UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL 2011

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Prepared by:
Corey Freije

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Federal Milk Market Administrator's Office
1600 West 82nd Street, Suite 200
Minneapolis, Minnesota 55431-1420

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I. INTRODUCTION

This study analyzes the component levels and values comprising milk production for Federal Order 30 for 2011. The payroll data for producers who were associated with the Upper Midwest Marketing Order were examined. On average, 15,743 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. The exception to this is Michigan whose included area is held to the Upper Peninsula. The data are aggregated to the farm level which is consistent with other staff papers done by this office.

II. 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 price relationships between classes and other Federal marketing orders. The result is a significant 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

[1] The author, Dr. Corey Freije, is an Agricultural Economist with the Market Administrator's Office, Minneapolis, Minnesota. Assisting Dr. Freije were Rachel M. Benecke and Henry Schaefer of the Upper Midwest Market Administrator's office.

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 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. 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 2011, average component levels by size of producer marketings were also examined.

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.

III. SEASONAL VARIATION IN MILK COMPONENT LEVELS AND SOMATIC CELL COUNT

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 winter drop also lead to seasonal movements in component tests. As Table 1 indicates, butterfat, protein and snf tests have their lowest levels in July and peak in November and December. Somatic cell counts peak in the warm summer months and reach a low point in December. Other solids tests show little variation but usually peak in the spring or summer months.

Seasonal changes in component levels for 2011 appeared to be relatively normal. Beginning in January, butterfat and protein tests tapered off during the spring to low points in July, then rose to peak levels at some time in the winter. Other solids tests increased slightly in the spring and then declined slightly and leveled off for the remainder of the year. 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 appeared to be typical, with higher levels in the summer and lower levels in the fall and winter. Monthly weighted average component levels and scc for 2011 are summarized in Table 1 and miscellaneous annual statistics, in addition to weighted averages, are summarized in Table 2.

Table 1

Weighted Average Levels of Selected Components and Somatic Cell Count in Milk by Month

2011

Month	Butterfat Test - % -	Protein Test - % -	Other Solids Test - % -	Solids-Not-Fat Test - % -	Somatic Cell Count - 1,000 -
January	3.82	3.11	5.75	8.86	242
February	3.78	3.09	5.74	8.83	244
March	3.76	3.08	5.75	8.83	241
April	3.73	3.05	5.76	8.81	238
May	3.68	3.03	5.74	8.77	237
June	3.61	2.98	5.76	8.74	249
July	3.58	2.92	5.74	8.66	276
August	3.58	2.97	5.72	8.70	287
September	3.69	3.07	5.74	8.81	259
October	3.78	3.14	5.74	8.88	235
November	3.86	3.17	5.74	8.91	218
December	3.86	3.16	5.75	8.91	216
Minimum	3.58	2.92	5.72	8.66	216
Maximum	3.86	3.17	5.76	8.91	287
Annual Average	3.73	3.06	5.75	8.81	245

During the year, butterfat levels dropped from 3.82% in January to 3.58% in July, then rose to 3.86% by November. Protein and snf showed similar seasonal patterns during the year by bottoming out in the summer and peaking by year-end. The standard deviation for butterfat, protein and snf was 0.29, 0.16 and 0.19 percentage points, respectively. Other solids demonstrated the narrowest range of variation with no apparent seasonal pattern. Other solids levels ranged from a high of 5.76% in June and April and a low of 5.72% in August. The seasonal high scc of 287,000 was reached in August before a low of 216,000 in December, a change of 71,000 during the year.

For the year, the simple average butterfat and protein levels were higher than the weighted average for each respective component. The simple averages being higher relative to the weighted averages for these components indicates that smaller producers (in terms of monthly milk deliveries) tended to have higher levels of these components than their larger counterparts. Conversely, the simple averages for other solids and snf were lower than the weighted averages for the respective components indicating that larger producers tended to have higher levels of these components than smaller producers. For the year 2011, the simple average scc (299,000) was higher than the weighted average (245,000) indicating that larger producers tended to have, on average, lower scc than their smaller counterparts. Moreover, the median scc level (223,000) was also lower than the simple average scc, indicating that the distribution of scc levels for the market was skewed toward higher scc levels.

Table 2

Component Levels and Somatic Cell Count of Milk:
Weighted Average, Simple Average, Weighted Standard Deviation,
Weighted Median, Minimum and Maximum

2011

Component	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum
	- % -	- % -	- % -	- % -	- % -	- % -
Butterfat	3.73	3.82	0.29	3.70	1.18	6.91
Protein	3.06	3.07	0.16	3.05	0.91	4.61
Other Solids	5.75	5.69	0.09	5.76	1.68	7.35
SNF	8.81	8.76	0.19	8.81	2.59	10.86
SCC (1,000's)	245	299	115	223	0	5,400

As Table 2 shows, the weighted values for the tests other than solids-not-fat and other solids lies below the simple average. This relationship indicates that production itself is, like somatic cell counts, skewed towards lower values. The more numerous smaller dairies will have tests more likely equal to the simple average and the fewer larger dairies will more likely equal the weighted average. 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 twelve months.

The overall distributions for butterfat, protein and solids-not-fat tests are all approximately normal with other solids and somatic cell counts being skewed. Somatic cell counts are skewed right with a large number of observations at lower levels and fewer values above the weighted average.

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 1.18% and as high as 6.91%; protein levels ranged from 0.91% to 4.61%; other solids levels ranged from 1.68% to 7.35%; solids-not-fat levels ranged from 2.59% to 10.86%; and scc ranged from 0 to 5,400,000.

However, during the year, the component test levels and scc levels in most producer milk were within one standard deviation of the weighted average.[2] The ranges of component levels within one standard deviation of the weighted average were: 3.44% to 4.02% for butterfat; 2.90% to 3.22% for protein; 5.66% to 5.84% for other solids; 8.62% to 9.00% for solids-not-fat; and 130,000 to 360,000 for scc. Approximately three-quarters of the observed component levels and scc in the 2011 data were within these ranges.

The differences in the weighted and simple averages and the 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 2011 were divided into 10 percentiles, 10 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 also shown in Table 3b.

[2] By definition, for a *normal distribution*, approximately 68 percent of observations are within one standard deviation of the weighted average.

Table 3a

Weighted Average Component Tests by Monthly Average Producer Milk Production
Producers with Production in Each Month of 2011

Percentile	Number of Producers	Butterfat Test	Protein Test	Other Solids Test	Solids-Not-Fat Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
1	1,477	3.93	3.10	5.59	8.69	362
2	1,477	3.88	3.08	5.63	8.71	351
3	1,478	3.86	3.07	5.67	8.74	333
4	1,477	3.84	3.07	5.68	8.75	321
5	1,477	3.82	3.06	5.70	8.77	304
6	1,478	3.80	3.06	5.71	8.77	285
7	1,477	3.78	3.06	5.72	8.78	280
8	1,478	3.78	3.06	5.73	8.80	257
9	1,477	3.76	3.06	5.74	8.80	239
10	1,477	3.68	3.04	5.76	8.81	219
Average	14,773	3.81	3.07	5.69	8.76	295

Table 3b

Monthly Average Producer Milk by Producer Size
Producers with Production in Each Month of 2011

Percentile	Number of Producers	Monthly Average Pounds	Minimum Monthly Average Pounds	Maximum Monthly Average Pounds	Total Pounds	Percent of Total Pounds	Cumulative Percent of Total
1	1,477	21,846	3,137	32,091	387,196,446	1.01%	1.01%
2	1,477	39,456	32,094	46,791	699,319,500	1.82%	2.83%
3	1,478	53,344	46,846	60,241	946,115,810	2.47%	5.30%
4	1,477	67,661	60,254	75,188	1,199,231,833	3.13%	8.42%
5	1,477	83,290	75,191	92,014	1,476,231,964	3.85%	12.27%
6	1,478	102,232	92,035	113,579	1,813,195,467	4.73%	16.99%
7	1,477	128,463	113,583	145,592	2,276,882,567	5.93%	22.93%
8	1,478	171,341	145,597	206,682	3,038,910,986	7.92%	30.85%
9	1,477	277,981	206,765	392,913	4,926,933,010	12.84%	43.69%
10	1,477	1,219,154	393,252	18,859,004	21,608,290,061	56.31%	100.00%
Total or Average	14,773	216,455			38,372,307,643		

A more detailed look at the relationship between producer size and component levels shows that larger producers tend to have lower butterfat tests and scc than do smaller producers. Producers averaging 21,846 pounds per month had an average butterfat test of 3.93% while producers averaging 1,219,154 pounds averaged a 3.68% butterfat test. The butterfat test declined steadily from a weighted average of 3.93% for the smallest group to a weighted average of 3.78% and 3.76% for groups 8 and 9, while the group 10 producers,

those averaging 1,219,154 pounds per month, had a weighted average butterfat test of 3.68%. The scc declined steadily from an average of 362,000 for producers averaging 21,846 pounds per month to an average of 219,000 for producers averaging 1,219,154 pounds per month, a difference in the scc of 143,000.

Protein tests also declined from the smaller producers to the larger producers but to a smaller extent than for butterfat, falling from 3.10% for producer's averaging 21,846 pounds per month to 3.04% percent for producers averaging 1,219,154 pounds of milk marketed per month.

Other solids and solids-not-fat tests steadily increased as average monthly production increased. Other solids tests increased from 5.59% to 5.76%, while solids-not-fat tests increased steadily from 8.69% to 8.81% as monthly average production increased from 21,846 pounds to 1,219,154 pounds.

The data from this group of producers also offers some interesting insight into the structure of the market. For instance, the smallest ten percent of producers supply less than two percent of the milk while the largest ten percent of producers supply more than 50 percent of the milk in the market. More than 80 percent of the producers have a monthly production below the monthly average market production of 216,455 pounds.

IV. VARIATIONS IN MILK COMPONENT LEVELS AND SOMATIC CELL COUNTS WITHIN THE MARKETING AREA

Milk component levels and scc were examined for the seven states that have counties residing 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 that are wholly or partially located in the Upper Midwest Marketing Area, North Dakota had the highest weighted average butterfat test and South Dakota had the highest weighted average protein test. South Dakota had the highest weighted average other solids test and weighted average solids-not-fat test. Of the states that are included in the Upper

Midwest Marketing Area, Wisconsin had the lowest weighted average scc and North Dakota had the highest.

Table 4

Weighted Average Components Levels and Somatic Cell Count in Milk by State 2011

State	Butterfat Test	Protein Test	Other Solids Test	Solids-Not-Fat Test	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
Illinois	3.77	3.08	5.71	8.79	251
Iowa	3.72	3.09	5.75	8.84	246
Michigan U.P.	3.67	3.04	5.72	8.76	259
Minnesota	3.76	3.08	5.76	8.84	252
North Dakota	3.81	3.14	5.76	8.90	296
South Dakota	3.78	3.16	5.75	8.92	263
Wisconsin	3.71	3.05	5.74	8.79	241
Market	3.73	3.06	5.75	8.81	245
Minimum	3.67	3.04	5.71	8.76	241
Maximum	3.81	3.16	5.76	8.92	296

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 butterfat and protein tests tend to decline as scale increases and somatic cell counts tend to decline, though none of the trends are monotonic. The largest scale of production has a substantial increase in butterfat and protein tests and a drop in somatic cell counts over the next size range. Table 5b indicates the average monthly production for the largest range is twice the second largest size range's average monthly delivery. Table 5b also shows the largest size category produces 9.08% of the total production.

Table 5a

Weighted Average Component Tests by Monthly Average Producer Milk Production
All Producers 2011

Size Categories (in pounds)	Monthly Average Pounds	Butterfat Test	Protein Test	Other Solids Test	Solids-Not-Fat Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
Up to 49,999	31,006	3.91	3.10	5.62	8.72	355
50,000 to 99,999	73,212	3.83	3.07	5.69	8.76	311
100,000 to 249,999	150,994	3.78	3.06	5.73	8.79	264
250,000 to 399,999	310,948	3.74	3.06	5.75	8.80	235
400,000 to 599,999	486,144	3.70	3.04	5.76	8.79	223
600,000 to 999,999	773,047	3.69	3.03	5.76	8.79	220
1,000,000 to 1,499,999	1,221,467	3.65	3.03	5.77	8.80	211
1,500,000 to 2,499,999	1,908,602	3.66	3.06	5.78	8.83	219
2,500,000 to 4,999,999	3,343,118	3.63	3.07	5.78	8.85	229
5,000,000 or more	7,787,920	3.73	3.14	5.77	8.92	214
Average	208,369	3.73	3.06	5.75	8.81	245

Table 5b

Monthly Average Producer Milk by Producer Size
All Producers 2011

Size Categories (in pounds)	Number of Observations	Monthly Average Pounds	Minimum Monthly Average Pounds	Maximum Monthly Average Pounds	Total Pounds	Percent of Total Pounds	Cumulative Percent of Total
Up to 49,999	46,896	31,006	121	49,998	1,454,077,279	3.69%	3.69%
50,000 to 99,999	58,334	73,212	50,000	99,996	4,270,751,806	10.85%	14.54%
100,000 to 249,999	54,389	150,994	100,003	249,994	8,212,405,615	20.86%	35.40%
250,000 to 399,999	11,497	310,948	250,001	399,993	3,574,966,498	9.08%	44.49%
400,000 to 599,999	6,218	486,144	400,002	599,952	3,022,844,387	7.68%	52.17%
600,000 to 999,999	5,082	773,047	600,038	999,919	3,928,626,356	9.98%	62.15%
1,000,000 to 1,499,999	2,804	1,221,467	1,000,066	1,499,120	3,424,992,820	8.70%	70.85%
1,500,000 to 2,499,999	2,047	1,908,602	1,500,120	2,499,520	3,906,908,571	9.92%	80.77%
2,500,000 to 4,999,999	1,195	3,343,118	2,500,651	4,999,420	3,995,025,660	10.15%	90.92%
5,000,000 or more	459	7,787,920	5,008,150	20,709,910	3,574,655,197	9.08%	100.00%
Total or Average	188,921	208,369			39,365,254,188		

V. 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 2011. 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.

In 2011, the cumulative value of butterfat, protein, other solids and an adjustment for scc averaged $19.15 per cwt. for the market. The value of each component comprised by the $19.15 per cwt. price was $8.01 for butterfat, $9.07 for protein, and $1.97 for other solids. The scc adjustment for the year amounted to about $0.09 per cwt.

Categorized by size range of delivery, average values of producer milk ranged from a low of $18.93 per cwt. for monthly producer milk deliveries greater than 1,000,000 pounds and less than 1,499,999 to a high of $19.47 per cwt. for monthly producer milk deliveries of less than 49,999. In general, the average value of producer milk, per hundredweight, declined as monthly deliveries increased. These results correspond well to comparisons between simple and weighted average component levels in Part III of this paper.

Component Value

Table 6 contains the component prices announced by the Federal orders for 2011. Table 7 indicates the overall component value for each size category using Table 6 prices and Upper Midwest producer data. Given the distribution of larger component test values at smaller sized farms it's not surprising that the value per hundredweight is larger. Table 8 shows the breakdown by component on a hundredweight basis for overall milk value. Butterfat and protein contribute the vast majority of the milk's value with other solids and somatic cell counts contributing just 10.79%.

Table 6

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

2011

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	----------($/Pound)----------			($/cwt. Per 1,000 SCC)
January	$2.0239	$1.7590	$0.2002	$0.00070
February	$2.2967	$2.5586	$0.2310	$0.00087
March	$2.2859	$3.3024	$0.2665	$0.00099
April	$2.2113	$2.4984	$0.2902	$0.00085
May	$2.2497	$2.3133	$0.3026	$0.00083
June	$2.3702	$2.9807	$0.3339	$0.00095
July	$2.2511	$3.8292	$0.3608	$0.00106
August	$2.2985	$3.8305	$0.3811	$0.00107
September	$2.2005	$3.0282	$0.4053	$0.00093
October	$1.9592	$2.9211	$0.4286	$0.00087
November	$1.9508	$3.2341	$0.4521	$0.00092
December	$1.7443	$3.3404	$0.4683	$0.00090
Simple Average	$2.1535	$2.9663	$0.3434	$0.00091

Table 7

Aggregated Component Values by Size Range of Monthly Producer Milk Deliveries

2011

Size Categories (Pounds)	Aggregated Component Values*	Producer Milk (Pounds)	Weighted Average Value (Cwt.)
Up to 49,999	$283,143,153.16	1,454,077,279	$19.47
50,000 to 99,999	$824,414,327.43	4,270,751,806	$19.30
100,000 to 249,999	$1,576,243,537.67	8,212,405,615	$19.19
250,000 to 399,999	$684,420,634.57	3,574,966,498	$19.14
400,000 to 599,999	$575,928,889.34	3,022,844,387	$19.05
600,000 to 999,999	$746,251,783.58	3,928,626,356	$19.00
1,000,000 to 1,499,999	$648,367,255.61	3,424,992,820	$18.93
1,500,000 to 2,499,999	$741,633,349.17	3,906,908,571	$18.98
2,500,000 to 4,999,999	$761,670,955.76	3,995,025,660	$19.07
5,000,000 or more	$694,841,989.20	3,574,655,197	$19.44
Total	$7,536,915,875.49	39,365,254,188	$19.15

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

Table 8
Breakdown of Component Values of Producer Milk Deliveries

2011

	Component				
	Butterfat	Protein	Other Solids	Somatic Cell Count	Total Value
Value ($/cwt.)*	$8.01	$9.07	$1.97	$0.09	$19.15
Percentage	41.86%	47.35%	10.30%	0.49%	100.00%

*Sum does not add due to rounding.

VII. 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, somatic cell counts increase in the summer months as the other tests are decreasing. The somatic cell counts are also distributed with a skewness to higher values and a median value lower than the weighted average somatic cell count. The producer data has a large number of farms producing a relatively small proportion of total milk. The component tests for these small farms are higher including somatic cell counts. As a consequence of this skewness, the hundredweight component value of the milk is also higher for smaller farms. Statewide average component values reflect the makeup of the producer distribution.

Smaller producers, based on average monthly milk marketed, had higher butterfat tests, protein tests and scc than larger producers, while larger producers had higher other solids and snf tests than smaller producers.

The smallest producers marketed less than four percent of the milk while the largest producers, those over 1,000,000 pounds, marketed a third of all the milk. The monthly average pounds of milk marketed were 208,369 pounds, however over 80 percent of the producers had marketings below the market average.

Under multiple component pricing, the annual weighted average value of butterfat, protein, and other solids, adjusted for scc, was $19.15 per cwt. for the market. Butterfat and protein contribute most of the milk's value with other solids and scc contributing 10.79% of the total value.