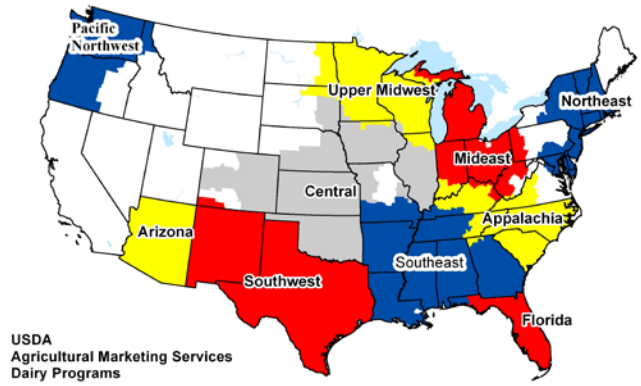
Determining U.S. Milk Quality Using Bulk-Tank Somatic Cell Counts, 2016

The USDA's Animal and Plant Health Inspection Service's Center for Epidemiology and Animal Health, 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*): Upper Midwest, Central, Mideast, and Southwest (figure 1). The remaining six FMOs do not collect BTSCC data.

Figure 1. Federal Milk Marketing Order areas



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 also 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 the milk in violation is not sold as Grade A; or

3) Imposing a monetary penalty in lieu of permit suspension, provided 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 to have a maximum BTSCC of 400,000 cells/mL.[13 14] A few States, however, have reduced the 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]

U.S. producers that have four consecutive rolling 3-month BTSCC geometric means greater than the 400,000 cells/mL limit cannot export milk to the EU unless a derogation◊ is requested and approved. If the derogation is not approved, the milk supplier must suspend pick up of milk from the farm, segregate the products made from that milk from the products that comply with EU requirements, or discontinue certifying products made from noncompliant milk.[14]

*FMOs are administrative units made up 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 were Central, Mideast, Southwest, and Upper Midwest.

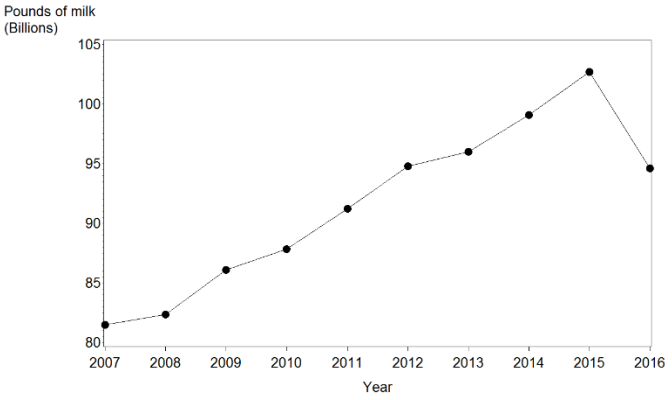
◊A derogation is a provision in an EU legislative measure that allows for all or part of the legal measure to be applied differently, or not at all, to individuals, groups, or organizations.

The EU also regulates bacterial standard plate counts. For these regulations, 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

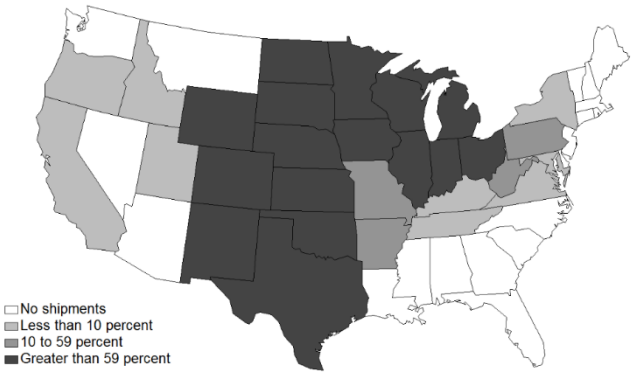
In 2016, milk from the Upper Midwest, Central, Mideast, and Southwest FMOs was monitored. In total, these FMOs monitored milk from 24,131 producers, and the monitored milk accounted for 94.6 billion pounds (44.6 percent) of the 212.4 billion pounds of milk produced in the United States in 2016.[16] For the first time since 2007, the pounds of milk monitored by the four FMOs decreased (figure 2).

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



Producers in 29 States marketed at least 1 milk shipment through one of the 4 monitored FMOs during 2016 (figure 3). The States that shipped greater than 59 percent of total State milk production were primarily in the central part of the United States. California and the southeastern States are not well represented in these data.

Figure 3. Percentage of total State milk production shipped through the four monitored FMOs during 2016, by State



Of the 24,131 producers that shipped milk through one of the four FMOs in 2016, 58.6 percent were from the Upper Midwest while only 2.4 percent were from the Southwest order. A total of 237,966 milk shipments were monitored (table 1), with 133,000 (55.9 percent) coming from the Upper Midwest. The Upper Midwest FMO accounted for 40.1 percent of milk monitored by the four FMOs and 17.9 percent of all milk produced in the United States. The Upper Midwest and Mideast FMOs had a higher percentage of shipments relative to the amount of monitored milk. Conversely, in the Central and Southwest FMOs, 14.5 and 2.7 percent of shipments accounted for 18.7 and 19.1 percent of the monitored milk, respectively, reflecting that larger herds supply milk through these two FMOs.

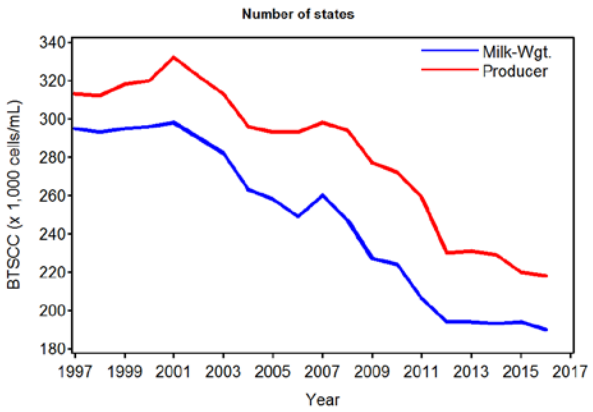
Table 1. Number and percentage of producers, shipments, and milk marketed through the four monitored FMOs during 2016

	FMO				
	Upper Midwest	Central	Mideast	South-west	Total
Producers					
Number	14,157	3,422	5,977	575	24,131
Percent	58.6	14.2	24.8	2.4	100.0
Shipments					
Number (x1,000)	133.0	34.5	63.9	6.5	238.0
Percent	55.9	14.5	26.9	2.7	100.0
Milk					
Billion pounds	37.9	17.7	20.9	18.1	94.6
Percent monitored	40.1	18.7	22.1	19.1	100.0
Percent of U.S. production	17.9	8.3	9.9	8.5	44.6

2016 BTSCC trends

In 2016, the milk-weighted geometric BTSCC mean in the United States was 190,000 cells/mL, a slight decrease from 194,000 in 2015 (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 219,000 cells/mL, very close to the 220,000 cells/mL calculated in 2015.

Figure 4. Milk-weighted and producer BTSCCs for the four monitored FMOs, 1997–2016



Evaluating BTSCC levels

In 2016, 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, 96.0 percent of milk produced was below 400,000 cells/mL, and 70.0 percent of producers shipped milk below this limit for the entire year. Of 24,131 producers, 97.1 percent shipped milk with BTSCCs below 750,000 cells/mL during all months monitored.

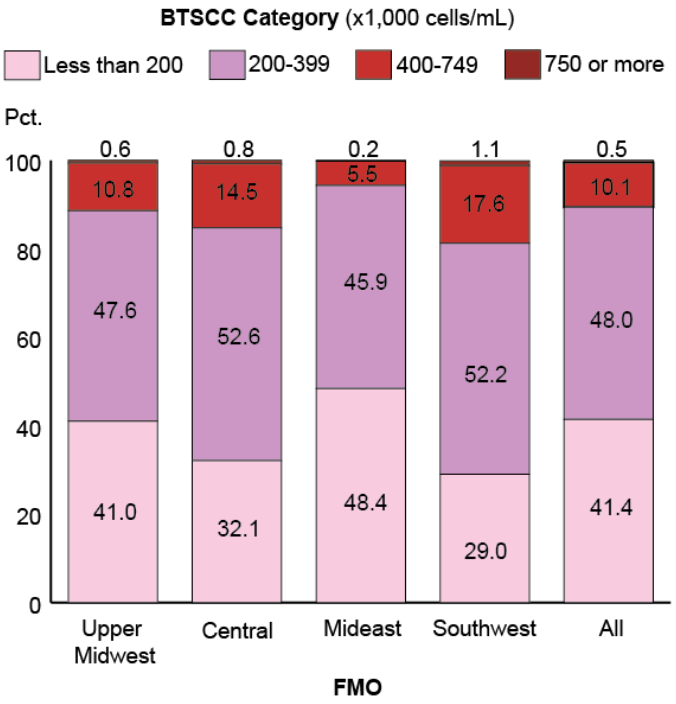
Table 2. Percentage of milk, shipments, and producers for the four monitored FMOs, by BTSCC level during 2016

BTSCC (x1,000 cells/mL)	Percent		
	Milk (94.6 billion pounds)	Shipments (237,966)	Producers* (24,131)
Less than 100	5.9	6.4	1.4
Less than 200	55.5	41.4	18.5
Less than 400	96.0	89.4	70.0
Less than 650	99.7	98.8	94.6
Less than 750	99.9	99.5	97.1

*All shipments for the entire year met criteria.

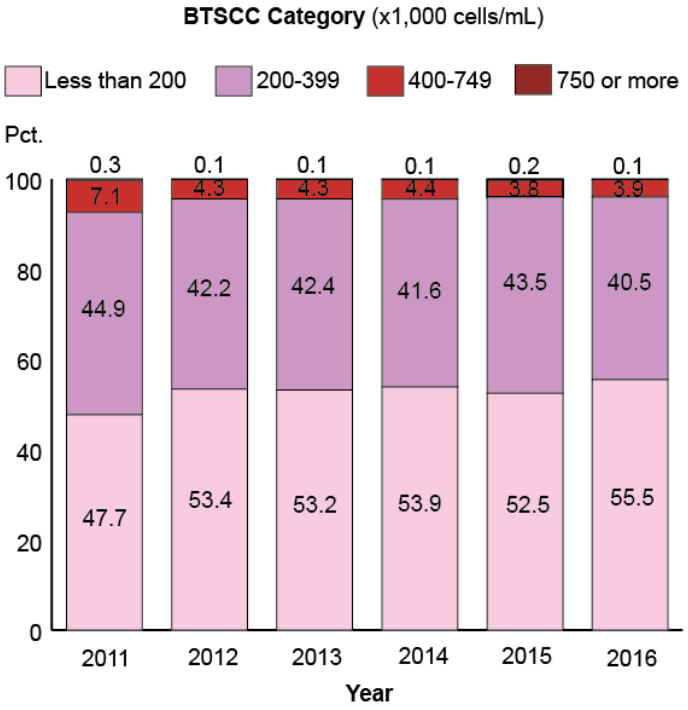
In 2016, about 50 percent of shipments in all monitored FMOs had BTSCCs between 200,000 and 399,000 cells/mL. More than 90 percent of shipments in the Mideast FMO (94.3 percent) and more than 80 percent of shipments in the other three FMOs were below 400,000 cells/mL (figure 5).

Figure 5. Percentage of shipments, by FMO and by BTSCC category, 2016



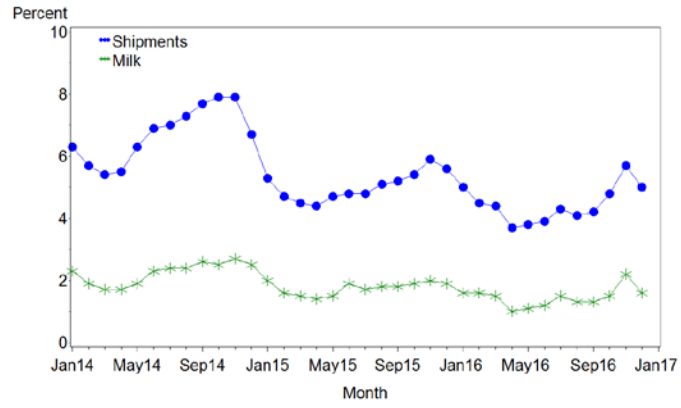
From 2011 to 2016, the percentage of total milk shipped with BTSCCs less than 200,000 cells/mL increased from 47.7 to 55.5 percent (figure 6). The percentage of total milk with counts less than 400,000 cells/mL increased from 92.6 to 96.0 percent during the same time period.

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



One criterion for the EU Health Certification Program from USDA–AMS is based on a 3-month geometric mean BTSCC. Shipments for which the 3-month geometric mean is above 400,000 cells/mL for 4 consecutive months are considered to be noncompliant. Less than 6.5 percent of monitored U.S. shipments and 3 percent of monitored milk were noncompliant during 2016 (figure 7).

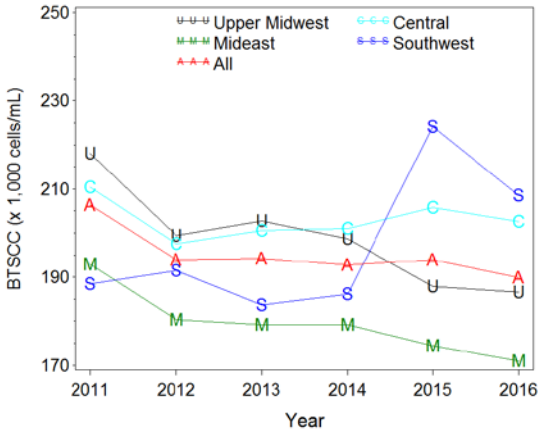
Figure 7. Percentage of milk and shipments sent through the four monitored FMOs from 2014 to 2016 that would not have met the EU Health Certification Program's BTSCC criteria, by month



FMO and State BTSCC trends

Overall, BTSCCs decreased from 2011 to 2012 and, since then, have leveled out. BTSCCs for the Central and Southwest FMOs increased in 2015 but both decreased in 2016 (figure 8).

Figure 8. Milk-weighted BTSCCs, by FMO and by year



Sixteen States marketed 60 percent or more of the milk produced in their States through the monitored FMOs and accounted for 96.6 percent of the monitored milk in the four FMOs (table 3). Wisconsin, Texas, Michigan, New Mexico, and Minnesota accounted for 69.3 percent of all FMO-monitored milk. Compared with 2015, 9 of the 16 States had decreased BTSCCs in 2016, 6 States had increased counts, and 1 State was unchanged.

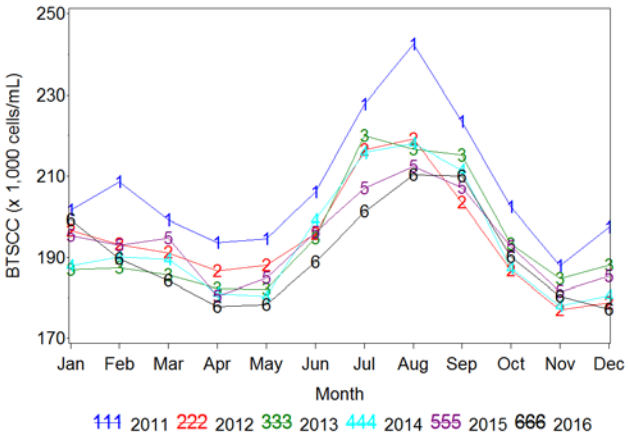
Table 3. Milk-weighted BTSCCs for States shipping 60 percent or more of their total milk production through the four monitored FMOs

State	Percent total monitored milk—2016	BTSCC (x1,000 cells/mL) by Year					
		2011	2012	2013	2014	2015	2016
CO	4.1	186	168	184	193	189	185↓
IL	1.7	241	214	215	209	205	209↑
IN	3.2	204	197	198	201	200	192↓
IA	6.2	228	206	211	214	204	199↓
KS	2.5	205	204	199	199	212	196↓
MI	11.9	167	156	158	160	156	157↑
MN	7.8	227	205	210	207	196	198↑
NE	1.4	182	182	177	171	171	177↑
NM	9.3	167	175	166	170	209	199↓
ND	0.2	276	243	237	222	182	168↓
OH	5.5	220	202	198	195	187	182↓
OK	0.5	326	322	288	287	302	307↑
SD	1.9	247	220	226	232	207	218↑
TX	12.6	208	207	199	196	235	214↓
WI	27.7	218	199	202	196	185	185
WY	0.1	127	124	143	147	128	125↓
16 States	96.6	206	193	194	192	194	189↓

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 9). In 2016, monthly milk-weighted BTSCCs were highest during August and September (210,000 cells/mL) and lowest in April and May (178,000 cells/mL).

Figure 9. Milk-weighted BTSCCs for the four monitored FMOs, by year and by month



Figures 10 to 13 represent seasonal fluctuations in BTSCCs for each FMO by month and year. Monthly BTSCCs for 2016 were generally lower compared with 2011 through 2014 for the Upper Midwest and Mideast FMOs but were higher in the Southwest FMO. The area of New Mexico and Texas covered by the Southwest FMO was hit with a major snowstorm—"Goliath"—in December 2015. The storm made it very difficult and in some instances impossible for producers to conduct normal management practices. An estimated 35,000 adult dairy cows died during the storm. With normal milking practices disrupted, BTSCC increased to 315,000 cells/mL during January 2016 but were still below 2015 levels for all but 3 months of 2016.

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

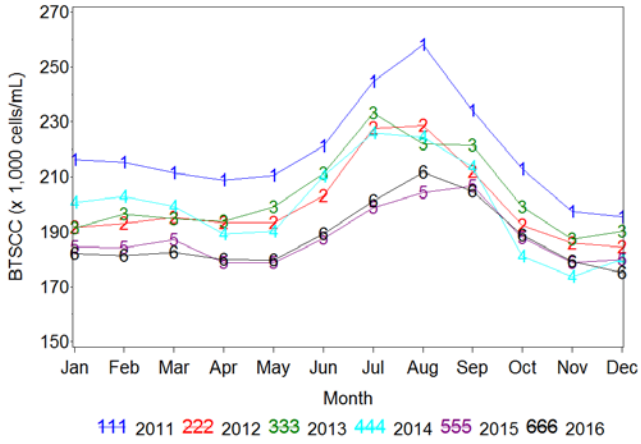


Figure 11. Central Order milk-weighted BTSCCs, by year and by month

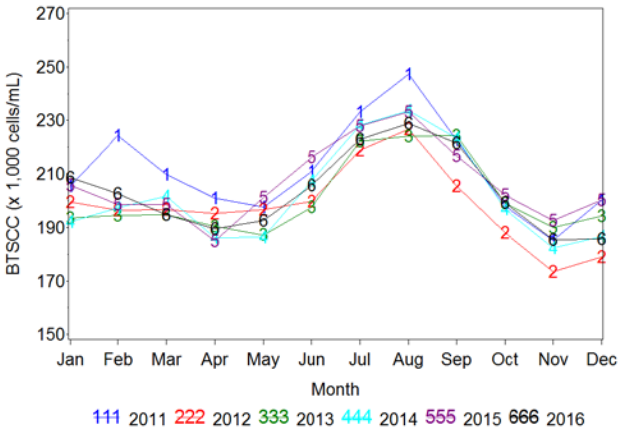


Figure 12. Mideast Order milk-weighted BTSCCs, by year and by month

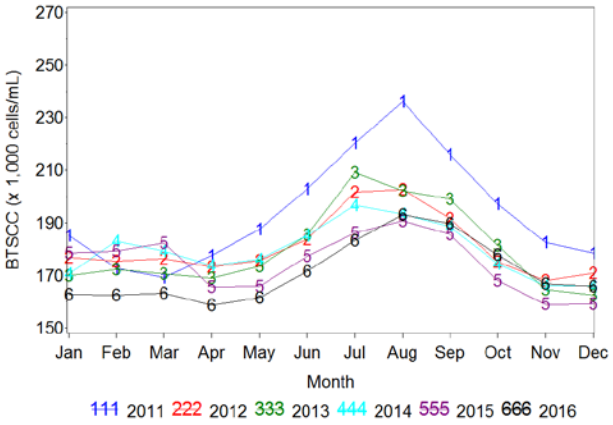
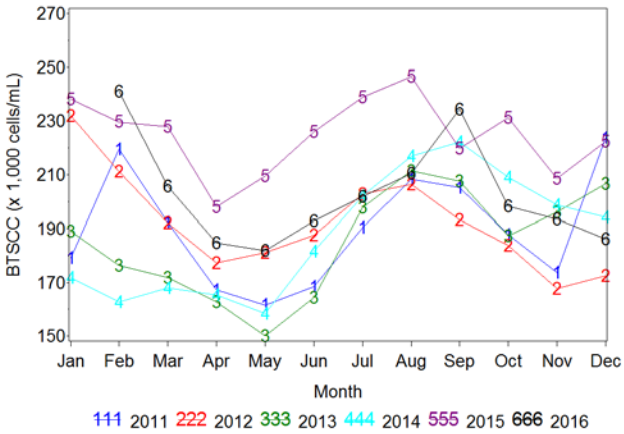


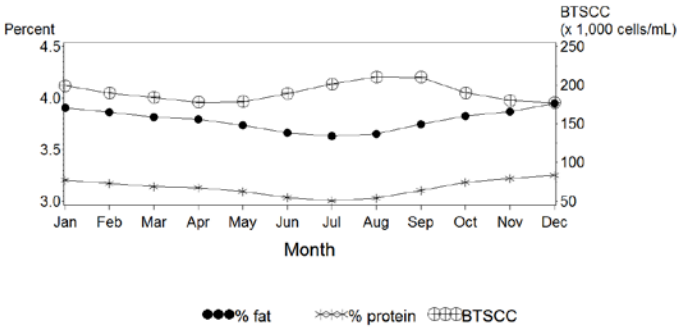
Figure 13. Southwest Order milk-weighted BTSCCs, by year and by month



Fat and protein

Whereas BTSCCs generally peak during the summer months, the percentages of fat and protein in monitored milk were at their lowest values in summer (figure 14).

Figure 14. Percentage of fat and percentage of protein in monitored milk and BTSCC for the four monitored FMOs during 2016, 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 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 203,000 cells/mL, higher than the average milk-weighted BTSCC of 190,000 cells/mL reported in this summary.[17] A comparison of DHIA and FMO State-level BTSCCs are provided in table 4. For 12 of the 15 comparable States, the FMO BTSCC was lower than the DHIA BTSCC. DHIA data include herds from the southeastern United States which generally experience higher temperature and humidity values than other parts of the country. Another potential reason that the DHIA average would be higher than the BTSCC is that all cows are tested and included, even those that had milk withheld from the bulk tank. Milk from cows with mastitis have elevated SCC are 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, 2016

	BTSCC (x1,000 cells/mL)	
State	**FMO**	**DHIA**
CO	185	210
IL	209	226
IN	192	215
IA	199	205
KS	196	248
MI	157	157
MN	198	243
NE	177	219
NM	199	209
ND	168	205
OH	182	197
OK	307	304
SD	218	253
TX	214	209
WI	185	203
WY	125	NR
All	190	203

Summary

BTSCCs 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 190,000 cells/mL in 2016. Overall, BTSCCs have decreased since 2011 and leveled off since 2012. The BTSCCs for all four of the FMOs decreased between 2015 and 2016. Ten of the 16 States shipping 60 percent or more of their milk through the 4 FMOs had the same or lower BTSCCs in 2016 compared with 2015. BTSCC increased in the summer months, 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 may be partially responsible for the decrease in BTSCCs and the corresponding improvement in milk quality since 2011.

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