J. Dairy Sci. 98:3741–3753
http://dx.doi.org/10.3168/jds.2014-8675

Exploring the characteristics and dynamics of Ontario dairy herds experiencing increases in bulk milk somatic cell count during the summer

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ABSTRACT

Regionally aggregated bulk milk somatic cell count (BMSCC) data from around the world shows a repeatable cyclicity, with the highest levels experienced during warm, humid seasons. No studies have evaluated this seasonal phenomenon at the herd level. The objectives of this study were to define summer seasonality in BMSCC on an individual herd basis, and subsequently to describe the characteristics and dynamics of herds with increased BMSCC in the summer. The data used for this analysis were from all dairy farms in Ontario, Canada, between January 2000 and December 2011 (n ≈ 4,000 to 6,000 herds/yr). Bulk milk data were obtained from the milk marketing board and consisted of bulk milk production, components (fat, protein, lactose, other solids), and quality (BMSCC, bacterial count, inhibitor presence, freezing point), total milk quota of the farm, and milk quota and incentive fill percentage. A time-series linear mixed model, with random slopes and intercepts, was constructed using sine and cosine terms as predictors to describe seasonality, with herd as a random effect. For each herd, seasonality was described with reference to 1 cosine function of variable amplitude and phase shift. The predicted months of maximal and minimal BMSCC were then calculated. Herds were assigned as low, medium, and high summer increase (LSI, MSI, and HSI, respectively) based on percentiles of amplitude in BMSCC change for each of the 4 seasons. Using these seasonality classifications, 2 transitional repeated measures logistic regression models were built to assess the characteristics of MSI and HSI herds, using LSI herds as controls. Based on the analyses performed, a history of summer BMSCC increases increased the odds of experiencing a subsequent increase. As herd size decreased, the odds of experiencing HSI to MSI in BMSCC increased. Herds with more variability in daily BMSCC were at higher odds of experiencing MSI and HSI in BMSCC, as were herds with lower annual mean BMSCC. Finally, a negative association was noted between filling herd production targets and experiencing MSI to HSI in BMSCC. These findings provide farm advisors direction for predicting herds likely to experience increases in SCC over the summer, allowing them to proactively focus udder health prevention strategies before the high-risk summer period.
Key words: somatic cell count, seasonality, dairy herd

INTRODUCTION

Mastitis is among the most pervasive and economically important diseases faced by the dairy industry (Hogeveen et al., 2011). At the cow level, an elevated SCC is a sign of inflammation in the udder, the cause of which is most likely a bacterial IMI (Dohoo and Meek, 1982). Cows with higher SCC produce less milk with altered processing characteristics, namely reduced shelf life, and altered protein content (Le Marechal et al., 2011; Hand et al., 2012). As such, bulk milk SCC (**BMSCC**) is a commonly used gauge of milk quality, with dairy processors and regulators worldwide placing regulations on acceptable levels.

It is a well-established and globally widespread finding that regionally aggregated BMSCC means shows a repeatable, cyclic seasonal pattern (Green et al., 2006b; Olde Riekerink et al., 2007). Typically, BMSCC levels are highest during the warm months of the year, from July through October, in the northern hemisphere. Studies in Ontario, Canada, have found BMSCC averages are lowest in April and highest in October, a trend consistent over a 6-yr period (Sargeant et al., 1998). In Ontario, monthly provincial mean BMSCC levels typically ranged from a nadir of less than 200,000 cells/mL in the winter to their highest levels of 300,000 cells/mL in the summer (Sargeant et al., 1998).

This seasonal compromise in milk quality is concerning for several reasons. Producers with elevated BMSCC experience decreased milk production (Hand et al., 2012) and face financial penalties when they exceed

Received July 28, 2014.
Accepted February 22, 2015.
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the SCC regulatory thresholds (Dekkers et al., 1996). It has been shown that increased BMSCC in summer poses a significant challenge for producers to comply with such regulatory standards (Lukas et al., 2008). Historically, a positive association between external pressure to lower BMSCC and inhibitor penalties (antibiotic residues in milk), likely due to increased use of intramammary antibiotic treatment (Schukken et al., 1992a; Sargeant et al., 1998).

Several factors contribute to the seasonal pattern in BMSCC. The increased heat and humidity of summer provide optimal environmental conditions for bacterial growth, increasing infection pressure and, ultimately, the incidence of clinical mastitis during the summer (Hogan et al., 1989). In addition, the summer increase in BMSCC is also associated with an increase in the proportion of cows with a chronically high SCC (2 consecutive tests greater than 200,000 cells/mL), with these cows accounting for 71% of the increase in BMSCC over the summer (Green et al., 2006b).

There are also potential animal-level risk factors associated with the summer, potentially leading to increases in IMI and, thus, BMSCC. Animals experiencing heat and humidity could develop heat stress and subsequent immune suppression, potentially increasing the risk of IMI (do Amaral et al., 2011). Also, the incidence of metabolic disease is often elevated in the summer (Duffield et al., 1998), which could further contribute to immune suppression and an increased IMI risk (van Straten et al., 2009).

Milk is a supply managed commodity in Canada, whereby the amount of milk sold by individual dairy farmers is controlled through a quota system, expressed in kilograms of butterfat per day, and hereafter referred to as milk quota (**MQ**), to match the domestic demand. Milk quota is designed to be filled and reconciled monthly, with limited ability to compensate for over- or under-production in 1 mo by offsetting production in another month. Producers are typically allotted the right to sell additional milk, over and above their allotted MQ, in the face of supply and demand mismatch, termed as incentive days (**ID**). Typically, the summer and fall periods are times where demand for milk outstrips supply. Producers aim to temporarily increase milk production, either to attain fall or summer ID or to increase production levels after periods of underproduction. Temporary increases in production are primarily achieved by maintaining higher-lactating cow numbers through cow retention, acquisition, or targeted breeding. This could become a risk factor for summer BMSCC increases when facilities are inadequate in size or capacity to accommodate such temporary fluctuations, leading to higher stocking densities with potential increased levels manure accumulation (Magnusson et al., 2008) or higher levels of social stress with potential immune suppression (Herskin et al., 2007). Producers who retain cows destined for culling could inadvertently keep cows with chronic IMI in the herd, contributing to higher levels of BMSCC and acting as a source of new IMI (Zadoks et al., 2002). The effects that the supply management system has on udder health have not been studied.

Studies evaluating seasonal SCC trends in entire regional populations of herds over extended periods are few in number. Also, there are no published studies that have described the characteristics and BMSCC dynamics of the seasonal phenomenon at the individual herd level. The objectives of the present study were to define summer seasonality in BMSCC on an individual herd basis, and, subsequently, to describe the characteristics and BMSCC dynamics of herds with increased BMSCC in the summer in the context of the Canadian dairy industry.

MATERIALS AND METHODS

Farms

The data used for this analysis were from the complete population of licensed dairy farms in Ontario, Canada, from January 2000 to December 2011. The number of farms and cows decreased from 6,100 herds and 380,000 milking cows in 2000 to approximately 4,000 herds and 319,000 milking cows in 2011. The average farm size (milking and dry cows) over this period ranged from approximately 40 in 2000 to 70 in 2011. For each year, only herds selling milk for a complete year (>90% of milk pickup data available) were retained for analysis. The Holstein breed accounts for greater than 90% of the cows milked in Ontario (CanwestDHI, 2012). All milk sold in the province is evaluated for component content and milk quality at 1 laboratory (University of Guelph, Laboratory Services Division). All milk is marketed to processors through the Dairy Farmers of Ontario (**DFO**; Mississauga, ON, Canada).

Data

The data used in the current study were obtained from the DFO and consisted of bulk milk production, components (fat, protein, lactose, other solids), and quality (BMSCC, bacterial count, inhibitor presence, freezing point), farm MQ, and MQ and ID fill percentage from every farm in Ontario. Between January 1, 2000, and May 31, 2010, bulk tank milk samples from each farm were analyzed 4 times per month. Subse-