UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL
2005

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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 2005. 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 2005 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 2005 were 3.69% butterfat, 3.02% protein, 5.72% other solids, 8.74% SNF and 285,000 SCC.

2) For 2005, weighted average butterfat, 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 July.

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 2005, the range of weighted average component levels within one standard deviation of the mean was: 3.43% to 3.95% for butterfat; 2.88% to 3.16% for protein; 5.62% to 5.82% for other solids; 8.55% to 8.91% for SNF; and 139,000 to 432,000 for SCC.

5) Based on the data for 2005, the following regression equations were derived:

$$SNF = 7.25589\% + 0.38394\ (BF)$$
$$SNF = 5.61615\% + 1.01655\ (PRO)$$
$$PRO = 1.51409\% + 0.40387\ (BF)$$

5) The annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $14.49 per cwt. for the market in 2005. 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 2005 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 2005 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 Order and for the State of Idaho. 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 2005, 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.

[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 2005 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 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 2005 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

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
Minimum	3.53	2.89	5.67	8.65	266
Maximum	3.85	3.13	5.76	8.83	322
Annual Average	3.69	3.02	5.72	8.74	285

During the year, butterfat levels dropped from 3.78% in January to 3.53% in July, then rose to 3.85% 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 0.32, 0.24 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 5.76% in June to a low of 5.67% in December. The seasonal high SCC of 322,000 was reached in July after a low of 266,000 in January, a change of 56,000 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 2005, the simple average SCC (333,000) was higher than the weighted average (285,000) indicating that larger producers tended to have, on average, lower SCC than their smaller counterparts. Moreover, the median SCC level (258,000) 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 1.328. 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

2005

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum
	- % -	- % -	- % -	- % -	- % -	- % -
Butterfat	3.69	3.78	0.26	3.67	1.75	7.75
Protein	3.02	3.04	0.14	3.01	1.50	5.16
Other Solids	5.72	5.67	0.10	5.73	2.39	8.64
SNF	8.74	8.71	0.17	8.74	3.90	11.84
SCC (1,000's)	285	333	147	258	0	4,444

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 1.75% and as high as 7.75%; protein levels ranged from 1.50% to 5.16%; other solids levels ranged from 2.39% to 8.64%; SNF levels ranged from 3.90% to 11.84%; and SCC ranged from 0 to 4,444,000.

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: 3.43% to 3.95% for butterfat; 2.88% to 3.16% for protein; 5.62% to 5.82% for other solids; 8.55% to 8.91% for SNF; and 139,000 to 432,000 for SCC. Approximately three-quarters of the observed component levels and SCC in the 2005 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 2005 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 2005 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 2005

Percentile	Monthly Average Pounds	Butterfat Test	Protein Test	Other Solids Test	Solids Not Fat Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
1	23,466	3.88	3.07	5.58	8.65	395
2	40,388	3.83	3.05	5.61	8.66	382
3	52,393	3.81	3.04	5.64	8.68	368
4	63,927	3.78	3.03	5.66	8.69	348
5	76,165	3.78	3.04	5.67	8.71	334
6	90,812	3.76	3.03	5.69	8.71	320
7	109,752	3.75	3.02	5.70	8.72	311
8	137,708	3.73	3.02	5.71	8.73	302
9	195,759	3.72	3.02	5.72	8.74	277
10	673,604	3.66	3.01	5.74	8.75	260
Average	146,378	3.77	3.03	5.67	8.70	330

Monthly Average Producer Milk by Producer Size 2005

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	1,759	23,466	1,547	33,421	41,276,679	1.60	0.00
2	1,760	40,388	33,429	46,627	71,083,182	2.76	4.36
3	1,760	52,393	46,635	58,053	92,211,543	3.58	7.94
4	1,760	63,927	58,081	69,879	112,510,788	4.37	12.31
5	1,759	76,165	69,881	82,883	133,973,573	5.20	17.51
6	1,760	90,812	82,889	99,422	159,829,882	6.21	23.72
7	1,760	109,752	99,430	121,292	193,163,031	7.50	31.22
8	1,760	137,708	121,319	158,224	242,366,930	9.41	40.63
9	1,760	195,759	158,230	255,207	344,535,193	13.38	54.01
10	1,759	673,604	255,260	10,334,701	1,184,869,450	46.00	100.00
Total or Average	17,597	146,378			2,575,820,250		

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 23,466 pounds per month had an average butterfat test of 3.88% while producers averaging 673,604 pounds averaged a 3.66% butterfat test. The butterfat test declined steadily from a weighted average of 3.88% for the smallest group to a weighted average of 3.73% and 3.72% for groups 8 and 9, while the group 10 producers, those averaging 673,604 pounds per month, had a weighted average butterfat test of 3.66%. The SCC declined steadily from an average of 395,000 for producers averaging 23,466 pounds per month to an average of 260,000 for producers averaging 673,604 pounds per month, a difference in the SCC of 135,000.

Protein tests also declined from the smaller producers to the larger producers but to a smaller extent than for butterfat, falling from 3.07% for producer's averaging 23,466 pounds per month to 3.01% percent for producers averaging 673,604 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 5.58% to 5.74%, while solids-not-fat tests increased steadily from 8.65% to 8.75% as monthly average production increased from 23,466 pounds to 673,604 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 146,378 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 as Idaho and a group of "other" states. However, no handler payrolls were received from handlers pooling milk in Idaho for November and December, therefore data for Idaho includes only January through October. Idaho is also reported separately due to the relatively large percentage of the milk on the market from Idaho in 2005. 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, while Iowa, Idaho, and Michigan tied for the highest weighted average protein test. Idaho, Iowa, and the Dakotas 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 Wisconsin had the lowest weighted average SCC and Michigan had the highest. The aggregated value for the Other states had the lowest SCC overall. Detailed state information by month for 2005 is presented in Table A-2 (see Appendix).

Table 4

Weighted Average Components Levels and Somatic Cell Count in Milk by State 2005

State	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
Idaho*	3.60	3.06	5.74	8.80	245
Illinois	3.69	3.01	5.72	8.73	296
Iowa	3.68	3.06	5.74	8.80	315
Michigan U.P.	3.63	3.06	5.71	8.77	389
Minnesota	3.70	3.03	5.71	8.74	309
North Dakota	3.74	3.05	5.74	8.79	300
South Dakota	3.71	3.05	5.74	8.79	312
Wisconsin	3.70	3.01	5.72	8.73	277
Other[8]	3.61	3.03	5.73	8.77	240
Market	3.69	3.02	5.72	8.74	285
Minimum	3.60	3.01	5.70	8.73	245
Maximum	3.74	3.06	5.74	8.80	357

*Includes data for January through October.

IV. STATISTICAL RELATIONSHIPS AMONG MILK COMPONENTS

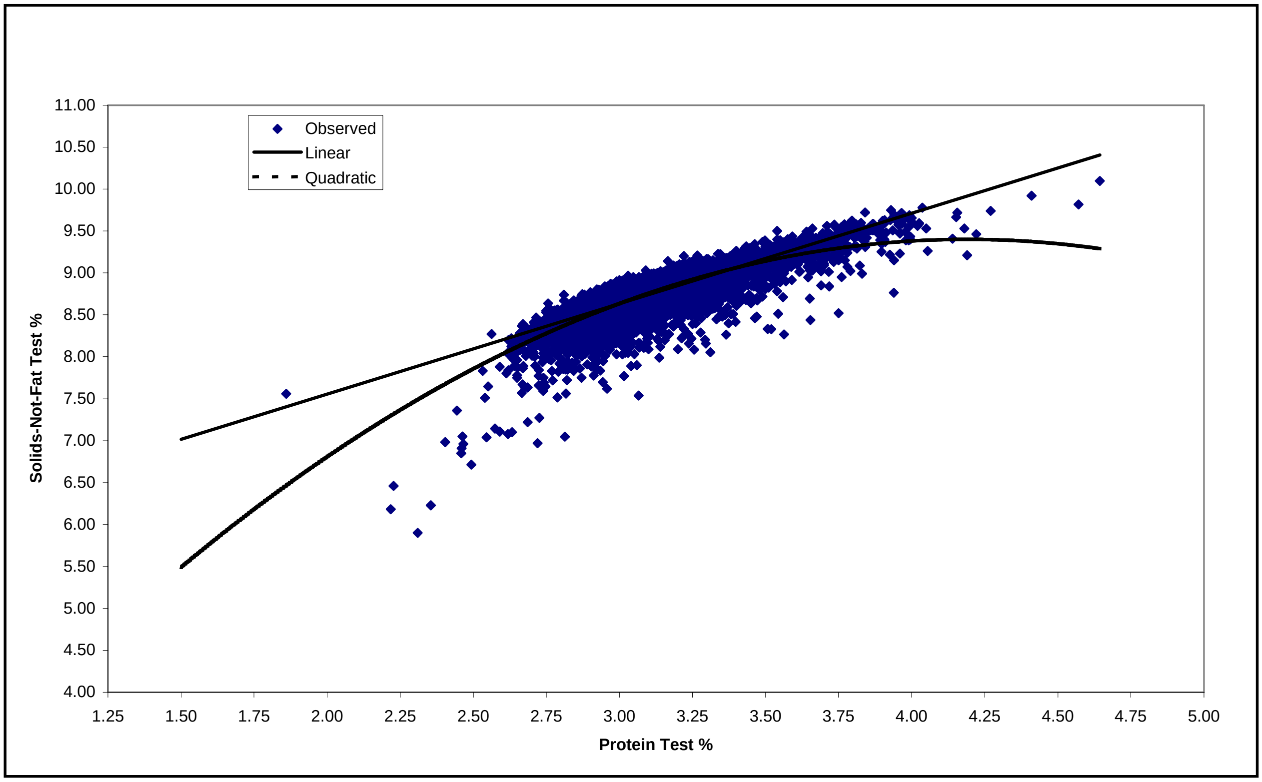
Past Upper Midwest staff papers dealing with milk component levels and the relationships between components in the milk discussed the relationships between milk components

[8] Includes milk from California, Indiana, Kansas, Missouri, Montana, Nebraska, Ohio, Oregon, Utah, and Wyoming.

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 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 2005



Regression analysis was used to estimate the linear relationship between components. Results from the 2005 data were compared with results from previous Upper Midwest Order studies (1993-2004), 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 seventeen 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 2005 data was within that range at 0.38394. 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 (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 2005 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 June 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 2005. 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 2005, for the linear model is:

$$\text{Solids-not-fat Test} = 5.61615 + 1.01655 * \text{Protein Test},$$

while the equation for the quadratic model is:

$$\text{Solids-not-fat Test} = 1.9097 + (3.404 * \text{Protein Test}) + (-0.383 * (\text{Protein Test})^2).$$

The R-squared for the linear model is 0.540 while the R-squared for the quadratic model is 0.550. 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 (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 2005 data was that the constant of 1.51409 and the coefficient of 0.40387 for the independent variable fell within the range of coefficients previously computed. The constant of 1.51409 was the second smallest for the fifteen years of data and continues a steady decline since 1986.

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 (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 January 2005 data. 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. The equation for 2005, for the linear model is:

$$\textit{Protein Test} = 1.51409 + 0.40387 * \textit{Butterfat Test},$$

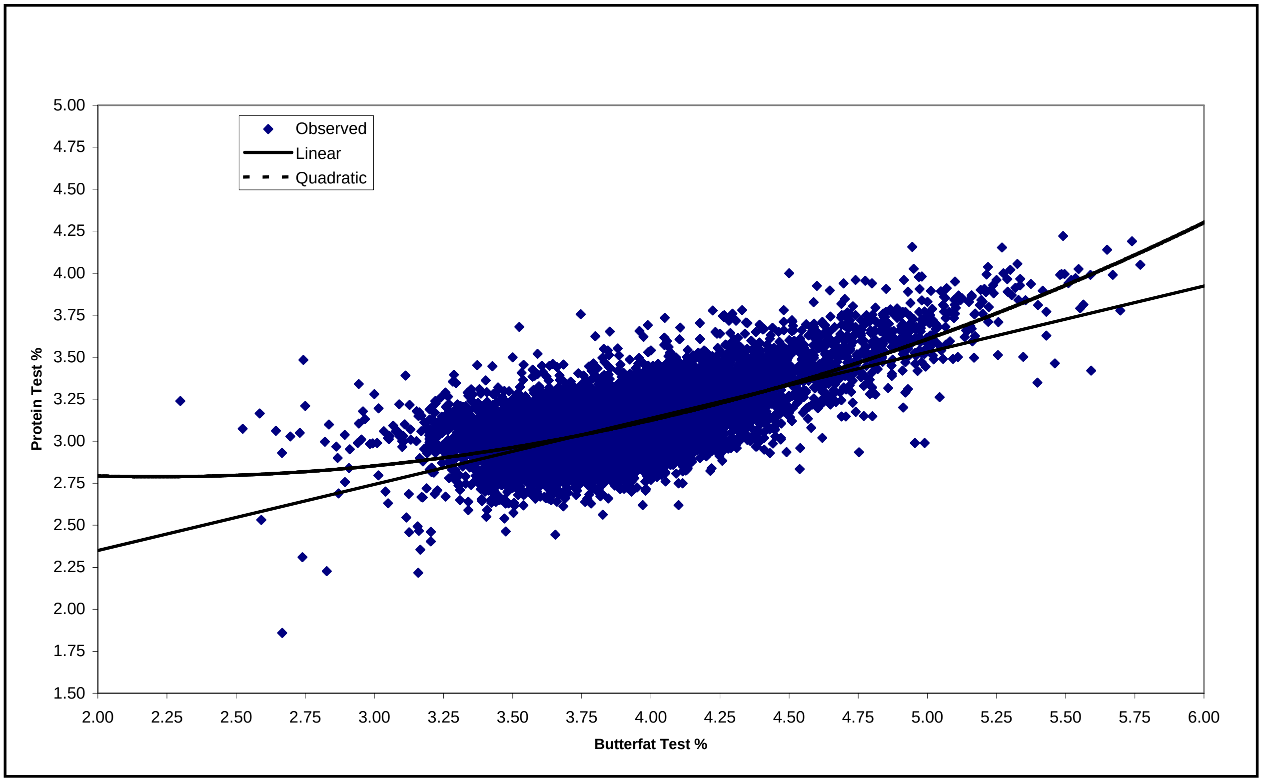
while the equation for the quadratic model is:

$$\textit{Protein Test} = 3.72466 + (-0.72568 * \textit{Butterfat Test}) + (0.14266 * (\textit{Butterfat Test})^2).$$

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 2005 dataset has a slightly higher adjusted R-squared of 0.449, versus 0.446 for the linear model, suggesting a better fit.

Figure 2

Scatter Plot of Protein and Butterfat Tests -- January 2005



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.

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 2005

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

Variable	Beta	Standard Error	t-stat
Protein Test	**1.101736**	**0.015119**	**72.87011**
January	5.325483	0.047479	112.1654
February	5.361126	0.046854	114.4224
March	5.375830	0.046754	114.9810
April	5.395435	0.046135	116.9486
May	5.396063	0.046067	117.1349
June	5.418909	0.045184	119.9285
July	5.379545	0.044604	120.6060
August	5.359128	0.045453	117.9056
September	5.364604	0.046786	114.6635
October	5.308796	0.048310	109.8905
November	5.321992	0.048686	109.3133
December	5.303901	0.048252	109.9201

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

Table 8 (continued)

Fixed Effects Model for 2005

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

Variable	Beta	Standard Error	t-stat
Butterfat Test	**0.359257**	**0.001**	**359.1434**
January	1.696552	0.003993	424.9296
February	1.670400	0.003950	422.9287
March	1.662527	0.003953	420.6049
April	1.640817	0.003899	420.8825
May	1.647906	0.003867	426.1427
June	1.631952	0.003750	435.2291
July	1.613272	0.003694	436.6803
August	1.661968	0.003717	447.1192
September	1.715449	0.003815	449.7046
October	1.769352	0.003946	448.4173
November	1.760872	0.004037	436.2247
December	1.726763	0.004050	426.3478

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	**0.358604**	**0.009139**	**39.2381**
January	7.339267	0.036477	201.2020
February	7.344451	0.036085	203.5335
March	7.350590	0.036113	203.5437
April	7.344158	0.035618	206.1924
May	7.351403	0.035330	208.0764
June	7.352169	0.034258	214.6129
July	7.290063	0.033753	215.9818
August	7.324166	0.033960	215.6695
September	7.392293	0.034851	212.1088
October	7.400886	0.036050	205.2966
November	7.408130	0.036880	200.8728
December	7.352967	0.037003	198.7120

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 2005

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

	Beta	Standard Error	t-stat
(Constant)	**1.689116**	**0.003801**	**444.4231**
January	0.361327	0.001000	361.4539
February	0.354535	0.001012	350.4799
March	0.352447	0.001011	348.6711
April	0.346500	0.001027	337.4696
May	0.348127	0.001035	336.2219
June	0.343474	0.001070	320.9647
July	0.338070	0.001088	310.6897
August	0.351570	0.001081	325.2550
September	0.366244	0.001051	348.3224
October	0.380093	0.001014	374.8546
November	0.377553	0.000990	381.1865
December	0.368922	0.000987	373.7384

Dependent Variable: Protein

Table 9 (continued)

Random Effects Model for 2005

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

	Beta	Standard Error	t-stat
(Constant)	**7.357155**	**0.034741**	**211.7694**
January	0.354169	0.009138	38.75952
February	0.355411	0.009247	38.43710
March	0.357058	0.009240	38.64352
April	0.355178	0.009385	37.84375
May	0.356977	0.009464	37.71772
June	0.357308	0.009782	36.52760
July	0.339856	0.009946	34.16893
August	0.349442	0.009880	35.36742
September	0.367778	0.009611	38.26595
October	0.369814	0.009269	39.89993
November	0.371531	0.009054	41.03659
December	0.357655	0.009023	39.63808

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	230341	936555.6	2.18
Protein and Butterfat	11	230341	669713.2	2.18
Solids-Not-Fat and Protein	11	230341	549789.7	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	89401	37594
Butterfat and Solids-Not-Fat	2207.8	511.41
Somatic Cell Count and Butterfat	3463.2	1993.7

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 2005

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	0.99678	0.88255	1.08240	0.80637	0.75010	0.81883
b^b	0.40380	0.39954	-0.46187	1.05980	0.15778	29.41500
b^w	0.42801	0.26561	50.27000	1.29010	1.70490	-158.58000
b^t	0.40387	0.38381	-4.64430	1.10440	0.54441	-4.64430

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 2005. 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 2005, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $14.49 per cwt. for the market. The value of each component comprised by the $14.49 per cwt. price was $6.30 for butterfat, $7.45 for protein, and $0.70 for other solids. The SCC adjustment for the year amounted to about $0.05 per cwt.

Categorized by size range of delivery, average values of producer milk ranged from a low of $14.36 per cwt. for monthly producer milk deliveries greater than 400,000 pounds to a high of $15.07 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. 2000 - 2005 WEIGHTED AVERAGE COMPONENT TESTS

Weighted average component data for the past six years, 2000, 2001, 2002, 2003, 2004, and 2005 are shown in Table 13. Over these six years the yearly average tests have changed very little. Yearly average butterfat tests were 3.73 percent, 3.70 percent, 3.72 percent, 3.69 percent, 3.72 percent, and 3.69 percent for 2000, 2001, 2002, 2003, 2004, and 2005 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, increasing slightly from 2000 to 2001 and then declining from 336,000 in 2001 to 285,000 in 2005.

Graphs (see Appendix Figures A-6 through A-10) show the monthly weighted average component tests for 2001, 2002, 2003, 2004, and 2005. 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 2000 through 2005 would indicate that these two factors have not 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

2000

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.82	3.05	5.67	8.71	308
February	3.79	3.02	5.68	8.70	317
March	3.76	3.00	5.72	8.71	328
April	3.76	3.00	5.72	8.71	322
May	3.67	2.95	5.74	8.69	328
June	3.64	2.95	5.74	8.69	351
July	3.58	2.91	5.72	8.63	374
August	3.59	2.92	5.69	8.62	381
September	3.67	3.00	5.69	8.69	358
October	3.77	3.06	5.69	8.75	317
November	3.82	3.07	5.70	8.77	307
December	3.85	3.08	5.68	8.76	308
Annual Average	3.73	3.00	5.70	8.70	333

Table 13 (continued)

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

2001

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.80	3.05	5.69	8.73	328
February	3.78	3.04	5.70	8.74	321
March	3.76	3.06	5.67	8.73	325
April	3.73	2.99	5.72	8.71	323
May	3.64	2.96	5.73	8.70	326
June	3.61	2.94	5.70	8.65	341
July	3.55	2.90	5.71	8.61	371
August	3.55	2.92	5.69	8.62	390
September	3.66	3.03	5.70	8.73	360
October	3.77	3.11	5.69	8.80	318
November	3.80	3.10	5.69	8.78	306
December	3.81	3.08	5.69	8.77	319
Annual Average	3.70	3.01	5.70	8.71	336

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

VII. SUMMARY

This staff paper analyzes milk components and SCC in producer milk associated with the Upper Midwest Order during 2005. 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 2005 were: 3.69% butterfat, 3.02% protein, 5.72% other solids, 8.74% SNF and 285,000 SCC. Weighted average butterfat, 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 January and highest in July.

Approximately three-quarters of monthly average component levels ranged from: 3.43% to 3.95% for butterfat; 2.88% to 3.16% for protein; 5.62% to 5.82% for other solids; 8.55% to 8.91% for SNF; and 139,000 to 432,000 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 146,378 pounds, however over 80 percent of the producers had average marketings below the market average.

Based on the data for 2005, the following regression equations were derived:

$$SNF = 7.25589\% + 0.38394\,(BF)$$
$$SNF = 5.61615\% + 1.01655\,(PRO)$$
$$PRO = 1.51409\% + 0.40387\,(BF)$$

Under MCP, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $14.49 per cwt. for the market. Protein contributed slightly 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

2005

Butterfat

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.78	3.89	0.25	3.77	1.75	7.75	19,293
February	3.74	3.84	0.24	3.72	2.12	6.29	19,126
March	3.73	3.85	0.25	3.72	2.08	6.38	18,632
April	3.69	3.79	0.24	3.67	2.08	5.55	19,569
May	3.66	3.76	0.24	3.65	2.01	5.73	19,598
June	3.57	3.64	0.21	3.56	2.01	5.41	19,018
July	3.53	3.58	0.21	3.53	2.04	5.23	19,318
August	3.55	3.60	0.21	3.54	2.17	5.23	19,520
September	3.63	3.70	0.22	3.62	2.05	5.47	19,349
October	3.74	3.84	0.24	3.73	1.76	6.09	18,675
November	3.83	3.93	0.26	3.82	2.05	6.50	19,050
December	3.85	3.94	0.25	3.83	2.22	7.12	19,077
Total	3.69	3.78	0.26	3.67	1.75	7.75	230,226

Protein

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.08	3.09	0.17	3.07	1.50	4.64	19,293
February	3.04	3.05	0.13	3.02	1.64	4.71	19,126
March	3.03	3.04	0.12	3.02	1.76	4.10	18,632
April	2.99	3.00	0.12	2.98	1.70	5.16	19,569
May	2.98	3.00	0.12	2.97	1.66	4.02	19,598
June	2.92	2.94	0.12	2.91	1.53	4.07	19,018
July	2.89	2.90	0.11	2.89	1.56	4.14	19,318
August	2.94	2.96	0.11	2.93	1.61	3.98	19,520
September	3.02	3.05	0.12	3.01	1.61	4.27	19,349
October	3.11	3.15	0.13	3.09	1.73	4.26	18,675
November	3.13	3.17	0.13	3.12	1.69	4.71	19,050
December	3.12	3.14	0.13	3.11	1.61	5.09	19,077
Total	3.02	3.04	0.14	3.01	1.50	5.16	230,226

Table A-1 (continued)

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

2005

Other Solids

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	5.69	5.64	0.09	5.70	2.39	5.98	19,293
February	5.72	5.67	0.09	5.73	3.61	6.01	19,126
March	5.73	5.69	0.09	5.74	3.20	6.05	18,632
April	5.74	5.70	0.10	5.75	3.14	6.01	19,569
May	5.74	5.70	0.09	5.75	4.31	6.05	19,598
June	5.76	5.72	0.10	5.77	3.72	6.19	19,018
July	5.76	5.67	0.24	5.77	4.33	6.40	19,318
August	5.72	5.66	0.10	5.73	4.34	5.99	19,520
September	5.70	5.64	0.10	5.72	3.81	6.00	19,349
October	5.69	5.63	0.10	5.70	3.31	5.95	18,675
November	5.70	5.64	0.10	5.71	3.38	8.64	19,050
December	5.67	5.62	0.10	5.69	3.56	8.64	19,077
Total	5.72	5.67	0.10	5.73	2.39	8.64	230,226

Solids-Not-Fat

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	8.77	8.73	0.20	8.77	3.90	10.10	19,293
February	8.76	8.72	0.16	8.76	5.61	10.11	19,126
March	8.76	8.73	0.16	8.76	5.98	9.75	18,632
April	8.74	8.70	0.16	8.74	6.20	10.85	19,569
May	8.72	8.70	0.15	8.72	6.76	9.68	19,598
June	8.69	8.66	0.16	8.69	6.52	9.90	19,018
July	8.65	8.57	0.27	8.66	6.46	9.79	19,318
August	8.66	8.62	0.16	8.67	6.61	9.60	19,520
September	8.72	8.69	0.16	8.73	5.96	9.69	19,349
October	8.79	8.78	0.16	8.79	5.36	9.92	18,675
November	8.83	8.82	0.17	8.83	5.60	11.84	19,050
December	8.80	8.77	0.17	8.80	6.16	11.72	19,077
For the Year	8.74	8.71	0.17	8.74	3.90	11.84	230,226

Table A-1 (continued)

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

2005

Somatic Cell Count

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	------------------------------------- (1,000)	-----------------------------------					
January	266	315	136	238	0	3,175	19,293
February	270	319	142	239	16	1,720	19,126
March	268	318	137	239	16	1,861	18,632
April	275	327	136	246	0	1,492	19,569
May	276	322	135	247	0	3,358	19,598
June	295	344	141	266	0	1,962	19,018
July	322	374	149	295	0	1,630	19,318
August	321	370	146	295	0	4,444	19,520
September	305	348	137	282	0	2,000	19,349
October	287	322	167	259	21	2,630	18,675
November	270	312	124	247	16	2,131	19,050
December	271	320	131	246	19	2,292	19,077
For the Year	285	333	147	258	0	4,444	230,226

Table A-2

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2005

Butterfat

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.68	3.79	3.79	3.64	3.79	3.82	3.81	3.80	3.74	3.78
February	3.64	3.73	3.74	3.58	3.75	3.76	3.75	3.76	3.66	3.74
March	3.62	3.73	3.72	3.58	3.74	3.77	3.73	3.76	3.64	3.74
April	3.62	3.66	3.64	3.53	3.68	3.72	3.68	3.71	3.61	3.69
May	3.53	3.62	3.62	3.57	3.68	3.69	3.67	3.68	3.56	3.66
June	3.51	3.51	3.54	3.47	3.59	3.61	3.60	3.58	3.54	3.57
July	3.44	3.50	3.50	3.44	3.55	3.54	3.55	3.53	3.48	3.53
August	3.51	3.52	3.51	3.48	3.57	3.57	3.56	3.55	3.49	3.55
September	3.64	3.61	3.60	3.56	3.66	3.70	3.65	3.62	3.56	3.63
October	3.67	3.78	3.77	3.72	3.75	3.85	3.80	3.74	3.62	3.75
November	*	3.90	3.85	3.77	3.81	3.88	3.84	3.83	3.75	3.83
December	*	3.96	3.89	3.74	3.83	3.91	3.89	3.85	3.83	3.85
Total	3.60	3.69	3.68	3.63	3.70	3.74	3.71	3.70	3.61	3.69

Protein

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.13	3.08	3.13	3.08	3.09	3.21	3.12	3.06	3.11	3.08
February	3.10	3.03	3.08	3.01	3.05	3.07	3.08	3.02	3.06	3.04
March	3.07	3.02	3.07	3.04	3.03	3.06	3.06	3.02	3.05	3.03
April	3.06	2.98	3.02	2.99	3.00	3.02	3.01	2.97	3.04	2.99
May	3.01	2.97	3.01	2.99	2.98	2.99	2.98	2.97	3.01	2.98
June	2.99	2.89	2.95	2.91	2.93	2.93	2.94	2.91	2.96	2.92
July	2.95	2.87	2.91	2.89	2.90	2.90	2.91	2.89	2.91	2.89
August	2.98	2.92	2.97	2.93	2.96	2.96	2.97	2.93	2.95	2.94
September	3.08	3.00	3.05	3.01	3.04	3.06	3.05	3.01	3.04	3.02
October	3.13	3.11	3.15	3.14	3.12	3.14	3.16	3.09	3.07	3.11
November	*	3.15	3.18	3.08	3.15	3.17	3.18	3.12	3.13	3.13
December	*	3.13	3.17	3.18	3.13	3.17	3.17	3.11	3.13	3.12
Total	3.06	3.01	3.06	3.06	3.03	3.06	3.05	3.01	3.03	3.02

* No payroll data were received from Idaho handlers for November and December 2005.

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2005

Other Solids

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	5.69	5.70	5.72	5.69	5.66	5.69	5.69	5.70	5.71	5.69
February	5.71	5.73	5.74	5.67	5.69	5.73	5.71	5.73	5.74	5.72
March	5.74	5.74	5.76	5.75	5.72	5.75	5.74	5.73	5.75	5.73
April	5.75	5.76	5.77	5.74	5.72	5.75	5.75	5.75	5.75	5.74
May	5.76	5.74	5.74	5.74	5.73	5.77	5.76	5.74	5.74	5.74
June	5.78	5.75	5.76	5.76	5.77	5.82	5.80	5.76	5.74	5.76
July	5.74	5.73	5.76	5.73	5.72	5.82	5.80	5.75	5.75	5.74
August	5.72	5.69	5.72	5.71	5.72	5.76	5.77	5.71	5.72	5.72
September	5.73	5.69	5.73	5.69	5.70	5.72	5.73	5.71	5.72	5.71
October	5.74	5.68	5.72	5.70	5.67	5.69	5.71	5.69	5.72	5.69
November	*	5.70	5.74	5.68	5.68	5.70	5.72	5.70	5.73	5.70
December	*	5.68	5.72	5.71	5.63	5.64	5.65	5.68	5.74	5.67
Total	5.74	5.72	5.74	5.71	5.70	5.74	5.74	5.72	5.73	5.72

Solids-Not-Fat

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	8.82	8.78	8.85	8.77	8.75	8.91	8.81	8.76	8.82	8.77
February	8.81	8.75	8.82	8.68	8.74	8.81	8.79	8.74	8.80	8.75
March	8.81	8.76	8.83	8.78	8.75	8.81	8.81	8.75	8.80	8.76
April	8.81	8.73	8.79	8.73	8.72	8.77	8.76	8.72	8.79	8.73
May	8.76	8.71	8.75	8.73	8.71	8.76	8.74	8.71	8.74	8.72
June	8.78	8.64	8.71	8.67	8.70	8.75	8.74	8.66	8.71	8.69
July	8.69	8.60	8.67	8.62	8.62	8.72	8.71	8.64	8.66	8.64
August	8.69	8.62	8.70	8.64	8.68	8.72	8.73	8.65	8.67	8.66
September	8.82	8.69	8.77	8.70	8.74	8.79	8.79	8.72	8.76	8.73
October	8.87	8.79	8.86	8.84	8.79	8.83	8.86	8.78	8.79	8.79
November	*	8.85	8.92	8.76	8.83	8.87	8.90	8.82	8.86	8.83
December	*	8.81	8.89	8.89	8.76	8.81	8.83	8.79	8.87	8.79
Total	8.80	8.73	8.80	8.77	8.73	8.79	8.79	8.73	8.77	8.74

* No payroll data were received from Idaho handlers for November and December 2005.

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE

2005

Somatic Cell Counts

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	233	278	317	292	295	293	299	256	253	266
February	237	284	337	311	301	314	312	258	258	271
March	243	283	312	312	293	298	287	260	244	269
April	243	283	293	303	299	298	284	273	239	277
May	252	276	294	308	296	291	293	273	229	278
June	252	298	321	347	326	325	328	290	262	297
July	290	334	344	360	356	363	368	309	264	325
August	288	332	347	391	348	344	358	311	271	323
September	250	324	336	400	325	304	330	297	243	307
October	229	291	297	557	307	264	300	275	215	289
November	*	277	281	306	287	251	281	263	264	271
December	*	291	304	255	284	259	293	269	173	275
Total	245	296	315	357	310	300	312	278	240	287

* No payroll data were received from Idaho handlers for November and December 2005.

Table A-3

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2005

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)	7.255892	0.005871		0.211549
Butterfat (b)	0.383939	0.001549	247.8558	
SNF = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	7.339	.036	201.202	0.216
Butterfat (b)	.359	.009	39.238	
February	.005	.012	.444	
March	.011	.012	.968	
April	.005	.012	.416	
May	.012	.012	1.031	
June	.013	.012	1.081	
July	-.049	.012	-4.073	
August	-.015	.012	-1.255	
September	.053	.012	4.465	
October	.062	.012	5.237	
November	.069	.012	5.825	
December	.014	.012	1.158	

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)	5.616145	0.005956		0.539789
Protein (b)	1.016554	0.001956	519.7759	
SNF = c + b(PRO) + m(February) + . . . + m(December)				
Constant (c)	5.325	.047	112.165	0.675
Protein (b)	1.102	.015	72.870	
February	.036	.012	3.072	
March	.050	.012	4.335	
April	.070	.012	5.975	
May	.071	.012	6.029	
June	.093	.012	7.880	
July	.054	.012	4.499	
August	.034	.012	2.843	
September	.039	.012	3.349	
October	-.017	.012	-1.427	
November	-.003	.012	-.296	
December	-.022	.012	-1.836	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2005

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)	1.514093	0.003554		0.446024
Butterfat (b)	0.403873	0.000938	430.6423	
PRO = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	1.697	.004	424.930	0.497
Butterfat (b)	.359	.001	359.143	
February	-.026	.001	-20.447	
March	-.034	.001	-26.588	
April	-.056	.001	-43.323	
May	-.049	.001	-37.755	
June	-.065	.001	-49.433	
July	-.083	.001	-62.977	
August	-.035	.001	-26.258	
September	.019	.001	14.538	
October	.073	.001	56.525	
November	.064	.001	49.704	
December	.030	.001	23.323	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2005

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	5.227768	1.145627	0.005868	0.656507	0.138087
February	5.262704	1.129284	0.005854	0.652538	0.136707
March	5.183132	1.162940	0.005789	0.669155	0.129233
April	5.075661	1.200000	0.010000	0.693748	0.120760
May	5.162078	1.176452	0.005398	0.705334	0.111412
June	5.155314	1.180896	0.005895	0.669621	0.119477
July	4.909869	1.257350	0.006250	0.672116	0.122985
August	5.034144	1.212220	0.006175	0.661638	0.123058
September	5.120941	1.173846	0.006392	0.632305	0.130847
October	5.406721	1.072027	0.005909	0.627044	0.131115
November	5.490364	1.040041	0.005968	0.608671	0.141873
December	5.492667	1.044102	0.005711	0.631860	0.137063

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	-1.341000	5.313000	0.083000	-0.65900	0.013000	0.695550	0.130002
February	-0.815060	5.019694	0.086348	-0.62045	0.013742	0.684934	0.130178
March	-1.278670	5.350216	0.090724	-0.67626	0.014625	0.701167	0.122821
April	-1.637850	5.617050	5.617050	-0.72412	0.014887	0.726376	0.114146
May	-0.276520	4.748935	4.748935	-0.58512	0.015847	0.724267	0.107773
June	-0.703340	5.061583	5.061583	-0.64094	0.018445	0.688601	0.115994
July	-2.118690	5.969275	5.969275	-0.78780	0.018793	0.698878	0.117860
August	-1.252670	5.347543	5.347543	-0.67832	0.017839	0.684751	0.118781
September	-1.595990	5.522031	5.522031	-0.70178	0.018689	0.656955	0.126385
October	0.483923	4.143515	4.143515	-0.47756	0.016699	0.641986	0.128462
November	1.046156	3.797900	3.797900	-0.42626	0.014729	0.624749	0.138928
December	0.314770	4.260390	4.260390	-0.49738	0.013550	0.655668	0.132557

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2005

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	1.469922	0.414423	0.003250	0.449102	0.123683
February	1.474008	0.408148	0.003348	0.428502	0.125415
March	1.558775	0.382012	0.003397	0.387900	0.123647
April	1.707058	0.340379	0.003501	0.322787	0.124494
May	1.789274	0.320672	0.003550	0.291341	0.123342
June	1.765175	0.325827	0.003694	0.282111	0.122044
July	1.614829	0.364121	0.003586	0.342827	0.113529
August	1.658314	0.361489	0.003565	0.342782	0.115082
September	1.666298	0.365336	0.003473	0.360777	0.116871
October	1.632284	0.385696	0.003276	0.414583	0.121341
November	1.543317	0.406052	0.003168	0.456950	0.125371
December	1.530348	0.404592	0.003109	0.465085	0.125785

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	3.547775	-0.618390	-0.618390	0.127556	0.004464	0.470745	0.121229
February	3.607442	-0.655050	-0.655050	0.131690	0.004819	0.449231	0.123119
March	3.862717	-0.782820	-0.782820	0.146459	0.005250	0.410857	0.121306
April	3.976117	-0.824840	-0.824840	0.148874	0.005287	0.348791	0.122080
May	4.743221	-1.210580	-1.210580	0.197479	0.005727	0.331370	0.119808
June	5.030322	-1.400780	-1.400780	0.227224	0.006630	0.322285	0.118580
July	4.137783	-0.987130	-0.987130	0.180152	0.006629	0.366471	0.111468
August	4.346529	-1.063930	-1.063930	0.188127	0.006187	0.372200	0.112477
September	4.555382	-1.143760	-1.143760	0.196114	0.005603	0.398336	0.113385
October	4.614517	-1.103380	-1.103380	0.184798	0.004882	0.454484	0.117132
November	3.968693	-0.780320	-0.780320	0.144061	0.004282	0.486686	0.121890
December	4.161500	-0.881340	-0.881340	0.155952	0.004205	0.500360	0.121567

Table A-4

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

2005

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	($/Pound)			($/cwt. Per 1,000 SCC)
January	$1.7330	$2.5300	$0.0899	$0.00076
February	$1.7754	$2.6613	$0.0915	$0.00079
March	$1.7279	$2.5019	$0.0951	$0.00075
April	$1.6964	$2.7055	$0.1020	$0.00078
May	$1.5475	$2.5965	$0.1043	$0.00074
June	$1.5932	$2.5741	$0.1139	$0.00074
July	$1.8007	$2.4558	$0.1240	$0.00076
August	$1.8246	$2.1619	$0.1317	$0.00072
September	$1.8872	$2.3009	$0.1411	$0.00075
October	$1.8256	$2.3780	$0.1491	$0.00075
November	$1.6114	$2.2724	$0.1606	$0.00070
December	$1.5036	$2.3846	$0.1702	$0.00070
Simple Average	$1.7105	$2.4602	$0.1228	$0.00075

Table A-5

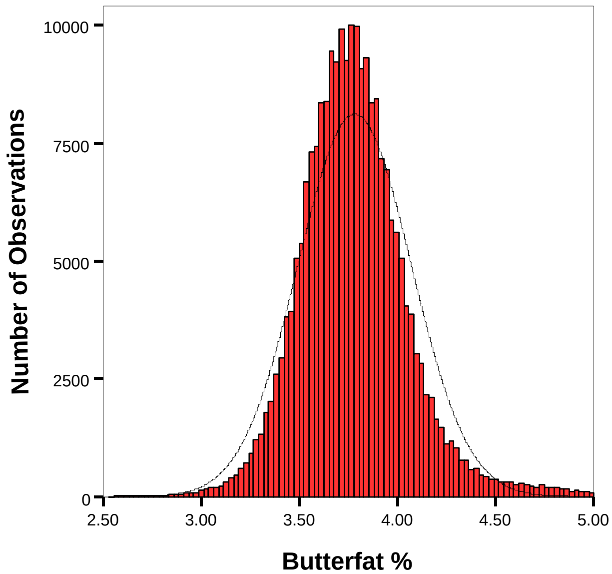
AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

2005

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	$20,539,224.55	136,329,114	$15.07
20,000	30,000	$46,275,762.58	310,147,666	$14.92
30,000	50,000	$208,075,733.71	1,409,676,035	$14.76
50,000	70,000	$331,987,821.73	2,260,935,098	$14.68
70,000	100,000	$550,412,168.75	3,766,506,568	$14.61
100,000	150,000	$705,437,103.23	4,849,633,885	$14.55
150,000	250,000	$707,967,471.35	4,874,813,090	$14.52
250,000	400,000	$481,266,821.13	3,318,044,223	$14.50
400,000		$2,123,879,479.28	14,794,137,324	$14.36
Total		$5,175,841,586.30	35,720,223,003	
Weighted Average				$14.49

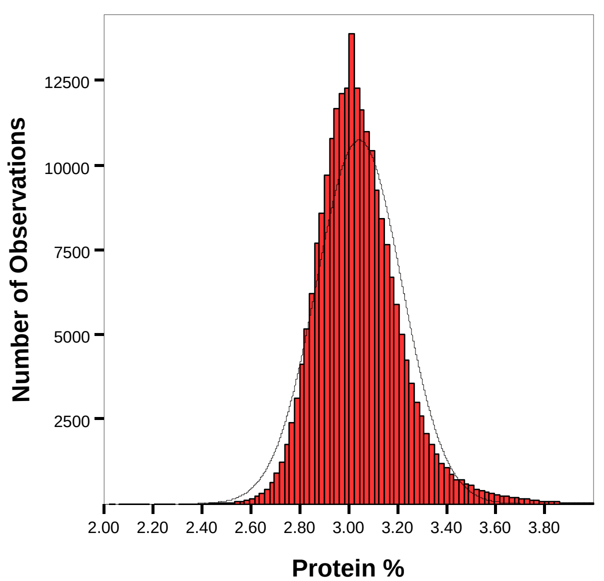
* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

Figure A-1
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE BUTTERFAT LEVELS, 2005



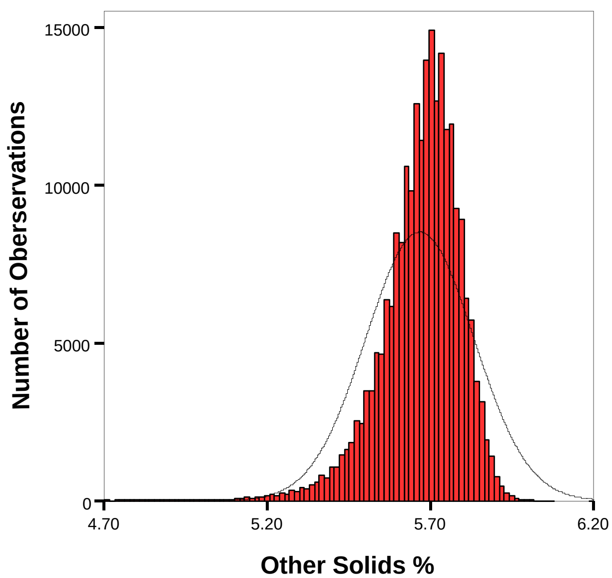
Skewness statistic: 0.8831
Kurtosis statistic: 4.497

Figure A-2
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE PROTEIN LEVELS, 2005



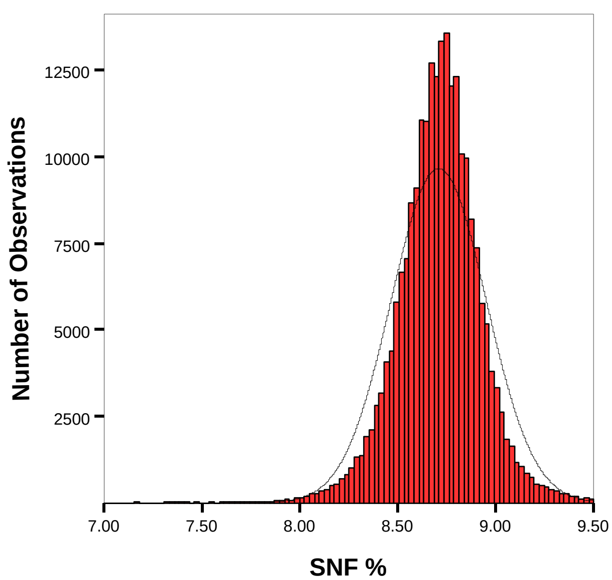
Skewness statistic: 0.6803
Kurtosis statistic: 4.738

Figure A-3
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE OTHER SOLIDS LEVELS, 2005



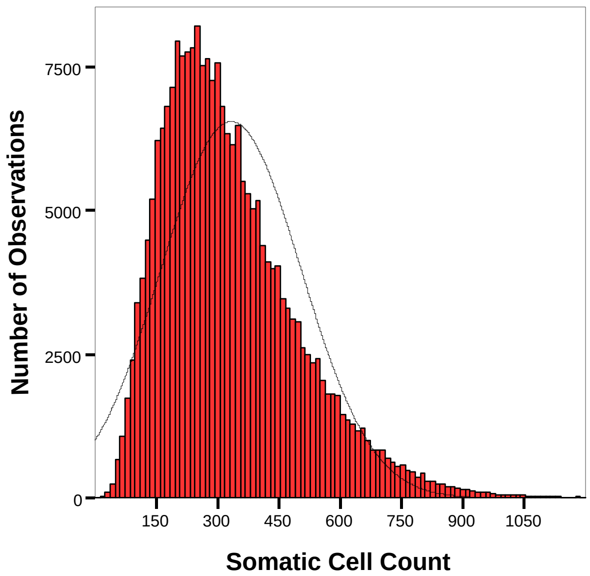
Skewness statistic: -12.195
Kurtosis statistic: 464.882

Figure A-4
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS, 2005



Skewness statistic: -3.598
Kurtosis statistic: 90.944

Figure A-5
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOMATIC CELL COUNT, 2005



Skewness statistic: 2.09
Kurtosis statistic: 17.34

Figure A-6
WEIGHTED AVERAGE MONTHLY BUTTERFAT TESTS
2001, 2002, 2003, 2004, & 2005

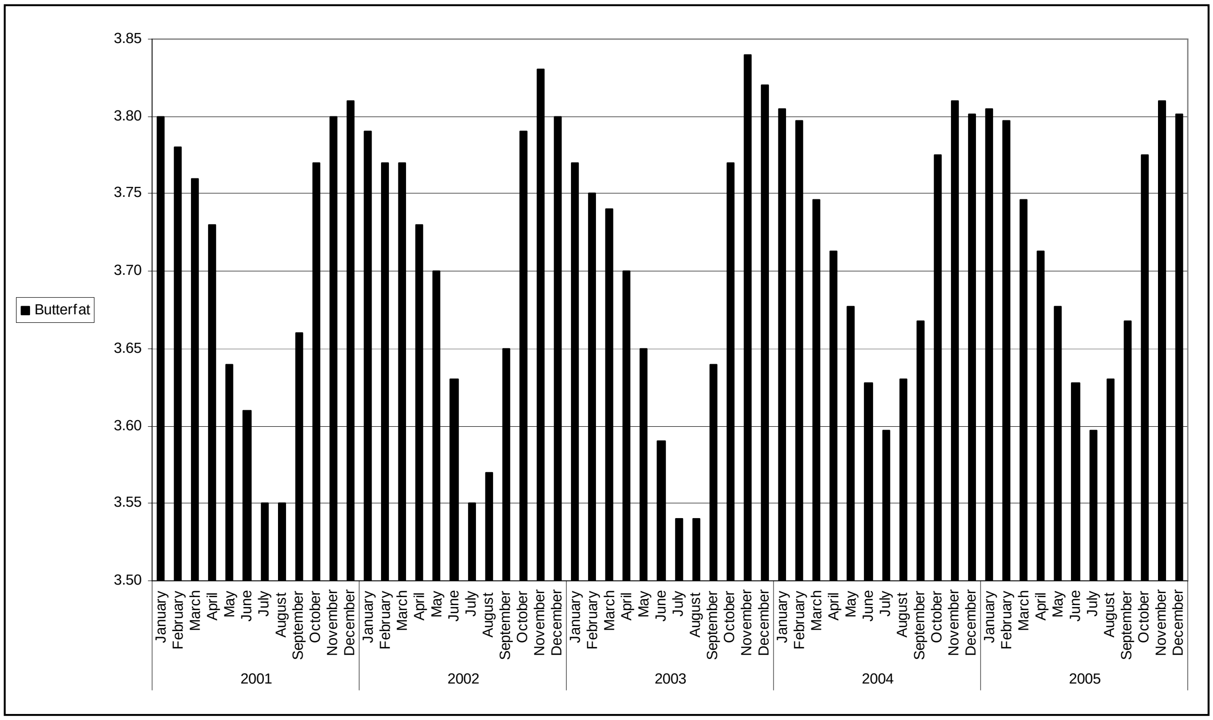


Figure A-7
WEIGHTED AVERAGE MONTHLY PROTEIN TESTS
2001, 2002, 2003, 2004, & 2005

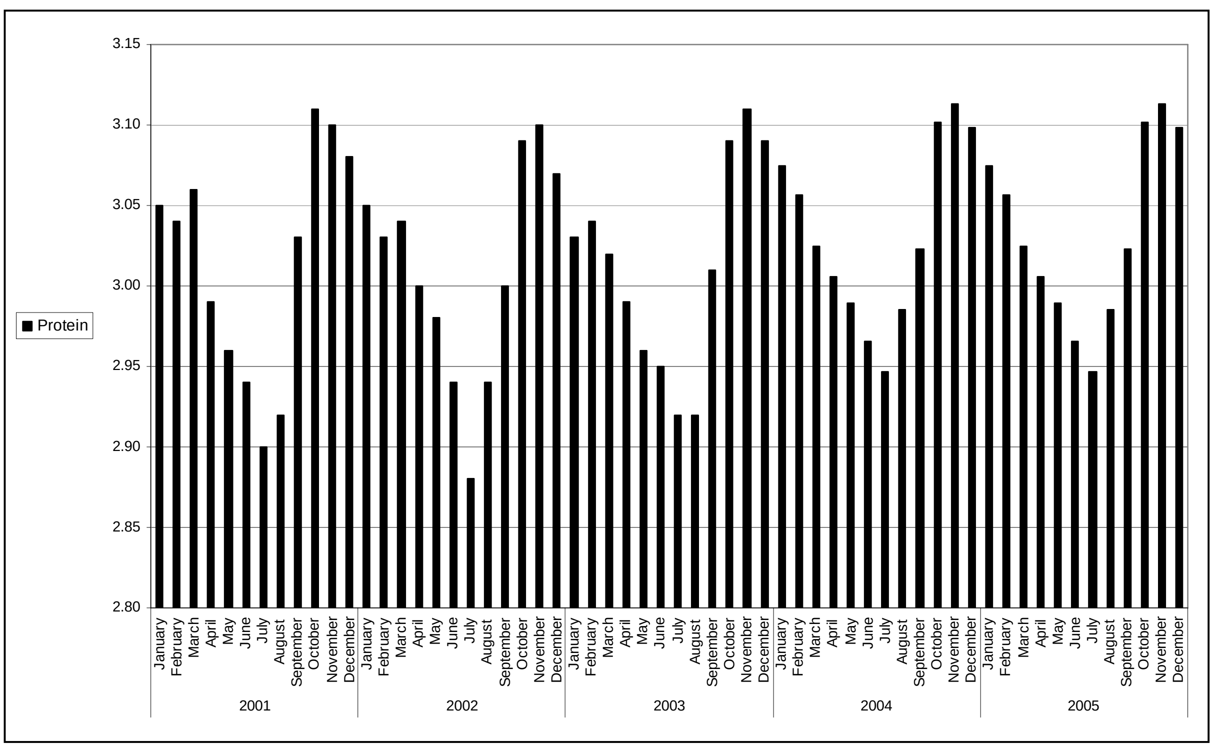


Figure A-8
WEIGHTED AVERAGE MONTHLY OTHER SOLIDS TESTS
2001, 2002, 2003, 2004, & 2005

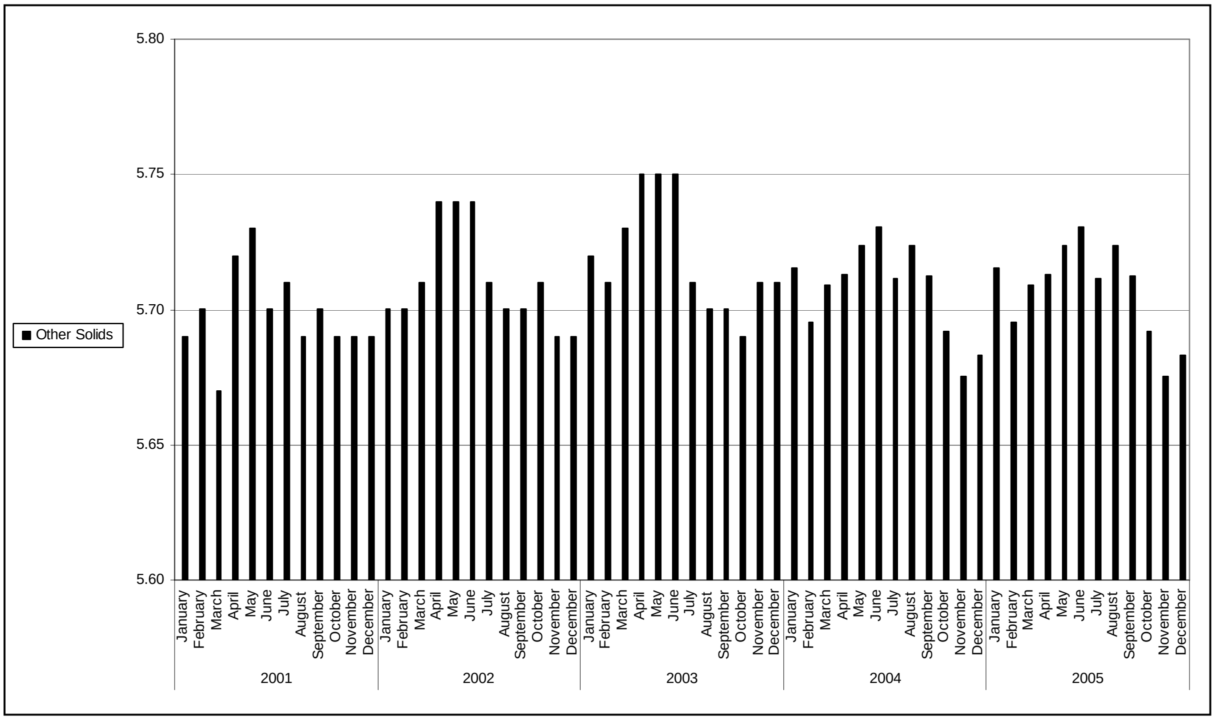


Figure A-9
WEIGHTED AVERAGE MONTHLY SOLIDS-NOT-FAT TESTS
2001, 2002, 2003, 2004, & 2005

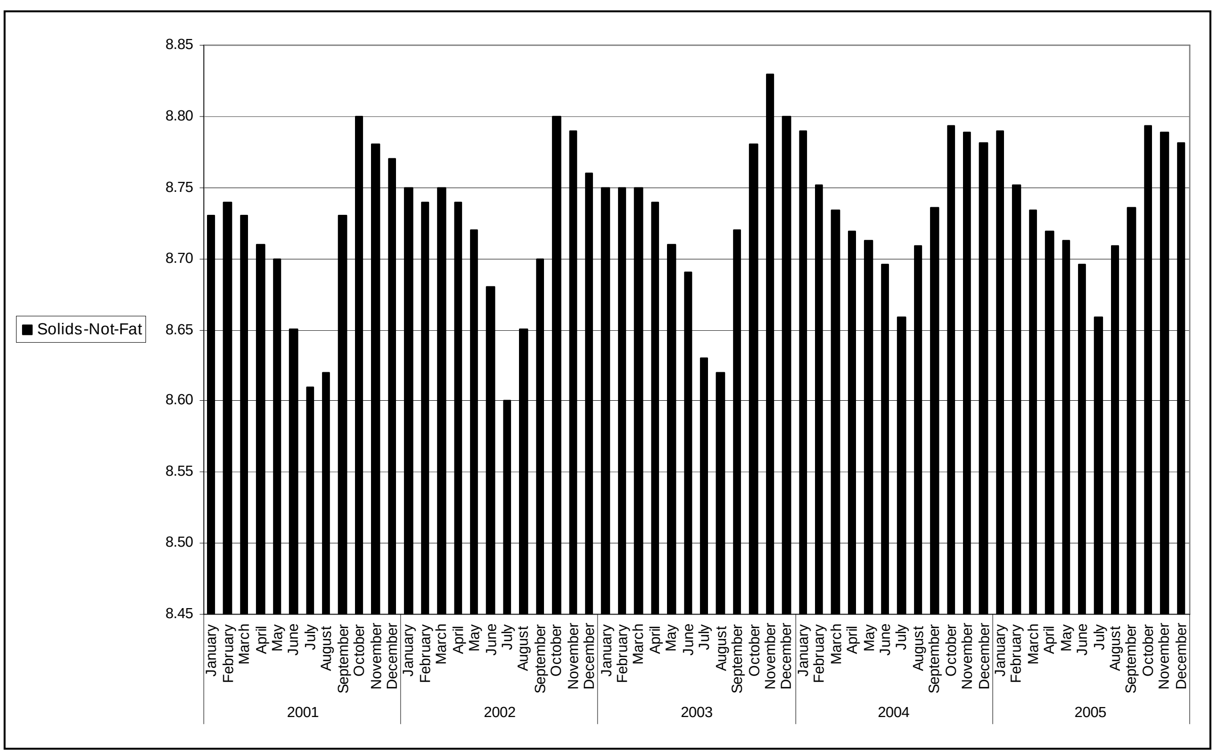


Figure A-10
WEIGHTED AVERAGE MONTHLY SOMATIC CELL COUNTS
2001, 2002, 2003, 2004, & 2005