UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL 2006

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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 2006. 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 2006 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 2006 were 3.71% butterfat, 3.03% protein, 5.73% other solids, 8.76% SNF and 280,000 SCC.

2) For 2006, weighted average butterfat levels were lowest in August, 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 2006, the range of weighted average component levels within one standard deviation of the mean was: 3.46% to 3.96% for butterfat; 2.89% to 3.17% for protein; 5.64% to 5.82% for other solids; 8.59% to 8.93% for SNF; and 147,000 to 413,000 for SCC.

5) Based on the data for 2006, the following regression equations were derived:

$$SNF = 7.21470\% + 0.40136\ (BF)$$
$$SNF = 5.48006\% + 1.06412\ (PRO)$$
$$PRO = 1.54359\% + 0.40000\ (BF)$$

5) The annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $12.30 per cwt. for the market in 2006. 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 2006 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 2006 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 2006, 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 2006 appeared to be relatively "normal". Beginning in January, butterfat and protein tests tapered off during the spring to low points in August and in July, respectively, then rose to peak levels at some time in the late fall or 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 2006 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

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
Minimum	3.56	2.92	5.70	8.65	259
Maximum	3.83	3.12	5.74	8.85	326
Annual Average	3.71	3.03	5.73	8.76	280

During the year, butterfat levels dropped from 3.77% in January to 3.56% in August, then rose to 3.83% by November. 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 0.27, 0.20 and 0.20 percentage points, respectively. Other solids demonstrated the narrowest range of variation with no apparent seasonal pattern. Other solids levels ranged from a high of 5.74% in May and July to a low of 5.70% in December. The seasonal high SCC of 326,000 was reached in August before a low of 259,000 in November, a change of 67,000 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 2006, the simple average SCC (330,000) was higher than the weighted average (280,000) 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 1.399. 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**

2006

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -
Butterfat	3.71	3.79	0.25	3.69	1.11	6.56
Protein	3.03	3.06	0.14	3.02	1.36	4.95
Other Solids	5.73	5.68	0.09	5.74	2.38	6.80
SNF	8.76	8.74	0.17	8.76	3.74	11.30
SCC (1,000's)	280	330	133	252	0	3,308

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 1.11% and as high as 6.56%; protein levels ranged from 1.36% to 4.95%; other solids levels ranged from 2.38% to 6.80%; SNF levels ranged from 3.74% to 11.30%; and SCC ranged from 0 to 3,308,000.

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: 3.46% to 3.96% for butterfat; 2.89% to 3.17% for protein; 5.64% to 5.82% for other solids; 8.59% to 8.93% for SNF; and 147,000 to 413,000 for SCC. Approximately three-quarters of the observed component levels and SCC in the 2006 data were within these ranges[7] (see also Appendix Table A-2 and Appendix Figures A-1 through A-5).

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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 2006 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 2006 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 2006

Percentile	Monthly Average Pounds	Butterfat Test	Protein Test	Other Solids Test	Solids Not Fat Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
1	24,409	3.88	3.09	5.60	8.69	388
2	41,042	3.83	3.07	5.63	8.70	372
3	53,229	3.81	3.06	5.66	8.72	360
4	65,410	3.80	3.06	5.67	8.73	345
5	78,330	3.78	3.06	5.69	8.74	331
6	93,010	3.77	3.04	5.69	8.74	319
7	113,295	3.76	3.04	5.70	8.75	309
8	143,259	3.75	3.04	5.71	8.75	293
9	207,661	3.74	3.04	5.72	8.76	275
10	745,395	3.65	3.02	5.76	8.78	248
Average	156,489	3.71	3.03	5.73	8.76	282

Monthly Average Producer Milk by Producer Size 2006

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	1,768	24,409	2,525	34,592	43,154,689	1.56	1.56
2	1,769	41,042	34,600	47,408	72,602,504	2.62	4.18
3	1,768	53,229	47,417	59,076	94,109,424	3.40	7.58
4	1,769	65,410	59,092	71,623	115,710,311	4.18	11.76
5	1,768	78,330	71,627	84,927	138,487,684	5.00	16.77
6	1,769	93,010	84,951	102,051	164,534,250	5.95	22.71
7	1,769	113,295	102,055	126,004	200,419,342	7.24	29.96
8	1,768	143,259	126,006	165,141	253,281,109	9.15	39.11
9	1,769	207,661	165,145	270,625	367,351,711	13.27	52.38
10	1,768	745,395	270,827	11,084,883	1,317,857,727	47.62	100.00
Total or Average	17,685	156,489			2,767,508,750		

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 24,409 pounds per month had an average butterfat test of 3.88% while producers averaging 745,395 pounds averaged a 3.65% butterfat test. The butterfat test declined steadily from a weighted average of 3.88% for the smallest group to a weighted average of 3.75% and 3.74% for groups 8 and 9, while the group 10 producers, those averaging 745,395 pounds per month, had a weighted average butterfat test of 3.65%. The SCC declined steadily from an average of 388,000 for producers averaging 24,409 pounds per month to an average of 248,000 for producers averaging 745,395 pounds per month, a difference in the SCC of 140,000.

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 producer's averaging 24,409 pounds per month to 3.02% percent for producers averaging 745,395 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 5.60% to 5.76%, while solids-not-fat tests increased steadily from 8.69% to 8.78% as monthly average production increased from 24,409 pounds to 745,395 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 almost 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 156,489 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. However, handler payrolls were received from handlers pooling milk in Idaho only for June and November, therefore data for Idaho is included in the Other category. 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 and Illinois had the highest weighted average butterfat test, while North Dakota, and South Dakota tied for the highest weighted average protein test. North Dakota had the highest weighted average other solids test and weighted average SNF test. Of the states that are included in the Upper Midwest Marketing area Michigan had the lowest weighted average SCC and Iowa had the highest. The aggregated value for the Other states had the lowest SCC overall. Detailed state information by month for 2006 is presented in Table A-2 (see Appendix).

Table 4

Weighted Average Components Levels and Somatic Cell Count in Milk by State 2006

State	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
Illinois	3.74	3.03	5.72	8.76	302
Iowa	3.71	3.07	5.74	8.81	308
Michigan U.P.	3.61	3.02	5.72	8.74	255
Minnesota	3.70	3.05	5.72	8.77	291
North Dakota	3.74	3.10	5.75	8.85	267
South Dakota	3.73	3.10	5.74	8.83	294
Wisconsin	3.72	3.03	5.73	8.75	276
Other[8]	3.69	3.01	5.72	8.73	249
Market	3.71	3.03	5.73	8.76	280
Minimum	3.61	3.01	5.72	8.73	249
Maximum	3.74	3.10	5.75	8.85	308

IV. STATISTICAL RELATIONSHIPS AMONG MILK COMPONENTS

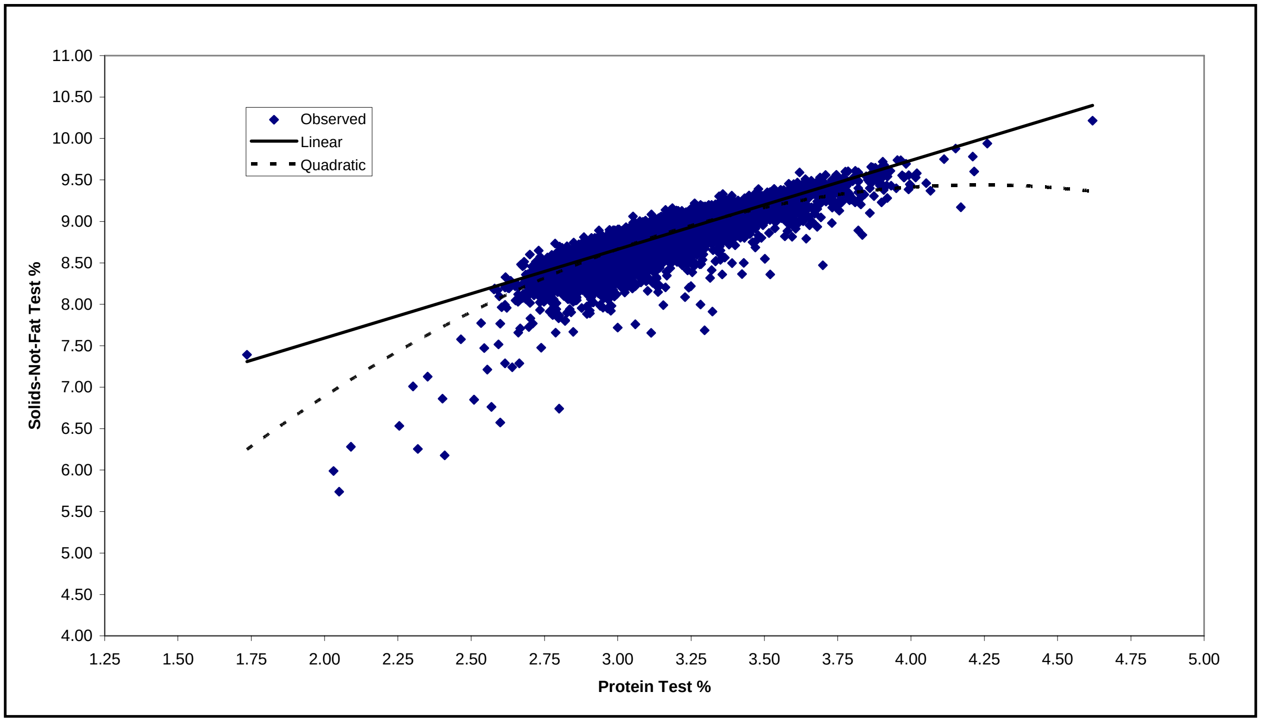
Past Upper Midwest staff papers dealing with milk component levels and the relationships between components in the milk discussed the relationships between milk components based on regression analysis using the formula for a straight line. However, if we look at a scatter plot of solids-not-fat and protein, Figure 1, one can see that a straight line has a

[8] Includes milk from Idaho, Indiana, Kansas, Missouri, Montana, Nebraska, North Carolina, Ohio, Pennsylvania and Wyoming.

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 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 2006



Regression analysis was used to estimate the linear relationship between components. Results from the 2006 data were compared with results from previous Upper Midwest Order studies (1993-2005), 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:

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

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 eighteen 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 2006 data was within that range at 0.40136. 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 (2007)	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 2006 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 2006. 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 2006, for the linear model is:

$$\text{Solids-not-fat Test} = 5.48006 + 1.06412 * \text{Protein Test},$$

while the equation for the quadratic model is:

$$\text{Solids-not-fat Test} = 0.083 + (4.448 * \text{Protein Test}) + (-0.527 * (\text{Protein Test})^2).$$

The R-squared for the linear model is 0.693 while the R-squared for the quadratic model is 0.698. 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 (2007)	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 2004 data and those of Halverson/Kyburz (see Table 7). The primary observation from the equation derived for the 2006 data was that the constant of 1.54359 and the coefficient of 0.40000 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 (2007)	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 2006 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 2006, for the linear model is:

$$\text{Protein Test} = 1.54359 + 0.40000 * \text{Butterfat Test},$$

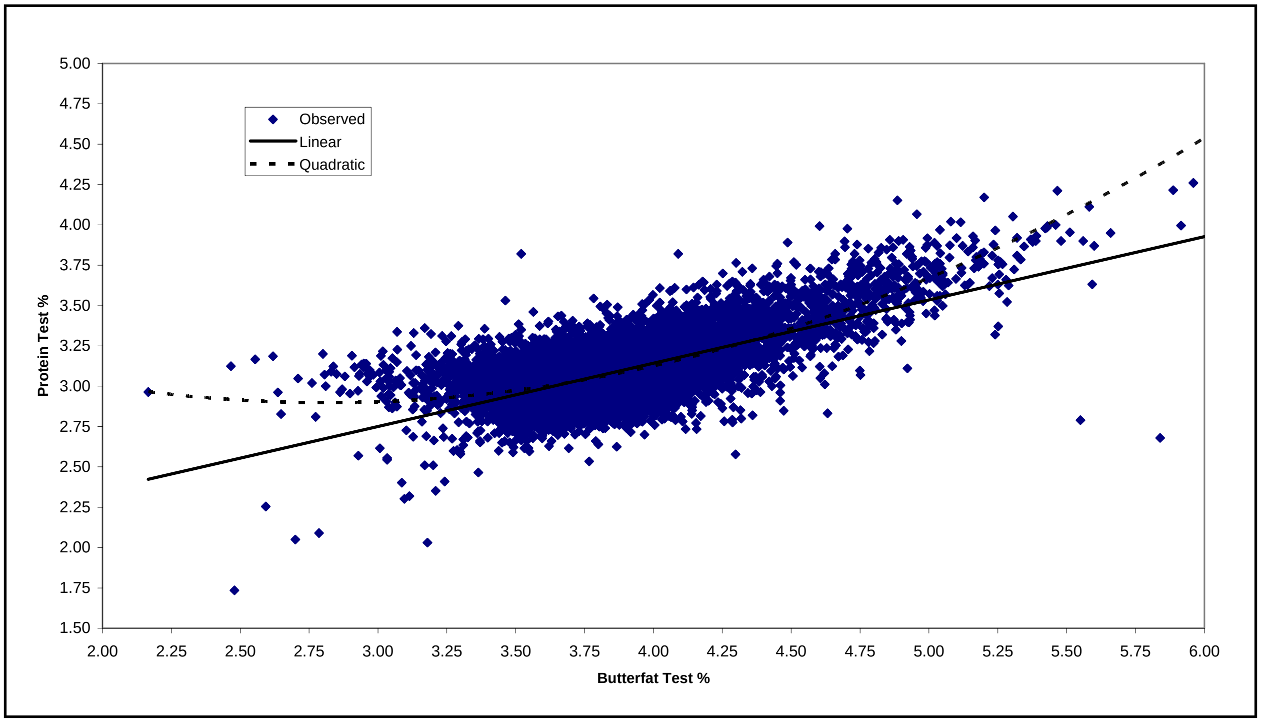
while the equation for the quadratic model is:

$$\text{Protein Test} = 3.51963 + (-0.61386 * \text{Butterfat Test}) + (0.12923 * (\text{Butterfat Test})^2).$$

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 2006 dataset has a slightly higher adjusted R-squared of 0.485, versus 0.444 for the linear model, suggesting a better fit.

Figure 2

Scatter Plot of Protein and Butterfat Tests -- January 2006



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 0.694 suggests that a moderately strong linear relationship exists while protein and SNF appears to have a strong relationship with a coefficient of 0.732. 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 2006

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

Variable	Beta	Standard Error	t-stat
Protein Test	**1.097205**	**0.001623**	**675.9337**
January	5.370408	0.005085	1056.168
February	5.390455	0.005092	1058.698
March	5.388843	0.005057	1065.695
April	5.387306	0.005004	1076.702
May	5.405271	0.004984	1084.540
June	5.393863	0.004911	1098.426
July	5.395906	0.004824	1118.609
August	5.383531	0.004896	1099.510
September	5.361553	0.005097	1051.828
October	5.358157	0.005221	1026.223
November	5.357010	0.005201	1029.986
December	5.352154	0.005158	1037.553

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

Table 8 (continued)

Fixed Effects Model for 2006

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

Variable	Beta	Standard Error	t-stat
Butterfat Test	**0.360476**	**0.000984**	**366.2918**
January	1.693831	0.003904	433.8921
February	1.700844	0.003896	436.5121
March	1.680904	0.003891	431.9495
April	1.663204	0.003850	431.9826
May	1.672830	0.003792	441.1412
June	1.660972	0.003702	448.7134
July	1.627331	0.003647	446.2545
August	1.671486	0.003650	457.9487
September	1.733692	0.003818	454.0259
October	1.759809	0.003955	444.9834
November	1.738717	0.003977	437.1529
December	1.719561	0.003957	434.5177

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	**0.369137**	**0.001477**	**249.8965**
January	7.330752	0.005860	1251.069
February	7.358291	0.005849	1258.142
March	7.334672	0.005841	1255.717
April	7.312576	0.005779	1265.354
May	7.339499	0.005692	1289.476
June	7.312576	0.005556	1316.128
July	7.276165	0.005474	1329.323
August	7.312316	0.005479	1334.720
September	7.363237	0.005732	1284.691
October	7.392244	0.005936	1245.305
November	7.368586	0.005970	1234.269
December	7.342154	0.005940	1236.046

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 2006

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

	Beta	**Standard Error**	**t-stat**
(Constant)	**1.698019**	**0.003608**	**470.6473**
January	0.360197	0.000956	376.9257
February	0.361925	0.000958	377.9534
March	0.356055	0.000959	371.3443
April	0.351229	0.000970	362.0825
May	0.353588	0.000986	358.6401
June	0.350262	0.001012	346.0937
July	0.340834	0.001029	331.2621
August	0.352912	0.001028	343.3829
September	0.369796	0.000980	377.5219
October	0.376334	0.000944	398.8086
November	0.370917	0.000937	395.7136
December	0.366119	0.000942	388.5327

Dependent Variable: Protein Test

Table 9 (continued)

Random Effects Model for 2006

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

	Beta	**Standard Error**	**t-stat**
(Constant)	**7.336982**	**0.005541**	**1324.1050**
January	0.368247	0.001468	250.9038
February	0.375344	0.001471	255.2115
March	0.368519	0.001473	250.2482
April	0.362616	0.001490	243.3974
May	0.369696	0.001514	244.1507
June	0.362586	0.001554	233.2728
July	0.352527	0.001580	223.0862
August	0.362274	0.001578	229.5101
September	0.375926	0.001504	249.8811
October	0.383178	0.001449	264.3892
November	0.377075	0.001440	261.9292
December	0.370489	0.001447	255.9952

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	11	222572	358.4	2.18
Protein and Butterfat	11	222572	1600.9	2.18
Solids-Not-Fat and Protein	11	222572	472.3	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
Butterfat and Protein	27707	27472
Butterfat and Solids-Not-Fat	2085	0.0709
Somatic Cell Count and Butterfat	1060	1941

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 2006

Coefficient	State			Month		
	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	0.71675	0.95944	0.99094	0.83472	0.82921	0.83514
b^b	0.40405	0.70668	-0.11326	0.36085	0.36826	29.35500
b^w	0.39218	0.50262	-144.83000	0.60188	0.56621	-157.34000
b^t	0.40069	0.69840	-1.42430	0.40069	0.40207	-1.42430

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 2006. 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 2006, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $12.30 per cwt. for the market. The value of each component comprised by the $12.30 per cwt. price was $4.92 for butterfat, $6.35 for protein, and $0.99 for other solids. The SCC adjustment for the year amounted to about $0.04 per cwt.

Categorized by size range of delivery, average values of producer milk ranged from a low of $12.18 per cwt. for monthly producer milk deliveries greater than 400,000 pounds to a high of $12.82 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 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. 2002 - 2006 WEIGHTED AVERAGE COMPONENT TESTS

Weighted average component data for the past five years, 2002, 2003, 2004, 2005 and 2006 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, 3.72 percent, 3.69 percent, and 3.71 percent for 2002, 2003, 2004, 2005, and 2006 respectively. Yearly average protein and other solids tests varied even less than the butterfat test between the six years. Yearly weighted average somatic cell counts also did not change much over the six-year period, decreasing from 326,000 in 2002 to 280,000 in 2006.

Graphs (see Appendix Figures A-6 through A-10) show the monthly weighted average component tests for 2002, 2003, 2004, 2005, and 2006. 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 2002 through 2006 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

2002

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.79	3.05	5.70	8.75	317
February	3.77	3.03	5.70	8.74	318
March	3.77	3.04	5.71	8.75	320
April	3.73	3.00	5.74	8.74	322
May	3.70	2.98	5.74	8.72	310
June	3.63	2.94	5.74	8.68	325
July	3.55	2.88	5.71	8.60	379
August	3.57	2.94	5.70	8.65	386
September	3.65	3.00	5.70	8.70	346
October	3.79	3.09	5.71	8.80	307
November	3.83	3.10	5.69	8.79	300
December	3.80	3.07	5.69	8.76	289
Annual Average	3.72	3.01	5.71	8.72	326

Table 13 (continued)

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

2003

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.77	3.03	5.72	8.75	301
February	3.75	3.04	5.71	8.75	314
March	3.74	3.02	5.73	8.75	316
April	3.70	2.99	5.75	8.74	308
May	3.65	2.96	5.75	8.71	315
June	3.59	2.95	5.75	8.69	322
July	3.54	2.92	5.71	8.63	345
August	3.54	2.92	5.70	8.62	348
September	3.64	3.01	5.70	8.72	330
October	3.77	3.09	5.69	8.78	290
November	3.84	3.11	5.71	8.83	274
December	3.82	3.09	5.71	8.80	277
Annual Average	3.69	3.01	5.72	8.73	312

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

VII. SUMMARY

This staff paper analyzes milk components and SCC in producer milk associated with the Upper Midwest Order during 2006. 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 2006 were: 3.71% butterfat, 3.03% protein, 5.73% other solids, 8.76% SNF and 280,000 SCC. The weighted average butterfat level was lowest in August, 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 lowest in December and exhibited less variation during the year relative to the three other components. Weighted average SCC was lowest in December and highest in July. Approximately three-quarters of monthly average component levels ranged from: 3.46% to 3.96% for butterfat; 2.89% to 3.17% for protein; 5.64% to 5.82% for other solids; 8.59% to 8.93% for SNF; and 147,000 to 413,000 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 156,489 pounds, however over 80 percent of the producers had average marketings below the market average.

Based on the data for 2006, the following regression equations were derived:

$$SNF = 7.21470\% + 0.40136\,(BF)$$
$$SNF = 5.48006\% + 1.06412\,(PRO)$$
$$PRO = 1.54359\% + 0.40000\,(BF)$$

Under MCP, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $12.30 per cwt. for the market. Protein contributed slightly more than half of the total value.

BIBLIOGRAPHY

Bhattacharyya, Gouri H. and Johnson, Richard A. Statistical Concepts and Methods. John Wiley & Sons, New York. 1977.

Freije, Corey. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 2005." Upper Midwest Marketing Area Staff Paper 06-04. December 2006.

Freije, Corey. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 2003." Upper Midwest Marketing Area Staff Paper 06-01. April 2006.

Freije, Corey. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 2004." Upper Midwest Marketing Area Staff Paper 06-03. July 2006.

Halverson, Victor and Kyburz, H. Paul. "Analysis of Component Levels in Individual Herd Milk at the Farm Level: 1984 and 1985." Upper Midwest Marketing Area Staff Paper 86-01. March 1986.

Jack, E. L., et al. "Relationship of Solids-Not-Fat to Fat in California Milk." California Agricultural Experiment Station Bulletin 726. September 1951.

Jacobson, Moses S. "Butterfat and Total Solids in New England Farmers' Milk as Delivered to Processing Plants." Journal of Dairy Science, 19:171-76. 1936.

Mykrantz, John L. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1992." Upper Midwest Marketing Area Staff Paper 93-01. June 1993.

Mykrantz, John L. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1993." Upper Midwest Marketing Area Staff Paper 94-01. May 1994.

Schaefer, Henry H. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 2001." Upper Midwest Marketing Area Staff Paper 02-02. December 2002.

Schaefer, Henry H. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 2002." Upper Midwest Marketing Area Staff Paper 03-01. December 2003.

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1994." Upper Midwest Marketing Area Staff Paper 95-01. August 1995.

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1995." Upper Midwest Marketing Area Staff Paper 96-02. September 1996.

BIBLIOGRAPHY - continued

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1996." Upper Midwest Marketing Area Staff Paper 97-01. September 1997.

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1997." Upper Midwest Marketing Area Staff Paper 98-01. July 1998.

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1998." Upper Midwest Marketing Area Staff Paper 99-01. July 1999.

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 1999." Upper Midwest Marketing Area Staff Paper 00-02. September 2000.

Sebastian, Rodney M. "Analysis of Component Levels and Somatic Cell Count in Individual Herd Milk at the Farm Level: 2000." Upper Midwest Marketing Area Staff Paper 01-02. November 2001.

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APPENDIX

TABLES

FIGURES

Table A-1

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

2006

Butterfat

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.77	3.86	0.23	3.76	2.17	6.41	19,257
February	3.77	3.85	0.23	3.75	1.80	6.50	19,259
March	3.75	3.85	0.23	3.74	2.23	6.26	19,324
April	3.71	3.81	0.23	3.70	1.11	5.76	19,309
May	3.67	3.75	0.22	3.66	2.00	5.60	19,300
June	3.60	3.65	0.20	3.59	2.04	5.76	19,242
July	3.57	3.59	0.19	3.56	1.76	5.18	19,092
August	3.56	3.59	0.21	3.55	1.49	5.95	19,016
September	3.70	3.77	0.23	3.69	2.12	6.29	18,960
October	3.81	3.91	0.24	3.80	1.36	6.29	18,919
November	3.83	3.94	0.25	3.81	1.23	6.56	18,977
December	3.81	3.92	0.26	3.79	1.46	6.33	18,918
Total	3.71	3.79	0.25	3.69	1.11	6.56	229,573

Protein

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.06	3.09	0.15	3.05	0.30	4.62	19,257
February	3.07	3.09	0.15	3.06	0.30	4.72	19,259
March	3.05	3.07	0.12	3.04	1.94	4.16	19,324
April	3.02	3.04	0.11	3.01	1.64	4.05	19,309
May	3.00	3.02	0.11	2.99	2.23	4.18	19,300
June	2.96	2.98	0.11	2.95	2.26	3.87	19,242
July	2.92	2.92	0.11	2.91	2.28	4.22	19,092
August	2.95	2.97	0.11	2.94	1.36	4.14	19,016
September	3.06	3.09	0.12	3.04	1.67	4.50	18,960
October	3.12	3.17	0.13	3.11	1.83	4.45	18,919
November	3.12	3.16	0.13	3.10	1.95	4.70	18,977
December	3.10	3.13	0.13	3.09	1.55	4.95	18,918
Total	3.03	3.06	0.14	3.02	0.30	4.95	229,573

Table A-1 (continued)

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

2006

Other Solids

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	5.72	5.67	0.09	5.73	3.69	6.01	19,257
February	5.73	5.69	0.09	5.74	2.86	6.00	19,259
March	5.73	5.69	0.09	5.74	3.78	6.01	19,324
April	5.72	5.68	0.09	5.73	3.44	6.26	19,309
May	5.74	5.70	0.08	5.75	3.96	6.05	19,300
June	5.73	5.68	0.09	5.74	3.55	6.05	19,242
July	5.74	5.68	0.10	5.75	4.38	5.99	19,092
August	5.73	5.67	0.11	5.74	2.38	6.06	19,016
September	5.72	5.66	0.10	5.74	4.33	6.80	18,960
October	5.72	5.67	0.10	5.74	3.43	6.08	18,919
November	5.72	5.66	0.10	5.73	2.65	6.05	18,977
December	5.70	5.66	0.09	5.72	2.90	5.97	18,918
Total	5.73	5.68	0.09	5.74	2.38	6.80	229,573

Solids-Not-Fat

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	8.78	8.76	0.18	8.78	5.74	10.22	19,257
February	8.80	8.78	0.18	8.81	4.61	10.26	19,259
March	8.78	8.76	0.16	8.79	5.84	9.67	19,324
April	8.74	8.72	0.15	8.75	5.09	10.05	19,309
May	8.74	8.72	0.15	8.74	6.51	9.69	19,300
June	8.69	8.66	0.15	8.69	6.24	9.56	19,242
July	8.65	8.60	0.16	8.67	6.80	9.79	19,092
August	8.68	8.64	0.16	8.69	3.74	9.74	19,016
September	8.78	8.76	0.16	8.78	6.84	11.30	18,960
October	8.85	8.84	0.16	8.85	5.71	9.91	18,919
November	8.84	8.82	0.16	8.84	4.60	10.04	18,977
December	8.80	8.79	0.17	8.81	4.45	10.07	18,918
For the Year	8.76	8.74	0.17	8.76	3.74	11.30	229,573

Table A-1 (continued)

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

2006

Somatic Cell Count

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	(1,000)						
January	275	326	134	248	17	2,282	19,257
February	272	323	134	242	0	1,833	19,259
March	272	326	136	242	0	2,492	19,324
April	274	328	134	243	0	2,800	19,309
May	270	317	127	242	0	2,524	19,300
June	286	337	132	258	13	1,732	19,242
July	301	357	137	273	12	2,058	19,092
August	326	381	144	298	13	2,101	19,016
September	298	344	133	274	10	3,308	18,960
October	267	309	119	245	14	1,502	18,919
November	259	303	119	235	0	2,243	18,977
December	264	312	125	236	0	2,325	18,918
For the Year	280	330	133	252	0	3,308	229,573

Table A-2

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2006

Butterfat

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.86	3.78	3.70	3.75	3.80	3.80	3.78	3.79	3.77
February	3.85	3.77	3.69	3.75	3.79	3.78	3.78	3.77	3.77
March	3.79	3.76	3.68	3.73	3.77	3.76	3.77	3.76	3.75
April	3.72	3.71	3.65	3.68	3.73	3.71	3.73	3.68	3.71
May	3.66	3.65	3.59	3.65	3.66	3.68	3.69	3.65	3.67
June	3.61	3.59	3.52	3.59	3.61	3.61	3.61	3.58	3.60
July	3.59	3.57	3.53	3.56	3.59	3.57	3.57	3.60	3.57
August	3.58	3.56	3.53	3.55	3.58	3.56	3.56	3.59	3.56
September	3.73	3.70	3.57	3.69	3.70	3.70	3.70	3.69	3.70
October	3.82	3.80	3.64	3.81	3.82	3.82	3.82	3.82	3.81
November	3.85	3.84	3.63	3.84	3.89	3.87	3.83	3.81	3.83
December	3.82	3.81	3.57	3.81	3.89	3.85	3.81	3.81	3.81
Total	3.74	3.71	3.61	3.70	3.74	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	3.06	3.10	3.08	3.07	3.12	3.12	3.05	3.07	3.06
February	3.07	3.10	3.08	3.08	3.13	3.13	3.06	3.06	3.07
March	3.06	3.09	3.06	3.07	3.13	3.12	3.04	3.05	3.05
April	3.03	3.06	3.01	3.03	3.09	3.08	3.01	3.01	3.02
May	3.01	3.04	2.99	3.01	3.06	3.06	2.99	2.98	3.00
June	2.96	3.00	2.95	2.97	3.01	3.01	2.95	2.94	2.96
July	2.90	2.95	2.94	2.93	2.97	2.97	2.91	2.92	2.92
August	2.93	2.97	2.96	2.96	3.01	3.00	2.95	2.94	2.95
September	3.04	3.08	3.03	3.07	3.12	3.11	3.05	3.08	3.06
October	3.14	3.16	3.08	3.13	3.19	3.18	3.12	3.13	3.12
November	3.14	3.15	3.10	3.13	3.19	3.19	3.11	3.11	3.12
December	3.11	3.13	3.05	3.11	3.18	3.18	3.09	3.12	3.10
Total	3.03	3.07	3.02	3.05	3.10	3.10	3.03	3.01	3.03

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2006

Other Solids

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	5.71	5.75	5.73	5.70	5.72	5.71	5.72	5.73	5.72
February	5.72	5.75	5.73	5.72	5.73	5.74	5.74	5.72	5.73
March	5.73	5.74	5.73	5.73	5.74	5.75	5.73	5.72	5.73
April	5.74	5.76	5.71	5.71	5.74	5.73	5.72	5.72	5.72
May	5.74	5.77	5.73	5.73	5.76	5.75	5.74	5.73	5.74
June	5.71	5.75	5.72	5.72	5.75	5.75	5.73	5.72	5.73
July	5.73	5.74	5.72	5.74	5.77	5.77	5.73	5.73	5.74
August	5.72	5.74	5.70	5.75	5.80	5.79	5.72	5.71	5.73
September	5.72	5.73	5.71	5.73	5.77	5.76	5.72	5.71	5.72
October	5.72	5.73	5.73	5.71	5.74	5.73	5.73	5.71	5.72
November	5.71	5.72	5.70	5.72	5.75	5.73	5.72	5.71	5.72
December	5.69	5.71	5.69	5.68	5.70	5.69	5.71	5.69	5.70
Total	5.72	5.74	5.72	5.72	5.75	5.74	5.73	5.72	5.73

Solids-Not-Fat

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	8.77	8.84	8.81	8.77	8.84	8.83	8.77	8.81	8.78
February	8.79	8.86	8.81	8.80	8.86	8.87	8.80	8.78	8.80
March	8.78	8.83	8.79	8.79	8.88	8.86	8.77	8.77	8.78
April	8.77	8.82	8.72	8.74	8.83	8.81	8.73	8.73	8.74
May	8.75	8.81	8.72	8.74	8.82	8.80	8.73	8.71	8.74
June	8.67	8.75	8.68	8.69	8.76	8.76	8.68	8.66	8.69
July	8.63	8.69	8.67	8.67	8.74	8.74	8.64	8.64	8.65
August	8.65	8.71	8.66	8.71	8.82	8.79	8.67	8.64	8.68
September	8.76	8.81	8.74	8.80	8.89	8.86	8.77	8.79	8.78
October	8.86	8.89	8.81	8.84	8.93	8.91	8.84	8.85	8.85
November	8.85	8.88	8.80	8.84	8.94	8.91	8.83	8.82	8.84
December	8.80	8.83	8.75	8.79	8.88	8.87	8.80	8.80	8.80
Total	8.76	8.81	8.74	8.77	8.85	8.83	8.75	8.73	8.76

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2006

Somatic Cell Counts

	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	312	309	235	283	273	288	274	224	275
February	315	304	237	277	263	285	270	224	272
March	305	306	240	279	276	280	271	224	272
April	300	301	238	288	277	289	270	223	274
May	289	296	231	286	267	291	266	222	270
June	307	315	256	302	273	306	281	250	286
July	328	332	265	317	287	319	296	260	301
August	350	357	305	340	297	338	320	296	326
September	314	325	288	309	273	308	291	319	298
October	269	287	276	276	244	279	261	285	267
November	262	279	258	266	232	268	254	270	259
December	268	284	257	268	241	283	260	257	264
Total	302	308	255	291	267	294	276	249	280

Table A-3

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2006

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)	7.214700	0.005190		0.274
Butterfat (b)	0.401356	0.001365	294.0013	
SNF = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	7.3308	0.0059	1251.069	0.290
Butterfat (b)	0.3691	0.0015	249.897	
February	0.028	0.002	14.526	
March	0.004	0.002	2.070	
April	-0.018	0.002	-9.585	
May	0.009	0.002	4.598	
June	-0.018	0.002	-9.458	
July	-0.055	0.002	-28.118	
August	-0.018	0.002	-9.492	
September	0.032	0.002	17.026	
October	0.061	0.002	32.266	
November	0.038	0.002	19.849	
December	0.011	0.002	5.982	

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)	5.4800633	0.004534		0.693
Protein (b)	1.0641154	0.001479	719.3054	
SNF = c + b(PRO) + m(February) + . . . + m(December)				
Constant (c)	5.3704	0.0051	1056.168	0.698
Protein (b)	1.0972	0.0016	675.934	
February	0.020	0.001	16.213	
March	0.018	0.001	14.918	
April	0.017	0.001	13.645	
May	0.035	0.001	28.114	
June	0.023	0.001	18.773	
July	0.025	0.001	20.119	
August	0.013	0.001	10.454	
September	-0.009	0.001	-7.133	
October	-0.012	0.001	-9.805	
November	-0.013	0.001	-10.748	
December	-0.018	0.001	-14.671	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2006

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)	1.543593	0.003550		0.444
Butterfat (b)	0.400001	0.000934	428.2859	
PRO = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	1.6938	0.0039	433.892	0.485
Butterfat (b)	0.3605	0.0010	366.292	
February	0.007	0.001	5.553	
March	-0.013	0.001	-10.243	
April	-0.031	0.001	-24.242	
May	-0.021	0.001	-16.568	
June	-0.033	0.001	-25.664	
July	-0.067	0.001	-51.417	
August	-0.022	0.001	-17.268	
September	0.040	0.001	31.358	
October	0.066	0.001	51.963	
November	0.045	0.001	35.346	
December	0.026	0.001	20.262	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2006

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	5.493744	1.057237	0.004863	0.710540	0.123469
February	5.454585	1.076452	0.004850	0.718921	0.120658
March	5.342121	1.112432	0.005564	0.674155	0.119251
April	5.197442	1.159761	0.005660	0.684963	0.113747
May	5.304648	1.130493	0.005339	0.699049	0.107077
June	5.158038	1.176427	0.005817	0.680093	0.109035
July	5.000859	1.232402	0.006187	0.675133	0.115441
August	5.060035	1.206227	0.006886	0.617371	0.129157
September	5.454872	1.067034	0.006248	0.606008	0.128279
October	5.618181	1.015187	0.005611	0.633768	0.125803
November	5.619512	1.014078	0.005558	0.636935	0.128911
December	5.476406	1.057522	0.005470	0.663966	0.127656

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	0.258665	4.342093	0.088081	-0.513333	0.013802	0.690798	0.119180
February	0.083808	4.447724	0.088218	-0.527179	0.013855	0.700305	0.116187
March	-1.025910	5.173523	0.102164	-0.645525	0.016217	0.698836	0.114646
April	-0.728731	5.006646	0.104666	-0.622730	0.016920	0.705602	0.109958
May	0.062857	4.530956	0.110084	-0.550016	0.017786	0.713245	0.104521
June	-0.926949	5.189455	0.127615	-0.660051	0.020969	0.695746	0.106334
July	-1.296406	5.474362	0.125394	-0.712660	0.021042	0.693531	0.112124
August	-2.866829	6.464151	0.119805	-0.869846	0.019790	0.652645	0.123060
September	1.233354	3.735298	0.121202	-0.420427	0.019072	0.615835	0.126669
October	1.374373	3.622175	0.103319	-0.399025	0.015791	0.645707	0.123736
November	0.975555	3.868818	0.092035	-0.437072	0.014066	0.654496	0.125755
December	-0.093592	4.506769	0.082675	-0.531898	0.012724	0.692371	0.122142

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2006

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	1.582707	0.389253	0.003839	0.348062	0.147739
February	1.640065	0.376247	0.003850	0.331464	0.146573
March	1.677752	0.361295	0.003186	0.399546	0.119483
April	1.780159	0.329746	0.003264	0.345835	0.116969
May	1.835150	0.317134	0.003474	0.301561	0.120643
June	1.756419	0.334327	0.003438	0.329451	0.110660
July	1.661000	0.351101	0.003545	0.339347	0.109759
August	1.851749	0.310328	0.003532	0.288726	0.114709
September	1.813420	0.339332	0.003445	0.338477	0.121269
October	1.645265	0.389749	0.003214	0.437344	0.122281
November	1.624561	0.389473	0.003061	0.460413	0.123684
December	1.600639	0.390847	0.003037	0.466804	0.123904

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	4.123992	-0.880737	0.045306	0.157644	0.005604	0.373763	0.144797
February	4.052157	-0.836302	0.045240	0.151459	0.005631	0.355637	0.143899
March	3.985954	-0.801438	0.040682	0.145568	0.005078	0.424011	0.117024
April	3.983656	-0.800814	0.039543	0.144268	0.005029	0.372543	0.114557
May	5.042413	-1.353143	0.045245	0.216357	0.005845	0.347837	0.116578
June	4.567910	-1.167744	0.046805	0.199687	0.006206	0.363656	0.107801
July	4.294363	-1.086805	0.046857	0.195449	0.006352	0.370536	0.107137
August	4.426042	-1.098426	0.039980	0.191854	0.005425	0.332595	0.111116
September	5.101291	-1.361753	0.041039	0.218882	0.005263	0.393747	0.116093
October	4.456405	-0.999406	0.037203	0.170562	0.004552	0.476194	0.117984
November	4.036284	-0.789819	0.031659	0.143150	0.003826	0.497458	0.119362
December	3.985608	-0.780166	0.032200	0.142689	0.003907	0.501895	0.119757

Table A-4

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

2006

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	---------------------($/Pound)--------------------			($/cwt. Per 1,000 SCC)
January	$1.4684	$2.3994	$0.1881	$0.00069
February	$1.3469	$2.1220	$0.1999	$0.00063
March	$1.2596	$1.8836	$0.1874	$0.00058
April	$1.2343	$1.9238	$0.1508	$0.00058
May	$1.2582	$1.9115	$0.1251	$0.00058
June	$1.2436	$2.0790	$0.1255	$0.00061
July	$1.2228	$1.9807	$0.1257	$0.00059
August	$1.3008	$1.9050	$0.1416	$0.00059
September	$1.4191	$2.1346	$0.1649	$0.00065
October	$1.4149	$2.0775	$0.2026	$0.00064
November	$1.3852	$2.2383	$0.2276	$0.00066
December	$1.3481	$2.4388	$0.2564	$0.00068
Simple Average	$1.3252	$2.0912	$0.1746	$0.00062

Table A-5

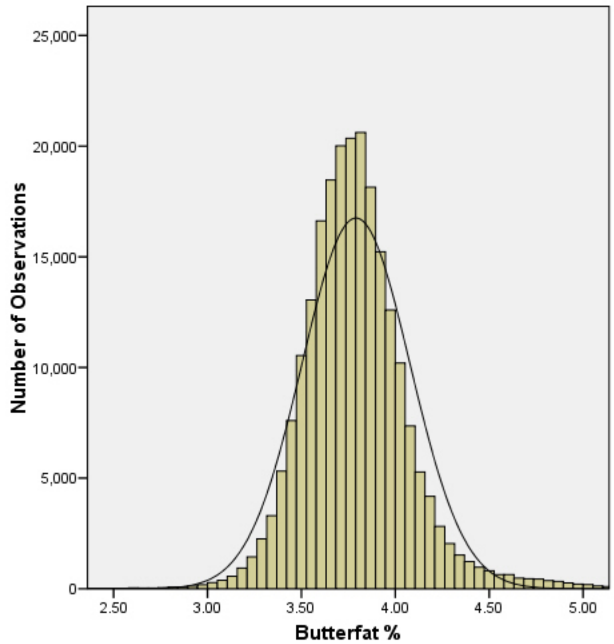
AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

2006

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	$16,679,946.58	130,087,290	$12.82
20,000	30,000	$37,664,019.56	296,178,769	$12.72
30,000	50,000	$178,459,790.58	1,424,816,618	$12.53
50,000	70,000	$274,906,990.90	2,206,197,637	$12.46
70,000	100,000	$463,216,220.05	3,741,201,622	$12.38
100,000	150,000	$600,723,676.26	4,867,021,505	$12.34
150,000	250,000	$616,223,025.52	4,991,140,705	$12.35
250,000	400,000	$423,313,988.82	3,432,401,540	$12.33
400,000		$1,872,303,424.20	15,376,673,062	$12.18
Total		$4,483,491,082.48	36,465,718,749	
Weighted Average				$12.30

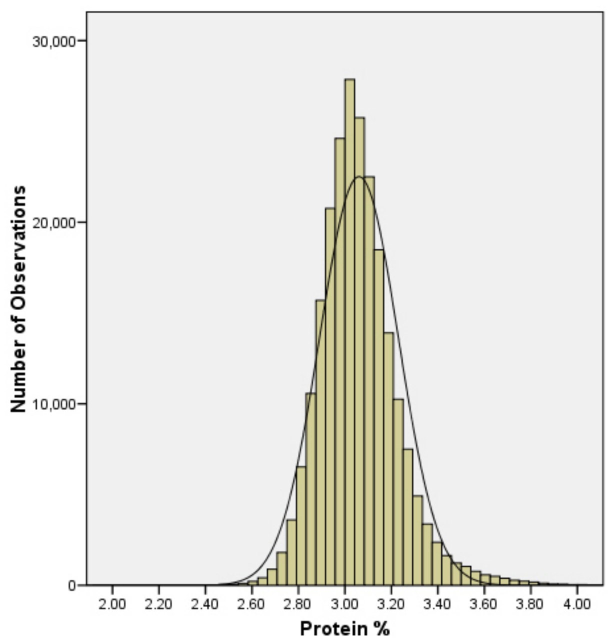
* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

Figure A-1
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE BUTTERFAT LEVELS, 2006



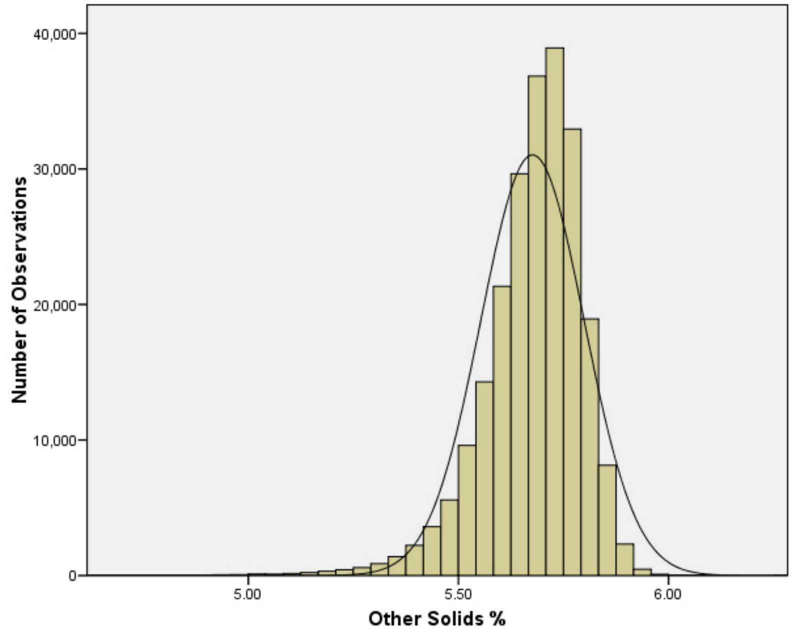
Skewness statistic: 0.894
Kurtosis statistic: 4.534

Figure A-2
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE PROTEIN LEVELS, 2006



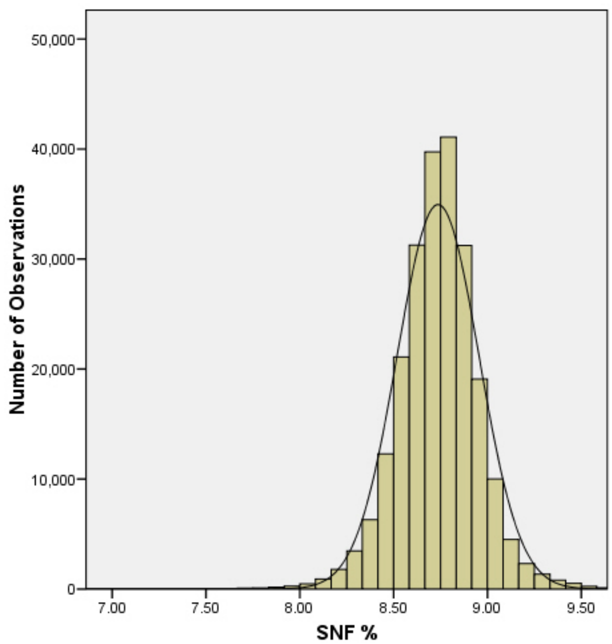
Skewness statistic: 0.865
Kurtosis statistic: 4.384

Figure A-3
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE OTHER SOLIDS LEVELS, 2006



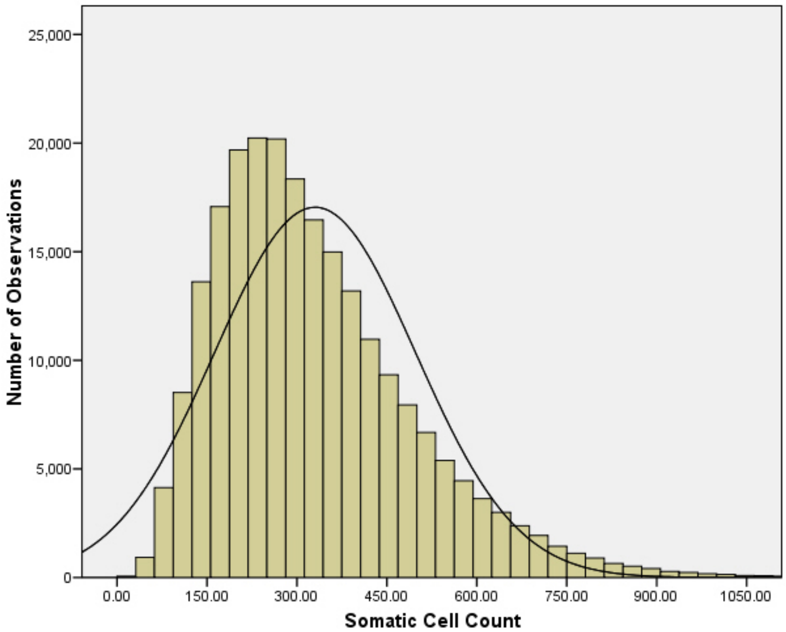
Skewness statistic: -1.711
Kurtosis statistic: 14.088

Figure A-4
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS, 2006



Skewness statistic: -0.439
Kurtosis statistic: 7.305

Figure A-5
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOMATIC CELL COUNT, 2006



Skewness statistic: 1.399
Kurtosis statistic: 3.371

Figure A-6
WEIGHTED AVERAGE MONTHLY BUTTERFAT TESTS
2002, 2003, 2004, 2005, & 2006

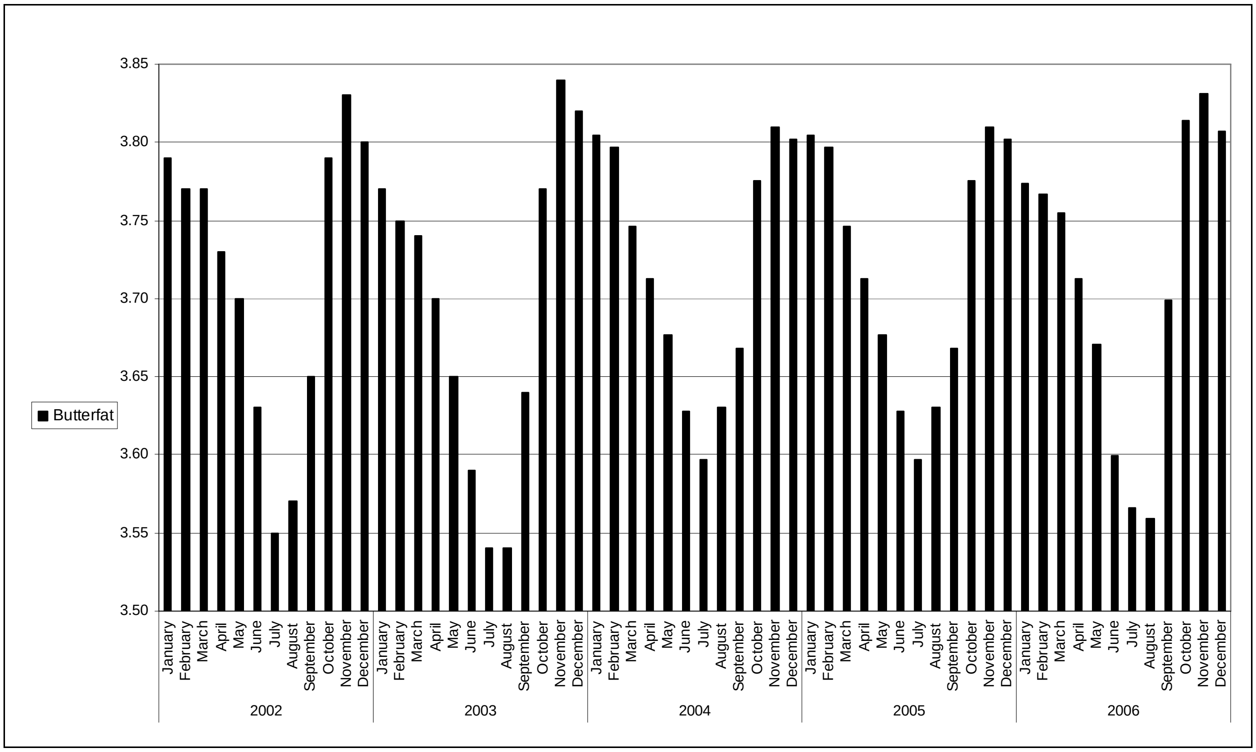


Figure A-7
WEIGHTED AVERAGE MONTHLY PROTEIN TESTS
2002, 2003, 2004, 2005, & 2006

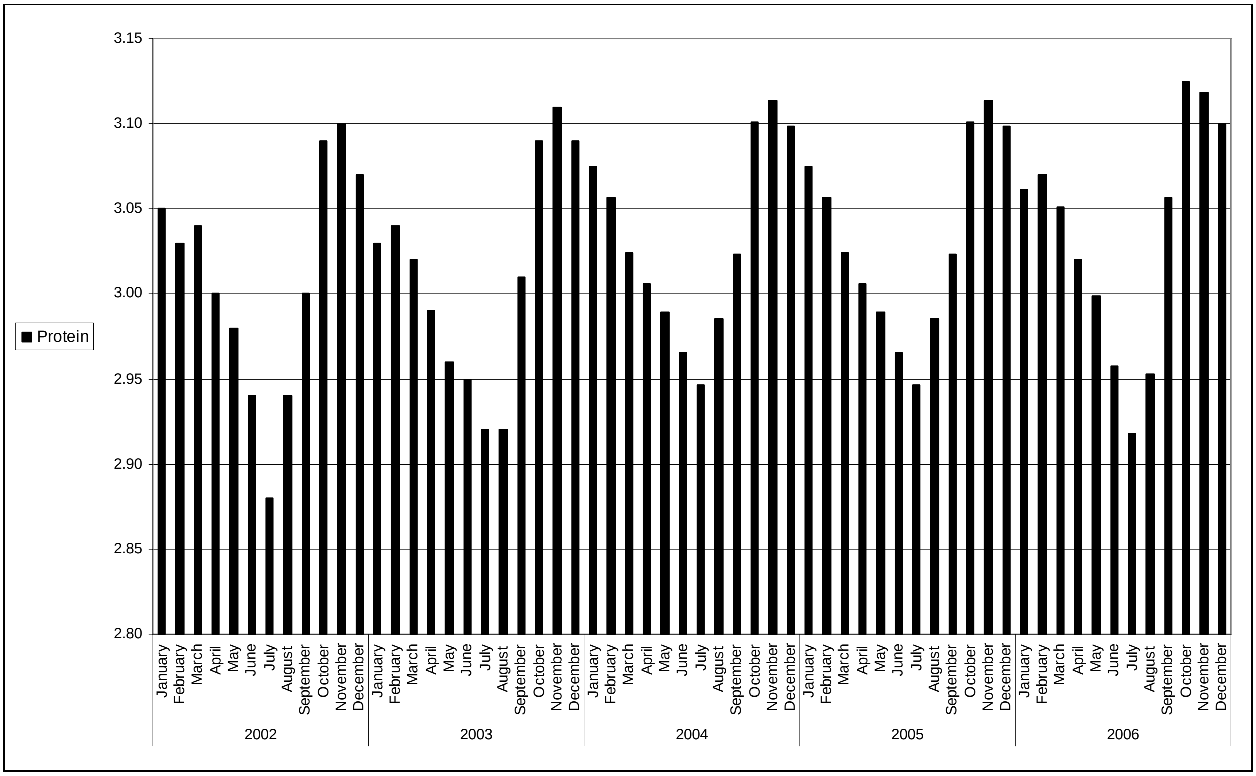


Figure A-8
WEIGHTED AVERAGE MONTHLY OTHER SOLIDS TESTS
2002, 2003, 2004, 2005, & 2006

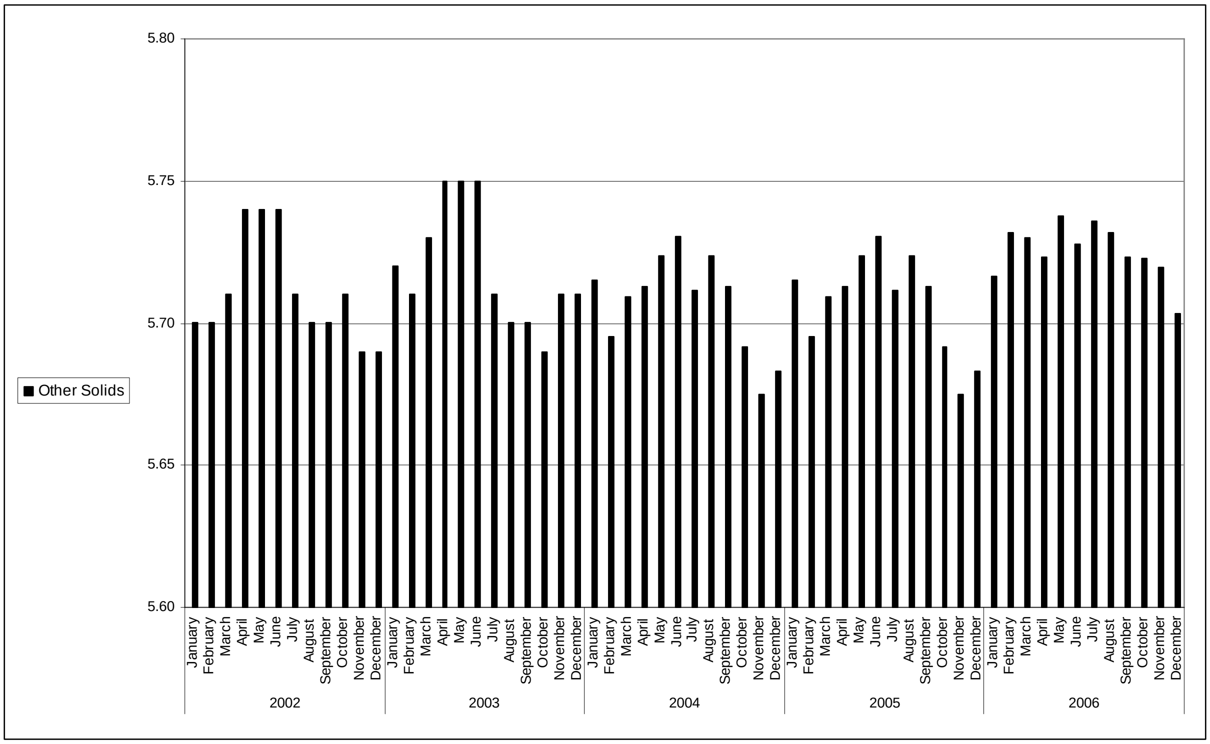


Figure A-9
WEIGHTED AVERAGE MONTHLY SOLIDS-NOT-FAT TESTS
2002, 2003, 2004, 2005, & 2006

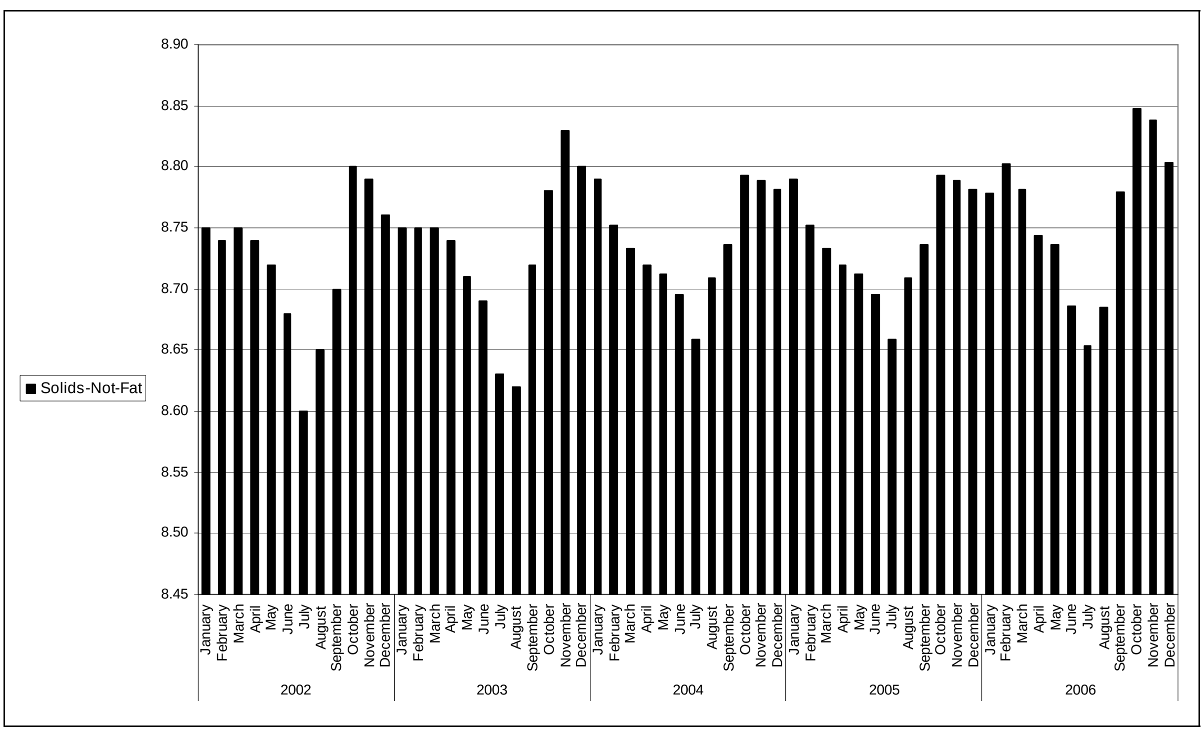


Figure A-10
WEIGHTED AVERAGE MONTHLY SOMATIC CELL COUNTS
2002, 2003, 2004, 2005, & 2006