UPPER MIDWEST MARKETING AREA

Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level

2024

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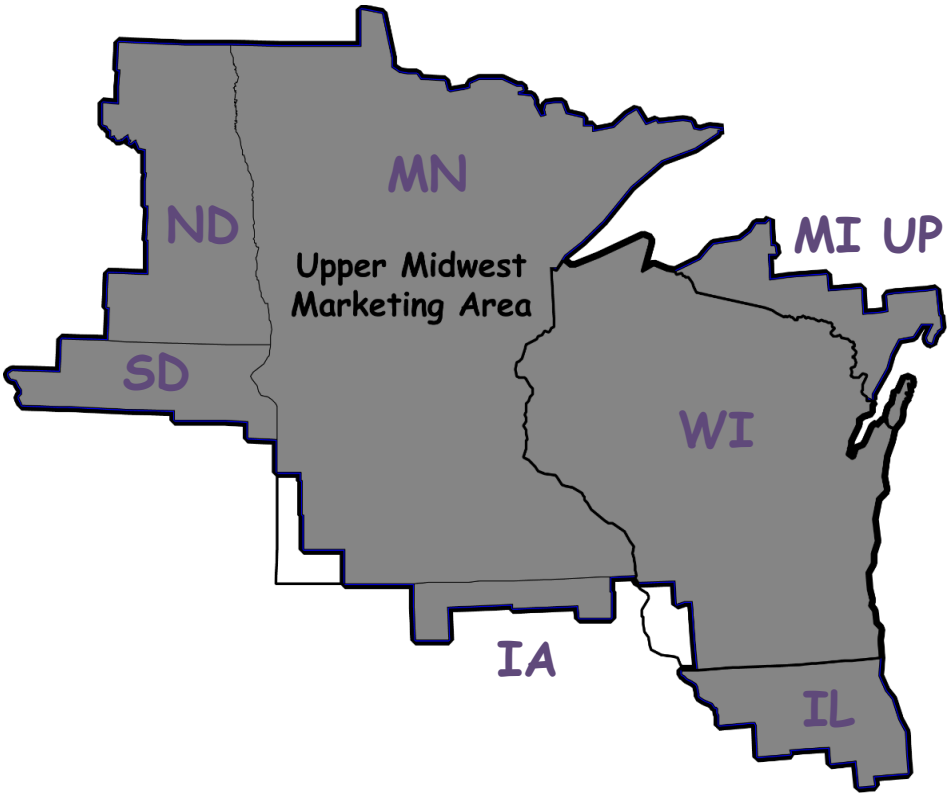

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2024

Areerat Kichkha[1]

Introduction

This study analyzes the component levels and values comprising milk production for Federal Order 30 for 2024. The payroll data for producers who were associated with the Upper Midwest Milk Marketing Order were examined. On average, 7,473 dairy producers were associated with the market every month.

The payroll data presented for this study are for those dairy farmers residing in any county in the states comprising Federal Order 30. In Michigan, only dairy farmers in the Upper Peninsula are included. The data are aggregated to the farm level which is consistent with other staff papers done by this office.

Data and Methodology

The data used in this analysis are from monthly payroll records submitted to the Upper Midwest Order. Since handlers generally submit their entire payrolls, the data include not only producer milk pooled on the Upper Midwest, but also may include, in some cases, producer milk pooled on other orders and milk historically associated with the order but not pooled in some months because of class price relationships and prices in other Federal marketing orders. The result is a difference between the number of producers and milk production reported in this study and the number of producers and milk production reported as pooled on the Upper Midwest Order.

Also, there are a number of instances in which there are multiple cases representing producer milk from one farm. These are situations where more than one producer received a share of the milk check, or there is more than one bulk tank on the farm. For individual producers, total monthly milk marketed, component pounds and somatic cell count (SCC) from payrolls submitted to the Market Administrator's office are aggregated to the farm level for this analysis. All producer milk was included in the analysis that follows, unless otherwise noted in the text, figures, or tables.

Other solids, for purposes of Federal milk order pricing, are defined as solids-not-fat (SNF) minus protein. Therefore, other solids consist primarily of lactose and ash. Ash

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traditionally has been considered a constant in SNF, while lactose does vary somewhat in the SNF.

Many factors such as weather, feed quality and feeding practices, breed of cattle, etc., may impact component levels and relationships among components in milk. No attempt was made to estimate the specific effects of such factors on milk composition. However, average component levels were examined for seasonal or within-year variation. In addition, component levels were examined for the seven primary states that are at least partially within the milk procurement area of the Upper Midwest Order. Since the procurement area stretches from south of Chicago to northwestern North Dakota, state level component and SCC statistics provide a means of reflecting variation in milk composition across a large geographic area. For 2024, average component levels by size of producer marketings were also examined.

This paper also looks at somatic cell count data for the period 2012 to 2024. The analysis seeks to identify and quantify a possible trend in decreasing somatic cell counts. The trend component must also be separated from the cyclical component endemic to somatic cell counts.

The cumulative value of butterfat, protein and other solids, adjusted for SCC, on an annual per cwt. basis, was examined to observe how milk values varied under differing constraints. Monthly Federal order component prices that apply to the Upper Midwest Order were used to calculate milk values for this study.

Seasonal Variation in Milk Component Levels and SCC

While widespread use of artificial insemination, freestall barns, and total mix rations have reduced production swings, seasonality is still present. Seasonal production 'spring flush' and the winter drop in production also lead to seasonal movements in component tests. Butterfat, protein and SNF tests generally have their lowest levels in July and peak in November. Somatic cell counts peak in the warm summer months and reach a low point in November. Other solids tests show little variation but usually peak in the spring or summer months.

Monthly weighted average component levels and SCC for 2024 are summarized in Table 1. Seasonal changes in component levels for 2024 appeared to be relatively normal. Beginning in January, butterfat, protein and SNF tests tapered off during the summer to low points in July, then rose to peak levels around December. Other solids tests peaked in July and then declined slightly for the remainder of the year.

Table 1

Weighted Average Components Levels and Somatic Cell Count, by Month

2024

Month	Butterfat	Protein	Other Solids	SNF	SCC
	- % -	- % -	- % -	- % -	- 1,000 -
January	4.42	3.36	5.79	9.15	167
February	4.37	3.33	5.79	9.12	167
March	4.36	3.33	5.78	9.11	164
April	4.34	3.32	5.77	9.09	165
May	4.25	3.27	5.80	9.06	174
June	4.19	3.21	5.80	9.01	181
July	4.17	3.19	5.80	8.99	198
August	4.19	3.21	5.79	9.00	203
September	4.24	3.27	5.79	9.06	195
October	4.36	3.35	5.79	9.14	179
November	4.46	3.41	5.79	9.19	168
December	4.54	3.43	5.78	9.21	164
Annual Weighted Average	**4.32**	**3.30**	**5.79**	**9.09**	**177**
Minimum	4.17	3.19	5.77	8.99	164
Maximum	4.54	3.43	5.80	9.21	203

The seasonality of changes and magnitude of variation in component levels during the year were generally similar to the observed results from previous studies. Seasonal variation in the monthly average SCC in 2024 appeared to be typical with higher levels in the summer, but with slightly atypical lower levels which appeared late in the fall and winter with the lowest point in March and December 2024.

Several miscellaneous annual statistics, in addition to weighted averages, are summarized in Table 2. The simple averages for butterfat, protein, other solids, and SNF were lower than the weighted average, indicating that larger producers (in terms of monthly milk deliveries) tended to have higher levels of these components than smaller producers.

The period from 2012 to 2024 has seen higher protein levels and overall higher component levels in the largest production group, as seen in Tables 5a and 5b for 2024. The more numerous smaller dairies have tests more likely to be around the simple average and the fewer larger dairies are biased toward the weighted average.

Table 2

Component Levels and Somatic Cell Count (SCC)

2024

Component	Weighted Average	Simple Average	Weighted Standard Deviation	Simple Median	Minimum	Maximum
	- % -	- % -	- % -	- % -	- % -	- % -
Butterfat	4.32	4.16	0.39	4.15	2.05	5.99
Protein	3.30	3.21	0.24	3.20	1.59	4.48
Other Solids	5.79	5.72	0.11	5.75	3.01	6.96
SNF	9.09	8.93	0.27	8.95	4.65	11.16
SCC (per 1,000)	177	223	83	201	13	1279

The simple average SCC of 223,000 was higher than the weighted average of 177,000, indicating that larger producers on average tended to have lower SCC than their smaller counterparts. Moreover, the simple median SCC level of 201,000 was also lower than the simple average, indicating that the distribution of SCC levels for the market was skewed toward higher levels. A more detailed breakdown of that skewness is presented in Tables 3a and 3b. The data for Tables 3a and 3b are from producers for which we have data for all 12 months during the year.

The overall distributions for butterfat, protein, and SNF tests are all approximately normal, with other solids and SCC being skewed. Somatic cell counts are skewed right with a large number of observations at lower levels and fewer large values, i.e. 81% of the farms have a higher SCC than the weighted average SCC. The lower SCC of the larger producers drags down the weighted average.

The ranges of component levels observed in the data were fairly wide. While the ranges of protein and SCC levels continued to be slightly smaller than in the preceding year, the ranges of butterfat, other solids and SNF levels were wider. Monthly average individual producer butterfat levels in the data ranged from 2.05% to 5.99%; protein levels from 1.59% to 4.48%; other solids levels from 3.01% to 6.96%; SNF levels from 4.65% to 11.16%; and SCC from 13,000 to 1,279,000. See Table 2.

However, during the year, the component tests and SCC levels in most producer milk were within one standard deviation of the weighted average. As shown in Table 1, the ranges of component levels within one standard deviation of the weighted average were: 3.93% - 4.71% for butterfat; 3.06% - 3.54% for protein; 5.68% - 5.90% for other solids; 8.82% - 9.36% for SNF; and 94,000 - 260,000 for SCC. Meanwhile, approximately three-quarters of the observed component levels and SCC in the 2024 data were within one simple standard deviation of the simple average ranges.

The differences in the weighted and simple averages and the simple medians of the component tests warrant a closer look at the relationship between farm size, based on monthly average milk marketed, and milk component levels. Producers with marketings for each month of 2024 were divided into ten percentiles, ten groups with the same number of producers, based on average monthly production. The monthly average production and component tests are shown in Table 3a. The range of average monthly production and total production by group are shown in Table 3b.

A more detailed look at the relationship between producer size and component levels shows that butterfat tests were lowest in the smallest group of producers (4.12% in group 1) and increased as the group sizes increased (4.37% in group 10), an unprecedented pattern from previous years. Protein tests also declined from the smaller producers to the larger producers but to a smaller extent than for butterfat. Protein tests fell from 3.21% in Group 1 to 3.19% in Groups 4 and 5 but rose to 3.33% in Group 10. The protein test pattern was similar to the butter and protein test pattern in 2021 - 2023 but different from prior years when the tests dropped as the average size of the producer increased.

The SCC declined steadily for producers as they increased in size. Starting with producers averaging 24,987 pounds per month with an average SCC of 294,000 to producers averaging 3,661,760 pounds per month with an average SCC of 165,000, a difference in the SCC of 129,000.

Table 3a

Weighted Average Components by Monthly Average Producer Milk for Producers with Production in Each Month

2024

Percentile Group	Number of Producers	Butterfat	Protein	Other Solids	SNF	SCC
		- % -	- % -	- % -	- % -	- 1,000 -
1	584	4.12	3.21	5.60	8.80	294
2	584	4.14	3.20	5.66	8.86	263
3	584	4.13	3.20	5.70	8.90	252
4	584	4.13	3.19	5.72	8.92	236
5	584	4.13	3.19	5.74	8.93	216
6	584	4.15	3.20	5.75	8.95	198
7	584	4.18	3.22	5.76	8.98	198
8	584	4.19	3.22	5.78	9.00	191
9	584	4.21	3.22	5.80	9.01	172
10	584	4.37	3.33	5.80	9.13	165
Total	5,838	4.30	3.29	5.79	9.08	175

Table 3b

Monthly Average Producer Milk by Producer Size for Producers with Production in Each Month

2024

Percentile Group	Monthly Average Pounds	Minimum Monthly Average Pounds	Maximum Monthly Average Pounds	Total Pounds	Percentage of Total Pounds	Cumulative Percentage of Total Pounds
1	24,987	273.28	39,047	175,036,844	0.44	0.44
2	51,088	39,054	62,659	357,869,172	0.89	1.33
3	74,870	62,661	87,276	524,462,437	1.30	2.63
4	99,813	87,279	113,053	699,190,381	1.74	4.37
5	129,165	113,056	147,439	904,802,709	2.25	6.62
6	171,625	147,443	201,474	1,202,060,795	2.99	9.61
7	248,030	201,485	308,925	1,737,453,560	4.32	13.93
8	419,621	308,948	567,459	2,939,442,937	7.31	21.25
9	857,609	567,520	1,322,664	6,007,547,899	14.95	36.19
10	3,661,760	1,322,813	22,860,800	25,646,965,183	63.81	100.00
Market Total	573,818	273.28	22,860,800	40,194,831,917		

Other solids and SNF tests steadily increased as average monthly production increased. Other solids tests increased from 5.60% to 5.80% from the smallest to the largest group, while SNF tests increased from 8.80% to 9.13% from the smallest to the largest group.

The data from Tables 3a and 3b also offer some interesting insight into the structure of the market. For instance, the two smallest ten percentile groups of producers supply less than two percent of the milk, while the largest ten percent of producers supply nearly 64 percent of the milk in the market. More than 80 percent of producers have monthly production below the monthly average market production of 573,818 pounds.

Variations in Component Levels and SCC Within the Marketing Area

Milk component levels and SCC were examined for the seven states that have counties within the Upper Midwest Marketing Area (see Table 4). Differences in average component levels and SCC between the states were observed. One-way analysis of variance was used to determine that the weighted averages of the states were not equal. In addition, several post hoc paired tests were conducted to determine if any of the individual states' weighted averages were equal. These tests indicated that even though the observed differences between some of the states were relatively small, the differences between the weighted averages were significant.

Of the states located in the Upper Midwest Marketing Area, South Dakota had the highest weighted average component tests. Wisconsin had the lowest weighted average SCC and Iowa had the highest.

Figure 1

Upper Midwest Marketing Area

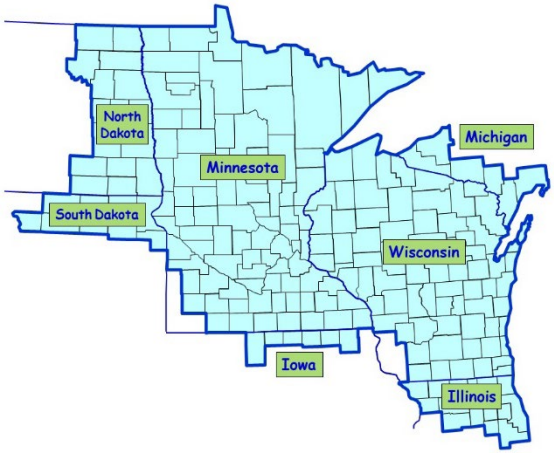


Table 4

Weighted Average Component Levels and SCC by State

2024

State	Butterfat	Protein	Other Solids	SNF	SCC
	- % -	- % -	- % -	- % -	- 1,000 -
Illinois	4.10	3.19	5.79	8.99	191
Iowa	4.45	3.38	5.79	9.17	214
Michigan UP	4.10	3.20	5.78	8.99	209
Minnesota	4.48	3.39	5.77	9.16	189
North Dakota	4.19	3.28	5.77	9.05	211
South Dakota	4.64	3.57	5.80	9.37	183
Wisconsin	4.22	3.23	5.80	9.03	165
Market Total	**4.32**	**3.30**	**5.79**	**9.09**	**177**
Minimum	4.10	3.19	5.77	8.99	165
Maximum	4.64	3.57	5.80	9.37	214

Tables 5a and 5b use a scale of production employed by the Upper Midwest Milk Order to illustrate differences present over production ranges from less than 50,000 pounds to over 5,000,000 pounds. Table 5a shows that component tests tend to increase, but SCC tends to decline, as scale increases. None of the trends are monotonic, though they are more monotonic than previous years. The largest scale of production, 5,000,000 pounds or more, has a substantial increase in butterfat and protein tests and a drop in SCC over the next smaller size range. However, patterns in the other solids and SNF size ranges are not very evident. Table 5a indicates the average monthly production for the largest range is more than two and two-thirds times as much as the second largest size range. Table 5b also shows that the largest size category produces over 33% of total production.

Table 5a
Weighted Average Components by Size Range of Monthly Average Producer Milk
All Producers -- 2024

Size Range Categories *(Pounds)*	Monthly Average Pounds	Butterfat	Protein	Other Solids	SNF	SCC
		- % -	- % -	- % -	- % -	- 1,000 -
Up to 49,999	30,107	4.13	3.20	5.62	8.82	284
50,000 to 99,999	74,494	4.13	3.20	5.70	8.90	253
100,000 to 249,999	157,092	4.15	3.21	5.74	8.95	208
250,000 to 399,999	314,242	4.18	3.22	5.77	8.99	195
400,000 to 599,999	491,103	4.20	3.23	5.78	9.01	187
600,000 to 999,999	766,838	4.20	3.22	5.79	9.01	175
1,000,000 to 1,499,999	1,230,558	4.23	3.22	5.80	9.02	167
1,500,000 to 2,499,999	1,928,015	4.27	3.25	5.81	9.06	157
2,500,000 to 4,999,999	3,486,320	4.30	3.28	5.81	9.09	167
5,000,000 or more	9,444,998	4.51	3.44	5.80	9.23	173
Average	**589,198**	**4.32**	**3.30**	**5.79**	**9.09**	**177**

Table 5b
Monthly Average Producer Milk by Producer Size Range
All Producers -- 2024

Size Range Categories *(Pounds)*	Number of Observations	Minimum Monthly Average Pounds	Maximum Monthly Average Pounds	Percentage of Total Pounds	Cumulative Percentage of Total
Up to 49,999	13,610	170	49,998	0.78%	0.78%
50,000 to 99,999	18,103	50,000	99,986	2.55%	3.33%
100,000 to 249,999	27,148	100,006	249,968	8.07%	11.40%
250,000 to 399,999	8,390	250,029	399,964	4.99%	16.39%
400,000 to 599,999	5,621	400,019	599,839	5.22%	21.61%
600,000 to 999,999	5,548	600,009	999,657	8.05%	29.67%
1,000,000 to 1,499,999	3,463	1,000,130	1,499,906	8.07%	37.73%
1,500,000 to 2,499,999	3,388	1,500,305	2,499,820	12.36%	50.09%
2,500,000 to 4,999,999	2,561	2,500,498	4,992,210	16.90%	66.98%
5,000,000 or more	1,847	5,002,160	24,725,780	33.02%	100.00%
Total	**89,677**	**170**	**24,725,780**		

Component Values Under the Upper Midwest Order

Multiple component pricing on the Upper Midwest Order allows for component levels to be viewed in terms of the value of producer milk given its composition. Milk values, for the purpose of this study, were calculated on an annual basis using monthly Federal order component prices applied to producer milk associated with the Upper Midwest Order during 2024. These values reflect the aggregated value of butterfat, protein and other solids only. These values do not include monthly producer price differentials for the Upper Midwest Order, or premiums and/or deductions that handlers pooling milk under the order may apply to producer pay prices.

As observed in Table 6 the cumulative value of butterfat, protein, and other solids, with an adjustment for SCC, averaged $22.33 per cwt. for the market for 2024.

Table 6

Component Values in Producer Milk

2024

	Component				
	Butterfat	Protein	Other Solids	Somatic Cell Count	Total Value
Value (per cwt.)	$14.20	$6.23	$1.73	$0.16	$22.33
Percentage	63.61	27.92	7.76	0.71	100.00%

Categorized by size range of delivery in Table 7, average values of producer milk ranged from a low of $21.39 per cwt. for monthly producer milk deliveries of between 50,000 pounds and 100,000 pounds, to a high of $23.25 per cwt. for monthly producer milk deliveries of 5,000,000 or more. Historically, this relationship between value per cwt. and production has been inversely related with the producers in the 5,000,000 pound or more range having increased value over the next largest category since 2010. These results correspond well to comparisons between simple and weighted average component levels in the section of this paper beginning on the bottom of Page 2.

Table 7

Aggregated Component Values by Size Range of Monthly Producer Milk

2024

Size Range Categories (Pounds)	Aggregated Component Values *	Producer Milk	Weighted Average Value
	(Dollars)	(Pounds)	($/cwt.)
Up to 49,999	87,830,019.09	409,757,492	21.43
50,000 to 99,999	288,467,231.48	1,348,573,071	21.39
100,000 to 249,999	915,422,037.05	4,264,729,783	21.46
250,000 to 399,999	569,419,318.58	2,636,487,759	21.60
400,000 to 599,999	598,938,140.01	2,760,489,771	21.70
600,000 to 999,999	924,137,207.10	4,254,417,583	21.72
1,000,000 to 1,499,999	931,435,152.37	4,261,421,710	21.86
1,500,000 to 2,499,999	1,440,844,652.34	6,528,258,854	22.07
2,500,000 to 4,999,999	1,986,895,760.58	8,928,465,340	22.25
5,000,000 or more	4,055,347,481.86	17,444,910,697	23.25
Total	**11,798,737,000.46**	**52,837,512,060**	**22.33**

* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

Component Value in 2024

Table 8 contains the component prices announced by Federal orders for 2024. Table 7 indicates the overall component value for each size category using Table 8 prices and Upper Midwest producer data. Table 6 shows the breakdown by component on a per cwt. basis for overall milk value. Butterfat and protein contribute the vast majority of the milk's value with 91.5%, while other solids and the somatic cell value contribute 8.5%.

Table 8

Monthly Component Prices and Somatic Cell Adjustment Rate for the Upper Midwest Order Producers

2024

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	Dollars per Pound			*Dollars per cwt. per 1,000 SCC*
January	2.9765	1.1265	0.2417	0.00076
February	3.1031	1.2255	0.2738	0.00080
March	3.2385	1.1265	0.2881	0.00080
April	3.3309	0.8345	0.2367	0.00077
May	3.4636	1.7349	0.2181	0.00094
June	3.5444	2.0546	0.2326	0.00100
July	3.5720	1.9466	0.2571	0.00099
August	3.5632	2.1756	0.2959	0.00102
September	3.6114	2.9249	0.3430	0.00114
October	3.0851	3.3238	0.3705	0.00112
November	3.0623	2.3160	0.4049	0.00096
December	2.9104	1.9637	0.4493	0.00088
Simple Average	**3.2885**	**1.8961**	**0.3010**	**0.00093**

Trends in Somatic Cell Counts Under the Upper Midwest Order

In 2009, the European Union shifted to a lower SCC maximum for milk used to produce dairy products in the rest of the world that they imported to their market. The possibility of tighter restrictions not having a substantial effect rest on the assumption that changes in the dairy industry have led to lower and lower SCC. The data in Table 9 shows that the weighted average SCC and the weighted standard deviation in SCC data on the Upper Midwest Order has fallen over time and become steadily low in the past three years. In addition, this trend means, in general, that the average has fallen, and the distribution has tightened up around that average from 2012 to 2024.

Table 9

Weighted Average Somatic Cell Count in Milk

2012 to 2024

Year	Weighted Average Somatic Cell Count	Weighted Standard Deviation
	-1,000-	-1,000-
2012	220	98
2013	224	100
2014	222	104
2015	208	94
2016	211	98
2017	198	93
2018	182	89
2019	179	88
2020	177	82
2021	182	88
2022	179	83
2023	178	82
2024	177	83

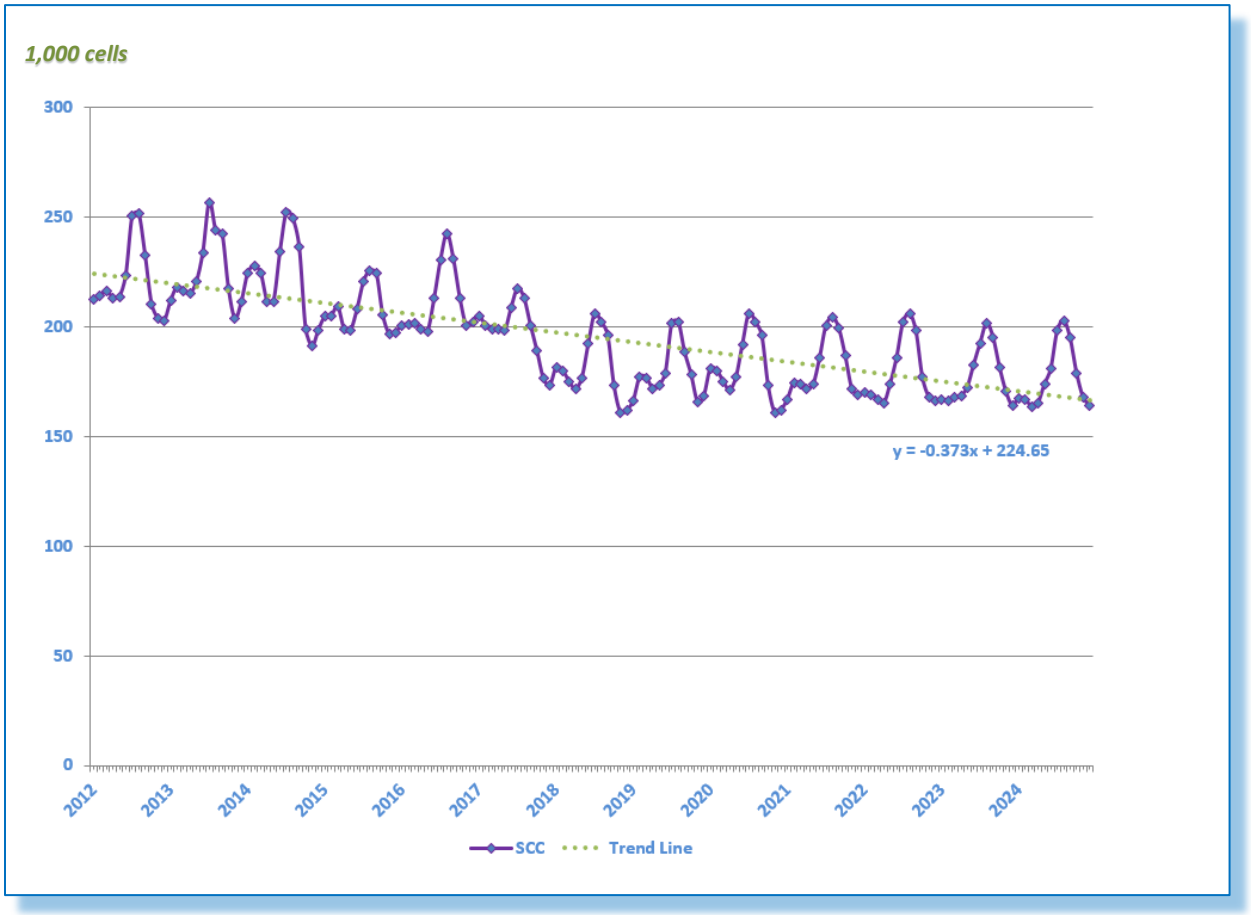
Figure 2 indicates that in addition to a downward sloped trend line, the effect of the trend is greater than the normal seasonal shifts in monthly SCC. The herd milk from producers

in recent years has a seasonal high SCC, usually in mid or late summer, that no longer rises to the winter lows of earlier years. The seasonal highs since 2019 are below the seasonal low for 2012. A trend line fitted to the 2024 data shows a downward slope of -0.373 times the average. That is, after a hundred observations, or months, the average cell count falls by 37.30 1,000s of cells per milliliter from January 2012 to December 2024. This trendline is flatter than the trendlines which include 2009, 2010 and/or 2011 data as seen in these component series papers in the past three years. Hence, the weighted average SCC and weighted standard deviation in the SCC data had become steadier.

Figure 2

Weighted Average Somatic Cell Count by Month

2012 to 2024



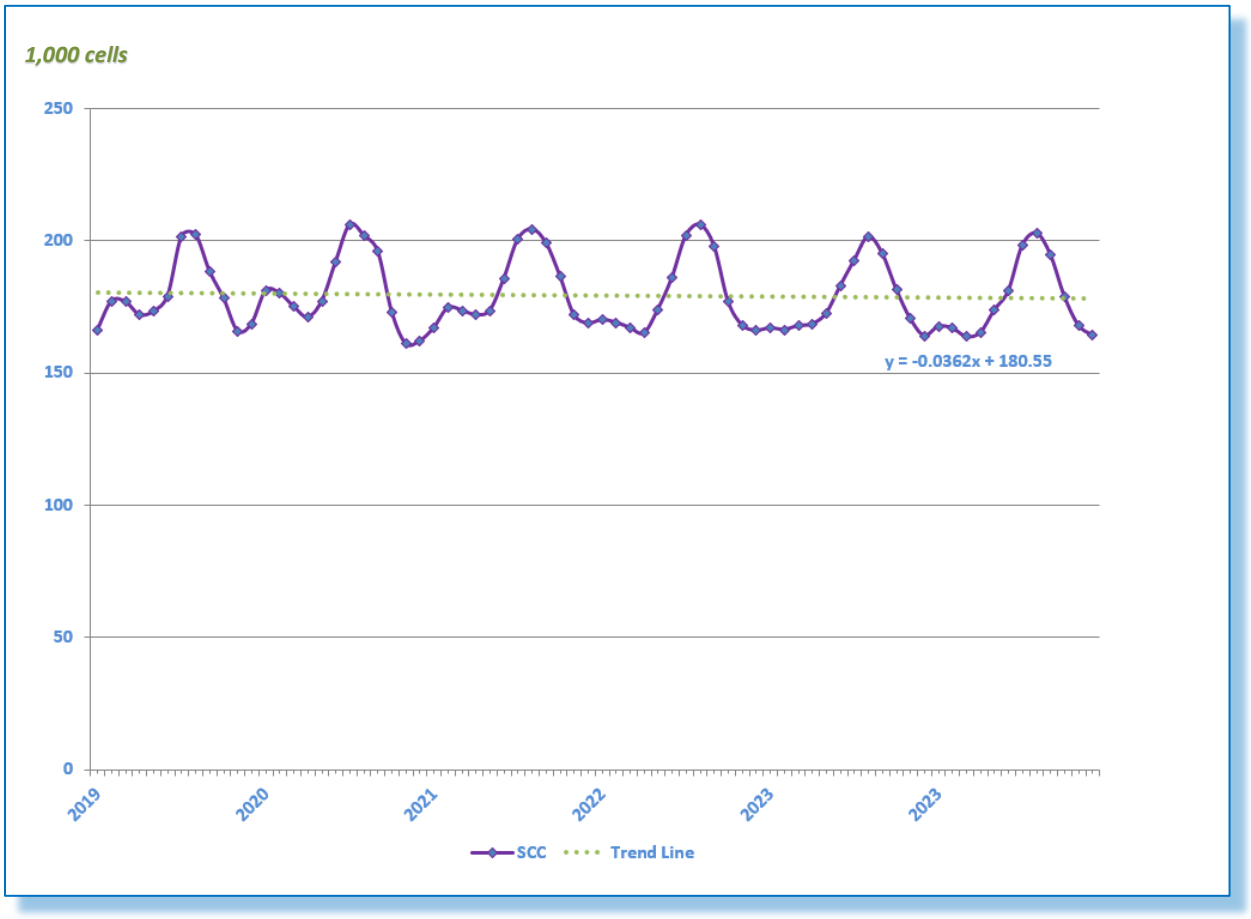
Somatic cell counts under the Upper Midwest Order also have shown steady distribution around the mean since 2019 as they have reached a no-trend state. As seen in Figure 3, a trend line fitted to the data shows an almost flat line with a slope of -0.0362 times the average, i.e. the average of somatic cell counts decreases by 3.62 1,000s of cells per

milliliter from January 2019 to December 2024. This disappearing trend suggests that SCC sustain a stationary state with more consistent predicted values over time.

Figure 3

Weighted Average Somatic Cell Count by Month

2019 to 2024



Summary

The producer payroll data for Federal Order 30 is characterized by seasonality, roughly normal distributions, and a pronounced skewness in number of producers by size. Seasonally, SCC increase in the summer months as the other tests are decreasing. The SCC are also distributed with a skewness to higher values and a median value lower than the simple average SCC. The producer data has a large number of farms producing a relatively small proportion of total milk. The component tests, including SCC, for these small farms have been historically higher. Historically, as a consequence of this skewness, the per cwt. component value of the milk is also higher for smaller farms. A

recent break from historical trends is that the largest categories of dairies have higher component tests and milk value.

Smaller producers, based on average monthly milk marketed in 2024, still had high butterfat and protein tests, but these were no longer the highest tests. They did still have higher SCC values compared to larger producers. Meanwhile, larger producers had higher butterfat, protein, other solids and SNF tests compared to smaller producers.

The smallest producers marketed less than 2 percent of the milk while the largest producers, those over 1,500,000 pounds, produced over 62 percent of all the milk. The monthly average pounds of milk marketed were 589,198 pounds, however, more than 81 percent of the producers had production below the market average.

Somatic cell counts under the Upper Midwest Order have shown a sustained and substantial downward trend from 2012 through 2024. This trend has coincided with a tightening of the distribution of SCC about the mean.

Under multiple component pricing, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $22.33 per cwt. for the market. Butterfat and protein contribute most of the milk's value with other solids and SCC contribution of 8.5% of the total value.

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