2017 A scoping review of research validating precision wearable sensors for monitoring dairy cattle behavior. A. M. Lee*[1], M. Brause[2], D. Foy[2], and M. C. Cantor[1], [1]*Pennsylvania State University, University Park, PA,* [2]*AgriGates LLC, Philadelphia, PA.*

For our scoping review, we identified the validity of precision livestock farming (PLF) validation work by (1) assessing the common statistical criteria used to validate wearables for dairy cattle behavior. We also (2) set validity criteria and compared the literature to our standards. We used the PICO method (population, intervention, comparison, and outcome) and asked, "How do we define the need for validation standards when considering precision technologies to record dairy cattle behavior?" Key words were extracted from PubMed and Web of Science, and 2,955 articles were collected. After a validated sifting process, we extracted 101 articles. We assessed the literature using Power BI (Microsoft Corp.) to extract the precision, accuracy, and bias (Bland-Altman plots, deviations from mean, best fit line, bias correction factors, or location scale shift). We also used Power BI to confirm the sensitivity, specificity, reproducibility (sample size, sensor type), and comparison method. One researcher manually categorized dairy cattle behavior into 10 categories for consistency. We considered a PLF wearable study to have validity if they reported a high precision ≥90%, did not observe bias, used reproducibility parameters, used a comparison method, and used an ethogram to describe the behavior. One researcher manually reviewed all papers that were reported as lacking bias measurements by Power BI, because multiple statistical techniques were used to assess bias. We found a very high reproducibility 93% (94/101) among studies. Activity behavior (61/101), feeding behavior (59/101), and resting (55/101) were commonly validated with wearable sensors in dairy cattle. However, precision was rarely calculated 40% (40/101) among studies. For studies that reported precision, 90% (36/40) met our criteria for precision and reproducibility. However, we observed that many precise studies failed to report and or observe a lack of bias 35% (14/40). Thus, a negligible level of research met our validity criteria, 14% (14/101). We suggest that PLF validation studies for dairy cattle management need to meet precision ≥90%, observe a lack of bias, and be reproducible for validity.

Key Words: precision livestock farming, technology

2018 Comparing behavioral responses to heat stress and reticulorumen temperature to 2 different heat mitigation systems in a commercial dairy farm. L. Morciglio-Matías*[1], J. Hollist[2], V. Narayanan[2], and C. B. Tucker[1], [1]*Center for Animal Welfare, Department of Animal Science, University of California Davis, Davis, CA,* [2]*University of California Davis Western Cooling Efficiency Center, Davis, CA.*

Heat mitigation strategies typically combine shade, ventilation, and soakers to reduce the adverse effects of heat stress. The goal of this study was to compare responses associated with heat stress in dairy cattle across 2 heat mitigation systems using fans and soakers in freestall barns. The first system was a conventional baseline controller (Baseline), which adjusted cooling based on set environmental temperature thresholds determined by the farm, and the second used an optimized algorithm that tailored cooling frequency to maintain desired, modeled core temperature (Optimized). Holstein cows (n = 16; DIM = 64.3 ± 16.7; lactation number = 2.4 ± 0.7), housed in a single pen on a commercial dairy farm in Merced County, California, were selected as focal animals. Data were collected via in-person scan sampling at 45-min intervals between 1000 h and 1900 h over a 12-d period (8 d and 4 d, Baseline and Optimized, respectively) in summer. Observed behaviors included respiration rate and panting score (assessed by the presence or absence of drool and open-mouth panting). Internal temperatures were recorded every 10 min using reticular boluses (smaXtec, Graz, Austria) for each focal animal. Average values were compared with paired *t*-tests. Reticulorumen temperature between 1000 and 1900 h was lower in the Optimized condition, compared with Baseline (39.76 vs. 39.92 ± 0.03°C, respectively, $P < 0.01$). Respiration rates indicated that cattle were appropriately cooled and did not differ between controllers (Optimized vs. Baseline: 62 vs. 63 ± 2 breaths/min). Similarly, drooling and open-mouth panting were rare and similar across treatments (drool: 2.4 vs. 3.0 ± 0.9% observations, $P = 0.36$; open-mouth panting: 0.8 vs. 1.2 ± 0.5% observations, $P = 0.28$; Optimized vs. Baseline, respectively). Compared with a conventional controller, the optimized algorithm performed well, keeping body temperature lower, although both systems worked well, as indicated by respiration rates, drooling, and open-mouth panting. Our next steps are to replicate this study on 3 other commercial sites.

Key Words: heat stress behavior, heat mitigation system

2019 Changes in activity related to mastitis in organic dairy cows. J. Bonney-King[1], E. E. Lindner[1], V. E. Cabrera[2], B. J. Heins[3], R. A. Lynch[4], G. M. Schuenemann[5], E. Silva[2], J. Velez[6], P. Pinedo[7], A. De Vries[1], and E. K. Miller-Cushon*[1], [1]*University of Florida, Gainesville, FL,* [2]*University of Wisconsin, Madison, WI,* [3]*University of Minnesota, Morris, MN,* [4]*Cornell University, Ithaca, NY,* [5]*The Ohio State University, Columbus, OH,* [6]*Aurora Organic Farms, Platteville, CO,* [7]*Colorado State University, Fort Collins, CO.*

This study assessed changes in activity as potential indicators of mastitis in organic dairy cows. Using data collected on a certified organic dairy farm, we analyzed daily behavioral activity measurements (standing time, standing bout frequency, step count) obtained using leg-based accelerometers (iceQube, IceRobotics) on cows (n = 634) with a focus on the period surrounding the diagnosis of clinical mastitis (d 0 ± 30 d). Cows were housed in sand-bedded freestall barns with continuous access to dry lots, with access to pasture during the warmer months (≥8 h/d; Apr.–Sep.). Upon diagnosis, cows were moved to a hospital pen and, in severe cases, administered aspirin and electrolytes. Data were analyzed using generalized linear mixed models, including days relative to diagnosis with mastitis as a repeated measure, with fixed effects of season and concurrent health events (diagnosed within the same week), parity, and DIM at diagnosis. Standing time increased on the day before mastitis diagnosis (+1.2 h/d; SE = 0.2; $P < 0.001$), returning to baseline on the day following diagnosis, and was greater overall when cows had pasture access (+0.4 h/d; SE = 0.3; $P < 0.001$). Step count decreased coinciding with the day of diagnosis, particularly in cows with pasture access (d −1 vs. d 0: 2,108 vs. 1,398 steps, SE = 128, with pasture access; 1,333 vs. 1,093 steps, SE = 82, with no pasture access; $P < 0.001$), returning to baseline at 7 d following diagnosis. Standing time decreased with concurrent lameness (−0.4 h/d; SE = 0.3; $P = 0.05$) or retained placenta (−1.9 h/d; SE = 0.4; $P < 0.001$), and step counts decreased with concurrent metritis (−363 steps/d; SE = 120; $P < 0.001$) or physical injury (−352 steps/d; SE = 123; $P = 0.02$). Standing bout frequency was not affected by mastitis or pasture access. In conclusion, these findings suggest that increased standing time and reduced step