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Comparison of modeled sampling strategies for estimation of dairy herd lameness prevalence and cow-level variables associated with lameness

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ABSTRACT

Monitoring herd lameness prevalence has utility for dairy producers and veterinarians in their efforts to reduce lameness, for animal welfare assessment programs, and for researchers. Locomotion scoring is a method used to quantify lameness and calculate prevalence. Because of the time necessary to locomotion score each cow in large dairy herds, a sampling strategy to determine herd lameness prevalence that allows scoring of fewer cows would be useful. Such a sampling strategy must be validated for accuracy compared with the lameness prevalence when all cows in a herd are locomotion scored. The purpose of this study was to assess 3 previously suggested methods of estimating lameness prevalence by strategic sampling of dairy herds. Sampling strategies tested included (1) sampling a calculated number of cows in the middle third of the milking parlor exit order for each pen, (2) sampling a calculated number of cows weighted across pens and distributed evenly within each pen, and (3) sampling all cows in the high production, low production, and hospital pens. Lactating cows on 5 dairy farms in Washington and Oregon (n = 4,422) were locomotion scored using a 5-point scale to determine herd-level lameness prevalence (percentage with locomotion score ≥3). Milking parlor exit order, order in headlocks at the feed bunk within each pen, and breed were recorded for each cow. The number of days in lactation, milk production, and parity were collected from farm computer records. Pen grouping strategy for each farm was obtained by interview with farm management. Sampling strategies were modeled using the locomotion score data set for each herd. Estimates of lameness prevalence obtained from the milking parlor exit order sample and the sample distributed across pens were within 5 percentage points of the whole herd prevalence. The third strategy estimated the lameness prevalence within 5 percentage points on 4 farms, but overestimated prevalence on 1 farm. Pen-level prevalence obtained by locomotion score of all cows in the pen was variable and not reliably predictive of herd-level prevalence. Cows of Holstein breed, parity >1, and exiting the milking parlor in the last 20% of the pen had greater odds of lameness compared with other breeds, parities, and milking parlor exit order groups in a multivariate analysis. This study indicates that the sampling strategies using the middle of milking parlor exit order and a calculated sample distributed across the herd may be used to obtain an estimate of herd lameness prevalence.
Key words: lameness, locomotion, prevalence, sampling

INTRODUCTION

Lameness in dairy cattle has a negative effect on production efficiency and animal welfare. Lameness has been shown to decrease milk production (Warnick et al., 2001; Juarez et al., 2003; Hernandez et al., 2005) and increase culling (Sprecher et al., 1997; Booth et al., 2004). Reproductive efficiency is affected by lameness, with lame cows having longer calving to conception intervals, higher risk of conception failure (Hernandez et al., 2001), and a higher incidence of delayed ovarian cyclicity (Garbarino et al., 2004). Including production and reproduction losses as well as treatment expenses, a case of lameness has been estimated to cost $120 to $215, depending on the cause (Cha et al., 2010). Additionally, lameness is an indication of limb pain and therefore affects animal well-being (Whay et al., 1997; O'Callaghan et al., 2003; Dyer et al., 2007).

The prevalence of lameness in dairy herds has been assessed in previous studies. Espejo et al. (2006) studied freestall-housed Holstein dairy cows in groups designated as high production and found an average lameness prevalence of 24.6%. Cook (2003) found an average herd lameness prevalence of 23.9% in winter and 21.1% in summer across freestall and tiestall herds. Wells et al. (1993) assessed lameness in primarily tiestall herds and found a lameness prevalence of 13.7% in the summer and 16.7% in the spring. Benchmarks for lameness prevalence in dairy herds of 15% (Nordlund

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et al., 2004) and 10% (National Milk Producers Federation, 2010) have been recommended, although the latter could include young stock and nonlactating cows. Given that the average levels of lameness reported from research studies are greater than these recommendations, reduction of lameness prevalence is needed.

Mitigation of a problem typically involves assessment and quantification of the problem first. Therefore, it is important to accurately estimate the level of lameness in a dairy herd to incorporate a lameness reduction program. Previous studies have found that producers tend to underestimate the level of lameness in their herds compared with evaluations made by an outside observer (Wells et al., 1993; Espejo et al., 2006). Therefore, if an independent observer such as a veterinarian or other dairy advisor could quickly assess the lameness prevalence in a herd, goal levels could be established and steps to mitigate lameness taken.

Locomotion scoring systems for assessing cow gait based on criteria developed by Sprecher et al. (1997) have been used to measure lameness (Cook, 2003; Juarez et al., 2003; Espejo et al., 2006). These scoring systems have been validated for intra- and inter-observer agreement and correlated with hoof pathology (Winckler and Willen, 2001; O'Callaghan et al., 2003; Bicalho et al., 2007; Tadich et al., 2010; Thomsen et al., 2012). Locomotion scoring requires the observation of a cow standing and walking, which may take several minutes before a score can be determined. An opportunity commonly used to observe cows for locomotion scoring is as they walk between the milking parlor and the housing pens. However, milking parlor throughput of 164 to 363 cows per hour has been reported (Thomas et al., 1996), which suggests that on large dairy farms cows exit the milking parlor over several hours, making the process of locomotion scoring all animals time or cost prohibitive.

Scoring a smaller number of cows using strategic sampling could reduce the time and cost of prevalence estimation. Strategies to sample cows for locomotion scoring have been suggested. Main et al. (2010) developed a sampling strategy based on milking parlor exit order using a calculated sample size that estimated lameness prevalence within 5% of the true prevalence. Farms included in that study had fewer than 300 cows and most of the cows were housed in one pen. That sampling strategy has not been tested on large farms (>300 cows) with multiple pens. Another sampling strategy is utilized by National Dairy FARM (Farmers Assuming Responsible Management) Program assessors, in which a sample size is calculated for the herd, weighted by number of cows per pen to determine sample size per pen, and cows are selected systematically from the pen (National Milk Producers Federation, 2010). Validation of this strategy for accuracy compared with true herd lameness prevalence has not been reported. Additionally, some have suggested that locomotion scoring certain pens or combinations of pens based on pen designation or production level would be predictive of herd-level prevalence. Hoof health industry representatives have suggested sampling 1 high-production, 1 low-production, and 1 hospital pen to determine herd prevalence. Previous studies assessing lameness prevalence have locomotion scored only a high-production pen to associate pen-level management, and are thus unable to represent the herd prevalence (Espejo et al., 2006; von Keyserlingk et al., 2012).

The purpose of the present study was to compare true herd lameness prevalence, as measured by locomotion scoring all lactating cows, to the estimated herd lameness prevalence based on 3 sampling strategies: (1) scoring the cows in the middle of the group based on the order they leave the milking parlor, (2) scoring based on a sample size distributed across pens, and (3) scoring groups based on their estimated production level.

MATERIALS AND METHODS

This study was approved by the Washington State University animal care and use committee. Five dairy farms volunteered to participate in the study, 4 in Washington State and 1 in Oregon. Cows were locomotion scored using a 5-level scoring system based on the back posture and gait of a cow (Sprecher et al., 1997), where a score of 1 indicates a sound cow with a level back walking and standing, a score of 2 indicates the cow develops an arched back posture while walking but not standing and the gait remains normal, a score of 3 indicates the cow maintains an arched back posture walking and standing and short-strides one or more legs, a score of 4 indicates the cow additionally has reduced weight bearing on at least one limb, and a score of 5 indicates refusal to bear weight on a limb. If the cow was not observed while standing, the presence or absence of a short-striding gait (failure to track-up hind feet, increased speed of leg movement asymmetrically) at the walk was used to distinguish a score 2 from a score 3. Cows were classified as "lame" if they had a locomotion score of 3 or greater. Locomotion scoring was performed by one of the authors (DM, AH, or JV), who completed the same training using online lameness scoring materials (Zinpro Corp., 2010).

For calculation of inter-observer agreement, observers watched the same 33 videos of cows walking and assigned a locomotion score to each cow. The percentage agreement among all 3 observers and kappa (κ), weighted κ (Cohen, 1968), and prevalence-adjusted