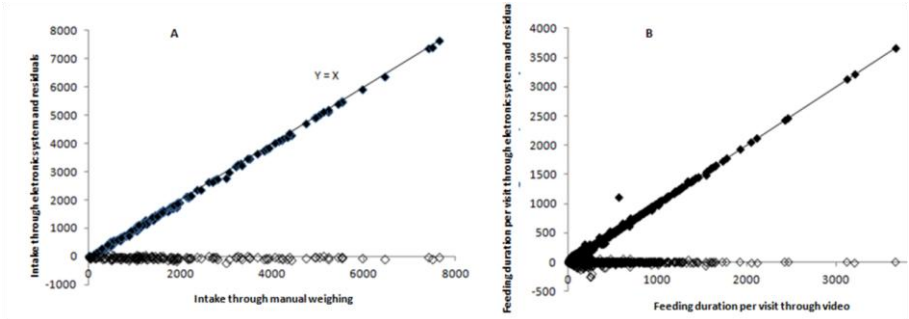

Figure 1. Recorded (solid symbols) feed intake (A, in grams) and duration (B, in seconds) per bin visit through the electronic system or through manual weighing and video observations. Open symbols represents residuals.

DeVries et al. (2003) reported a sensitivity and specificity of 87.7 and 99.2%, respectively, for an electronic feeding behavior system that monitored a cow's presence at a feeding area. The time spent in the feed bin, which was determined using the monitoring system and video recording, were similar. The regression slope for visit length, which was estimated using the monitoring system and video recording, did not differ ($P < 0.05$) from 1. The systematic error did not differ from zero. The regression coefficient was higher than the coefficient calculated for bunk visit event duration by Mendes et al. (2011) ($R^2 = 0.81$).

In one event, the monitoring system recorded a feed bin visit duration much longer than the duration recorded by video. This difference was due to a malfunction in the feed bin presence sensor, which indicated an uninterrupted feed bin visit by the cow until another animal arrived at this feed bin. The presence sensor must be improved to avoid further error due to mechanical failure of the mat switcher.

Conclusions

In conclusion, the Intergado system provides a reasonable feeding behavior and feed intake monitoring system for free stall housed dairy cows.

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