J. Dairy Sci. 98:1–16
http://dx.doi.org/10.3168/jds.2014-8840

Herd management and social variables associated with bulk tank somatic cell count in dairy herds in the eastern United States

R. L. Schewe,*[1] J. Kayitsinga,† G. A. Contreras,‡ C. Odom,§ W. A. Coats,§ P. Durst,# E. P. Hovingh,‖ R. O. Martinez,† R. Mobley,¶ S. Moore,# and R. J. Erskine‡
*Department of Sociology, Syracuse University, Syracuse, NY 13210
†Julian Samora Research Institute, and
‡Department of Large Animal Clinical Sciences, Michigan State University, East Lansing 48824
§Social Science Research Center, College of Arts and Sciences, Mississippi State University, Mississippi State 39762
#Michigan State University Extension, Michigan State University, East Lansing 48824
‖Department of Veterinary and Biomedical Sciences, The Pennsylvania State University, University Park 16802
¶College of Agriculture and Food Sciences, Florida Agricultural and Mechanical University, Tallahassee 32307

ABSTRACT

The ability to reduce somatic cell counts (SCC) and improve milk quality depends on the effective and consistent application of established mastitis control practices. The US dairy industry continues to rely more on nonfamily labor to perform critical tasks to maintain milk quality. Thus, it is important to understand dairy producer attitudes and beliefs relative to management practices, as well as employee performance, to advance milk quality within the changing structure of the dairy industry. To assess the adoption rate of mastitis control practices in United States dairy herds, as well as assess social variables, including attitudes toward employees relative to mastitis control, a survey was sent to 1,700 dairy farms in Michigan, Pennsylvania, and Florida in January and February of 2013. The survey included questions related to 7 major areas: sociodemographics and farm characteristics, milking proficiency, milking systems, cow environment, infected cow monitoring and treatment, farm labor, and attitudes toward mastitis and related antimicrobial use. The overall response rate was 41% (21% in Florida, 39% in Michigan, and 45% in Pennsylvania). Herd size ranged from 9 to 5,800 cows. Self-reported 3-mo geometric mean bulk tank SCC (BTSCC) for all states was 194,000 cells/mL. Multivariate analysis determined that proven mastitis control practices such as the use of internal teat sealants and blanket dry cow therapy, and not using water during udder preparation before milking, were associated with lower BTSCC. Additionally, farmer and manager beliefs and attitudes, including the perception of mastitis problems and the threshold of concern if BTSCC is above 300,000 cells/mL, were associated with BTSCC. Ensuring strict compliance with milking protocols, giving employees a financial or other penalty if BTSCC increased, and a perceived importance of reducing labor costs were negatively associated with BTSCC in farms with nonfamily employees. These findings highlight the need for a comprehensive approach to managing mastitis, one that includes the human dimensions of management to maintain the practice of scientifically validated mastitis control practices.
Key words: mastitis, behavior, attitudes, employees

INTRODUCTION

Mastitis continues to result in major economic losses to the US dairy industry, decreases farm productivity, and reduces the quality of dairy foods (Ma et al., 2000; Losinger, 2005; Cha et al., 2011; Hogeveen and Lam, 2011). The ability to reduce mastitis depends on effective and consistent application of established mastitis control practices. For example, farms that consistently use postmilking teat disinfection (**PMTD**), blanket dry cow therapy (**BDCT**), coliform mastitis vaccines, or provide inorganic bedding maintain lower bulk tank somatic cell counts (**BTSCC**) or clinical mastitis incidence than noncompliant herds (Erskine et al., 1987; Wenz et al., 2007; Hogan and Smith, 2012). However, some dairy herds continue to struggle with compliance of these proven mastitis control practices.

Over the past 2 decades, a marked shift has occurred in herd size of dairy farms in the United States. Farms with fewer than 100 cows accounted for 49% of the country's milk cows in 1992, but just 17% of milk cows in 2012. In contrast, farms with at least 1,000 cows accounted for 49% of all milk cows in 2012, up from 10% in 1992 (MacDonald and Newton, 2014). As variability in herd size increases, dairy farms are also becoming increasingly varied in terms of employment practices and organization (Jackson-Smith and Barham, 2000). Thus,

Received September 10, 2014.
Accepted July 9, 2015.
[1]Corresponding author: rlschewe@syr.edu

the diversity in farm size and labor structure makes it difficult to design and apply standardized mastitis control programs across US dairy farms.

Despite progress in mastitis control programs and their positive effect on udder health, their effectiveness and consistent application depend on dairy personnel (Fuhrmann, 2002; Brasier et al., 2006; Stup et al., 2006). Research has also demonstrated the importance of farmer attitudes and values in determining mastitis rates and antimicrobial use (Vaarst et al., 2002; Sato et al., 2008). In a survey of 336 Dutch dairy farms (Jansen et al., 2009), farmers' attitudes toward mastitis (e.g., believing mastitis was due to bad luck) were significantly associated with increased BTSCC and incidence of clinical mastitis as much as self-reported control procedures (e.g., forestripping cows before milking, or checking the milking vacuum daily). Therefore, to facilitate the development of mastitis control programs that successfully improve milk quality and reduce antimicrobial use, it is necessary to evaluate both farm practices and social factors including knowledge, behaviors, and beliefs about mastitis control and antimicrobial use, as well as labor management practices and attitudes.

Based on previous studies, it is hypothesized that farmers' and managers' attitudes, values, and employee management will have at least as large an effect on BTSCC as conventional herd and mastitis management practices. The purpose of this study was to determine the relative and combined effects of herd management and social variables, especially those related to farm labor, on self-reported BTSCC across a broad scope of herd sizes and characteristics.

MATERIALS AND METHODS

Dairy Farm Selection

Data for this study were collected using a mail survey that was sent to a stratified random sample of USDA grade A certified dairy farms in Michigan (**MI**), Pennsylvania (**PA**), and Florida (**FL**). Addresses of 7,983 grade A certified dairy farms in FL, MI, and PA were obtained to serve as the total farm population from which to select our survey sample.

Prior to sample selection, dairy farms in both MI and PA were stratified by herd size due to the small number of large herds in those states. Additionally, stratification was necessary to ensure that the diversity in labor structure across small and large dairies was accounted for. Therefore, MI and PA farms were stratified into large or small-to-medium strata based on herd size distribution in each state. In PA, large farms were defined as those >250 cows, and in MI, large farms were defined as those >500 cows due to the larger mean and median herd size as compared with PA. Due to the small number of dairy farms in FL, all 128 grade A farms in this state were included in the sample. This stratified sampling requires all analysis to be properly weighted to account for differential probability of selection across strata; sample weighting procedures are described in the statistical analysis section.

In MI, the sampling frame was obtained through Freedom of Information Act (**FOIA**) requests to the MI Department of Agriculture and Rural Development (**MDARD**), the MI Department of Environmental Quality (**MDEQ**), and consultation with MI State University Extension. The MDARD provided a spreadsheet of the names and addresses of all current grade A dairy farms in the state. Although herd size was also requested, the MDARD declined this portion of our FOIA request citing privacy concerns. This was a problem because without herd size, stratification would not be possible. However, a FOIA request to the MDEQ provided a spreadsheet of the current and pending concentrated animal feeding operation (**CAFO**) permits in the state. The CAFO records included name, address, and type of animal operation (i.e., dairy), and identified those dairy farms with >700 cows (the MDEQ requirement for a permit). This identified 98 farms with >700 cows to be included in the large-farm stratum. The updated sampling frame was then reviewed by MI State University Dairy Extension personnel (including campus faculty and extension educators) to identify any additional farms known to have over 500 cows. This added an additional 8 farms to the large-farm stratum. This resulted in a final sampling frame for MI of 106 large farms (i.e., >500 cows) and 1,651 small (≤250 cows) to medium farms (250–500 cows). To ensure adequate representation of large farms, all 106 farms in the large-farm stratum were sampled, giving them a sampling ratio of 1. Using a random number generator, 646 farms from the small-to-medium farm stratum were sampled, giving them a sampling rate of 0.39 and a sampling probability weight of 2.56 (**pweight** = 1/sampling ratio). The sample size of 646 farms in the small-to-medium farm stratum was designed to provide a 5% confidence interval for a response rate of approximately 40% (Kenny, 1987).

In PA, co-investigator E. Hovingh obtained the sampling frame through the PA Department of Agriculture, which provided access to a confidential list of grade A certified farms including herd size. Adhering to a privacy agreement with the PA Department of Agriculture, unique numerical identifiers were assigned to each farm, which produced a spreadsheet including only anonymous identifiers and herd size to be used by survey administrators to define strata and samples. A FOIA request to the PA Department of Environmental