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Estimating milk yield and value losses from increased somatic cell count on US dairy farms

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ABSTRACT

Milk loss due to increased somatic cell counts (SCC) results in economic losses for dairy producers. This research uses 10 mo of consecutive dairy herd improvement data from 2013 and 2014 to estimate milk yield loss using SCC as a proxy for clinical and subclinical mastitis. A fixed effects regression was used to examine factors that affected milk yield while controlling for herd-level management. Breed, milking frequency, days in milk, seasonality, SCC, cumulative months with SCC greater than 100,000 cells/mL, lactation, and herd size were variables included in the regression analysis. The cumulative months with SCC above a threshold was included as a proxy for chronic mastitis. Milk yield loss increased as the number of test days with SCC ≥100,000 cells/mL increased. Results from the regression were used to estimate a monetary value of milk loss related to SCC as a function of cow and operation related explanatory variables for a representative dairy cow. The largest losses occurred from increased cumulative test days with a SCC ≥100,000 cells/mL, with daily losses of $1.20/cow per day in the first month to $2.06/cow per day in mo 10. Results demonstrate the importance of including the duration of months above a threshold SCC when estimating milk yield losses. Cows with chronic mastitis, measured by increased consecutive test days with SCC ≥100,000 cells/mL, resulted in higher milk losses than cows with a new infection. This provides farm managers with a method to evaluate the trade-off between treatment and culling decisions as it relates to mastitis control and early detection.
Key words: mastitis, economics, SCC, milk yield

INTRODUCTION

Mastitis is one of the most expensive sources of disease costs on dairy farms (DeGraves and Fetrow, 1993; Seegers et al., 2003; Hand et al., 2012; Geary et al., 2012). Previous survey work has found the incidence of mastitis in US dairy herds rising over time (USDA-NAHMS, 2016), whereas milk quality premium standards have become more rigorous over the same time period. These factors have created a situation where mastitis cost and control measures are increasingly important to farm financial viability.

Somatic cell count is frequently used as a proxy for mastitis. Past research has evaluated the relationship between mastitis and milk yield loss. Hand et al. (2012) studied the relationship between 24-h milk loss and lactation milk loss due to mastitis across multiple herds to find milk loss increased across parity and production levels. Houben et al. (1993) emphasized a production loss bias due to dairy farmers likely keeping high-producing cows with mastitis but removing low-producing cows with mastitis. Other studies have focused on determining test-day milk yield loss at a cow level and found that parity, SCC, and herd-level management affects the amount of milk yield loss estimated (Jones et al., 1984; Bartlett et al., 1990; Lescourret and Coulon, 1994; Hortet et al., 1999; Miller et al., 2004; Durr et al., 2008). Comprehensive meta-analysis concluded that the economic cost of mastitis was a function of decreased milk yield, increased veterinary, labor, and treatment costs, reduced milk production, and premium payments received, among other factors (Houben et al., 1993, Seegers et al., 2003; Hand et al., 2012). Rollin et al. (2015) used a deterministic partial budget to estimate the economic impact of clinical mastitis in the first 30 d of the lactation to find that estimated future milk production losses resulted in 28% of the total cost of mastitis. Many of these studies focus on evaluating the relationship in a controlled experimental setting with a small number of cows, whereas other studies have used a repeated sample of dairy cows to estimate the

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relationship between milk yield loss and SCC (Barkema et al., 1999; Hortet et al., 1999; Bar et al., 2007; Hand et al., 2012).

Our analysis uses a large sample of DHI records from US dairy farms over 10 consecutive monthly test days. As DHI records do not routinely capture producer-identified mastitis events, we were not able to determine which cows were diagnosed or treated for mastitis. Instead, a threshold SCC was used as a proxy for mastitis for this analysis. Chronic mastitis was captured with the number of cumulative test days above the threshold SCC. Milk yields were estimated using a fixed effect regression analysis to provide an estimate of the indirect losses associated with SCC controlling for herd-level effects. These results are used to estimate the value of milk losses related to SCC as a function of cow- and operation-related explanatory variables. Our study contributes to previous research in 2 ways. First, this model evaluates the joint effect of numerous characteristics on milk quantity. This allows an examination of how factors change milk quantity while holding all other values constant. It also creates an opportunity to evaluate whether potential interactions exist across variables. Second, this analysis uses a large national sample of dairy cows with 10 mo of consecutive test-day lactation data.

MATERIALS AND METHODS

DHIA Data

Data from 2013 to 2014 DHI records were provided by AgriTech Analytics (Visalia, CA), AgSource Cooperative Services (Verona, WI), and Dairy Records Management Systems (DRMS; Raleigh, NC) via data transfer agreements with Colorado State University. These records included information on the cow, herd, and test-day (**TD**) milk yield, protein, and fat levels, and SCS in addition to cow, herd, and regional characteristics. A 10-mo balanced panel was generated from cows with consecutive TD of milk yield and SCC data beginning with the first TD of the lactation for each cow. The period covered included records from October 2013 through December 2014. A unique identifier was generated for each cow, which connected all cows within 1 herd. This allowed for a comprehensive analysis that tracked cows over identical time periods controlling for unobservable management differences within a herd. Cows with missing values for any of the variables used in the regression were dropped from the data set. This resulted in a data set with 5,415,940 individual cow lactation observations from 541,594 cows across 11,740 farms with 10 mo of TD data.

Variable Definitions

The data contained many cow and herd characteristics used to explain milk production levels in regression models. The variables used are explained here with a focus on the role of SCC on milk yield. The dependent variable in all regressions was TD milk yield per cow. The data also contained information on butterfat and protein yields. Past research suggested that SCC did not have an economically significant effect on milk component levels (Hortet and Seegers, 1998; Seegers et al., 2003). We estimated fat and protein components as dependent variables in the regressions and found results consistent with past research; therefore, it has been excluded from this paper.

To examine whether the explanatory variables had systematic relationships based on cow productivity, milk yield level was controlled by classifying cows into 3 production groups: low, medium, or high. The production groups were defined based on the distribution of cow-level data. The lowest 25% of the cows annually produced less than 9,072 kg of milk over 305 d and were classified as the low-production group. The highest 25% of cows produced greater than 12,700 kg of milk over 305 d and were classified as the high-production group. Cows that produced between 9,072 and 12,700 kg of milk in 305 d were classified as the medium-production group. Based on this cow-level categorization, it is possible that 1 herd could have cows in all 3 production groups.

Explanatory variables, other than season, were either cow- or herd-specific. Herd-level factors were assumed to apply to all cows in a herd. Cow-specific variables included breed, DIM, and lactation. Herd variables included milking frequency and herd size.

Previous literature has demonstrated that milk yield is influenced by the breed of the cow (Prendiville et al., 2009; Kadri et al., 2015). Multiple breeds and breed combinations were reported in the DHI data. Our analysis used the top 3 cow breeds reported, Holstein, Jersey, and crossbred, to evaluate its effect on milk yield loss. Holstein was set equal to 1 for all Holsteins and 0 otherwise. A similar variable was created for Jersey and crossbred.

As dairy farms have become larger and more specialized, the adoption of increased milking frequency has occurred on many operations (Erdman and Varner, 1995). DHI records allowed for 2 options for milking frequency: 2× or 3× a day. The majority of herds reported 2× milking frequency (**MFQ**); MFQ was set equal to 1 if the cow was milked 2× daily and 0 if the cow was milked 3× per day (MFQ did not change across the 10-mo lactation for an individual cow).