UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL 2008

Staff Paper 10-02

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ABSTRACT

Data on the butterfat, protein, other solids and solids-not-fat (SNF) levels and somatic cell count (SCC) were examined for producer milk associated with the Upper Midwest Order during 2008. Results from the analysis include: market and state averages and seasonal variation in component levels and SCC, and statistical relationships among the four components in individual herd milk at the farm level.

In this study, component prices from 2008 were applied to producer milk associated with the Upper Midwest Order, thus providing an opportunity to examine how component levels influence the value of producer milk.

Major findings of the analysis include:

1) Weighted average component levels and SCC for 2008 were 3.71% butterfat, 3.04% protein, 5.71% other solids, 8.75% SNF and 283,000 SCC.

2) For 2008, weighted average butterfat levels were lowest in July, while protein and SNF levels were lowest in July and highest during the fall and winter. In contrast, other solids levels varied little during the year. Weighted average SCC were lowest in the fall and winter and highest in August.

3) Butterfat, protein, and SCC tests declined with increasing monthly average milk production, while other solids and solids-not-fat tests increased with increasing monthly milk production.

4) In 2008, the range of weighted average component levels within one standard deviation of the mean was: 3.45% to 3.97% for butterfat; 2.89% to 3.19% for protein; 5.62% to 5.80% for other solids; 8.57% to 8.93% for SNF; and 146,000 to 420,000 for SCC.

5) Based on the data for 2008, the following regression equations were derived:

$$SNF = 7.23152\% + 0.39116\ (BF)$$

$$SNF = 5.45752\% + 1.06565\ (PRO)$$

$$PRO = 1.51689\% + 0.40586\ (BF)$$

6) The annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $18.01 per cwt. for the market in 2008. Protein was the most valuable component, contributing over half of the total value.

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I. INTRODUCTION

The data for this study were collected for milk marketed in 2008 from producers associated with the Upper Midwest Milk Marketing Order. The former Chicago Regional and Upper Midwest Orders were combined on January 1, 2000 as part of the milk order reform required by the 1996 Farm Bill. Geographically, the Upper Midwest Order now includes nearly all of Minnesota and Wisconsin and portions of the Dakotas, Illinois, Iowa and the Michigan Upper Peninsula. Multiple component pricing (MCP), initially adopted in the region in 1996, continued to be the basis for establishing the value of milk pooled under the new order. Under the current MCP plan, producer milk is priced on the cumulative value of butterfat, protein and other solids[2] pounds with adjustments for somatic cell count (SCC) levels. Prior to the introduction of MCP, earlier studies on component levels in individual herd milk were conducted for a sample of producers on the former Upper Midwest Order. In those studies, butterfat, protein, lactose, solids-not-fat (SNF) levels and SCC in milk were analyzed to determine: average component levels, regional and seasonal variation in component levels and SCC, and statistical relationships between the four components in individual herd milk at the farm level. Since MCP has been in effect for payments on producer milk under the order, monthly payroll records for producers associated with the Upper Midwest Order were used to determine monthly and annual average: butterfat, protein[3], other solids and solids-not-fat levels and SCC. Differences between states and seasonal variations of component levels and SCC were noted and analyses were conducted to evaluate the strength of relationships among components.

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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.

2 Other solids are defined as solids-not-fat less protein.

3 Protein tests for 2008 reflect the change from crude protein to true protein testing methods that occurred in January 2000. The difference between crude and true protein levels in milk is non-protein nitrogen (NPN). On an absolute basis, NPN accounts for about 0.19 percentage points of the “protein” in a crude protein value.

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 includes 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 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.

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.[4] 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 2008, average component levels by size of producer marketings were also examined.

Ordinary Least Square (OLS) regression analysis was used to determine the relationship between individual components as well as the impact of seasonality on component tests, for example, butterfat vs. SNF, butterfat vs. protein and protein vs. SNF.

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.

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4 According to historical data gathered through the Market Administrator's Marketing Service program, the "normal" seasonal variation in a given component level, from one year to another, follows a similar pattern.

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

Seasonal changes in component levels for 2008 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 2008 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

2008

Month	Butterfat - % -	Protein - % -	Other Solids - % -	Solids-Not-Fat - % -	Somatic Cell Count - 1,000 -
January	3.81	3.10	5.69	8.79	259
February	3.79	3.10	5.70	8.80	281
March	3.77	3.07	5.70	8.77	287
April	3.72	3.02	5.70	8.72	281
May	3.66	3.01	5.70	8.71	284
June	3.60	2.97	5.73	8.70	299
July	3.57	2.93	5.72	8.65	313
August	3.59	2.95	5.72	8.67	314
September	3.67	3.02	5.72	8.74	293
October	3.77	3.10	5.73	8.82	270
November	3.81	3.12	5.71	8.83	252
December	3.83	3.12	5.71	8.83	260
Minimum	3.57	2.93	5.69	8.65	252
Maximum	3.83	3.12	5.73	8.83	314
Annual Average	3.71	3.04	5.71	8.75	283

During the year, butterfat levels dropped from 3.81% in January to 3.57% in July, then rose to 3.83% by December. Protein and SNF showed similar seasonal patterns during the year by bottoming out in the summer and peaking by year-end. The range of variation for butterfat, protein and SNF was 0.26, 0.19 and 0.18 percentage points, respectively. Other solids demonstrated the narrowest range of variation with no apparent seasonal pattern. Other solids levels ranged from a high of 5.73% in June and October and a low of 5.69% in January. The seasonal high SCC of 314,000 was reached in August before a low of 252,000 in November, a change of 62,000 during the year.

Additional analysis was conducted to determine if the difference between the component tests for the months was significantly different. The analysis showed that as a group the means of the monthly component tests were not equal for each component. The same results were found when individual months were compared.

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 2008, the simple average SCC (335,000) was higher than the weighted average (283,000) indicating that larger producers tended to have, on average, lower SCC than their smaller counterparts. Moreover, the median SCC level (252,000) was also lower than the simple average SCC, indicating that the distribution of SCC levels for the market was skewed toward higher SCC levels (see Appendix Figure A-5).[5]

[5] The median represents the middle value of all SCC tests, ranked numerically from the lowest to the highest SCC level. The median, unlike the mean, is not influenced by outliers. The skewness statistic for SCC was 1.369. Skewness is a measure of the asymmetry of a distribution. A normal distribution is symmetric with a skewness value of zero. A skewness value greater than one indicates a distribution that differs significantly from a normal distribution.

Table 2

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

2008

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -
Butterfat	3.71	3.81	0.26	3.69	0.33	7.06
Protein	3.04	3.06	0.15	3.03	1.51	4.94
Other Solids	5.71	5.66	0.09	5.72	2.85	6.60
SNF	8.75	8.72	0.18	8.75	4.36	10.16
SCC (1,000's)	283	335	137	252	13	4,222

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 0.33% and as high as 7.06%; protein levels ranged from 1.51% to 4.94%; other solids levels ranged from 2.85% to 6.60%; SNF levels ranged from 4.36% to 10.16%; and SCC ranged from 13 to 4,222,000.

However, during the year, the component test levels and SCC levels in most producer milk were within one standard deviation of the mean.[6] The ranges of component levels within one standard deviation of the mean were: 3.45% to 3.97% for butterfat; 2.89% to 3.19% for protein; 5.62% to 5.80% for other solids; 8.57% to 8.93% for SNF; and 146,000 to 420,000 for SCC. Approximately three-quarters of the observed component levels and SCC in the 2008 data were within these ranges[7] (see also Appendix Table A-2 and Appendix Figures A-1 through A-5).

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

[7] The percentage of observations within one standard deviation of the mean in the 2008 data was higher than the approximate percentage attributed to a normal distribution. The kurtosis statistic measures the extent to which observations cluster around a central point. The kurtosis statistic is zero for a normal distribution. Each component and the SCC had kurtosis statistics that were greater than zero, which indicates more observations are clustered around the means than would be attributed to a normal distribution of observations.

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 2008 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 3. The range of average monthly production and total production by group are also shown in Table 3.

Table 3

Weighted Average Component Tests by Monthly Average Producer Milk Production 2008

Percentile	Monthly Average Pounds	Butterfat Test	Protein Test	Other Solids Test	Solids Not Fat Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
1	22,853	3.90	3.09	5.57	8.66	400
2	39,578	3.85	3.07	5.61	8.69	380
3	52,114	3.84	3.07	5.63	8.70	367
4	64,744	3.82	3.06	5.65	8.71	348
5	78,740	3.81	3.05	5.67	8.72	335
6	94,901	3.80	3.05	5.68	8.72	325
7	116,417	3.78	3.05	5.69	8.73	313
8	150,215	3.77	3.04	5.70	8.74	295
9	225,685	3.75	3.05	5.71	8.76	281
10	879,040	3.65	3.03	5.74	8.77	251
Average	172,404	3.72	3.04	5.71	8.75	283

Monthly Average Producer Milk by Producer Size 2008

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	1,612	22,853	765	32,378	36,838,698	1.33	1.33
2	1,613	39,578	32,393	46,151	63,839,449	2.30	3.62
3	1,613	52,114	46,152	58,003	84,060,549	3.02	6.64
4	1,612	64,744	58,007	71,691	104,366,651	3.75	10.40
5	1,613	78,740	71,700	86,287	127,007,246	4.57	14.97
6	1,613	94,901	86,299	104,380	153,075,207	5.51	20.47
7	1,612	116,417	104,382	130,753	187,663,623	6.75	27.22
8	1,612	150,215	130,759	175,781	242,296,564	8.72	35.94
9	1,613	225,685	175,786	302,308	364,029,968	13.09	49.03
10	1,612	879,040	302,661	11,223,320	1,417,013,180	50.97	100.00
Total or Average	16,126	172,404			2,780,191,134		

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 22,853 pounds per month had an average butterfat test of 3.90% while producers averaging 879,040 pounds averaged a 3.65% butterfat test. The butterfat test declined steadily from a weighted average of 3.90% for the smallest group to a weighted average of 3.77% and 3.75% for groups 8 and 9, while the group 10 producers, those averaging 879,040 pounds per month, had a weighted average butterfat test of 3.65%. The SCC declined steadily from an average of 400,000 for producers averaging 22,853 pounds per month to an average of 251,000 for producers averaging 879,404 pounds per month, a difference in the SCC of 149,000.

Protein tests also declined from the smaller producers to the larger producers but to a smaller extent than for butterfat, falling from 3.09 for producers averaging 22,853 pounds per month to 3.03% percent for producers averaging 879,040 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 5.57% to 5.74%, while solids-not-fat tests increased steadily from 8.66% to 8.77% as monthly average production increased from 22,853 pounds to 879,040 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 172,404 pounds.

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), as well a group of “other” states. Differences in average component levels and SCC between the states were observed. One-way analysis of variance was used to determine that the weighted average means of the states were not equal. In addition, several post hoc paired tests were conducted to determine if any of the individual states weighted average means were equal. These tests indicated that even though the observed differences between some of the states were relatively small, the differences between the weighted average means 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. South Dakota had the highest weighted average other solids test, highest weighted average protein test, and weighted average SNF test. Of the states that are included in the Upper Midwest Marketing area Michigan U.P. had the lowest weighted average SCC and Iowa had the highest. Detailed state information by month for 2008 is presented in Table A-2 (see Appendix).

Table 4

Weighted Average Components Levels and Somatic Cell Count in Milk by State 2008

State	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
Illinois	3.74	3.05	5.70	8.76	288
Iowa	3.67	3.07	5.73	8.80	315
Michigan U.P.	3.59	3.05	5.70	8.75	221
Minnesota	3.72	3.05	5.70	8.75	298
North Dakota	3.76	3.10	5.70	8.79	287
South Dakota	3.73	3.11	5.73	8.84	298
Wisconsin	3.72	3.03	5.71	8.74	275
Other[8]	3.67	3.06	5.72	8.78	308
Market	3.71	3.04	5.71	8.75	283
Minimum	3.59	3.03	5.70	8.74	221
Maximum	3.76	3.11	5.73	8.84	315

IV. STATISTICAL RELATIONSHIPS AMONG MILK COMPONENTS

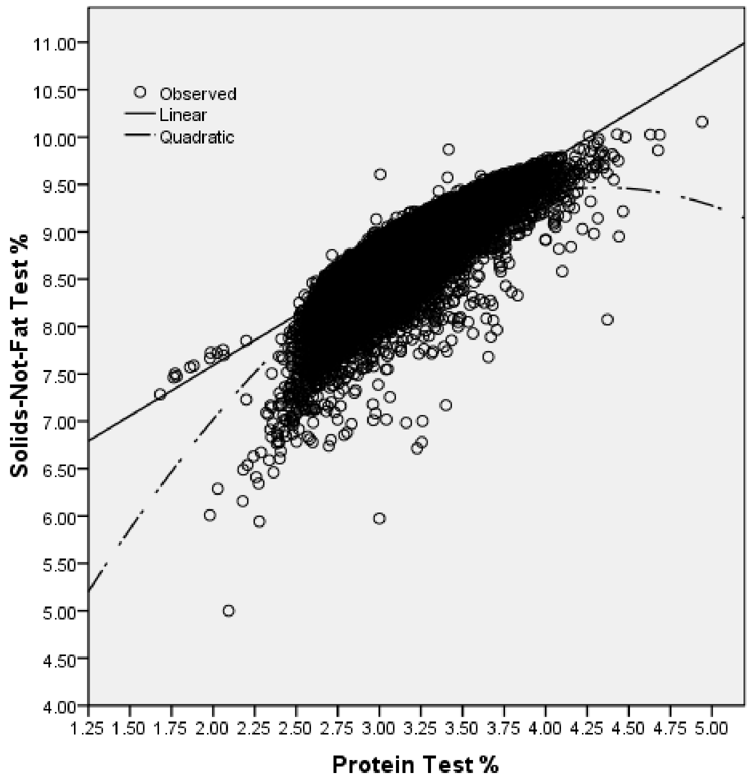
Past Upper Midwest staff papers dealing with milk component levels and the relationships between components in the milk discussed the relationships between milk components based on regression analysis using the formula for a straight line. However, if we look at a scatter plot of solids-not-fat and protein, Figure 1, one can see that a straight line has a tendency to miss the points at both the high end of the solids-not-fat and protein tests and the low end. This graph suggests that a relationship other than a linear one may better capture the relationship between solids-not-fat and protein. A quadratic model was found to result in a slightly better explanation of the relationship between butterfat and protein and

8 Includes milk from Idaho, Indiana, Kansas, Kentucky, Missouri, Montana, Nebraska, Ohio, Pennsylvania, and Washington.

solids-not-fat and protein than the linear model. For consistency with past studies, a discussion of the linear models and coefficients are included in this study. In addition, a discussion of the quadratic model and the resulting regression coefficients are included.

Figure 1

Scatter Plot of Solids-Not-Fat and Protein Tests -- January 2008



Regression analysis was used to estimate the linear relationship between components. Results from the 2008 data were compared with results from previous Upper Midwest Order studies (1993-2007), the findings of Halverson/Kyburz (1986), Jack et al. (1951) and Jacobson (1936) when comparable regression equations were derived. The regression equations in this section are of the following general form:

$$\textit{Component A} = c + b\,(\textit{Component B}) + e$$

where, *Component A* is the dependent variable, *c* is a constant, *b* is a coefficient, *Component B* is an independent variable, and *e* is an error term.

Monthly variation between component levels was also examined by introducing “month” variables into the equations to reflect seasonality. The general form of these equations are:

Component A = c + b(Component B) + m(February) + . . . + m(December) + e

where, in addition to the previously defined general form, *m* is a coefficient, and February through December are dummy variables (January is left out to establish a base line for the other months). Month coefficients for the equations are summarized in Table A-3 (see Appendix).

The general form of a quadratic equation and the one used in this study is:

Component A = c + b1 (Component B) + b2 (Component B-squared) + e

Where, Component A is the dependent variable, c is a constant, b1 and b2 are coefficients, Component B is an independent variable, and e is an error term. Since it has been previously determined that there are significant differences between monthly average component tests, individual equations were developed for each month (see Appendix Table A-3).

Generally, the inclusion of month variables in the equation did not significantly improve an equation’s ability to explain the relationship between components. However, nearly all of the month variables were statistically significant in each of the three final equations obtained through stepwise regression. These equations showed that the seasonal variation observed in component levels and the variations in the relationship between components are valid and measurable.

Butterfat Levels as a Predictor of SNF Levels

The regression equation, which uses butterfat levels to predict SNF levels, is written as:

SNF = c + b(BF).

In Table 5, comparisons are made between the results derived in each of the Upper Midwest Order studies and those derived by Halverson/Kyburz, Jack et al. and Jacobson. While a full comparison of the estimates was not possible, the equations did not appear to be appreciably different. The constants of all equations differed little from one another. The coefficients for butterfat, on the other hand, appear to cycle from year-to-year within a range of 0.38175 from Mykrantz 1993 to 0.4640 for Halverson/Kyburz. The butterfat coefficient derived from the 2008 data was within that range at 0.39116. No attempt was made to identify possible causes for the change in the butterfat coefficient.

Monthly dummy variables were added to the above equation to look at the impact of seasonality on the relationship between butterfat and solids-not-fat. Dummy variables for February through December were added. Table A-3 (see Appendix) contains the coefficients and related information for the constant, butterfat and months. Including the monthly variables slightly improved the R-squared value when compared to not including the monthly variables, and the months of July, September, October, and November were significant, indicating that season of the year has an impact on the relationship between solids-not-fat and butterfat. As pointed out earlier in this paper, the component data is based on milk of producers located predominately in the Upper Midwest. Component levels of producers in other areas of the United States may show seasonal trends but the timing of the trends probably will not be the same as those shown in the Upper Midwest.

Applying a quadratic formula to the relationship between solids-not-fat and butterfat resulted in no applicable difference from the linear model.

Table 5

Comparison of Regression Results: Butterfat Levels as a Predictor of SNF Levels

Study (Region and Year)	Equation
Upper Midwest (2010 Staff Paper 10-02)	SNF = 7.23152% + 0.39116 (BF)
Upper Midwest (2008 Staff Paper 08-01)	SNF = 7.15274% + 0.41445 (BF)
Upper Midwest (2007 Staff Paper 07-01)	SNF = 7.21470% + 0.40136 (BF)
Upper Midwest (2006 Staff Paper 06-04)	SNF = 7.25589% + 0.38394 (BF)
Upper Midwest (2006 Staff Paper 06-03)	SNF = 7.21824% + 0.39023 (BF)
Upper Midwest (2006 Staff Paper 06-01)	SNF = 7.13098% + 0.41596 (BF)
Upper Midwest (2003)	SNF = 7.15780% + 0.40439 (BF)
Upper Midwest (2002)	SNF = 7.06534% + 0.42925 (BF)
Upper Midwest (2001)	SNF = 7.21994% + 0.38823 (BF)
Upper Midwest (2000)	SNF = 7.00097% + 0.44840 (BF)
Upper Midwest (1999)	SNF = 7.13236% + 0.41482 (BF)
Upper Midwest (1998)	SNF = 7.10099% + 0.41530 (BF)
Upper Midwest (1997)	SNF = 6.95151% + 0.45570 (BF)
Upper Midwest (1996)	SNF = 7.01575% + 0.43459 (BF)
Upper Midwest (1995)	SNF = 7.07430% + 0.41700 (BF)
Mykrantz (Upper Midwest, 1994)	SNF = 7.20057% + 0.38175 (BF)
Mykrantz (Upper Midwest, 1993)	SNF = 7.04990% + 0.42228 (BF)
Halverson/Kyburz (Upper Midwest, 1986)	SNF = 6.97% + 0.4640 (BF)
Jack et al. (California, 1951)	SNF = 7.07% + 0.4440 (BF)
Jacobson (New England, 1930's)	SNF = 7.07% + 0.4000 (BF)

Protein Levels as a Predictor of SNF Levels

The regression equation, which uses protein levels to predict SNF levels, is written as:

$$SNF = c + b(PRO).$$

Comparisons were made with the results derived in each of the Upper Midwest Order studies and those derived by Halverson/Kyburz (see Table 6). The 2008 results were not appreciably different from the results for previous years.

Estimates for the relationship between protein and SNF on a monthly basis are presented in Table A-3 (see Appendix). The regression containing the monthly variables performed as expected, all parameters were statistically significant and of the expected sign. The R-squared statistic for the formula containing monthly variables was slightly greater than for the formula without the monthly variables. The monthly coefficients appeared to have a seasonal pattern as they increased from February to July and then decreased to the end of the year.

Figure 1 is a scatter plot of monthly producer solids-not-fat and protein tests for January 2008. The straight line is the result of the linear model for January while the curved line is the result of the quadratic model for January. This graph is representative of the data for each month and the annual data. The equation for 2008, for the linear model is:

$$\text{Solids-not-fat Test} = 5.45752 + 1.06565 * \text{Protein Test},$$

while the equation for the quadratic model is:

$$\text{Solids-not-fat Test} = 1.06306 + (3.868 * \text{Protein Test}) + (-0.445 * (\text{Protein Test})^2).$$

The R-squared for the linear model is 0.696 while the R-squared for the quadratic model is 0.713. The quadratic model has a slightly better fit than the linear model and is concave downward.

Both the linear model and the quadratic model yielded similar results when the protein tests were within the first standard deviation, while the quadratic model appears to fit the data better than the linear model at the higher and lower protein tests. The reason that the relationship between solids-not-fat and protein is not constant across the entire range of tests may be due to variables that were not measured in this study, such as breed of the individual farm herds, ration, and feeding practices.

Table 6

Comparison of Regression Results: Protein Levels as a Predictor of SNF Levels

Study (Region and Year)	Equation
Upper Midwest (2010 Staff Paper 10-02)	SNF = 5.45752% + 1.06565 (PRO)
Upper Midwest (2008 Staff Paper 08-01)	SNF = 5.47427% + 1.06208 (PRO)
Upper Midwest (2007 Staff Paper 07-01)	SNF = 5.48006% + 1.06412 (PRO)
Upper Midwest (2006 Staff Paper 06-04)	SNF = 5.61615% + 1.01655 (PRO)
Upper Midwest (2006 Staff Paper 06-03)	SNF = 5.41126% + 1.08236 (PRO)
Upper Midwest (2006 Staff Paper 06-01)	SNF = 5.30149% + 1.12321 (PRO)
Upper Midwest (2003)	SNF = 5.39150% + 1.08985 (PRO)
Upper Midwest (2002)	SNF = 5.38415% + 1.09176 (PRO)
Upper Midwest (2001)	SNF = 5.43058% + 1.07894 (PRO)
Upper Midwest (2000)	SNF = 5.32439% + 1.04863 (PRO)
Upper Midwest (1999)	SNF = 5.27270% + 1.07108 (PRO)
Upper Midwest (1998)	SNF = 5.26469% + 1.06562 (PRO)
Upper Midwest (1997)	SNF = 5.10546% + 1.11637 (PRO)
Upper Midwest (1996)	SNF = 5.31567% + 1.04484 (PRO)
Upper Midwest (1995)	SNF = 5.26948% + 1.05511 (PRO)
Mykrantz (Upper Midwest, 1994)	SNF = 5.36198% + 1.03041 (PRO)
Mykrantz (Upper Midwest, 1993)	SNF = 5.16244% + 1.08507 (PRO)
Halverson/Kyburz (Upper Midwest, 1986)	SNF = 5.08% + 1.1138 (PRO)

Butterfat Levels as a Predictor of Protein Levels

The regression equation, which uses butterfat levels to predict protein levels, is written as:

$$PRO = c + b(BF).$$

Comparisons were made between the results derived from the 1992 through 2008 data and those of Halverson/Kyburz (see Table 7). The primary observation from the equation derived for the 2008 data was that the constant of 1.51689 and the coefficient of 0.40586 for the independent variable fell within the range of coefficients previously computed

On a monthly basis, estimates of the relationship between butterfat and protein are shown in Table A-3 (see Appendix). The parameters of the monthly variables were statistically significant. The R-squared statistic was again slightly higher for the formula using the monthly variables than for the formula without the monthly variables.

Table 7

Comparison of Regression Results: Butterfat Levels as a Predictor of Protein Levels

Study (Region and Year)	Equation
Upper Midwest (2010 Staff Paper 10-02)	PRO = 1.51689% + 0.40586 (BF)
Upper Midwest (2008 Staff Paper 08-01)	PRO = 1.48682% + 0.41490 (BF)
Upper Midwest (2007 Staff Paper 07-01)	PRO = 1.54359% + 0.40000 (BF)
Upper Midwest (2006 Staff Paper 06-04)	PRO = 1.51409% + 0.40387 (BF)
Upper Midwest (2006 Staff Paper 06-03)	PRO = 1.59839% + 0.37888 (BF)
Upper Midwest (2006 Staff Paper 06-01)	PRO = 1.56388% + 0.38754 (BF)
Upper Midwest (2003)	PRO = 1.55781% + 0.38770 (BF)
Upper Midwest (2002)	PRO = 1.47804% + 0.40962 (BF)
Upper Midwest (2001)	PRO = 1.55107% + 0.38831 (BF)
Upper Midwest (2000)	PRO = 1.57404% + 0.43420 (BF)
Upper Midwest (1999)	PRO = 1.65909% + 0.40796 (BF)
Upper Midwest (1998)	PRO = 1.61984% + 0.41715 (BF)
Upper Midwest (1997)	PRO = 1.63183% + 0.41397 (BF)
Upper Midwest (1996)	PRO = 1.61375% + 0.41951 (BF)
Upper Midwest (1995)	PRO = 1.71454% + 0.39416 (BF)
Mykrantz (Upper Midwest, 1994)	PRO = 1.73836% + 0.38269 (BF)
Mykrantz (Upper Midwest, 1993)	PRO = 1.79012% + 0.37609 (BF)
Halverson/Kyburz (Upper Midwest, 1986)	PRO = 1.74% + 0.4042 (BF)

Figure 2 is a scatter plot of monthly average producer butterfat tests and protein tests for 2008 data. The straight line is the result of the linear model while the curved line is the result of the quadratic model. The equation for 2008, for the linear model is:

$$\textit{Protein Test} = 1.51689 + 0.40586 * \textit{Butterfat Test},$$

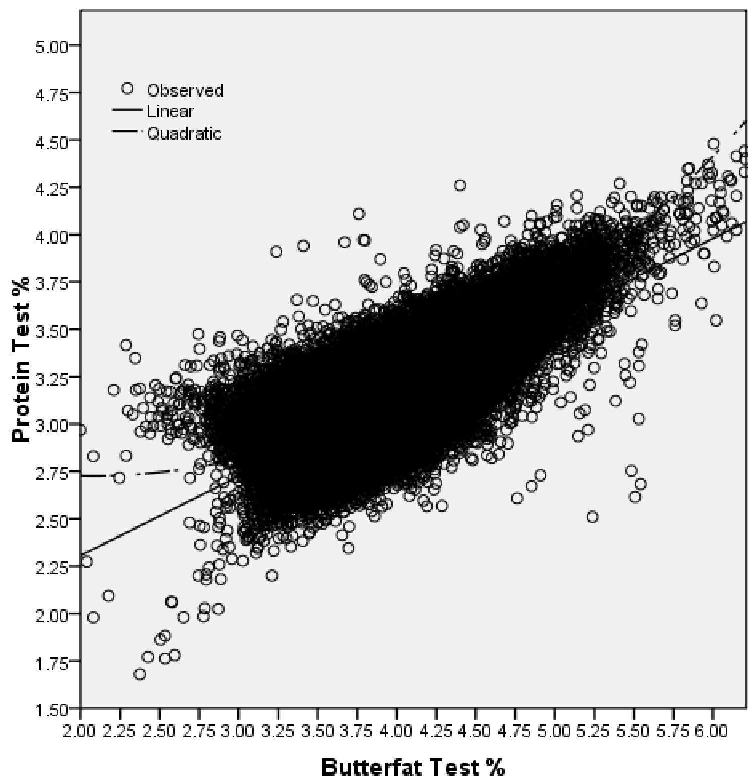
while the equation for the quadratic model is:

$$\textit{Protein Test} = 3.20620 + (-0.45968 * \textit{Butterfat Test}) + (0.11015 * (\textit{Butterfat Test})^2).$$

As one can see in Figure 2, the linear model has a tendency to understate the estimate of the protein test at the higher butterfat tests, while the quadratic model's estimate of the protein test seems to follow the actual protein tests more closely at the higher range of butterfat tests. In the range of butterfat tests included in one standard deviation of the mean, both the linear and quadratic models appear to give similar results. At the lower range of the butterfat tests, the protein tests seem to split, with some increasing with decreasing butterfat tests, and some decreasing with decreasing butterfat tests. The linear model seems to fall between the split in the tests while the quadratic model estimates increasing protein tests with decreasing butterfat tests. The quadratic model, for the 2008 dataset has a slightly higher adjusted R-squared of 0.506, versus 0.475 for the linear model, suggesting a better fit.

Figure 2

Scatter Plot of Protein and Butterfat Tests -- January 2008



Even though the quadratic model does show a slightly better fit than the linear model, the point to note is the relationship between butterfat and protein is not constant across the range of average butterfat and protein tests found in this study. It is also important to note that the data included in this study are average monthly tests from numerous herds, and that the butterfat to protein ratio may be affected by various variables, which are not included in this study. Some of these variables may include breed; traditionally the colored breeds have had higher butterfat tests and may have a higher proportion of protein that would show up in the larger number of observations at the higher butterfat tests. Ration and feeding practices may also have an impact on butterfat to protein ratios.

Other Solids Levels

Beginning in 2000, as part of Federal Order reform, the other solids price on the Upper Midwest order was calculated from the survey price[9] for dry whey rather than being the residual of the basic formula price after removing the value of the butterfat and protein. Pounds of other solids in producer milk were reported monthly to the Market Administrator, from which the other solids content of milk was determined for the market and individual producers. As with butterfat and protein, other solids levels in producer milk were analyzed with respect to finding observable relationships with other components.

Other solids, for purposes of Federal milk order pricing, are defined as solids-not-fat minus protein. Therefore, other solids consist primarily of lactose and ash. Ash traditionally has been considered a constant in solids-not-fat, while lactose does vary somewhat in the solids-not-fat.

A comparison of correlation coefficients for other solids with butterfat and protein revealed that the statistical relationships are very weak at best. In contrast, the correlation coefficient for other solids and SNF of 0.625 suggests that a moderately strong linear relationship exists while protein and SNF appears to have a strong relationship with a coefficient of 0.835. These results, however, are not surprising due to the fact that SNF is the sum of the protein and other solids components.

Regression analysis was used to explore the use of butterfat and protein as predictors for other solids as was done in previous studies for predicting SNF. The results, like the correlation coefficients, show that neither butterfat nor protein are suitable predictors to estimate other solids levels. These results do show that the protein portion, rather than the other solids portion of SNF, is the more influential component in terms of estimating changes in the level of SNF in milk.

Hypothesis Tests among Milk Components

As mentioned above various regressions are estimated between component tests to determine what statistical relationships exist. These relationships can be further inspected to determine if the underlying structure of the regression equation is statistically significant.

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9 Component prices are calculated from the weighted average values of survey information on cheddar cheese, butter, nonfat dry milk and dry whey sales gathered by the National Agricultural Statistics Service, USDA.

The regression equations include simple linear equations, quadratic equations, and both fixed effects and random effects models. Briefly the equations are as follows:

Simple linear $Y = \alpha + \beta X + \varepsilon$

Quadratic $Y = \alpha + \beta_1 X + \beta_2 X^2 + \varepsilon$

Fixed Effects $Y = \alpha + \beta_1 X + \beta_2 D_{jan} \ldots + \beta_{13} D_{dec} + \varepsilon$

which has an equivalent representation as:

$$Y = \alpha_c + \alpha_1 D_{jan} + \ldots \alpha_{11} D_{nov} + \beta X + \varepsilon$$

Where the equivalency comes in as:

$$\alpha_1 = \alpha_c - \beta_2$$

The Fixed Effects model has the assumption that the underlying differences in the data between two units can be attributed to a difference in the constant term thus preserving and assuming the relationship between the independent and dependent variable represented by the beta coefficient is constant.

Table 8

Fixed Effects Model for 2008

$$SNFtest = \beta_1 Proteintest + \alpha_{jan} \ldots + \alpha_{\mathrm{dec}} + \varepsilon$$

Variable	Beta	Standard Error	t-stat
Protein Test	**1.090446**	**0.001659**	**657.4517**
January	5.366566	0.005258	1020.565
February	5.370435	0.005250	1022.904
March	5.376018	0.005201	1033.674
April	5.381820	0.005116	1052.036
May	5.384329	0.005111	1053.558
June	5.412360	0.005054	1070.892
July	5.401577	0.004947	1091.860
August	5.387205	0.004989	1079.709
September	5.379077	0.005125	1049.638
October	5.377491	0.005288	1016.927
November	5.370487	0.005306	1012.175
December	5.372090	0.005296	1014.282

Dependent Variable: Solids-Not-Fat Test
Linear Regression through the Origin

Table 8 (continued)

Fixed Effects Model for 2008

$$Protein\,test = \beta_1 Butterfat\,test + \alpha_{jan} \ldots + \alpha_{dec} + \varepsilon$$

Variable	Beta	Standard Error	t-stat
Butterfat Test	**0.368914**	**0.000955**	**386.3448**
January	1.682863	0.003836	438.718
February	1.684266	0.003820	440.952
March	1.658465	0.003808	435.505
April	1.621405	0.003771	430.023
May	1.647203	0.003698	445.481
June	1.640493	0.003627	452.240
July	1.592083	0.003585	444.145
August	1.614478	0.003594	449.255
September	1.654908	0.003700	447.270
October	1.707929	0.003818	447.356
November	1.700450	0.003864	440.039
December	1.687705	0.003882	434.782

Dependent Variable: Protein Test
Linear Regression through the Origin

$$SNF\ test = \beta_1 Butterfat\,test + \alpha_{jan} \ldots + \alpha_{dec} + \varepsilon$$

Variable	Beta	Standard Error	t-stat
Butterfat Test	**0.358467**	**0.001468**	**244.2229**
January	7.372764	0.005896	1250.415
February	7.377382	0.005871	1256.522
March	7.354122	0.005854	1256.334
April	7.317895	0.005796	1262.623
May	7.344929	0.005684	1292.279
June	7.362301	0.005576	1320.369
July	7.296744	0.005510	1324.267
August	7.307262	0.005524	1322.826
September	7.348240	0.005687	1292.012
October	7.409982	0.005869	1262.663
November	7.397067	0.005940	1245.299
December	7.385552	0.005967	1237.784

Dependent Variable: Solids-Not-Fat Test
Linear Regression through the Origin

Random Effects

The Random Effects model assumes the constant is unchanging between units but that the variation is due to differences in the underlying relationship between the independent and dependent variables as represented by the beta coefficient. This model also then can be interpreted as a missing or omitted variable construction that can be used for hypothesis testing.

$$Y = \alpha_c + \beta_1 X_{jan} + \ldots + \beta_{12} X_{dec} + \varepsilon$$

The hypothesis tests involving these models include simple t-statistics, F-tests, and Lagrange Multiplier statistics.

Table 9

Random Effects Model for 2008

$$Protein\,test = \alpha + \beta_{\mathrm{jan}} Butterfat\ test \ldots \beta_{\mathrm{dec}} Butterfat\ test + \varepsilon$$

	Beta	Standard Error	t-stat
(Constant)	**1.663716**	**0.003664**	**454.1007**
January	0.373538	0.000959	389.3180
February	0.374379	0.000965	387.8676
March	0.367692	0.000970	378.8733
April	0.357826	0.000979	365.4811
May	0.364354	0.001002	363.7813
June	0.362549	0.001023	354.4951
July	0.349239	0.001036	337.2334
August	0.355359	0.001032	344.2355
September	0.366524	0.001000	366.3741
October	0.380326	0.000968	393.0570
November	0.378357	0.000954	396.5416
December	0.375106	0.000950	395.0316

Dependent Variable: Protein Test

Table 9 (continued)

Random Effects Model for 2008

$$SNF\ test = \alpha + \beta_{jan} Butterfat\ test \ldots \beta_{dec} Butterfat\ test + \varepsilon$$

	Beta	Standard Error	t-stat
(Constant)	**7.358485**	**0.005636**	**1305.6175**
January	0.361834	0.001476	245.1509
February	0.363462	0.001485	244.7851
March	0.357428	0.001493	239.4157
April	0.347931	0.001506	231.0155
May	0.354763	0.001541	230.2552
June	0.359642	0.001573	228.5963
July	0.341789	0.001593	214.5458
August	0.344577	0.001588	216.9848
September	0.355672	0.001539	231.1142
October	0.371521	0.001488	249.5961
November	0.368156	0.001468	250.8265
December	0.365231	0.001461	250.0346

Dependent Variable: Solids-Not-Fat Test

The F-Test

$$F(n-1, nT-n-K) = \frac{(R_u^2 - R_p^2) / (n-1)}{(1-R_u^2) / (nT-n-K)}$$

Table 10

F-Test Results for Monthly Data

Model	n-1	n-2	F-value	Critical Value
Solids-Not-Fat and Butterfat	19622	215845	602.5	2.18
Protein and Butterfat	19622	215845	195.6	2.18
Solids-Not-Fat and Protein	19622	215845	1444.5	2.18

The 1% significance level at these degrees of freedom is 1.00 so the hypothesis that all the monthly effects are the same is rejected.

The Lagrange Multiplier Test

$$LM = \frac{nT}{2(T-1)}\left[\frac{e'DD'e}{e'e}\right]^2$$

The Lagrange Multiplier test is distributed as a chi-squared with one degree of freedom since we're testing the constraint that the off-diagonal components are zero resulting in a zero variance for the supposed missing variable. The critical values for this distribution are then 2.71 and 6.63 at the 90% and 99% confidence levels.

Table 11
Lagrange Multiplier Tests for the Random Effects Model

Model	Months	States
Solids-Not-Fat and Butterfat	26429	4698
Protein and Butterfat	115300	28086
Somatic Cell Count and Butterfat	5124	26204

The Lagrange Multiplier values above reject the null hypothesis at the 99% level for monthly data indicating the random effects model is appropriate. This evidence can further imply that there is some model misspecification in the form of omitted variables. The value for the state data is not able to reject the null hypothesis; this result is probably due to the larger within unit variation in the state data.

The Correlation Decomposition

By examining the data in units and comparing the behavior of those units to the group as a whole and to each other we can get some idea of which model is most appropriate. Our units will be comprised of individual producer data points grouped according to month and also for state. Once the models are estimated a weighted measure of variation can be computed. This number shows the importance of the between units variation to the overall variation relative to the variation within units. Again this can determine in our case whether there is more variation within months versus between months and whether there's more variation between states versus variation within a state. Computing this number begins with the coefficients of correlation for the dataset as a whole, b^t, the correlation within units, b^w, and the correlation between units, b^b. These correlation coefficients are defined as follows:

$$b^t = \left[S^t_{xx}\right]^{-1}\left[S^t_{xy}\right], \quad b^w = \left[S^w_{xx}\right]^{-1}\left[S^w_{xy}\right], \quad b^b = \left[S^b_{xx}\right]^{-1}\left[S^b_{xy}\right].$$

Where S_{xx}^{t} is the sum of the squared x's for the dataset and S_{xx}^{w} is the sum of squared x's for the within units data etc.

We then compute m as follows:

$$m = \frac{b^t - b^b}{b^w - b^b}$$

where

$$b^t = mb^w + (1-m)b^b.$$

For the monthly and state data the results are:

Table 12

Correlation Decomposition May 2008

	State			Month		
Coefficient	**Butterfat and Protein**	**Butterfat and Solids-Not-Fat**	**Somatic Cell Count and Butterfat**	**Butterfat and Protein**	**Butterfat and Solids-Not-Fat**	**Somatic Cell Count and Butterfat**
m	1.02150	0.99095	1.00400	0.85861	0.85858	0.98349
b^b	0.41998	0.69618	0.00003	0.38209	0.36962	0.00010
b^w	0.49924	0.19187	0.00155	0.63799	0.59643	-0.00430
b^t	0.41824	0.69162	0.00003	0.41827	0.40169	0.00002

As you can see most of the variation in the data is within the month and within the state data. The variation between months and between states is much less.

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 2008. 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 2008, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $18.01 per cwt. for the market. The value of each component comprised by the $18.01 per cwt. price was $5.81 for butterfat, $11.82 for protein, and $0.32 for other solids. The SCC adjustment for the year amounted to about $0.06 per cwt.

Categorized by size range of delivery, average values of producer milk ranged from a low of $17.86 per cwt. for monthly producer milk deliveries greater than 400,000 pounds to a high of $18.52 per cwt. for monthly producer milk deliveries of less than 20,000 pounds (see Appendix Table A-5). 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.

VI. 2004 - 2008 WEIGHTED AVERAGE COMPONENT TESTS

Weighted average component data for the past five years, 2004, 2005, 2006, 2007 and 2008 are shown in Table 13. Over these five years the yearly average tests have changed very little. Yearly average butterfat tests were 3.72 percent, 3.69 percent, 3.71 percent, 3.70 percent and 3.71 percent for 2004, 2005, 2006, 2007 and 2008 respectively. Yearly average protein and other solids tests varied even less than the butterfat test between the five years. Yearly weighted average somatic cell counts also did not change much over the five-year period, decreasing from 289,000 in 2004 to 283,000 in 2008.

Graphs (see Appendix Figures A-6 through A-10) show the monthly weighted average component tests for 2004, 2005, 2006, 2007, and 2008. As one can see in the graphs, the butterfat and protein tests varied very little from year to year and showed a consistent yearly pattern. Other solids weighted average monthly tests showed more inconsistency from year to year than either the butterfat or protein monthly weighted average tests. Since nonfat solids consist primarily of protein and other solids, the monthly variations from year to year are predominantly a result of the fluctuations in the protein and other solids tests.

Somatic cell counts also showed a consistent seasonal pattern, increasing in the summer and declining through the fall and winter.

Year to year changes in components and SCC counts may be attributed to several factors including changes in feeding practices, breeding, composition of the dairy herd, weather and in the case of SCC herd health. Breeding and composition of the dairy herd take relatively longer periods of time for the changes in component levels to show up. The data for the years 2004 through 2008 would indicate that these two factors have had an impact on the weighted average component tests of the market. Probably the largest factor influencing year-to-year fluctuations in component tests and SCC is the weather.

Table 13

Weighted Average Levels of Selected Components and Somatic Cell Count in Milk Year to Year

2004

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.80	3.07	5.72	8.79	280
February	3.80	3.06	5.70	8.75	291
March	3.75	3.02	5.71	8.73	300
April	3.71	3.01	5.71	8.72	295
May	3.68	2.99	5.72	8.71	290
June	3.63	2.97	5.72	8.69	308
July	3.60	2.95	5.71	8.66	322
August	3.63	2.99	5.72	8.71	317
September	3.67	3.02	5.71	8.74	291
October	3.77	3.10	5.69	8.79	263
November	3.81	3.11	5.68	8.79	255
December	3.80	3.10	5.68	8.78	255
Annual Average	3.72	3.03	5.71	8.74	289

Table 13 (continued)

Weighted Average Levels of Selected Components and Somatic Cell Count in Milk Year to Year

2005

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.78	3.08	5.69	8.77	266
February	3.74	3.04	5.72	8.76	270
March	3.73	3.03	5.73	8.76	268
April	3.69	2.99	5.74	8.74	275
May	3.66	2.98	5.74	8.72	276
June	3.57	2.92	5.76	8.69	295
July	3.53	2.89	5.76	8.65	322
August	3.55	2.94	5.72	8.66	321
September	3.63	3.02	5.70	8.72	305
October	3.74	3.11	5.69	8.79	287
November	3.83	3.13	5.70	8.83	270
December	3.85	3.12	5.67	8.80	271
Annual Average	3.69	3.02	5.72	8.74	285

2006

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.77	3.06	5.72	8.78	275
February	3.77	3.07	5.73	8.80	272
March	3.75	3.05	5.73	8.78	272
April	3.71	3.02	5.72	8.74	274
May	3.67	3.00	5.74	8.74	270
June	3.60	2.96	5.73	8.69	286
July	3.57	2.92	5.74	8.65	301
August	3.56	2.95	5.73	8.68	326
September	3.70	3.06	5.72	8.78	298
October	3.81	3.12	5.72	8.85	267
November	3.83	3.12	5.72	8.84	259
December	3.81	3.10	5.70	8.80	264
Annual Average	3.71	3.03	5.73	8.76	280

Table 13 (continued)

Weighted Average Levels of Selected Components and Somatic Cell Count in Milk Year to Year

2007

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.77	3.07	5.73	8.80	268
February	3.80	3.09	5.70	8.78	285
March	3.75	3.05	5.69	8.74	293
April	3.71	3.02	5.72	8.75	286
May	3.64	2.98	5.72	8.70	280
June	3.58	2.94	5.72	8.66	295
July	3.55	2.92	5.73	8.65	306
August	3.56	2.95	5.72	8.66	329
September	3.65	3.02	5.73	8.75	311
October	3.74	3.08	5.71	8.79	288
November	3.82	3.14	5.70	8.85	260
December	3.84	3.13	5.70	8.84	255
Annual Average	3.70	3.03	5.71	8.75	288

2008

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.81	3.10	5.69	8.79	259
February	3.79	3.10	5.70	8.80	281
March	3.77	3.07	5.70	8.77	287
April	3.72	3.02	5.70	8.72	281
May	3.66	3.01	5.70	8.71	284
June	3.60	2.97	5.73	8.70	299
July	3.57	2.93	5.72	8.65	313
August	3.59	2.95	5.72	8.67	314
September	3.67	3.02	5.72	8.74	293
October	3.77	3.10	5.73	8.82	270
November	3.81	3.12	5.71	8.83	252
December	3.83	3.12	5.71	8.83	260
Annual Average	3.71	3.04	5.71	8.75	283

VII. SUMMARY

This staff paper analyzes milk components and SCC in producer milk associated with the Upper Midwest Order during 2008. The data include component levels for butterfat, protein, other solids and SNF and SCC. The study determined: average component levels and SCC, regional and seasonal differences in component levels and SCC, and relationships among components in individual herd milk at the farm level in the Upper Midwest Order milk procurement area. Also, component levels were analyzed on the basis of differing values based on milk composition under the MCP provisions of the market.

Weighted average component levels and SCC for 2008 were: 3.71% butterfat, 3.04% protein, 5.71% other solids, 8.75% SNF and 283,000 SCC. The weighted average butterfat level was lowest in July, while protein and SNF levels were lowest in July and highest in the late fall and winter. The weighted monthly average levels of other solids were highest in June and October and lowest in January and exhibited less variation during the year relative to the three other components. Weighted average SCC was lowest in November and highest in August. Approximately three-quarters of monthly average component levels ranged from: 3.45% to 3.97% for butterfat; 2.89% to 3.19% for protein; 5.62% to 5.80% for other solids; 8.57% to 8.93% for SNF; and 146,000 to 420,000 for SCC.

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 solids-not-fat tests than smaller producers.

The smallest ten percent of producers marketed less than two percent of the milk while the largest ten percent of producers marketed almost 50 percent of the milk. The monthly average pounds of milk marketed were 172,404 pounds, however over 80 percent of the producers had average marketings below the market average.

Based on the data for 2008, the following regression equations were derived:

$$SNF = 7.23152\% + 0.39116\ (BF)$$
$$SNF = 5.45752\% + 1.06565\ (PRO)$$
$$PRO = 1.51689\% + 0.40586\ (BF)$$

Under MCP, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $18.01 per cwt. for the market. Protein contributed more than half of the total value.

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APPENDIX

TABLES

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Table A-1

STATISTICAL DATA FOR PRODUCERS ON THE UPPER MIDWEST ORDER INCLUDED IN COMPONENT ANALYSIS

2008

Butterfat

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.81	3.90	0.25	3.78	0.86	23.00	18,429
February	3.79	3.89	0.25	3.77	0.72	6.44	18,378
March	3.77	3.87	0.24	3.75	1.70	6.47	17,791
April	3.72	3.84	0.24	3.70	0.78	6.02	18,359
May	3.66	3.75	0.23	3.64	0.76	6.02	17,808
June	3.60	3.68	0.22	3.59	0.80	6.02	17,740
July	3.57	3.63	0.21	3.55	1.18	6.02	17,896
August	3.59	3.64	0.21	3.58	0.33	6.02	18,025
September	3.67	3.76	0.23	3.65	0.79	6.37	17,964
October	3.77	3.88	0.26	3.75	0.67	6.30	17,754
November	3.81	3.93	0.27	3.79	1.38	7.06	17,925
December	3.83	3.95	0.28	3.80	1.00	6.89	17,777
Total	3.71	3.81	0.26	3.69	0.33	23.00	215,846

Protein

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.10	3.12	0.14	3.09	2.20	4.63	18,429
February	3.10	3.12	0.14	3.08	1.68	4.69	18,378
March	3.07	3.09	0.13	3.05	2.48	4.68	17,791
April	3.02	3.04	0.12	3.01	2.09	4.21	18,359
May	3.01	3.03	0.13	3.00	1.76	4.17	17,808
June	2.97	3.00	0.12	2.96	1.78	4.20	17,740
July	2.93	2.93	0.12	2.92	1.51	4.11	17,896
August	2.95	2.96	0.12	2.94	1.77	4.09	18,025
September	3.02	3.04	0.12	3.00	1.86	4.06	17,964
October	3.10	3.14	0.14	3.08	1.98	4.29	17,754
November	3.12	3.15	0.14	3.10	2.02	4.44	17,925
December	3.12	3.15	0.14	3.11	2.38	4.94	17,777
Total	3.04	3.06	0.15	3.03	1.51	4.94	215,846

Table A-1 (continued)

STATISTICAL DATA FOR PRODUCERS ON THE UPPER MIDWEST ORDER INCLUDED IN COMPONENT ANALYSIS

2008

Other Solids

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	5.69	5.65	0.09	5.71	3.52	5.94	18,429
February	5.70	5.65	0.09	5.71	3.98	5.97	18,378
March	5.70	5.66	0.09	5.71	4.22	6.15	17,791
April	5.70	5.66	0.08	5.71	2.91	6.05	18,359
May	5.71	5.66	0.09	5.72	4.21	6.45	17,808
June	5.73	5.68	0.09	5.74	4.07	6.16	17,740
July	5.72	5.67	0.09	5.74	2.85	6.60	17,896
August	5.72	5.65	0.09	5.73	2.97	6.01	18,025
September	5.72	5.65	0.10	5.74	3.74	6.02	17,964
October	5.73	5.66	0.09	5.74	3.77	6.02	17,754
November	5.71	5.66	0.09	5.73	3.77	5.97	17,925
December	5.71	5.66	0.08	5.72	3.70	6.07	17,777
Total	5.71	5.66	0.09	5.72	2.85	6.60	215,846

Solids-Not-Fat

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	8.79	8.77	0.17	8.79	6.59	10.03	18,429
February	8.80	8.77	0.17	8.79	6.01	10.02	18,378
March	8.77	8.74	0.17	8.77	7.02	9.86	17,791
April	8.72	8.69	0.16	8.72	5.00	9.75	18,359
May	8.71	8.69	0.16	8.71	6.54	9.87	17,808
June	8.70	8.68	0.16	8.70	6.34	9.67	17,740
July	8.65	8.60	0.17	8.66	4.36	9.67	17,896
August	8.67	8.61	0.17	8.67	5.97	9.57	18,025
September	8.74	8.69	0.17	8.74	6.20	9.62	17,964
October	8.82	8.80	0.16	8.82	6.69	9.74	17,754
November	8.83	8.82	0.17	8.83	6.54	9.88	17,925
December	8.83	8.80	0.17	8.83	6.44	10.16	17,777
For the Year	8.75	8.72	0.18	8.75	4.36	10.16	215,846

Table A-1 (continued)

STATISTICAL DATA FOR PRODUCERS ON THE UPPER MIDWEST ORDER INCLUDED IN COMPONENT ANALYSIS

2008

Somatic Cell Count

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	---------- (1,000) ----------						
January	259	312	129	230	21	1,748	18,429
February	281	338	145	248	22	2,716	18,378
March	287	343	147	250	24	3,053	17,791
April	281	338	140	246	26	2,873	18,359
May	284	335	136	254	24	2,464	17,808
June	299	351	141	267	24	1,773	17,740
July	313	353	143	283	27	1,740	17,896
August	314	369	142	286	20	2,003	18,025
September	293	339	131	267	15	1,690	17,964
October	270	313	122	244	21	2,001	17,754
November	252	298	118	226	18	4,222	17,925
December	260	311	126	230	13	2,398	17,777
For the Year	283	335	137	252	13	4,222	215,846

Table A-2

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2008

Butterfat

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.85	3.80	3.67	3.81	3.85	3.81	3.81	3.82	3.81
February	3.82	3.78	3.67	3.78	3.83	3.77	3.79	3.79	3.79
March	3.79	3.74	3.63	3.77	3.81	3.75	3.77	3.77	3.77
April	3.75	3.69	3.58	3.73	3.79	3.71	3.73	3.71	3.72
May	3.66	3.61	3.52	3.66	3.72	3.68	3.67	3.61	3.66
June	3.59	3.53	3.52	3.61	3.66	3.63	3.61	3.56	3.60
July	3.57	3.52	3.46	3.58	3.53	3.63	3.58	3.52	3.57
August	3.57	3.53	3.48	3.60	3.54	3.64	3.60	3.53	3.59
September	3.67	3.61	3.54	3.69	3.65	3.67	3.67	3.65	3.67
October	3.79	3.71	3.64	3.79	3.82	3.76	3.77	3.71	3.77
November	3.87	3.77	3.68	3.82	3.87	3.80	3.82	3.78	3.81
December	3.91	3.80	3.72	3.84	3.92	3.83	3.83	3.79	3.83
Total	3.74	3.67	3.59	3.72	3.76	3.73	3.72	3.69	3.71

Protein

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.10	3.15	3.14	3.10	3.16	3.18	3.09	3.13	3.10
February	3.10	3.14	3.13	3.10	3.15	3.17	3.09	3.11	3.10
March	3.09	3.11	3.09	3.07	3.13	3.13	3.05	3.08	3.07
April	3.03	3.06	3.03	3.04	3.10	3.08	3.01	3.03	3.02
May	3.02	3.03	3.02	3.01	3.06	3.08	3.00	3.03	3.01
June	2.97	2.99	2.96	2.97	3.03	3.06	2.96	2.97	2.97
July	2.94	2.95	2.95	2.93	2.94	3.01	2.92	2.95	2.93
August	2.95	2.97	2.98	2.96	2.97	3.02	2.94	2.98	2.95
September	3.03	3.04	3.02	3.03	3.07	3.08	3.00	3.05	3.02
October	3.13	3.12	3.08	3.09	3.15	3.15	3.09	3.12	3.10
November	3.16	3.13	3.12	3.11	3.17	3.18	3.11	3.14	3.12
December	3.16	3.14	3.14	3.12	3.19	3.19	3.11	3.16	3.12
Total	3.05	3.07	3.05	3.05	3.10	3.11	3.03	3.06	3.04

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2008

Other Solids

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	5.70	5.72	5.70	5.67	5.66	5.69	5.70	5.68	5.69
February	5.70	5.72	5.70	5.68	5.67	5.71	5.70	5.69	5.70
March	5.71	5.74	5.70	5.69	5.66	5.71	5.70	5.67	5.70
April	5.70	5.72	5.67	5.69	5.66	5.71	5.70	5.66	5.70
May	5.71	5.73	5.70	5.70	5.68	5.73	5.70	5.69	5.71
June	5.71	5.73	5.71	5.72	5.74	5.75	5.73	5.69	5.73
July	5.70	5.72	5.72	5.72	5.74	5.76	5.73	5.69	5.72
August	5.69	5.74	5.71	5.72	5.74	5.76	5.71	5.68	5.72
September	5.69	5.74	5.71	5.73	5.74	5.77	5.72	5.67	5.72
October	5.71	5.74	5.70	5.73	5.72	5.76	5.73	5.70	5.73
November	5.69	5.73	5.69	5.70	5.70	5.73	5.72	5.69	5.71
December	5.71	5.74	5.68	5.70	5.70	5.72	5.71	5.69	5.71
Total	5.70	5.73	5.70	5.70	5.70	5.73	5.71	5.68	5.71

Solids-Not-Fat

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	8.79	8.87	8.84	8.78	8.81	8.87	8.79	8.81	8.79
February	8.80	8.86	8.83	8.78	8.82	8.87	8.79	8.79	8.80
March	8.79	8.85	8.79	8.76	8.79	8.84	8.76	8.76	8.77
April	8.73	8.78	8.71	8.73	8.76	8.80	8.71	8.69	8.72
May	8.72	8.76	8.72	8.71	8.74	8.80	8.70	8.71	8.71
June	8.68	8.72	8.68	8.69	8.77	8.81	8.69	8.66	8.70
July	8.64	8.67	8.67	8.65	8.68	8.76	8.65	8.64	8.65
August	8.64	8.71	8.69	8.68	8.71	8.78	8.65	8.67	8.67
September	8.71	8.78	8.73	8.76	8.82	8.85	8.72	8.72	8.74
October	8.84	8.86	8.79	8.82	8.87	8.91	8.81	8.82	8.82
November	8.85	8.86	8.82	8.82	8.87	8.90	8.83	8.83	8.83
December	8.87	8.88	8.82	8.82	8.89	8.91	8.82	8.85	8.83
Total	8.76	8.80	8.75	8.75	8.79	8.84	8.74	8.75	8.75

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2008

Somatic Cell Counts

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	271	299	217	259	249	261	256	291	259
February	293	332	236	286	297	288	274	308	281
March	297	344	227	293	309	295	280	311	286
April	291	322	211	287	282	285	275	288	280
May	281	311	222	304	276	301	275	291	283
June	302	334	231	324	295	316	288	315	299
July	318	347	237	334	321	331	305	334	313
August	318	349	239	330	329	340	306	334	314
September	297	319	229	315	303	309	282	320	292
October	265	286	210	295	263	292	261	266	270
November	252	264	193	275	258	279	243	251	252
December	269	274	195	278	275	288	252	253	260
Total	288	315	221	298	287	298	275	295	282

Table A-3

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2008

Butterfat Levels as a Predictor of Solids-Not-Fat Levels

SNF = c + b(BF)

Month	Coefficient	Standard Error	t Statistic	R-squared (Adjusted)
SNF = c + b(BF)				
Constant (c)	7.2315246	0.0052879	1367.5485	0.270
Butterfat (b)	0.3911623	0.0013835	282.7333	
SNF = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	7.3728	0.0059	1250.415	0.292
Butterfat (b)	0.3585	0.0015	244.223	
February	0.005	0.002	2.367	
March	-0.019	0.002	-9.475	
April	-0.055	0.002	-28.078	
May	-0.028	0.002	-14.063	
June	-0.010	0.002	-5.240	
July	-0.076	0.002	-37.915	
August	-0.066	0.002	-32.777	
September	-0.025	0.002	-12.421	
October	0.037	0.002	18.909	
November	0.024	0.002	12.377	
December	0.013	0.002	6.496	

Protein Levels as a Predictor of Solids-Not-Fat Levels

SNF = c + b(PRO)

Month	Coefficient	Standard Error	t Statistic	R-squared (Adjusted)
SNF = c + b(PRO)				
Constant (c)	5.4575184	0.0046528	1172.9424	0.696
Protein (b)	1.0656476	0.0015164	702.7691	
SNF = c + b(PRO) + m(February) + . . . + m(December)				
Constant (c)	5.3666	0.0053	1020.565	0.713
Protein (b)	1.0904	0.0017	657.452	
February	0.004	0.001	3.042	
March	0.009	0.001	7.361	
April	0.015	0.001	11.912	
May	0.018	0.001	13.757	
June	0.046	0.001	35.212	
July	0.035	0.001	26.532	
August	0.021	0.001	15.786	
September	0.013	0.001	9.723	
October	0.011	0.001	8.513	
November	0.004	0.001	3.061	
December	0.006	0.001	4.305	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2008

Butterfat Levels as a Predictor of Protein Levels

PRO = c + b(BF)

Month	Coefficient	Standard Error	t Statistic	R-squared (Adjusted)
PRO = c + b(BF)				
Constant (c)	1.5168923	0.0035117	431.9531	0.475
Butterfat (b)	0.4058585	0.0009188	441.7368	
PRO = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	1.6829	0.0038	438.718	0.506
Butterfat (b)	0.3689	0.0010	386.345	
February	0.001	0.001	1.105	
March	-0.024	0.001	-19.061	
April	-0.061	0.001	-48.343	
May	-0.036	0.001	-27.694	
June	-0.042	0.001	-32.614	
July	-0.091	0.001	-69.597	
August	-0.068	0.001	-52.601	
September	-0.028	0.001	-21.765	
October	0.025	0.001	19.575	
November	0.018	0.001	13.767	
December	0.005	0.001	3.781	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2008

Protein Levels as a Predictor of Solids-Not-Fat Levels

$SNF = c + b(PRO)$

Month	c Constant	b Protein Coefficient	Standard Error of **b**	R-squared (Adjusted)	Standard Error
January	5.433740	1.068942	0.005406	0.679655	0.124494
February	5.427399	1.072180	0.005203	0.697940	0.120970
March	5.403898	1.081414	0.005506	0.684390	0.120139
April	5.178177	1.157519	0.005585	0.700553	0.115260
May	5.338231	1.105652	0.005627	0.684369	0.111877
June	5.207086	1.158945	0.005523	0.712805	0.108294
July	5.967885	1.238383	0.006152	0.693658	0.114394
August	5.033157	1.210140	0.006663	0.646639	0.121207
September	5.332527	1.105756	0.006665	0.605064	0.130638
October	5.673697	0.996115	0.005973	0.610378	0.129981
November	5.621968	1.010649	0.005571	0.647395	0.129563
December	5.609921	1.014832	0.005315	0.672214	0.128412

Protein Levels as a Predictor of Solids-Not-Fat Levels

$SNF = c + b_1(PRO) + b_2(PRO)^2$

Month	c Constant	b_1 Protein Coefficient	Standard Error of b_1	b_2 Protein Coefficient	Standard Error of b_2	R-squared (Adjusted)	Standard Error
January	0.085320	4.395724	0.090043	-0.515360	0.013925	0.701804	0.120113
February	0.720658	4.012449	0.083407	-0.457483	0.012954	0.717251	0.117066
March	0.335276	4.280382	0.099415	-0.502973	0.015608	0.701782	0.116782
April	-1.156956	5.248650	0.104053	-0.658575	0.016728	0.723854	0.110685
May	0.491185	4.242386	0.105438	-0.506065	0.016988	0.699338	0.109192
June	0.197703	4.433001	0.104456	-0.533442	0.016996	0.727900	0.105410
July	-1.968410	5.892409	0.108126	-0.778704	0.018065	0.722462	0.108883
August	-2.102679	5.947891	0.130424	-0.784481	0.021570	0.670783	0.116993
September	-1.571105	5.552679	0.130752	-0.714142	0.020972	0.628993	0.126618
October	0.904369	3.954556	0.112408	-0.457218	0.017349	0.625028	0.127514
November	0.935120	3.898450	0.096859	-0.443084	0.014838	0.664089	0.126459
December	1.070320	3.804582	0.082466	-0.426668	0.012588	0.692098	0.124456

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2008

Butterfat Levels as a Predictor of Protein Levels

PRO = c + b(BF)

Month	c Constant	b Butterfat Coefficient	Standard Error of **b**	R-squared (Adjusted)	Standard Error
January	1.827076	0.331991	0.003051	0.391133	0.132372
February	1.531738	0.408145	0.003293	0.455353	0.126571
March	1.558234	0.394801	0.003385	0.433243	0.123161
April	1.707249	0.346529	0.003346	0.368742	0.121009
May	1.791953	0.330341	0.003578	0.323742	0.122529
June	1.703895	0.351668	0.003666	0.341554	0.119455
July	1.615322	0.362514	0.003590	0.362904	0.110949
August	1.694646	0.346900	0.003491	0.353914	0.108910
September	1.700686	0.356727	0.003353	0.386597	0.114532
October	1.647513	0.384477	0.003197	0.448925	0.121244
November	1.595316	0.395644	0.003056	0.483186	0.124880
December	1.590721	0.393460	0.003044	0.484507	0.130103

Butterfat Levels as a Predictor of Protein Levels

PRO = c + b_1(BF) +b_2(BF)^2

Month	c Constant	b_1 Butterfat Coefficient	Standard Error of b_1	b_2 Butterfat Coefficient	Standard Error of b_2	R-squared (Adjusted)	Standard Error
January	3.757964	-0.685173	0.035520	0.133156	0.004295	0.713043	0.118937
February	3.734345	-0.682377	0.035769	0.134062	0.004379	0.481752	0.123466
March	4.162692	-0.901912	0.041099	0.160380	0.005067	0.463434	0.119836
April	4.075337	-0.855425	0.037806	0.151667	0.004753	0.401890	0.117789
May	4.183272	-0.914433	0.038273	0.161142	0.004934	0.361926	0.119020
June	4.111061	-0.924017	0.041464	0.168149	0.005445	0.375114	0.116371
July	3.667256	-0.739530	0.041571	0.147277	0.005536	0.387114	0.108821
August	3.664343	-0.713740	0.034689	0.142148	0.004627	0.386037	0.106168
September	3.919896	-0.796084	0.034486	0.148933	0.004435	0.422796	0.111102
October	4.081186	-0.828905	0.031821	0.150266	0.003922	0.490981	0.116526
November	3.895948	-0.725847	0.031421	0.135603	0.003782	0.517742	0.120633
December	3.894315	-0.720307	0.028265	0.133449	0.003369	0.526303	0.124717

Table A-4

MONTHLY COMPONENT PRICES AND SOMATIC CELL ADJUSTMENT RATES FOR THE UPPER MIDWEST ORDER PRODUCERS

2008

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	---------------------($/Pound)--------------------			($/cwt. Per 1,000 SCC)
January	$1.3319	$4.4994	$0.2097	$0.00100
February	$1.3010	$4.0180	$0.0803	$0.00092
March	$1.3604	$4.3331	$0.0493	$0.00098
April	$1.4748	$3.7579	$0.0622	$0.00091
May	$1.5562	$4.1108	$0.0766	$0.00098
June	$1.6160	$4.7193	$0.0826	$0.00108
July	$1.6774	$4.0025	$0.0707	$0.00098
August	$1.7413	$3.6497	$0.0529	$0.00093
September	$1.8196	$3.2689	$0.0234	$0.00089
October	$1.8507	$3.5490	-$0.0047	$0.00095
November	$1.7730	$3.1301	-$0.0099	$0.00088
December	$1.2998	$3.6390	-$0.0269	$0.00088
Simple Average	$1.5668	$3.8898	$0.0555	$0.00095

Table A-5

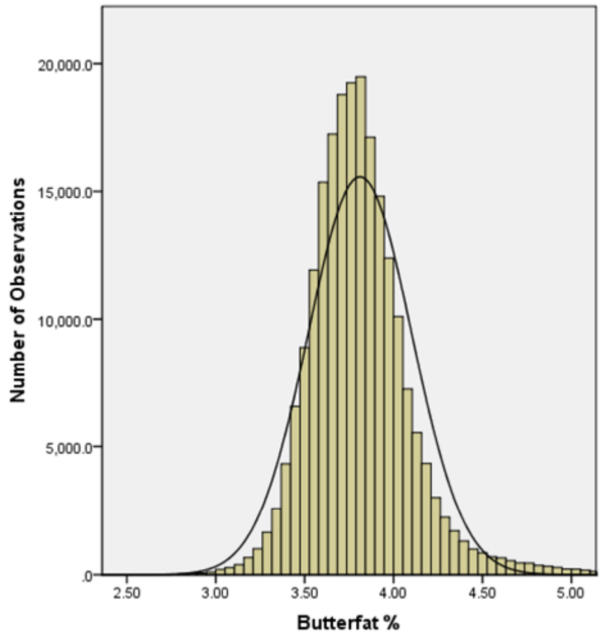
AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

2008

Size Range: Equal to or more than (Pounds)	Size Range: Less than (Pounds)	Aggregated Component Values* ($)	Producer Milk (Pounds)	Weighted Average Value ($/Cwt.)
	20,000	$26,439,217.75	142,147,367	$18.52
20,000	30,000	$55,154,239.15	298,683,631	$18.41
30,000	50,000	$238,236,069.28	1,300,395,687	$18.29
50,000	70,000	$356,570,270.39	1,952,681,677	$18.25
70,000	100,000	$604,919,842.58	3,333,649,409	$18.16
100,000	150,000	$802,411,652.92	4,434,065,641	$18.13
150,000	250,000	$858,945,111.87	4,759,466,107	$18.11
250,000	400,000	$644,054,439.75	3,571,788,355	$18.11
400,000		$3,166,322,946.77	17,826,630,957	$17.86
Total		$6,753,053,790.48	37,619,508,830	
Weighted Average				$18.01

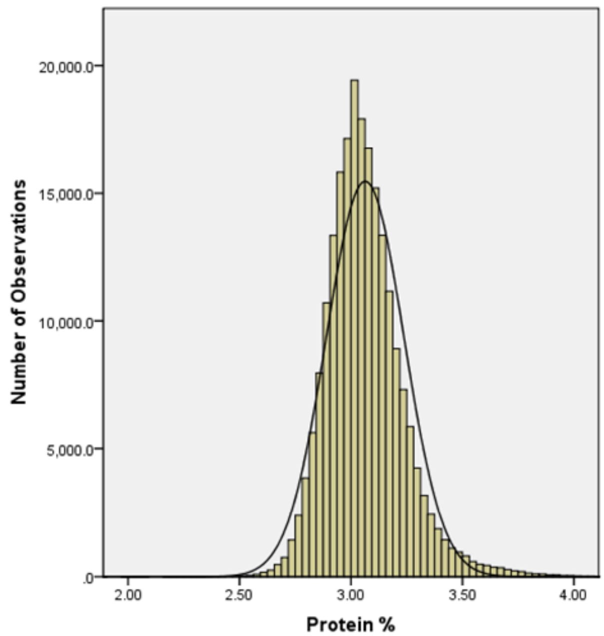
* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

Figure A-1
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE BUTTERFAT LEVELS, 2008



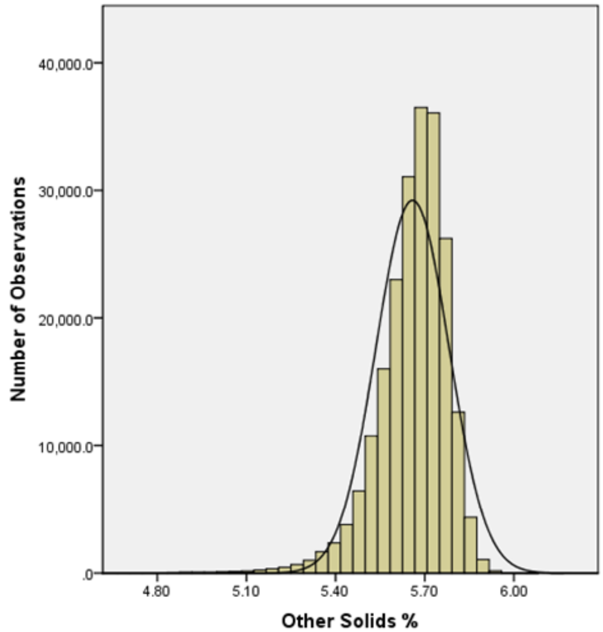
Skewness statistic: 2.323
Kurtosis statistic: 87.724

Figure A-2
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE PROTEIN LEVELS, 2008



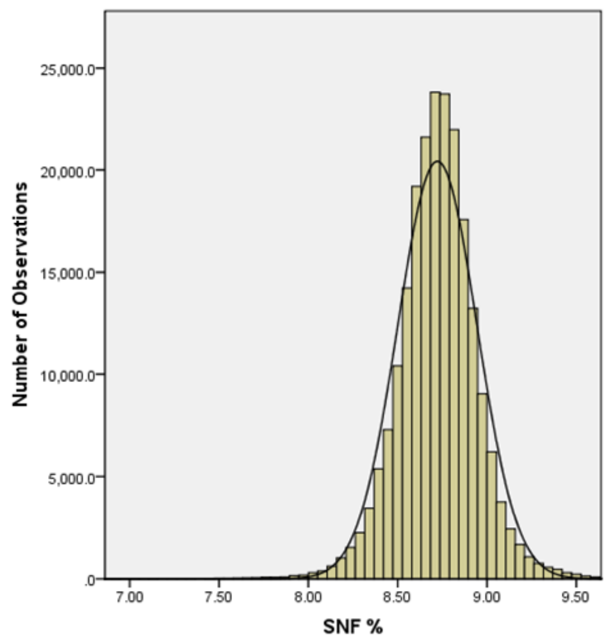
Skewness statistic: 0.985
Kurtosis statistic: 3.339

Figure A-3
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE OTHER SOLIDS LEVELS, 2008



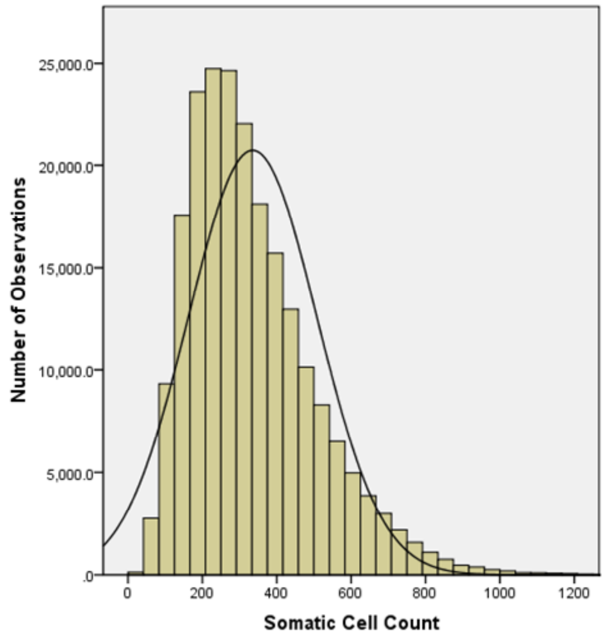
Skewness statistic: -2.267
Kurtosis statistic: 17.187

Figure A-4
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS, 2008



Skewness statistic: -0.488
Kurtosis statistic: 5.423

Figure A-5
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOMATIC CELL COUNT, 2008



Skewness statistic: 1.369
Kurtosis statistic: 5.211

Figure A-6
WEIGHTED AVERAGE MONTHLY BUTTERFAT TESTS
2004, 2005, 2006, 2007, & 2008

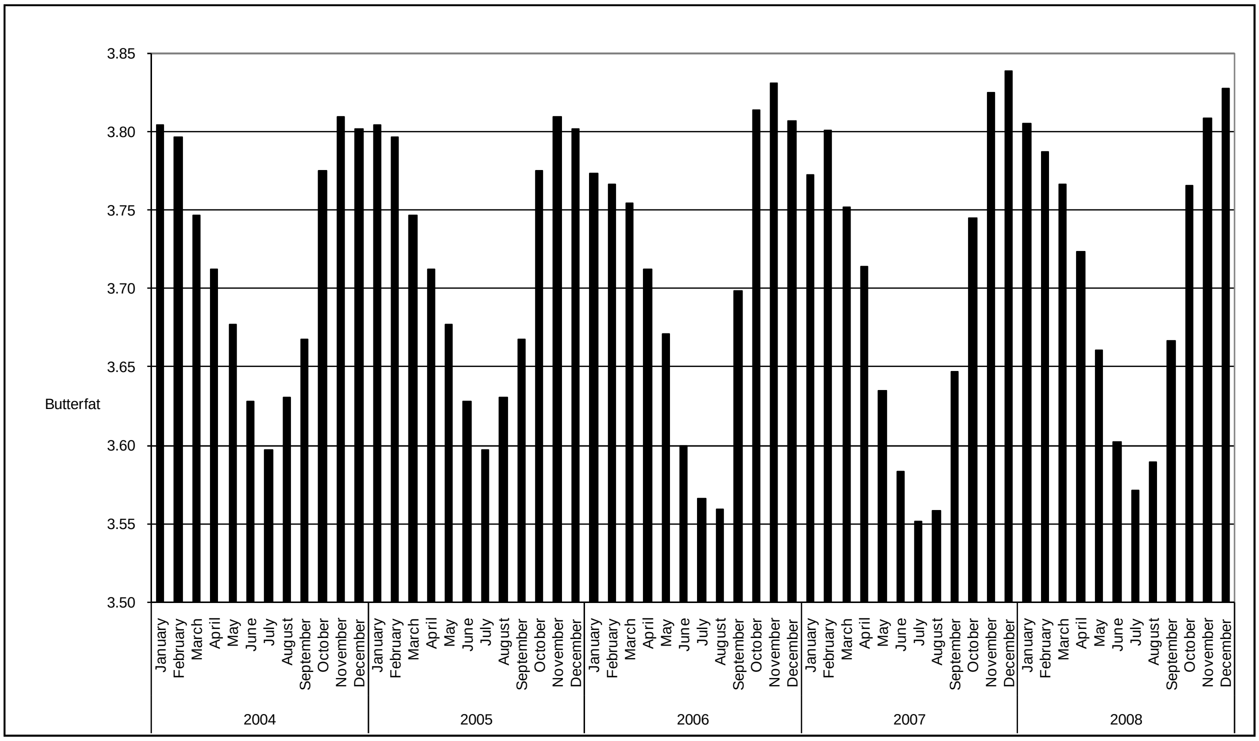


Figure A-7
WEIGHTED AVERAGE MONTHLY PROTEIN TESTS
2004, 2005, 2006, 2007, & 2008

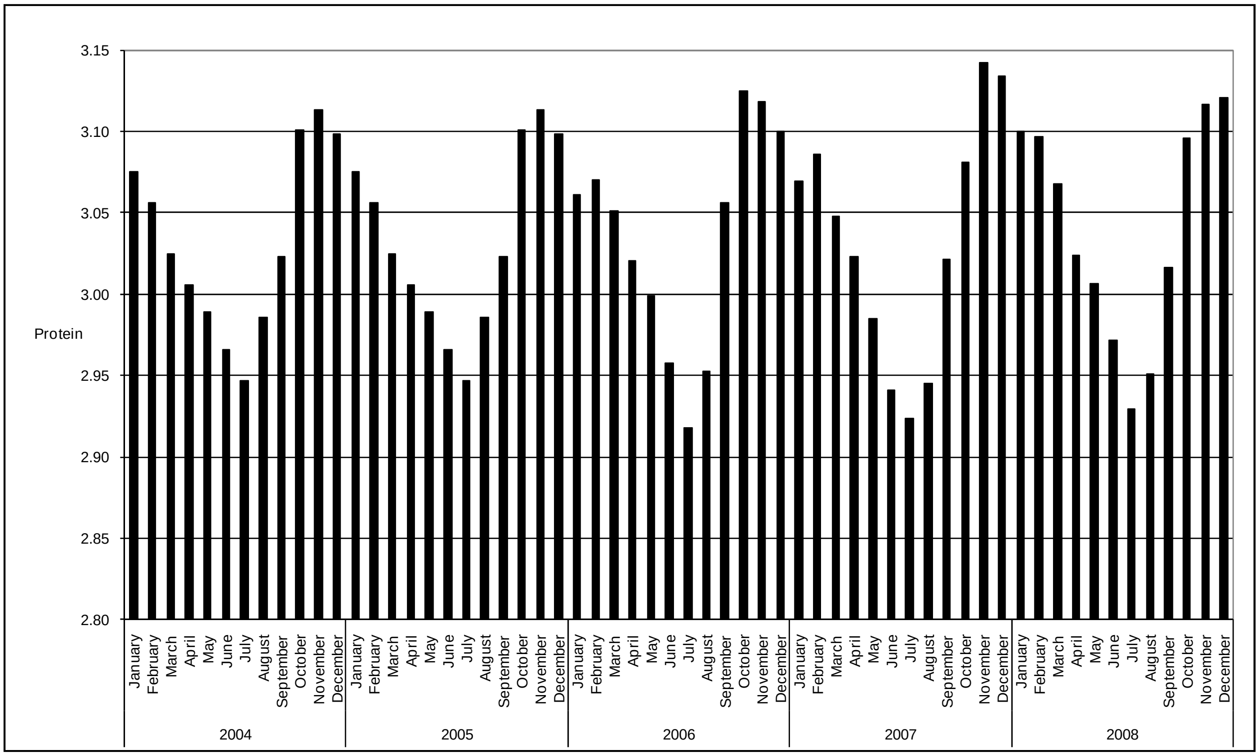


Figure A-8
WEIGHTED AVERAGE MONTHLY OTHER SOLIDS TESTS
2004, 2005, 2006, 2007, & 2008

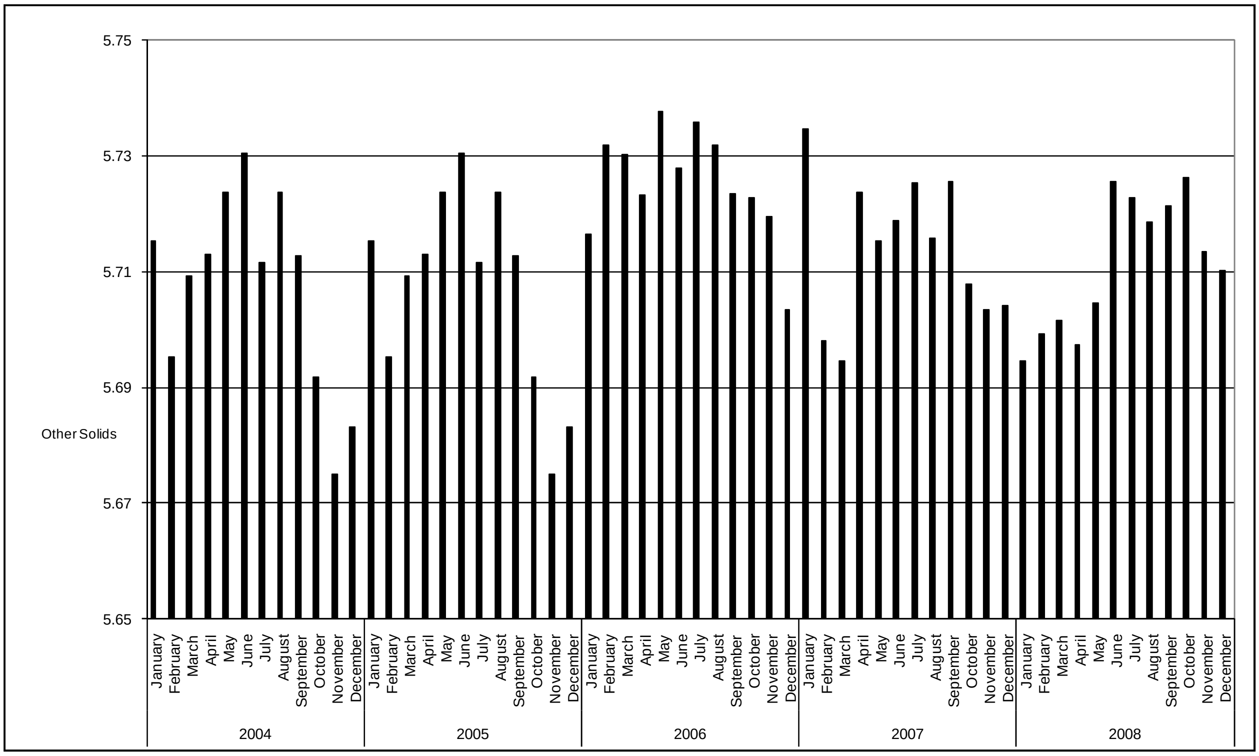


Figure A-9
WEIGHTED AVERAGE MONTHLY SOLIDS-NOT-FAT TESTS
2004, 2005, 2006, 2007, & 2008

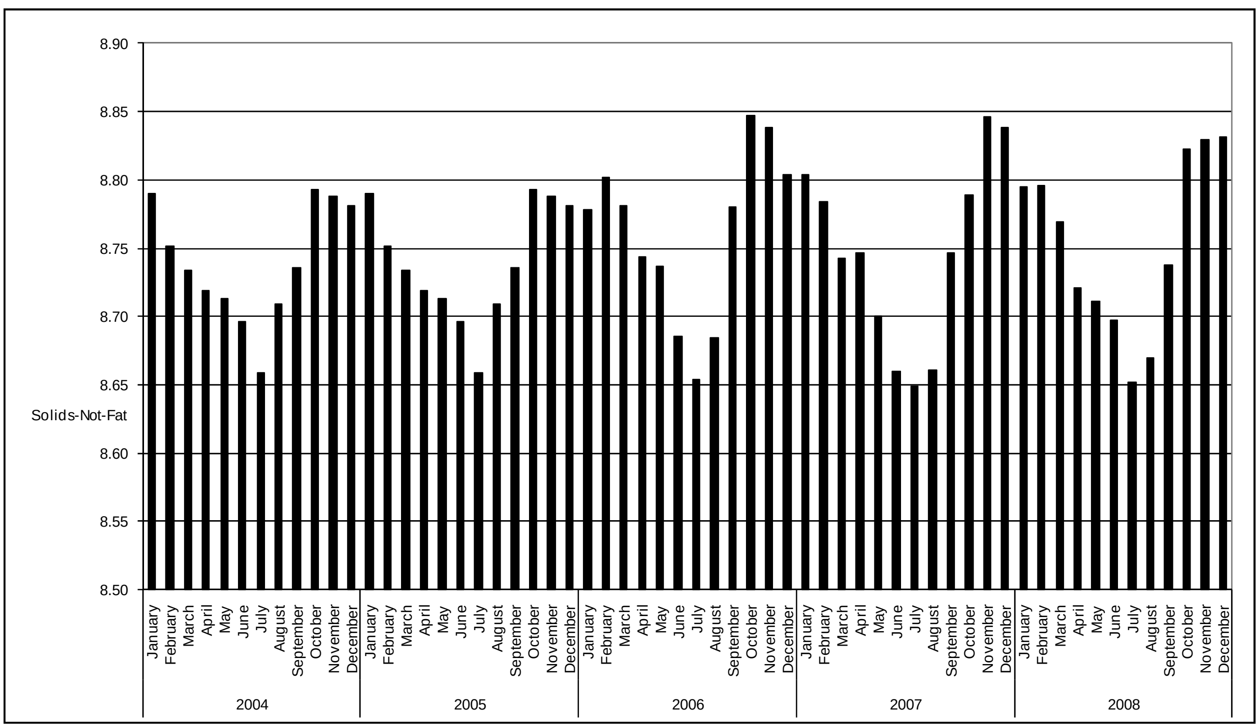


Figure A-10
WEIGHTED AVERAGE MONTHLY SOMATIC CELL COUNTS
2004, 2005, 2006, 2007, & 2008