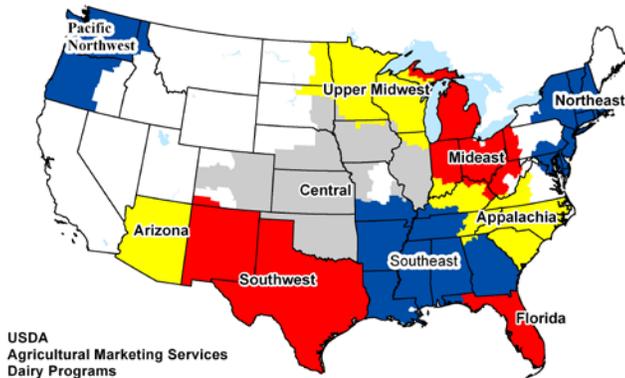


Determining U.S. Milk Quality Using Bulk-Tank Somatic Cell Counts, 2017

The USDA's Animal and Plant Health Inspection Service's Center for Epidemiology and Animal Health (CEAH), in conjunction with the USDA's Agricultural Marketing Service (AMS) and the National Mastitis Council's Milk Quality Monitoring Committee, monitor U.S. milk quality using data from bulk-tank somatic cell counts (BTSCCs). Data are provided by 4 of the Nation's 10 Federal Milk Marketing Orders (FMOs*): Central, Mideast, Southwest, and Upper Midwest (figure 1). The remaining six FMOs do not collect BTSCC data.

Figure 1. Federal Milk Marketing Order areas



By definition, BTSCCs are the number of white blood cells (primarily macrophages and leukocytes), secretory cells, and squamous cells per milliliter of raw milk.¹ BTSCCs are used as measures of milk quality and as indicators of overall udder health. There is an inverse relationship between BTSCCs and cheese yield and the quality/shelf life of pasteurized fluid milk.^{2,3,4} Numerous studies have shown that operations with increased BTSCCs are more likely to have milk that violates antibiotic residue standards.^{5,6,7} The most frequently cited reason for antibiotic residues in milk is placing cows treated with antibiotics in the milking string before the recommended withdrawal period.⁶

To ensure high-quality dairy products, BTSCCs are monitored in milk shipments using standards outlined in the U.S. Pasteurized Milk Ordinance (PMO).⁸ In the United States, the legal maximum BTSCC for Grade A milk shipments is 750,000 cells/mL. If a producer has two out of four shipments that test above the maximum BTSCC (usually tested 30 to 45 days apart), a written notice is issued and an additional sample is tested within 21 days. If three of the last five counts exceed the maximum BTSCC, regulatory action is required, which includes

- 1) Suspending the producer's permit; or
- 2) Foregoing permit suspension, provided that the milk in violation is not sold as Grade A; or
- 3) Imposing a monetary penalty in lieu of permit suspension, provided that the milk in violation is not sold or offered for sale as Grade A.

Maximum BTSCC levels for other countries include 400,000 cells/mL in the European Union (EU),⁹ Australia,¹⁰ New Zealand,¹⁰ and Canada.¹¹ The maximum BTSCC level in Brazil is 1,000,000 cells/mL.¹²

Although support for lowering the maximum BTSCC for Grade A milk in the United States to 400,000 cells/mL has increased in the last few years, changes to the PMO have yet to be made. The National Conference on Interstate Milk Shipments has not lowered the U.S. limit, even though in January 2012 the EU implemented regulations that require milk products exported to the EU have a maximum BTSCC of 400,000 cells/mL.^{13,14}

A few States, however, have reduced the maximum BTSCC limit for producers in their States. These States are California (600,000 cells/mL), Idaho (400,000 cells/mL), Oregon (500,000 cells/mL), and Washington (400,000 cells/mL).¹⁵ Producers in the United States that have four consecutive rolling 3-month BTSCC geometric means greater than 400,000 cells/mL limit cannot export milk to the EU unless a derogation[◇] is requested and approved. If the derogation is not approved, producers must suspend milk pick-ups from their farm, segregate any products made from that milk from the products that comply with EU requirements, or make sure that products made from noncompliant milk are not certified.¹⁴

*FMOs are administrative units consisting of groups of States and were established under the authority of the Agricultural Marketing Agreement Act of 1937, as amended. Their purpose is to stabilize markets by placing requirements on the handling of milk; data are collected to provide accurate information on milk supplies, utilization and sales. Monitored FMOs are Central, Mideast, Southwest, and Upper Midwest.

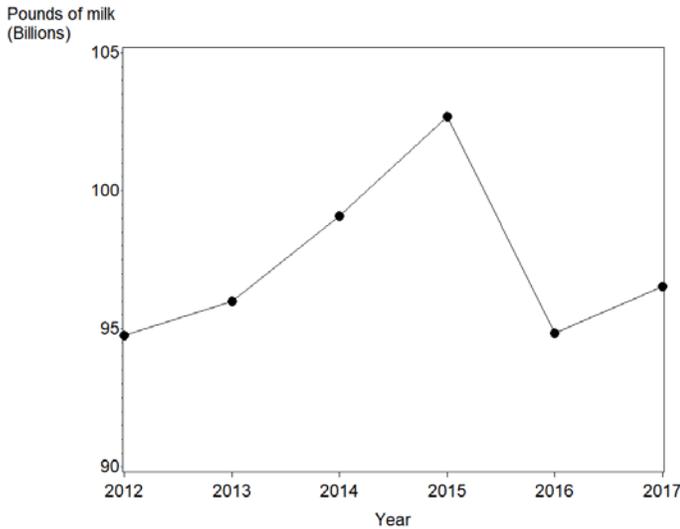
◇A derogation is a provision in an EU legislative measure that allows for all or part of the legal measure to be applied differently, or not at all, to individuals, groups, or organizations.

The EU also regulates bacterial standard plate counts in which a 2-month geometric mean is used based on a minimum of two standard plate counts performed per month. The bacterial limit for the EU is 100,000 bacteria/mL, which is also the limit for Grade A milk in the United States; however, the United States and the EU calculate compliance differently.^{8 14}

Monitored FMOs

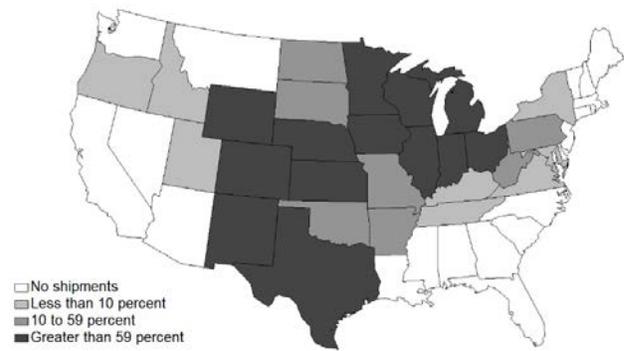
In 2017, milk from the Central, Midwest, Southwest, and Upper Midwest FMOs was monitored. In total, these FMOs monitored milk from 21,616 producers (53.7 percent) of the 40,219 producers, and the monitored milk accounted for 96.5 billion pounds (44.8 percent) of the 215.5 billion pounds of milk produced in the United States in 2017.¹⁶ The pounds of milk monitored by the four FMOs decreased in 2016 and increased in 2017 (figure 2).

Figure 2. Total pounds of milk shipped through the four monitored FMOs, by year



Producers in 28 States marketed at least 1 milk shipment through 1 of the 4 monitored FMOs during 2017 (figure 3). The States that shipped greater than 59 percent of the total State milk production were primarily in the Central and Upper Midwest regions of the United States. California and the southeastern States are not represented in these data.

Figure 3. Percentage of total State milk production shipped through the four monitored FMOs during 2017, by State



Of the 21,616 producers that shipped milk through one of the four FMOs in 2017, 55.8 percent were from the Upper Midwest FMO, while only 2.5 percent were from the Southwest FMO. In total, 210,332 milk shipments were monitored (table 1), with 113,252 (53.8 percent) coming from the Upper Midwest. The Upper Midwest FMO accounted for 38.3 percent of milk monitored by the four FMOs and 17.2 percent of all milk produced in the United States. The Upper Midwest and Midwest FMOs had a higher percentage of shipments relative to the amount of monitored milk. Conversely, in the Central and Southwest FMOs, 14.8 and 3.0 percent of shipments accounted for 19.2 and 20.5 percent of the monitored milk, respectively, reflecting that larger herds supply milk through these two FMOs.

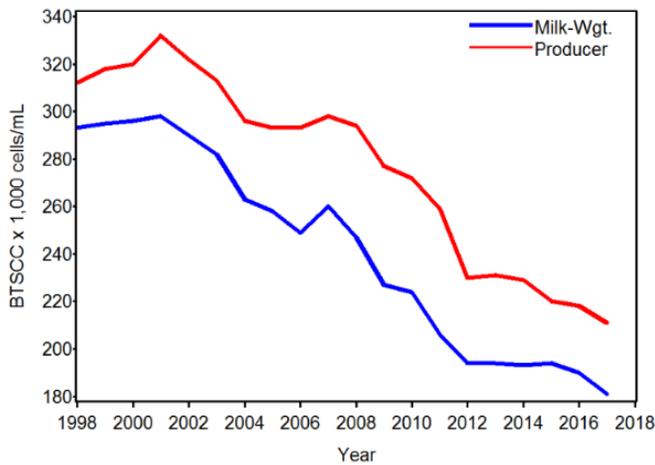
Table 1. Number and percentage of producers, shipments, and milk marketed through the four monitored FMOs during 2017

	FMO				Total
	Central	Midwest	South-west	Upper Midwest	
Producers					
Number	3,342	5,657	550	12,067	21,616
Percent	15.5	26.2	2.5	55.8	100.0
Shipments					
Number (x1,000)	31.1	59.6	6.3	113.3	210.3
Percent	14.8	28.4	3.0	53.8	100.0
Milk					
Billion pounds	18.5	21.2	19.8	37.0	96.5
Percent monitored	19.2	22.0	20.5	38.3	100.0
Percent of U.S. production	8.6	9.8	9.2	17.2	44.8

2017 BTSCC trends

In 2017, the milk-weighted geometric BTSCC mean in the United States was 181,000 cells/mL, a decrease from 190,000 in 2016 (figure 4). Milk-weighted BTSCCs take into account the amount of milk shipped by a producer, resulting in an overall BTSCC mean of monitored milk. The producer BTSCC—which is a geometric, nonmilk-weighted mean of all shipments—was 211,000 cells/mL, a decrease from the 219,000 cells/mL calculated in 2016.

Figure 4. Milk-weighted and producer BTSCCs for the four monitored FMOs, 1998–2017



Evaluating BTSCC levels

In 2017, more than 99 percent of milk and shipments monitored met the current PMO limit of 750,000 cells/mL (table 2). During all months monitored, 97.1 percent of milk produced was below 400,000 cells/mL, and 73.2 percent of producers shipped milk below this limit for the entire year. Of 21,616 producers, 97.9 percent shipped milk with BTSCCs below 750,000 cells/mL during all months monitored.

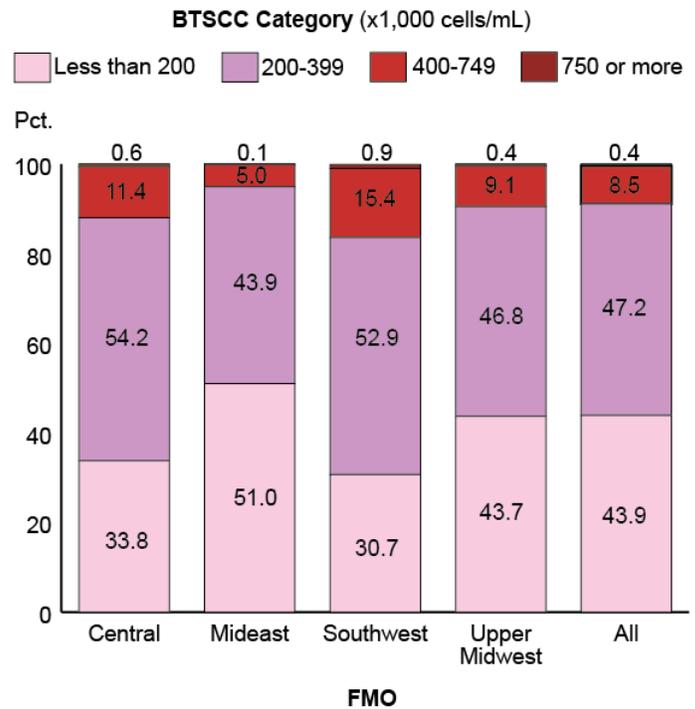
Table 2. Percentage of milk, shipments, and producers for the four monitored FMOs, by BTSCC level during 2017

BTSCC (x1,000 cells/mL)	Milk (96.5 billion pounds)	Percent	
		Shipments (210,332)	Producers* (21,616)
Less than 100	7.3	7.0	1.6
Less than 200	60.0	43.9	20.6
Less than 400	97.1	91.1	73.2
Less than 650	99.8	99.1	96.0
Less than 750	99.9	99.6	97.9

*All shipments for the entire year met criteria.

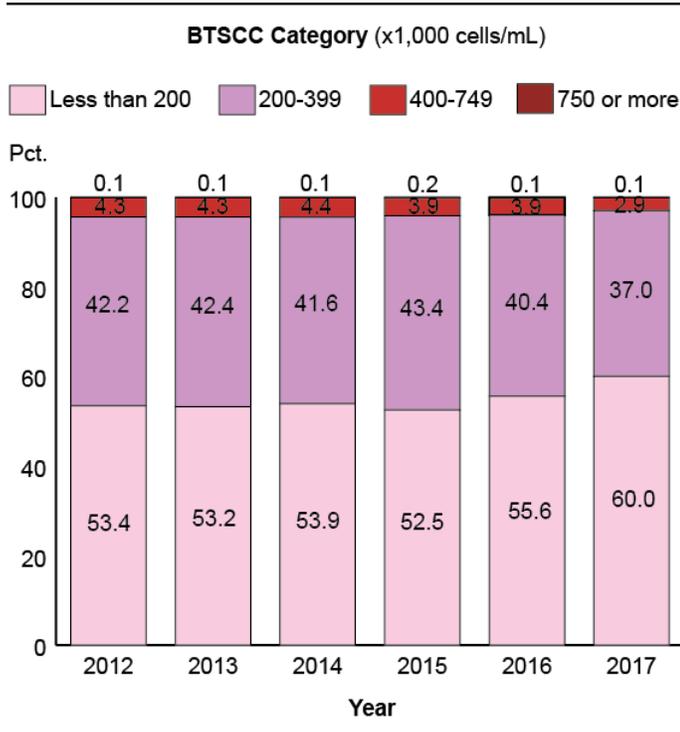
In 2017, about 50 percent of shipments in all monitored FMOs had BTSCCs from 200,000 and 399,000 cells/mL. More than 90 percent of shipments in the Upper Midwest and Mideast FMOs (90.5 and 94.9 percent, respectively) and more than 80 percent of shipments in the Central and Southwest FMOs (88.0 and 83.6 percent, respectively) were below 400,000 cells/mL (figure 5).

Figure 5. Percentage of shipments, by FMO and by BTSCC category, 2017



From 2012 to 2017, the percentage of total milk shipped with BTSCCs less than 200,000 cells/mL increased from 53.4 to 60.0 percent of milk shipped (figure 6). The percentage of total milk with counts less than 400,000 cells/mL increased from 95.6 to 97.0 percent during the same period.

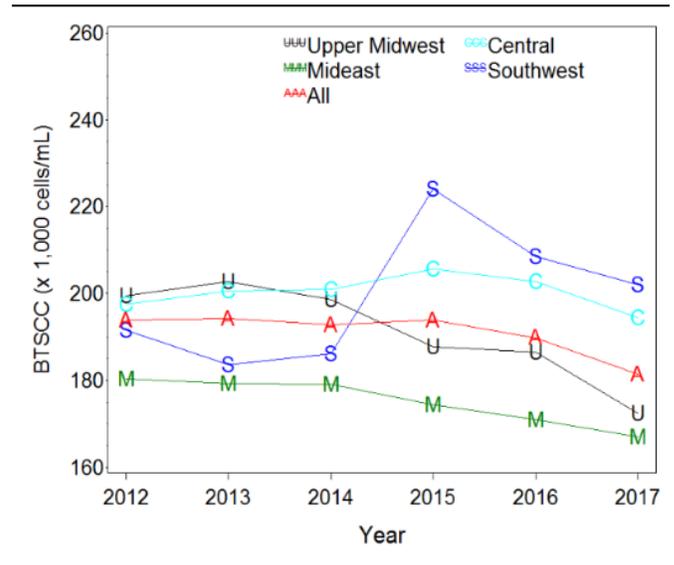
Figure 6. Percentage of total milk shipped through the four monitored FMOs, by BTSCC category and by year



FMO and State BTSCC trends

Overall, BTSCCs were level from 2012 to 2014. BTSCCs for the Central and Southwest FMOs increased in 2015, but both decreased in 2016. A continued slight decrease in BTSCCs was observed in 2017 for all FMOs (figure 7).

Figure 7. Milk-weighted BTSCCs, by FMO and by year



In total, 13 States marketed 60 percent or more of the milk produced in their States through the monitored FMOs and accounted for 98.6 percent of the monitored milk in the four FMOs (table 3). Wisconsin, Texas, Michigan, New Mexico, and Minnesota accounted for 74.0 percent of all FMO-monitored milk. Compared with 2016, 11 of the 13 States had decreased BTSCCs in 2017, 1 State had an increased count, and 1 State was unchanged.

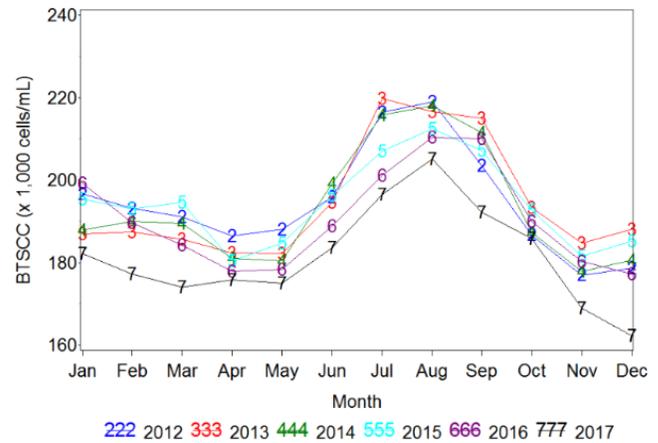
Table 3. Milk-weighted BTSCCs for States shipping 60 percent or more of their total milk production through the four monitored FMOs

State	Percent total monitored milk—2017	BTSCC (x1,000 cells/mL) by Year					
		2012	2013	2014	2015	2016	2017
CO	4.4	168	184	193	189	185	169↓
IL	1.8	214	215	209	205	209	200↓
IN	3.1	197	198	201	200	192	179↓
IA	5.2	206	211	214	204	199	197↓
KS	2.8	204	199	199	212	196	195↓
MI	11.9	156	158	160	156	157	157
MN	7.9	205	210	207	196	198	194↓
NE	1.7	182	177	171	171	177	161↓
NM	10.2	175	166	170	209	199	193↓
OH	5.5	202	198	195	187	182	177↓
TX	14.8	207	199	196	235	214	206↓
WI	29.2	199	202	196	185	185	169↓
WY	0.1	124	143	147	128	125	161↑
13 States	98.6	192	192	191	193	188	180↓

Seasonal BTSCC trends

Monthly monitoring continues to show that BTSCCs peak during summer (June through September) when higher temperatures and humidity increase stress on cows and provide conditions more favorable for bacterial growth (figure 8). In 2017, monthly milk-weighted BTSCCs were highest during August (205,000 cells/mL) and lowest in December (162,000 cells/mL).

Figure 8. Milk-weighted BTSCCs for the four monitored FMOs, by year and by month



Figures 9 to 12 represent seasonal fluctuations in BTSCCs for each FMO by month and year. Monthly BTSCCs for 2017 were generally lower compared with 2012 through 2016 for the Upper Midwest and Mideast FMOs but were higher in the Southwest FMO.

Figure 9. Central Order milk-weighted BTSCCs, by year and by month

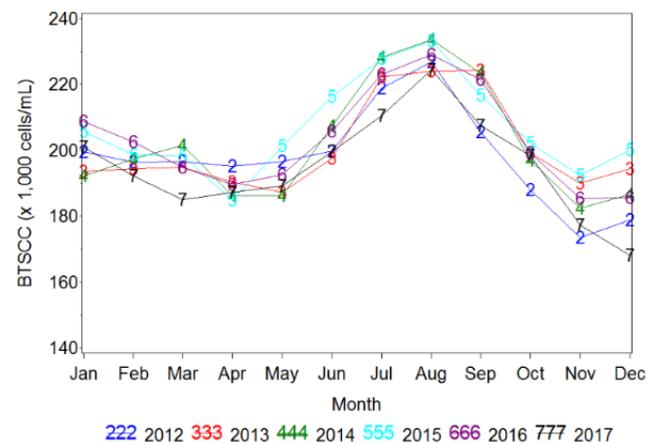


Figure 10. Mideast Order milk-weighted BTSCCs, by year and by month

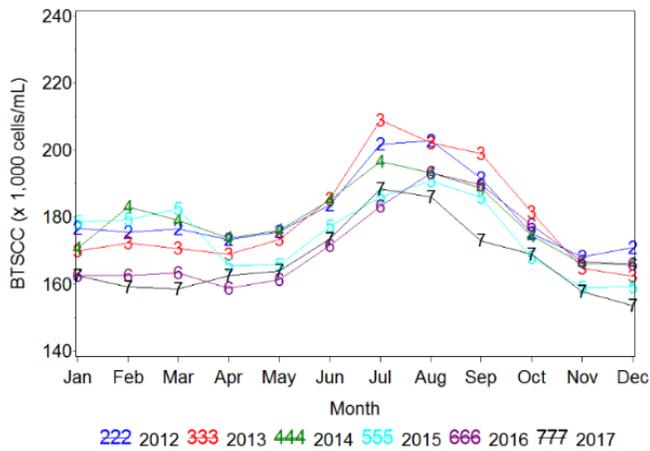


Figure 11. Southwest Order milk-weighted BTSCCs, by year and by month

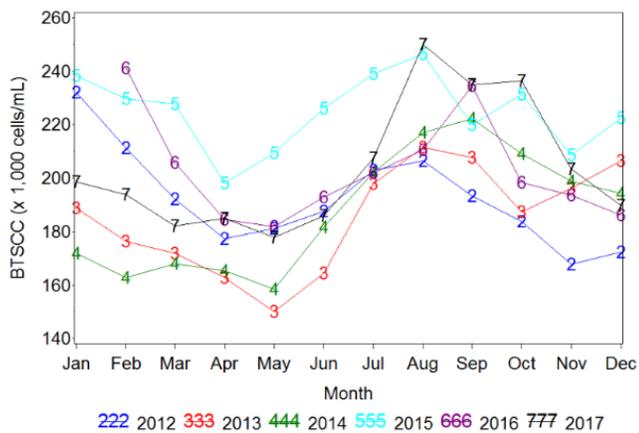
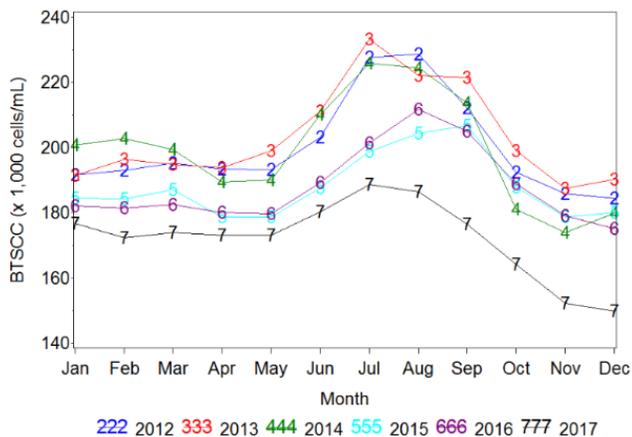


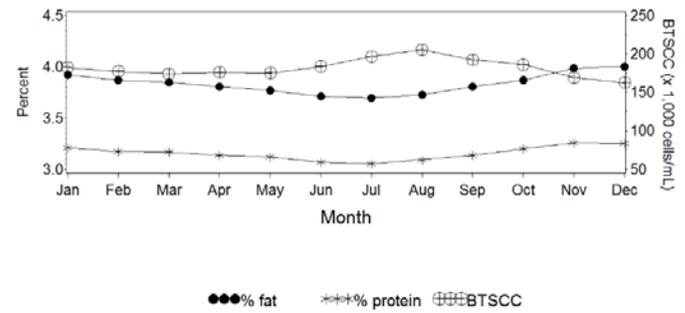
Figure 12. Upper Midwest Order milk-weighted BTSCCs, by year and by month



Fat and protein

Although BTSCCs generally peak during summer months, the percentages of fat and protein in monitored milk were at their lowest values in summer (figure 13).

Figure 13. Percentage of fat and percentage of protein in monitored milk and BTSCCs for the four monitored FMOs during 2017, by month



Comparison with Dairy Herd Improvement Association herds

Most herds enrolled in milk recording for the Dairy Herd Improvement Association (DHIA) elect to have individual cow's milk sampled and tested for somatic cell counts (SCC). Individual cow values are then weighted by the amount of milk produced in order to obtain an estimate of the herd-level SCC. The herds are weighted by the amount of milk in the same manner to produce an average SCC for DHIA herds in the Nation (for cows enrolled in DHIA herds across the United States); the average was 197,000 cells/mL, which is higher than the average milk-weighted BTSCC of 181,000 cells/mL reported in this summary.¹⁷ A comparison of DHIA and FMO State-level BTSCCs are provided in table 4. For 11 of the 12 comparable States, FMO BTSCCs were lower than the DHIA BTSCCs. DHIA data include herds from the southeastern United States, which generally experience higher temperature and humidity values than herds in other parts of the country. Another potential reason the DHIA average would be higher than the BTSCCs is that all DHIA cows are tested and included, even those that had milk withheld from the bulk tank. Milk from cows with mastitis have elevated SCCs is often withheld from the bulk tank.

Table 4. Milk-weighted BTSCCs for States shipping 60 percent or more of their total milk production through the four monitored FMOs and for DHIA herds, 2017

State	BTSCC (x1,000 cells/mL)	
	FMO	DHIA
CO	169	197
IL	200	214
IN	179	187
IA	197	200
KS	195	213
MI	157	154
MN	194	232
NE	161	212
NM	193	201
OH	177	192
TX	206	199
WI	169	180
WY	161	NR
All	181	197

Summary

Bulk-tank somatic cell counts from monitored FMOs are indicative of the quality of the Nation's milk supply. The milk-weighted mean BTSCC from the four monitored FMOs was 181,000 cells/mL in 2017. Overall, BTSCCs have decreased since 2012. The BTSCCs for all four of the FMOs decreased from 2016 to 2017. Twelve of the 13 States shipping 60 percent or more of their milk through the 4 FMOs had the same or lower BTSCCs in 2017 compared with 2016. In summer months, BTSCCs increased, whereas the percentages of fat and protein in milk decreased. In addition to influencing improvements in U.S. dairy management practices, the current EU import regulations might be partially responsible for the decrease in BTSCCs and the corresponding improvement in milk quality since 2012.

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