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# *Technical note:* Data loggers are a valid method for assessing the feeding behavior of dairy cows using the Calan Broadbent Feeding System

**P. D. Krawczel,[1] L. M. Klaiber, S. S. Thibeau, and H. M. Dann**
William H. Miner Agricultural Research Institute, Chazy, NY 12921

## ABSTRACT

Assessing feeding behavior is important in understanding the effects of nutrition and management on the well-being of dairy cows. Historically, collection of these data from cows fed with a Calan Broadbent Feeding System (American Calan Inc., Northwood, NH) required the labor-intensive practices of direct observation or video review. The objective of this study was to evaluate the agreement between the output of a HOBO change-of-state data logger (Onset Computer Corp., Bourne, MA), mounted to the door shell and latch plate, and video data summarized with continuous sampling. Data (number of feed bin visits per day and feeding time in minutes per day) were recorded with both methods from 26 lactating cows and 10 nonlactating cows for 3 d per cow (n = 108). The agreement of the data logger and video methods was evaluated using the REG procedure of SAS to compare the mean response of the methods against the difference between the methods. The maximum allowable difference (MAD) was set at ±3 for bin visits and ±20 min for feeding time. Ranges for feed bin visits (2 to 140 per d) and feeding time (28 to 267 min/d) were established from video data. Using the complete data set, agreement was partially established between the data logger and video methods for feed bin visits, but not established for feeding time. The complete data set generated by the data logger was screened to remove visits of a duration ≤3 s, reflecting a cow unable to enter a feed bin (representing 7% of all data) and ≥5,400 s, reflecting a failure of the data logger to align properly with its corresponding magnetic field (representing <1% of all data). Using the resulting screened data set, agreement was established for feed bin visits and feeding time. For bin visits, 4% of the data was beyond the MAD. For feeding time, 3% of the data was beyond the MAD and 74% of the data was ±1 min. The insignificant *P*-value, low coefficient of determination, and concentration of the data within the MAD indicate the agreement of the change-of-state data logger and video data. This suggests the usage of a change-of-state data logger to assess the feeding behavior of cows feeding from a Calan Broadbent Feeding System is appropriate. Use of the screening criteria for data analysis is recommended.
**Key words:** feeding behavior, dairy cow, validation

## Technical Note

Over the past decade, an interest in the feeding behavior of dairy cows, in addition to the effects on productivity of feedstuffs, has resulted in a more robust understanding of the effect of management and physiological state on these behaviors. A series of studies demonstrated that cows feeding followed a general diurnal pattern (DeVries et al., 2003a), which can be altered by management practices, such as the delivery of fresh feed (DeVries et al., 2005) or the frequency of feed delivery (DeVries and von Keyserlingk, 2005). Beyond management, dairy cows altered aspects of their feeding behavior as they approached peak lactational performance (DeVries et al., 2003b).

Observing and interpreting these feeding behaviors has become increasingly important in understanding the nutrition, production, social welfare, and overall health of dairy cattle. Accurate assessments of these behaviors require appropriate behavioral assays to establish the biological responses (Mitlöhner et al., 2001). Traditional methods to measure behavior, such as direct observation or time-lapse video (Overton et al., 2002), are labor intensive and time consuming. Thus, the development of automated systems that can continually and accurately quantify animal feeding behaviors are necessary for efficient data collection. Presently, the GrowSafe monitoring system (GrowSafe Systems Ltd., Airdrie, AB, Canada) was established as a validated approach for quantifying cow presence at the feed bunk and feeding intensity (DeVries et al., 2003c), but this approach does not measure DMI. Bach et al. (2004) validated an experimental approach to assessing the feeding behavior and DMI of loosely housed dairy cows. More recently, 2 commercially available systems, the GrowSafe 4000E (Mendes et al., 2011) and the Insentec monitoring system (Insentec BV, Marknesse, the

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[1]Corresponding author: pkrawcze@utk.edu

**Table 1.** Ingredient (%, DM basis; mean ± SD) analyzed chemical composition (DM basis) of the dry (n = 10) and lactation diets containing low (n = 11), medium (n = 4), and high (n = 11) starch concentrations fed to Holstein cows

| | Diet | | | |
|---|---|---|---|---|
| Item | Dry | Low | Medium | High |
| Corn silage | 30.38 | 34.49 ± 0.02 | 34.47 ± 0.01 | 34.47 ± 0.01 |
| Haylage | 8.89 | 11.41 ± 0.97 | 11.83 ± 0.59 | 11.41 ± 0.097 |
| Wheat straw | 26.67 | 4.06 | 4.06 | 4.06 |
| Corn meal | — | 6.85 ± 0.97 | 11.15 ± 0.01 | 16.73 ± 1.02 |
| Grain mix | 34.1 | 43.2 | 38.5 | 33.3 |
| ADF, % | 34.1 ± 0.3 | 22.8 ± 0.5 | 21.7 ± 0.9 | 20.1 ± 0.4 |
| NDF, % | 49.4 ± 0.6 | 35.3 ± 1.1 | 33.7 ± 1.0 | 31.5 ± 0.7 |
| NFC, % | 27.2 ± 0.2 | 37.1 ± 0.9 | 39.1 ± 0.2 | 40.9 ± 0.4 |
| NSC, % | 18.2 ± 1.8 | 26.3 ± 1.3 | 28.2 ± 0.4 | 31.2 ± 0.8 |
| Starch, % | 13.8 ± 1.7 | 20.4 ± 1.0 | 22.3 ± 0.4 | 25.2 ± 0.8 |
| Sugar, % | 4.4 ± 0.1 | 5.9 ± 0.4 | 5.9 ± 0.2 | 6.0 ± 0.5 |
| Fat, % | 2.7 ± 0.1 | 4.1 ± 0.3 | 4.2 ± 0.3 | 4.5 ± 0.1 |
| Ash, % | 8.7 ± 0.2 | 8.0 ± 0.9 | 9.4 ± 0.5 | 9.6 ± 0.9 |
| $NE_L$, Mcal/kg | 1.41 ± 0.00 | 1.66 ± 0.03 | 1.66 ± 0.01 | 1.70 ± 0.02 |

Netherlands; Chapinal et al., 2007), were established as valid methods to measure behavior and DMI. The last commonly used system for measuring DMI in loosely housed cattle, the Calan Broadbent Feeding System (American Calan Inc., Northwood, NH), provides the means to collect individual intake for dairy cows, but does not provide other important feeding behaviors such as feeding time and frequency. Therefore, the objective of this study was to evaluate the agreement between the output of a HOBO change-of-state data logger (Onset Computer Corp., Bourne, MA), mounted to the door shell and latch plate, and video data summarized with continuous sampling. It was hypothesized that the 2 methods for quantifying feeding behavior would conform to one another.

All management and experiment procedures were approved by the Institutional Animal Care and Use Committee (IACUC). The experiment was conducted at the William H. Miner Agricultural Research Institute (Chazy, NY). Thirty-six multiparous Holstein dairy cows [lactating cows, n = 26, mean parity = 2.3 ± 0.1 (mean ± SE), mean DIM = 20.5 ± 2.5; nonlactating cows, n = 10, mean parity = 1.7 ± 0.4, mean days relative to calving = −10.4 ± 2.6] were enrolled in this trial. Cows were housed in a freestall pen featuring sand-bedded stalls (n = 40) and individual feed bins (n = 40). Each cow was equipped with a transponder affixed to a collar situated around her neck that allowed access to a specific feed bin. Prior to this study, all participating cows were trained to successfully use their individual feed bins with a range of 10 to 80 d of feeding from a specific bin before data collection began. A TMR was delivered once daily beginning at approximately 0900 h (Table 1). Water was provided ad libitum. Cows were milked 3 times daily at approximately 0430, 1230, and 2030 h. Stalls and alleyways were cleaned once daily at approximately 0730 h.

Feeding behavior data was collected for 7 d through the use of video cameras (model IQ511, 1.3 megapixel color camera and a CAT-6 to POE power supply; IQinVision, San Juan Capistrano, CA) and data loggers [HOBO U9 State Data Logger (Part # U9–001); Onset Computer Corp.]. Digital video data was reviewed continuously (Omnicast Pro 4.1, IP video surveillance system; Genetec Inc., Saint-Laurent, QC, Canada). The data logger was mounted to the door shell of the Calan system. The magnetic component of the data logger was mounted to the corresponding latch plate. The displacement of the data logger from its corresponding magnetic field triggered a change-of-state event (recorded as a 0 in the output of the data logger) and the return of the logger into the magnetic field signaled the termination of that event (recorded as a 1 in the output of the data logger). The first 3 d of data from each cow were used (n = 108), unless video data was considered unacceptable for viewing (generally, lighting conditions that impaired visibility of cows at the feeder); in this case, the next acceptable day was used. The following response variables were measured:

- *Number of visits*—defined as the total number of times a cow entered her feed bin; for video data, a visit occurred each time a cow's head was completely obscured by the wooden barrier of the Calan system; for the data logger, the number of visits reflected the total number of 0 recordings for a 24-h period.
- *Feeding time*—defined as the summation of the duration of all visits to the feed bin during a 24-h period; for video data, a visit began when a cow's