

Abstract T169

Bulk tank somatic cells and its relationship to milk production, milk composition, and revenue in dairy farms located in Central Thailand

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SUMMARY

The objectives of this study were to monitor bulk tank somatic cell count (**BSC**) in Central Thailand and to estimate the association between **BSC** and monthly milk yield per cow (**MYC**), fat % (**FAT**), protein % (**PRO**), lactose % (**LAC**), solids not fat % (**SNF**) total solids % (**TS**), and monthly revenue per cow (**MRC**). The dataset included monthly milk production and milk composition (28,580 records) collected from 2004 to 2010 in 811 farms located in Central Thailand (Muaklek, Wang Muang, Phattana Nikhom, and Pak Chong). Seasons were winter (November to February), summer (March to June), and rainy (July to October). Farm sizes were classified by number of milking cows into small (<10 cows), medium (10 to 19 cows), and large (>19 cows). The dataset was analyzed using a linear model that contained year-season subclasses, farm size-farm location subclasses, and regression **BSC** as fixed effects, and residual as a random effect. The average **BSC** in this population was 681,430 (SD = 641,000) cells/ml. Milk produced in most farms (63%) had **BSC** values higher than 500,000 cells/ml. The **BSC** tended to increase over time (11,668 cells/ml/year-season; $R^2 = 0.74$). The **BSC** was linearly associated with milk production, milk composition, and milk revenue. Larger **BSC** were associated with lower **MYC** (-1.39 ± 0.12 kg/10⁵ cells/ml; $P < 0.0001$), **LAC** (-0.0074 ± 0.0002 %/10⁵ cells/ml; $P < 0.0001$), **SNF** (-0.0022 ± 0.0002 %/10⁵ cells/ml; $P < 0.0001$), and **MRC** (-17.51 ± 1.84 Thai baht/10⁵ cells/ml; $P < 0.0001$), but with higher **FAT** (0.0066 ± 0.0004 %/10⁵ cells/ml; $P < 0.0001$), **PRO** (0.0055 ± 0.0002 %/10⁵ cells/ml; $P < 0.0001$), and **TS** (0.0054 ± 0.0005 %/10⁵ cells/ml; $P < 0.0001$). *These results indicated the need for farmers to implement management practices to reduce BSC in order to increase milk yield and revenue in Central Thailand.*

INTRODUCTION

Thailand is a tropical country in Southeast Asia (5° 37' to 20° 27' North latitude and 97° 21' to 105° 37' East longitude; elevation 0 to 2565 m). The weather in this country is normally hot (17° to 36° Celsius) and humid (66 to 81%), and with yearly monsoon rains. Commercial dairy production has been promoted in Thailand since 1960. In order to increase milk production per cow, upgrading local cattle genetics to Holstein (H) has been practiced by Thai farmers. Currently, Thailand has approximately 204,805 milking cows raised in 17,837 farms (mean = 11 milking cows/farm), and produce 2,093,401 kg of milk/day (mean = 10 kg/cow/day) . Most dairy cattle in this country are crossbreds composed of up to seven different breeds (e.g., H, Brahman, Brown Swiss, Jersey, Red Dane, Red Sindhi, Sahiwal, Shorthorn, and Thai Native). The vast majority of milk (65%) is produced in Central Thailand. Bulk tank somatic cell count (**BSC**) has been used as an indicator of milk quality and herd health status in many countries. Almost all somatic cells found in milk are leukocytes, which normally increase in response to pathogenic bacteria (e.g., *Staphylococcus aureus* or *Staphylococcus agalactiae*). An increase in **BSC** reflects mastitis, thus it can be used as an indicator of the health status of milking cows in a dairy herd. High **BSC** could also suggest a reduction in milk production associated with quality of herd health management. Monitoring the level of **BSC** in milk produced by individual farms would help understand the current situation of dairy farms and herd health of dairy cows in Central Thailand. Thus, the objectives of this study were to monitor bulk tank somatic cell count (**BSC**) in Central Thailand and to estimate the association between **BSC** and monthly milk yield per cow (**MYC**), fat % (**FAT**), protein % (**PRO**), lactose % (**LAC**), solids not fat % (**SNF**) total solids % (**TS**), and monthly revenue per cow (**MRC**).

MATERIALS AND METHODS

Data, Farms, and Seasons

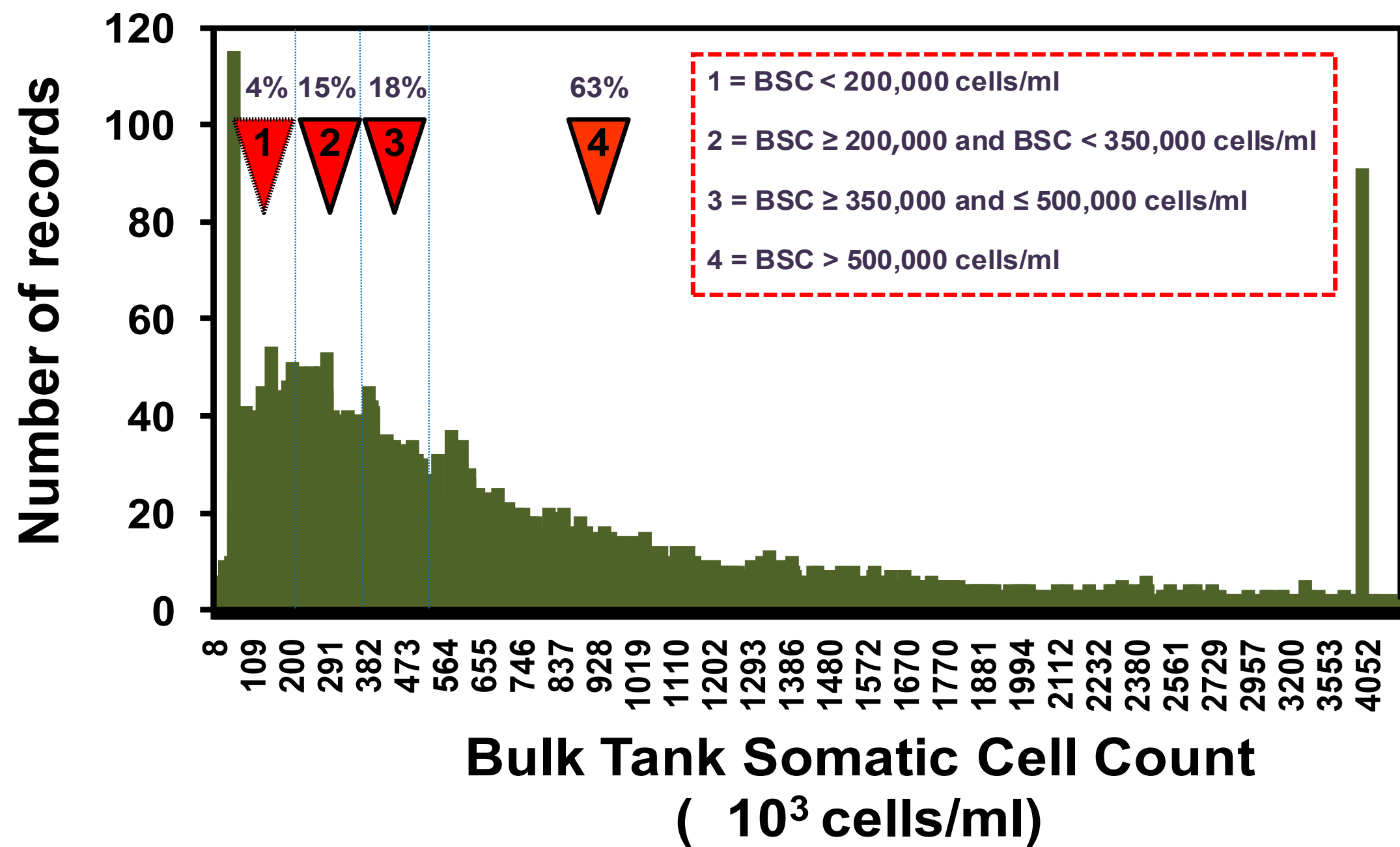
The dataset (28,580 records) contained information of monthly milk yield per cow (**MYC**; kg), fat percent (**FAT**; %), protein percent (**PRO**; %), lactose (**LAC**, %), solids not fat (**SNF**; %), total solids (**TS**; %), bulk tank somatic cell count (**BSC**; ×10³ cells/ml), and milk revenue per cow (**MRC**; Thai baht; 1 USD = 30.5 Thai baht) gathered from 811 dairy farms located in Central Thailand from 2004 to 2010. Farms were located in the districts of Muaklek (Saraburi province), Wang Muang (Saraburi province), Phattana Nikhom (Lop Buri province), and Pak Chong (Nakhon Rachasima province). Seasons in these locations were winter (November to February), summer (March to June), and rainy (July to October). Farm sizes were classified by number of milking cows into small (<10 cows), medium (10 to 19 cows), and large (>19 cows).



Data Analysis

A statistical description of the **BSC** records from 811 dairy farms in Central Thailand was conducted (frequency distribution, mean, median, skewness). Four **BSC** groups were defined based on **BSC** scores: **Group 1** (**BSC** < 200,000 cells/ml), **Group 2** (200,000 cells/ml ≤ **BSC** < 350,000 cells/ml), **Group 3** (350,000 cells/ml ≤ **BSC** ≤ 500,000 cells/ml) and **Group 4** (**BSC** > 500,000 cells/ml). The proportion of records and farms that fell within the range of these 4 **BSC** groups was determined. Means of **BSC** in particular year-season subclasses were used to draw phenotypic trend for **BSC** across year-season.

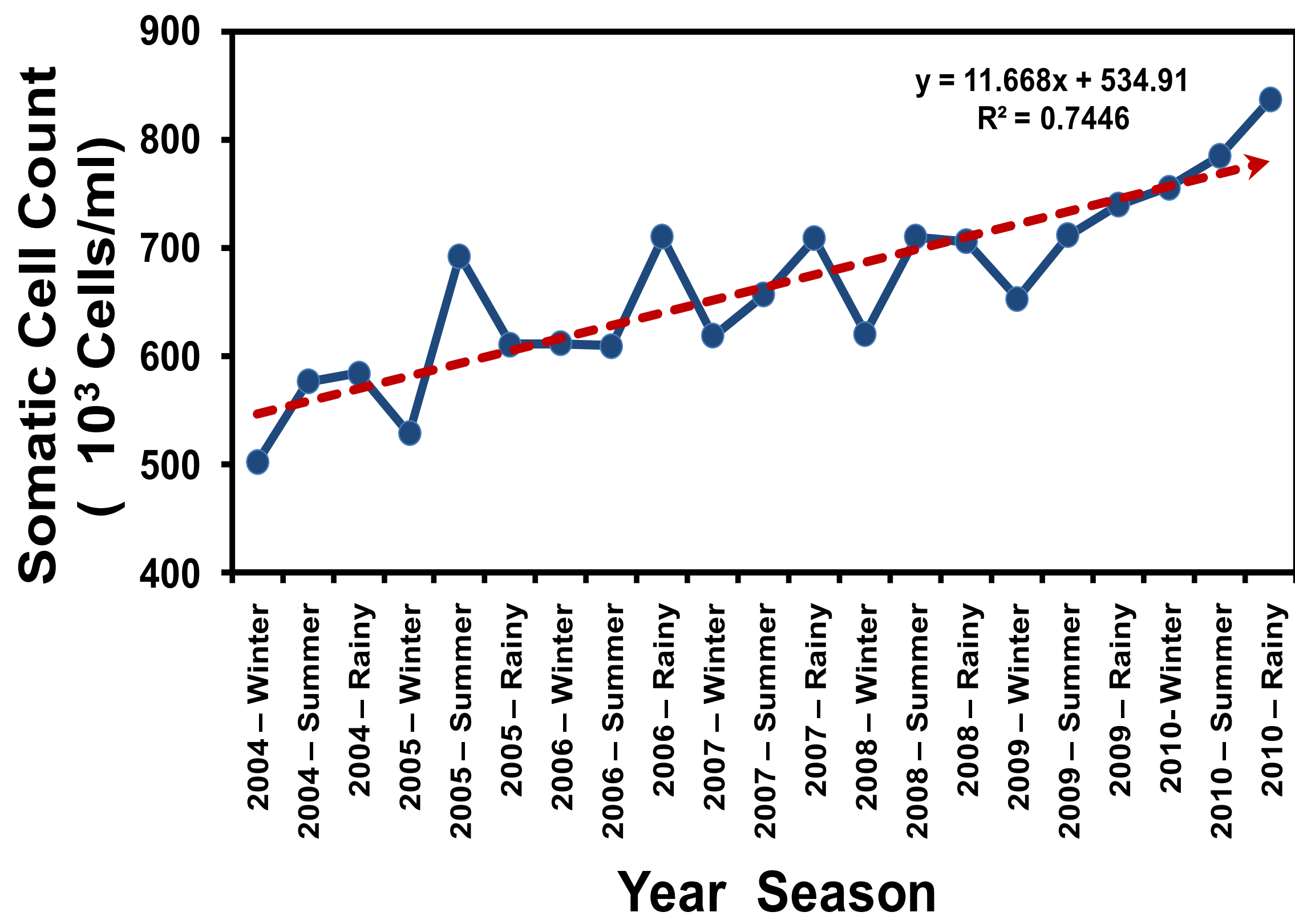
Linear associations between **BSC** and **MYC**, **FAT**, **PRO**, **LAC**, **SNF**, **TS** and **MRC** were estimated using a linear model that contained year-season subclasses, farm size–farm location subclasses, and regression **BSC** as fixed effects, and residual as a random effect. Regression coefficient estimates of the change in **MYC**, **FAT**, **PRO**, **LAC**, **SNF**, **TS** and **MRC** for a **BSC** unit were used to describe the association among them.



RESULTS AND DISCUSSION

Situation of BSC from dairy farms in Central Thailand

The distribution of **BSC** collected from individual dairy farms in Central Thailand from 2004 to 2010 was positively skewed (skewness = 2.45). The mean **BSC** was 681,430 cells/ml (SD = 641,000), and the median was 641,000 cells/ml. The highest frequency **BSC** value was 62,000 cells/ml. There were 4,538 records (31 farms, 4% of all farms) with **BSC** values lower than 200,000 cells/ml (**Group 1**), 5,145 records (119 farms, 15% of all farms) with **BSC** values from 200,000 cells/ml to less than 350,000 cells/ml (**Group 2**), 3,993 records (146 farms, 18% of all farms) with **BSC** values from 350,000 cells/ml to 500,000 cells/ml (**Group 3**), and 11,854 records (515 farms, 63% of all farms) with **BSC** values larger than 500,000 cells/ml (**Group 4**). Further, **BSC** tended to increase from 2004 to 2010 (11,668 cells/ml/year-season; $R^2 = 0.74$).



The higher than 500,000 cells/ml average **BSC** in milk collected from dairy farms in Central Thailand indicated a problem of herd health management, especially mastitis and stress. The increasing trend for **BSC** found in this study reflected the incidence of mastitis in Central Thailand, which was similar to those reported in Northern ([Boonyayatra and Chaisri, 2004](#)) and Northeastern Thailand ([Jarassaeng et al., 2008](#)). However, the large rate of increase of **BSC** between 2004 and 2010 (11,668 cells/ml/year-season) suggested that this situation needs to be taken seriously and **BSC** drastically reduced. Dairy farmers could reduce **BSC** by maintaining healthy cows through proper nutrition and management practices (e.g., sanitary farm management, housing, cooling, milking and dry cow therapy). Moreover, appropriate selection and matting of dairy cattle could also help to increase resistance to mastitis in the cow population ([Carlen et al., 2004](#))

Association between BSC and other dairy traits

The **BSC** was linearly associated ($P < 0.0001$) with milk production, milk composition, and milk revenue (**Table 1**). Each increase in **BSC** of one hundred thousand cells/ml decreased **MYC** (-1.39 ± 0.12 kg), **LAC** (-0.0074 ± 0.0002 %), **SNF** (-0.0022 ± 0.0002 %), and **MRC** (-17.51 ± 1.84 Thai baht), but it increased **FAT** (0.0066 ± 0.0004 %), **PRO** (0.0055 ± 0.0002 %), and **TS** (0.0054 ± 0.0005 %).

High **BSC** indicates the presence of mastitis in the dairy herd. An increase in **BSC** is mostly a result of inflammatory response to mastitis-causing organisms that infect mammary glands. Microbial toxics and enzymes from these responses damage the mammary cells and increase the permeability of tight junctions across endothelial and epithelial layers, which results in a decrease in milk synthesis and in secretion of major milk components (i.e., fat, lactose and casein). Furthermore, the influx of blood proteins (serum albumin, immunoglobulin and transferrin) into the udder leads to an increase in the amount of protein in milk, but a decline of casein secretion ([Shuster et al., 1991](#); [Bruckmaier et al., 2004](#); [Jones, 2009](#)). [Bruckmaier et al. \(2004\)](#) also reported an increase in fat concentration in infected cows. This increase in fat concentration appeared not be the result of increased synthesis, but due to a larger reduction in synthesis of milk and lactose relative to fat. In addition, fat droplets are larger than gaps between cells through which lactose escapes into the blood stream, thus they remain within the alveoli and fat concentration increases ([Petrovski, 2006](#)).

The decrease of **MYC** (-1.39 ± 0.12 kg) and **MRC** (-17.51 ± 1.84 Thai baht) associated with **BSC** increases of 10⁵ cells/ml indicated that Thai dairy farmers need to keep **BSC** as low as possible to increase the profitability and sustainability of their business. Farmers need to improve the quality of feed, management and health care to help dairy cattle be healthier and more productive under their particular environmental conditions. In addition, Thai dairy organizations need to agree on how to include **BSC** as a factor in the assignment of milk prices.



Table 1 Regression coefficient estimates and standard errors of milk production, milk composition, and milk revenue on bulk tank somatic cell count (BSC) in dairy farms from Central Thailand		
Traits	Regression coefficient estimates and standard errors of BSC (×10 ⁵ cells/ml)	P-value
Monthly milk yield per cow (kg)	-1.3865 ± 0.1204	$P < 0.0001$
Fat percentage (%)	0.0066 ± 0.0004	$P < 0.0001$
Protein percentage (%)	0.0055 ± 0.0002	$P < 0.0001$
Lactose percentage (%)	-0.0074 ± 0.0002	$P < 0.0001$
Solid not fat percentage (%)	-0.0022 ± 0.0002	$P < 0.0001$
Total solid percentage (%)	0.0054 ± 0.0005	$P < 0.0001$
Monthly revenue per cow (Thai baht)*	-17.5109 ± 1.8414	$P < 0.0001$
*1 USD = 30.5 Thai baht		

FINAL REMARKS

- The average BSC in this population was 681.43 ± 679.10 ×10³ cells/ml
- Milk produced in most farms (63%) had BSC values higher than 500,000 cells/ml
- The BSC tended to increase over time (11,668 cells/ml/year-season; $R^2 = 0.74$) in Central Thailand
- The BSC was linearly associated with a decrease in MYC, LAC, SNF and MRC, but an increase in FAT, PRO, and TS

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