UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL 2002

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Prepared by:
Henry H. Schaefer

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Federal Milk Market Administrator's Office
4570 West 77th Street, Suite 210
Minneapolis, Minnesota 55435

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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 2002. 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 2002 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 2002 were 3.72% butterfat, 3.01% protein, 5.71% other solids, 8.72% SNF and 326,000 SCC.

2) For 2002, weighted average butterfat, protein and SNF levels were lowest in July and August and highest during the late fall and winter. In contrast, other solids levels varied little during the year. Weighted average SCC were lowest in the 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 2002, the range of weighted average component levels within one standard deviation of the mean was: 3.48% to 3.96% for butterfat; 2.87% to 3.15% for protein; 5.61% to 5.81% for other solids; 8.54% to 8.90% for SNF; and 173,000 to 479,000 for SCC.

5) Based on the data for 2002, the following regression equations were derived:

$$SNF = 7.15780\% + 0.40439\ (BF)$$
$$SNF = 5.39150\% + 1.08985\ (PRO)$$
$$PRO = 1.55781\% + 0.38770\ (BF)$$

5) The annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $10.76 per cwt. for the market in 2002. Protein was the most valuable component, contributing a little more than half of the total value.

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I. INTRODUCTION

The data for this study were collected for milk marketed in 2002 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, Henry H. Schaefer, is an Agricultural Economist with the Market Administrator's Office, Minneapolis, Minnesota. Assisting Mr. Schaefer were Rachel M. Benecke and Michael J. McDonald of the Upper Midwest Market Administrator's Lisle, Illinois office.

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

[3] Protein tests for 2002 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 were 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 States of Idaho and Utah. 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 2002, 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 2002 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 2002 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

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
Minimum	3.55	2.88	5.69	8.60	289
Maximum	3.83	3.10	5.74	8.80	386
Annual Average	3.72	3.01	5.71	8.72	326

During the year, butterfat levels dropped from 3.79% in January to 3.55% in July, 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 0.28, 0.22 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 April, May and June to a low of 5.69% in November and December. The seasonal high SCC of 386,000 was reached in August before dropping to 289,000 in December, a change of 97,000 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 2002, the simple average SCC (371,000) was higher than the weighted average (326,000) indicating that larger producers tended to have, on average, lower SCC than their smaller counterparts. Moreover, the median SCC level (298,000) 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 1.836. 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

2002

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum
	- % -	- % -	- % -	- % -	- % -	- % -
Butterfat	3.72	3.78	0.24	3.71	1.35	6.30
Protein	3.01	3.02	0.14	3.00	1.65	5.79
Other Solids	5.71	5.66	0.10	5.72	.74	9.35
SNF	8.72	8.68	0.18	8.73	3.04	14.05
SCC (1,000's)	326	371	153	298	0	8,415

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 1.35% and as high as 6.30%; protein levels ranged from 1.65% to 5.79%; other solids levels ranged from .74% to 9.35%; SNF levels ranged from 3.04% to 14.05%; and SCC ranged from 0 to 8,415,000.

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: 3.48% to 3.96% for butterfat; 2.87% to 3.15% for protein; 5.61% to 5.81% for other solids; 8.54% to 8.90% for SNF; and 173,000 to 479,000 for SCC. Approximately three-quarters of the observed component levels and SCC in the 2002 data were within these ranges[7] (see also Appendix Table A-2 and Appendix Figures A-1 through A-5).

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

[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 2002 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.

milk marketed, and milk component levels. Producers with marketings for each month of 2002 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 2002

Percentile	Monthly Average Pounds	Butterfat Test	Protein Test	Other Solids Test	SNF Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
1	22,403	3.84	3.04	5.58	8.62	426
2	38,382	3.81	3.03	5.62	8.64	409
3	49,679	3.79	3.02	5.64	8.66	401
4	60,159	3.78	3.02	5.66	8.68	384
5	71,290	3.77	3.01	5.67	8.69	368
6	84,082	3.76	3.01	5.68	8.69	358
7	100,080	3.75	3.01	5.70	8.70	348
8	123,208	3.74	3.00	5.70	8.71	333
9	168,213	3.74	3.01	5.72	8.72	319
10	534,043	3.68	3.00	5.75	8.74	292
Average	125,147	3.72	3.01	5.71	8.72	326

Monthly Average Producer Milk by Producer Size 2002

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	1,741	22,403	1,404	31,861	468,049,162	1.8	
2	1,741	38,382	31,866	44,334	801,869,552	3.1	4.9
3	1,742	49,679	44,334	55,064	1,038,488,051	4.0	8.9
4	1,741	60,159	55,068	65,576	1,256,851,110	4.8	13.7
5	1,741	71,290	65,576	77,177	1,489,393,678	5.7	19.4
6	1,742	84,082	77,187	91,480	1,757,653,836	6.7	26.1
7	1,741	100,080	91,486	110,036	2,090,878,385	8.0	34.1
8	1,742	123,208	110,039	139,075	2,575,543,970	9.8	43.9
9	1,741	168,213	139,093	212,662	3,514,303,248	13.4	57.3
10	1,741	534,043	212,785	6,790,869	11,157,225,354	42.7	100.00
Total or Average	17,413	125,147			26,150,256,346		

A more detailed look at the relationship between producer size and component levels shows that larger producers tend to have lower butterfat tests and SCC than do smaller producers. Producers averaging 22,403 pounds per month had an average butterfat test of 3.84% while producers averaging 534,043 pounds averaged a 3.68% butterfat test. The butterfat test declined steadily from a weighted average of 3.84% for the smallest group to a weighted average of 3.74% for groups 8 and 9, while the group 10 producers, those averaging 534,043 pounds per month, had a weighted average butterfat test of 3.68%. The SCC declined steadily from an average of 426,000 for producers averaging 22,403 pounds per month to an average of 292,000 for producers averaging 534,043 pounds per month, a difference in the SCC of 134,000.

Protein tests also declined from the smaller producers to the larger producers but to a smaller extent than for butterfat, falling from 3.04% for producer's averaging 22,403 pounds per month to 3.00% percent for producers averaging 534,043 pounds of milk marketed per month. It is interesting to note that the protein test dropped off fairly rapidly and then leveled off for most of the size groups.

Other solids and solids-not-fat tests steadily increased as average monthly production increased. Other solids tests increased from 5.58% to 5.75%, while solids-not-fat tests increased steadily from 8.62% to 8.74% as monthly average production increased from 22,403 pounds to 534,043 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 43 percent of the milk in the market. There are approximately 80 percent of the producers with monthly production below the monthly average market production of 125,147 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). Idaho is also reported separately due to the relatively large percentage of the milk on the market from Idaho in 2002. Utah was also shown separately. 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, Illinois had the highest weighted average butterfat test, while Iowa had the highest weighted average protein test. Iowa and the Upper Peninsula of Michigan tied for the highest weighted average other solids tests, while Iowa had the highest weighted average SNF test. Utah had the highest protein test of the states shown. Of the states that are included in the Upper Midwest Marketing area North Dakota had the lowest weighted average SCC and Minnesota had the highest. Idaho had the lowest SCC of all the states. Detailed state information by month for 2002 is presented in Table A-2 (see Appendix).

Table 4

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

2002

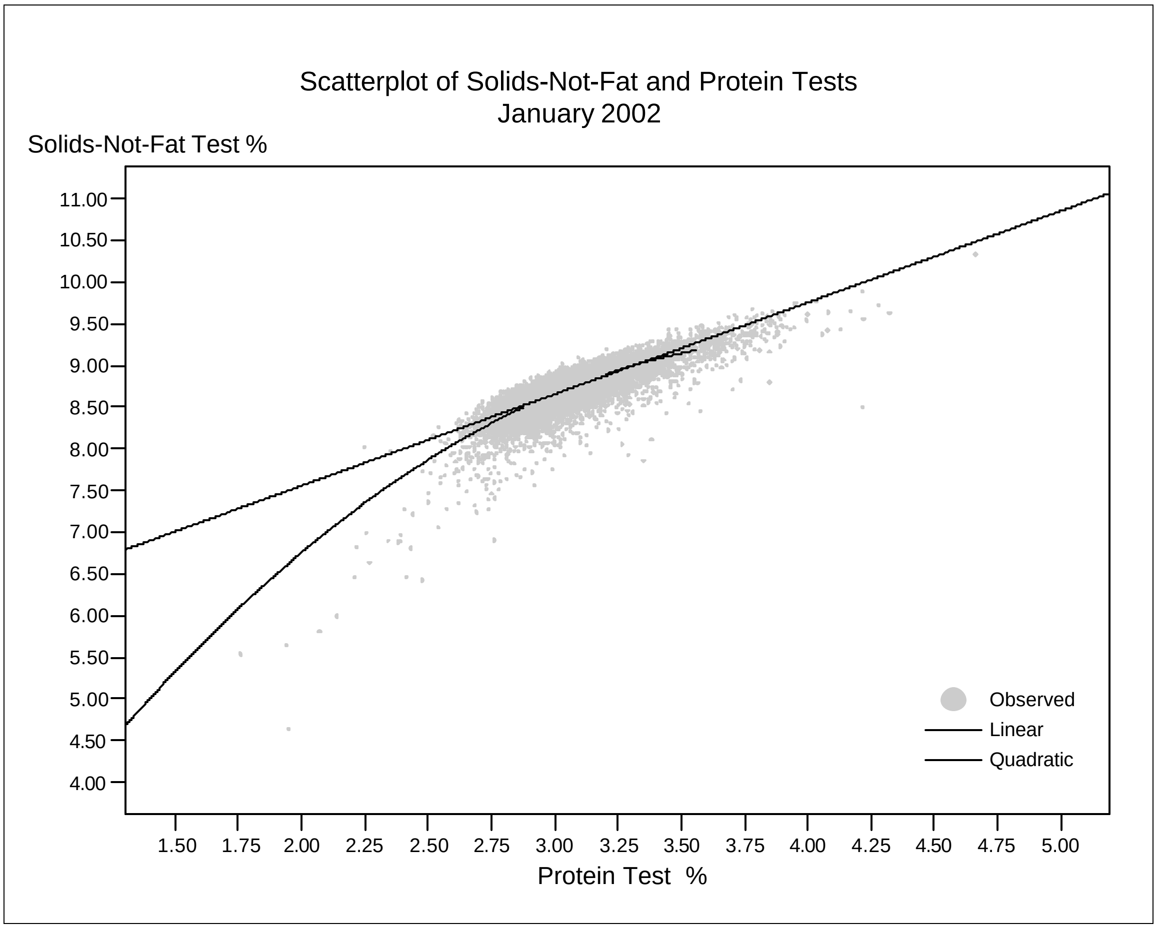
State	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
Idaho	3.60	3.06	5.76	8.82	285
Illinois	3.75	3.01	5.69	8.70	328
Iowa	3.73	3.07	5.76	8.83	350
Michigan U.P.	3.60	2.97	5.76	8.74	353
Minnesota	3.72	3.02	5.71	8.73	383
North Dakota	3.67	3.02	5.74	8.75	288
South Dakota	3.74	3.03	5.73	8.76	377
Utah	4.46	3.54	5.85	9.39	418
Wisconsin	3.73	2.99	5.71	8.70	307
All Other States[1/]	3.72	3.09	5.69	8.78	312
Market	3.72	3.01	5.71	8.72	326
Minimum	1.35	1.65	0.74	3.04	0
Maximum	6.30	5.79	9.35	14.05	8,415

[1/] Includes milk from California, Kansas, Missouri, Nebraska, Ohio and South Carolina.

IV. STATISTICAL RELATIONSHIPS AMONG MILK COMPONENTS

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



Regression analysis was used to estimate the linear relationship between components. Results from the 2002 data were compared with results from previous Upper Midwest Order studies (1993-2002), 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 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 thirteen 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 0.3817 from Mykrantz 1993 to 0.4640 for Halverson/Kyburz. The butterfat coefficient derived from the 2002 data was within that range at 0.40439. 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 all of the months except June 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 (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 2002 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 average producer solids-not-fat and protein tests for January 2002. 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 January, for the linear model is:

$$\textit{Solids-not-fat Test} = 5.3609 + 1.0988 * \textit{Protein Test},$$

while the equation for the quadratic model is:

$$\textit{Solids-not-fat Test} = -0.8561 + (5.0716 * \textit{Protein Test}) + (-0.6324 * (\textit{Protein Test})^2).$$

The R-squared for the linear model is 0.656 while the R-squared for the quadratic model is 0.690. 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 (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 2002 data and those of Halverson/Kyburz (see Table 7). The primary observation from the equation derived for the 2002 data was that the constant of 1.55781 and coefficient of 0.38770 for the independent variable were approximately the same as for the 2000 data.

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, except February, were statistically significant and of the expected sign. 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 (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 2002. 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 January, for the linear model is:

$$\textit{Protein Test} = 1.5061 + 0.4026 * \textit{Butterfat Test},$$

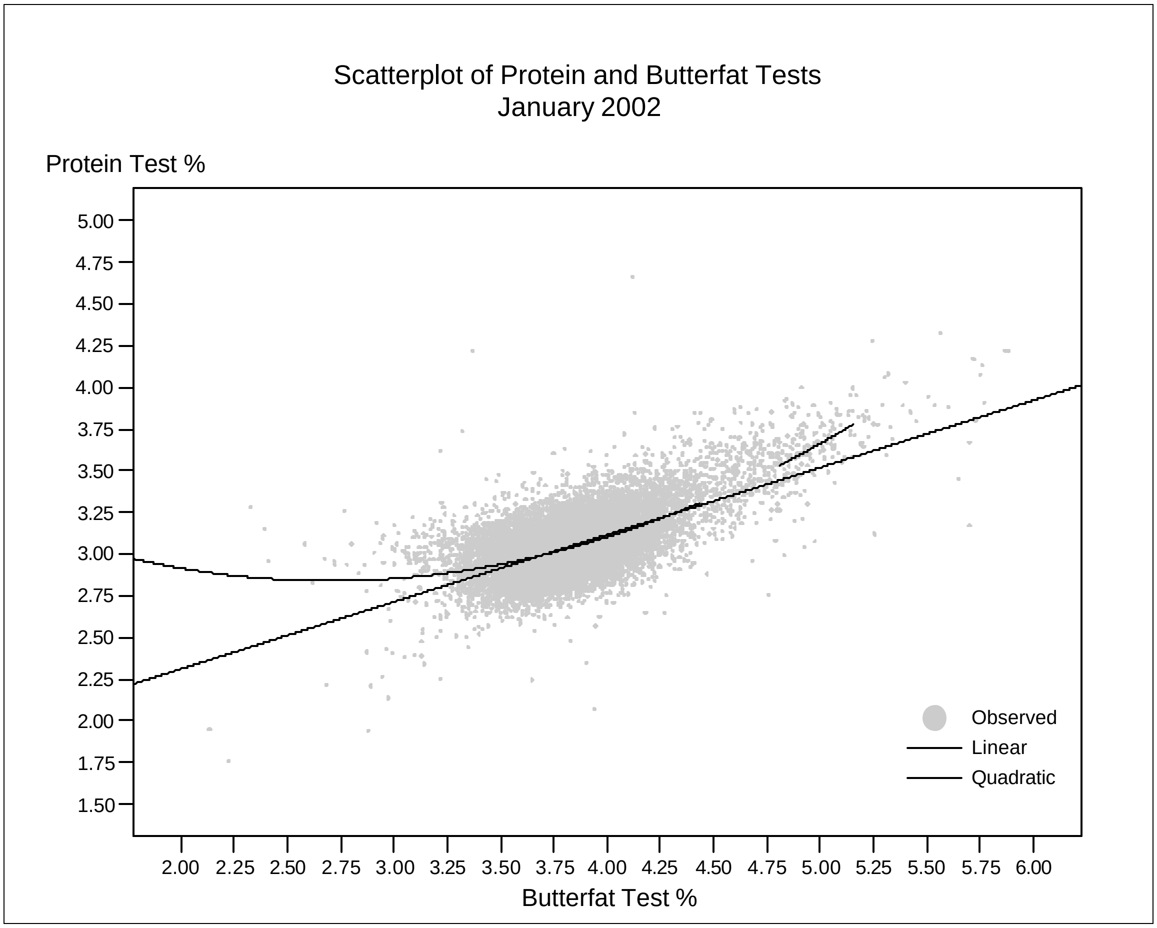
while the equation for the quadratic model is:

$$\textit{Protein Test} = 3.9745 + (-0.8408 * \textit{Butterfat Test}) + (0.1557 * (\textit{Butterfat Test})^2).$$

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 January

2002, has a slightly higher adjusted R-squared of 0.433, versus 0.406 for the linear model, suggesting a slightly better fit. The remaining months of 2002 had a similar difference in the R-squared value between the linear model and the quadratic model.

Figure 2



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[8] 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 0.68 suggests that a moderately strong linear relationship exists while protein and SNF appears to have a strong relationship with a coefficient of 0.81. 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.

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

[8] 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.

component prices applied to producer milk associated with the Upper Midwest Order during 2002. 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 2002, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $10.76 per cwt. for the market. The value of each component comprised by the $10.76 per cwt. price was $4.47 for butterfat, $5.94 for protein, and $0.34 for other solids. The SCC adjustment for the year amounted to about $0.014 per cwt.

Categorized by size range of delivery, average values of producer milk ranged from a low of $10.73 per cwt. for monthly producer milk deliveries greater than 400,000 pounds to a high of $11.04 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 - 2002 WEIGHTED AVERAGE COMPONENT TESTS

Weighted average component data for the past three years, 2000, 2001 and 2002, are shown in Table 8. Over these three years the yearly average tests have changed very little. Yearly average butterfat tests were 3.73 percent, 3.70 percent, and 3.72 percent for 2000, 2001 and 2003 respectively. Yearly average protein and other solids tests varied even less than the butterfat test with only a .01 percent difference between the three years. Yearly weighted average somatic cell counts also did not change much over the three-year period, increasing slightly from 2000 to 2001 and then declining from 336,000 in 2001 to 326,000 in 2002.

Graphs (see Appendix Figures A-6 through A-10) show the monthly weighted average component tests for 2000, 2001 and 2002. 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, 2001 and 2002 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 8

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 8 (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

VII. SUMMARY

This staff paper analyzes milk components and SCC in producer milk associated with the Upper Midwest Order during 2002. 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 2002 were: 3.72% butterfat, 3.01% protein, 5.71% other solids, 8.72% SNF and 326,000 SCC. Weighted average butterfat, protein and SNF levels were lowest in July and August and highest in the late fall and winter. The weighted monthly average levels of other solids were highest in April, May and June and lowest in November and December and exhibited less variation during the year relative to the three other components. Weighted average SCC were lowest in December and highest in August. Approximately three-quarters of monthly average component levels ranged from: 3.48% to 3.96% for butterfat; 2.87% to 3.15% for protein; 5.61% to 5.81% for other solids; 8.54% to 8.90% for SNF; and 173,000 to 479,000 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 43 percent of the milk. The monthly average pounds of milk marketed were 125,147 pounds, however almost 80 percent of the producers had average marketings below the market average.

Based on the data for 2002, the following regression equations were derived:

$$SNF = 7.15780\% + 0.40439\ (BF)$$
$$SNF = 5.39150\% + 1.08985\ (PRO)$$
$$PRO = 1.55781\% + 0.38770\ (BF)$$

Under MCP, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $10.76 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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FIGURES

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Table A-1

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

2002

Butterfat

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.79	3.84	0.22	3.78	2.13	5.89	20,355
February	3.77	3.83	0.22	3.76	1.68	6.30	20,075
March	3.77	3.85	0.23	3.77	1.73	5.89	19,613
April	3.73	3.82	0.22	3.72	1.90	5.57	19,604
May	3.70	3.76	0.22	3.69	2.28	5.80	19,275
June	3.63	3.68	0.21	3.63	2.36	5.51	19,331
July	3.55	3.57	0.20	3.55	2.40	5.65	19,280
August	3.57	3.60	0.20	3.57	1.42	5.19	19,906
September	3.65	3.69	0.21	3.64	2.11	5.29	19,701
October	3.79	3.87	0.23	3.79	2.41	5.82	19,726
November	3.83	3.91	0.24	3.82	1.35	6.00	19,830
December	3.80	3.88	0.24	3.79	1.53	6.23	19,726
For the Year	3.72	3.78	0.24	3.71	1.35	6.30	236,422

Protein

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median % -	Minimum - % -	Maximum - % -	Number of Observations
January	3.05	3.05	0.13	3.04	1.76	4.66	20,355
February	3.03	3.04	0.13	3.02	1.81	4.70	20,075
March	3.04	3.05	0.12	3.03	1.82	4.37	19,613
April	3.00	3.00	0.12	3.00	1.88	5.79	19,604
May	2.98	2.99	0.12	2.97	1.85	5.35	19,275
June	2.94	2.96	0.11	2.93	2.06	4.91	19,331
July	2.88	2.88	0.11	2.88	1.97	4.17	19,280
August	2.94	2.95	0.11	2.94	2.19	3.88	19,906
September	3.00	3.01	0.11	2.99	2.15	3.95	19,701
October	3.09	3.11	0.13	3.08	2.04	4.11	19,726
November	3.10	3.12	0.14	3.09	1.65	5.74	19,830
December	3.07	3.09	0.13	3.06	1.69	4.53	19,726
For the Year	3.01	3.02	0.14	3.00	1.65	5.79	236,422

Table A-1 (continued)

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

2002

Other Solids

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	5.70	5.66	0.10	5.71	2.69	6.01	20,355
February	5.70	5.66	0.11	5.71	2.71	9.35	20,075
March	5.71	5.68	0.09	5.73	1.56	6.04	19,613
April	5.74	5.70	0.09	5.75	3.10	7.24	19,604
May	5.74	5.69	0.10	5.75	3.59	6.08	19,275
June	5.74	5.70	0.10	5.76	3.62	7.41	19,331
July	5.71	5.66	0.11	5.73	2.64	6.22	19,280
August	5.70	5.64	0.11	5.72	4.17	6.03	19,906
September	5.70	5.63	0.11	5.72	0.74	6.01	19,701
October	5.71	5.65	0.11	5.73	3.85	6.00	19,726
November	5.69	5.63	0.10	5.71	3.23	8.32	19,830
December	5.69	5.64	0.10	5.70	2.96	6.08	19,726
For the Year	5.71	5.66	0.10	5.72	0.74	9.35	236,422

Solids-Not-Fat

Month	Weighted Average - % -	Simple Average - % -	Weighted Standard Deviation - % -	Weighted Median - % -	Minimum - % -	Maximum - % -	Number of Observations
January	8.75	8.72	0.17	8.75	4.64	10.34	20,355
February	8.74	8.70	0.18	8.74	5.26	12.46	20,075
March	8.75	8.72	0.16	8.75	3.04	9.94	19,613
April	8.74	8.71	0.16	8.75	5.36	11.38	19,604
May	8.72	8.69	0.17	8.72	5.44	11.09	19,275
June	8.68	8.65	0.16	8.69	5.91	12.32	19,331
July	8.60	8.54	0.17	8.61	5.27	9.86	19,280
August	8.65	8.59	0.18	8.66	6.43	9.61	19,906
September	8.70	8.65	0.17	8.71	3.76	9.62	19,701
October	8.80	8.76	0.17	8.81	6.25	10.00	19,726
November	8.79	8.76	0.17	8.80	4.89	14.05	19,830
December	8.76	8.72	0.17	8.76	4.65	9.93	19,726
For the Year	8.72	8.68	0.18	8.73	3.04	14.05	236,422

Table A-1 (continued)

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

2002

Somatic Cell Count

Month	Weighted Average	Simple Average	Weighted Standard Deviation	Weighted Median	Minimum	Maximum	Number of Observations
	(1,000)						
January	317	359	149	289	0	2,227	20,355
February	318	358	151	290	0	4,763	20,075
March	320	364	150	292	0	3,974	19,613
April	322	365	150	294	11	3,961	19,604
May	310	352	146	283	0	2,581	19,275
June	325	366	148	298	0	2,623	19,331
July	379	430	165	350	27	2,241	19,280
August	386	436	167	356	0	2,166	19,906
September	346	389	149	321	15	2,178	19,701
October	307	351	138	281	0	2,046	19,726
November	300	345	139	272	21	2,743	19,830
December	289	333	143	259	0	8,415	19,726
For the Year	326	371	153	298	0	8,415	236,422

Table A-2

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE
2002

Butterfat

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Utah	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.73	3.81	3.75	3.67	3.77	3.76	3.81	4.50	3.80	3.82	3.79
February	3.69	3.81	3.74	3.69	3.75	3.70	3.77	4.56	3.78	3.77	3.77
March	3.64	3.83	3.78	3.67	3.77	3.72	3.81	4.46	3.80	3.69	3.77
April	3.58	3.78	3.75	3.55	3.74	3.69	3.77	4.36	3.77	3.63	3.73
May	3.56	3.72	3.67	3.54	3.69	3.68	3.71	4.36	3.71	3.48	3.70
June	3.50	3.65	3.61	3.49	3.62	3.53	3.62	4.11	3.65	3.57	3.63
July	3.46	3.54	3.56	3.46	3.56	3.46	3.54	4.25	3.55	3.45	3.55
August	3.50	3.56	3.59	3.46	3.60	3.52	3.60	4.34	3.57	3.51	3.57
September	3.60	3.65	3.67	3.68	3.66	3.61	3.67	4.48	3.64	3.58	3.65
October	3.68	3.84	3.86	3.84	3.82	3.80	3.85	4.62	3.80	3.55	3.79
November	3.71	3.91	3.91	3.92	3.85	3.82	3.87	4.63	3.83	3.50	3.83
December	3.67	3.90	3.87	3.90	3.80	3.75	3.83	4.74	3.81	3.43	3.80
For the Year	3.60	3.75	3.73	3.60	3.72	3.67	3.74	4.46	3.73	3.72	3.72

Protein

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Utah	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.09	3.04	3.09	3.01	3.05	3.03	3.07	3.61	3.02	3.14	3.05
February	3.11	3.03	3.09	3.01	3.03	3.00	3.04	3.58	3.02	3.10	3.03
March	3.06	3.03	3.10	3.00	3.05	3.04	3.06	3.57	3.02	3.08	3.04
April	3.04	2.99	3.07	2.95	3.02	3.01	3.02	3.52	2.97	3.05	3.00
May	3.03	2.99	3.05	2.93	3.00	2.98	2.99	3.50	2.97	3.06	2.98
June	2.98	2.92	2.98	2.89	2.96	2.93	2.94	3.41	2.93	2.97	2.94
July	2.92	2.87	2.92	2.88	2.90	2.90	2.88	3.42	2.87	2.99	2.88
August	3.01	2.92	2.97	2.93	2.95	2.96	2.96	3.46	2.93	3.03	2.94
September	3.05	2.99	3.05	3.05	3.01	3.03	3.03	3.45	2.99	3.07	3.00
October	3.14	3.11	3.16	3.17	3.10	3.14	3.14	3.58	3.07	3.07	3.09
November	3.14	3.13	3.19	3.20	3.12	3.14	3.14	3.65	3.08	3.17	3.10
December	3.09	3.10	3.15	3.15	3.07	3.09	3.10	3.66	3.06	3.20	3.07
For the Year	3.06	3.01	3.07	2.97	3.02	3.02	3.03	3.54	2.99	3.09	3.01

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE
2002

Other Solids

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Utah	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	5.77	5.69	5.77	5.76	5.72	5.76	5.72	5.90	5.70	5.67	5.70
February	5.73	5.68	5.78	5.78	5.72	5.74	5.74	5.70	5.69	5.69	5.70
March	5.75	5.70	5.78	5.76	5.73	5.76	5.74	5.90	5.71	5.70	5.71
April	5.77	5.72	5.80	5.80	5.73	5.75	5.74	5.90	5.75	5.70	5.74
May	5.81	5.70	5.79	5.78	5.73	5.75	5.74	5.90	5.73	5.83	5.74
June	5.80	5.69	5.78	5.79	5.73	5.75	5.74	5.90	5.74	5.79	5.74
July	5.76	5.67	5.75	5.77	5.70	5.73	5.73	5.90	5.71	5.79	5.71
August	5.78	5.68	5.74	5.76	5.69	5.70	5.73	5.90	5.69	5.78	5.70
September	5.77	5.68	5.74	5.70	5.67	5.68	5.71	5.90	5.70	5.81	5.70
October	5.76	5.69	5.75	5.70	5.69	5.72	5.73	5.78	5.71	5.71	5.71
November	5.75	5.68	5.75	5.66	5.68	5.72	5.72	5.80	5.68	5.78	5.69
December	5.70	5.67	5.76	5.62	5.72	5.75	5.73	5.74	5.67	5.77	5.69
For the Year	5.76	5.69	5.76	5.76	5.71	5.74	5.73	5.85	5.71	5.69	5.71

Solids-Not-Fat

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Utah	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	8.86	8.72	8.87	8.77	8.77	8.79	8.79	9.51	8.72	8.80	8.75
February	8.84	8.71	8.87	8.79	8.75	8.74	8.77	9.28	8.71	8.78	8.74
March	8.81	8.74	8.88	8.76	8.77	8.79	8.80	9.47	8.73	8.78	8.75
April	8.81	8.71	8.87	8.75	8.75	8.76	8.76	9.41	8.72	8.75	8.74
May	8.84	8.69	8.84	8.70	8.74	8.73	8.73	9.40	8.70	8.88	8.72
June	8.78	8.62	8.76	8.68	8.70	8.68	8.68	9.31	8.66	8.76	8.68
July	8.68	8.54	8.67	8.66	8.59	8.63	8.61	9.32	8.58	8.78	8.60
August	8.79	8.60	8.71	8.69	8.64	8.66	8.69	9.36	8.62	8.81	8.65
September	8.82	8.67	8.78	8.75	8.68	8.71	8.74	9.35	8.68	8.89	8.70
October	8.90	8.80	8.91	8.86	8.80	8.86	8.87	9.36	8.78	8.79	8.80
November	8.89	8.82	8.94	8.86	8.80	8.85	8.86	9.45	8.77	8.95	8.79
December	8.79	8.78	8.91	8.78	8.78	8.84	8.84	9.40	8.73	8.96	8.76
For the Year	8.82	8.70	8.83	8.74	8.73	8.75	8.76	9.39	8.70	8.78	8.72

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE 2002

Somatic Cell Counts

	Idaho	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Utah	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	315	314	343	263	377	299	382	559	291	319	317
February	383	321	325	330	372	307	378	440	291	320	318
March	347	322	338	326	373	294	374	684	297	307	320
April	331	324	338	349	373	281	370	616	299	318	322
May	294	313	310	362	364	277	347	357	290	173	310
June	286	330	335	386	385	286	365	327	305	262	325
July	305	372	393	432	452	334	436	321	357	239	379
August	301	396	408	404	455	332	447	395	366	243	386
September	267	356	381	371	405	294	414	391	331	223	346
October	230	308	331	326	357	256	357	385	297	238	307
November	248	296	326	307	345	251	331	345	290	228	300
December	250	297	340	305	337	244	328	324	273	222	289
For the Year	285	328	350	353	383	288	377	418	307	312	326

Table A-3

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2002

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)	7.15180	.00557	1,283.989	.242
Butterfat (b)	.40439	.00147	274.653	
SNF = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	7.2732	.006	1,162.063	.253
Butterfat (b)	.3754	.002	236.176	
February	-.0096	.002	-4.919	
March	.0025	.002	1.265	
April	.0008	.002	.410	
May	.0055	.002	2.778	
June	.0014	.002	.708	
July	-.0731	.002	-36.398	
August	-.0349	.002	-17.600	
September	-.0117	.002	-5.968	
October	.0353	.002	18.077	
November	.0168	.002	8.609	
December	-.0053	.002	-2.703	

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)	5.39150	.00500	1087.288	.652
Protein (b)	1.08985	.00200	665.179	
SNF = c + b(PRO) + m(February) + . . . + m(December)				
Constant (c)	5.2589	.005	969.365	.667
Protein (b)	1.1322	.002	646.436	
February	.0008	.001	.579	
March	.0142	.001	10.857	
April	.0478	.001	36.534	
May	.0400	.001	30.434	
June	.0489	.001	37.026	
July	.0191	.001	14.182	
August	-.0037	.001	-2.847	
September	-.0231	.001	-17.662	
October	-.0175	.001	-13.410	
November	-.0380	.001	-29.048	
December	-.0303	.001	-23.209	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2002

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)	1.55781	.00400	425.892	.405
Butterfat (b)	.38770	.00100	401.313	
PRO = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	1.700	.004	425.113	.445
Butterfat (b)	.352	.001	346.945	
February	-.009	.001	-7.150	
March	-.011	.001	-8.449	
April	-.041	.001	-32.881	
May	-.029	.001	-22.911	
June	-.039	.001	-30.483	
July	-.076	.001	-59.118	
August	-.023	.001	-17.786	
September	.013	.001	10.409	
October	.046	.001	36.881	
November	.047	.001	37.752	
December	.021	.001	17.145	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2002

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	5.3609	1.0988	.0056	.6561	.1320
February	5.3338	1.1078	.0059	.6377	.1342
March	5.2995	1.1235	.0061	.6350	.1336
April	5.2613	1.1473	.0057	.6706	.1230
May	5.1643	1.1772	.0058	.6849	.1186
June	5.1492	1.1859	.0060	.6689	.1183
July	4.7932	1.3004	.0067	.6644	.1244
August	4.9421	1.2385	.0065	.6472	.1244
September	5.1857	1.1488	.0069	.5881	.1373
October	5.4419	1.0677	.0062	.5981	.1376
November	5.4684	1.0529	.0057	.6294	.1379
December	5.4525	1.0597	.0059	.6192	.1365

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	-0.8561	5.0716	.0841	-.6324	.0134	.6902	.1253
February	-1.3738	5.4176	.0928	-.6900	.0148	.6729	.1275
March	-1.4212	5.4336	.0989	-.6888	.0158	.6673	.1275
April	2.0378	3.2373	.0667	-.3376	.0107	.6864	.1200
May	0.5946	4.1679	.0824	-.4879	.0134	.7051	.1148
June	1.7242	3.4534	.0990	-.3743	.0163	.6776	.1167
July	-3.0761	6.6821	.1260	-.9179	.0215	.6935	.1189
August	-2.6421	6.2966	.1323	-.8413	.0220	.6713	.1200
September	-1.8004	5.6882	.1394	-.7354	.0226	.6092	.1337
October	-0.2198	4.6197	.1156	-.5553	.0181	.6165	.1344
November	3.3859	2.3380	.0732	-.1974	.0112	.6351	.1369
December	-0.0079	4.5003	.0934	-.5400	.0146	.6438	.1320

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2002

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	1.5061	.4026	.0034	.4064	.1279
February	1.5453	.3902	.0034	.3994	.1246
March	1.6184	.3706	.0034	.3721	.1243
April	1.6961	.3424	.0036	.3155	.1265
May	1.8093	.3154	.0037	.2739	.1266
June	1.8277	.3069	.0037	.2659	.1215
July	1.7515	.3165	.0035	.2949	.1130
August	1.8352	.3083	.0036	.2744	.1159
September	1.8195	.3234	.0036	.2958	.1198
October	1.6770	.3700	.0034	.3803	.1238
November	1.7466	.3523	.0036	.3222	.1405
December	1.5833	.3878	.0033	.4052	.1267

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	3.9745	-0.8408	.0402	.1557	.0050	.4332	.1250
February	4.1372	-0.9236	.0391	.1656	.0049	.4316	.1212
March	4.5300	-1.1001	.0420	.1849	.0053	.4093	.1205
April	4.5394	-1.1091	.0455	.1843	.0058	.3495	.1233
May	4.8142	-1.2485	.0454	.2025	.0059	.3163	.1229
June	5.0392	-1.4032	.0480	.2266	.0063	.3114	.1177
July	4.6643	-1.2876	.0444	.2199	.0061	.3397	.1094
August	5.3890	-1.6373	.0441	.2652	.0060	.3394	.1106
September	5.4988	-1.6310	.0439	.2583	.0058	.3605	.1142
October	4.9016	-1.2492	.0404	.2022	.0050	.4273	.1190
November	5.4641	-1.5002	.0383	.2295	.0047	.3942	.1329
December	4.4728	-1.0532	.0381	.1786	.0047	.4457	.1223

Table A-4

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

2002

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	($/Pound)			($/cwt. Per 1,000 SCC)
January	$1.4846	$1.9660	$0.1392	$0.00065
February	1.3817	2.0884	0.0965	0.00064
March	1.3638	1.8342	0.0688	0.00060
April	1.2890	2.0109	0.0566	0.00062
May	1.1433	2.2097	0.0371	0.00062
June	1.1211	2.0148	0.0247	0.00059
July	1.0929	1.8095	0.0150	0.00055
August	1.0701	1.9021	0.0177	0.00056
September	1.0099	2.0646	0.0367	0.00057
October	1.0726	2.1839	0.0755	0.00060
November	1.0923	1.8469	0.0850	0.00056
December	1.1922	1.7506	0.0584	0.00056
Simple Average	$1.1928	$1.9735	$0.0593	$0.00059

Table A-5

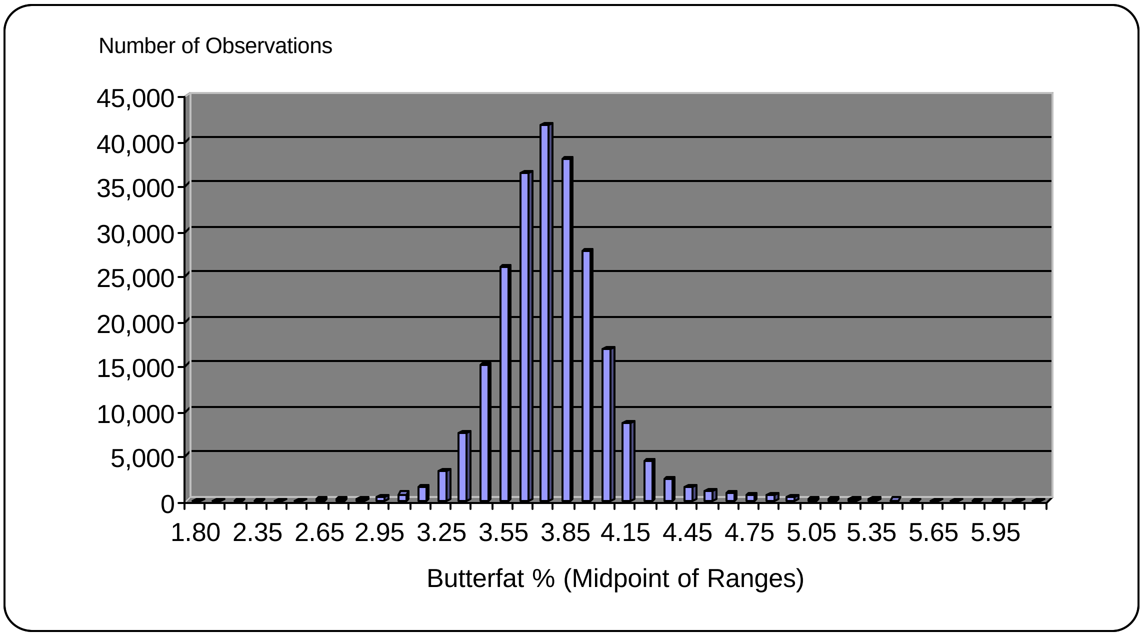
AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

2002

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	$16,752,764.25	151,782,024	$11.04
20,000	30,000	39,184,008.59	359,024,486	10.91
30,000	50,000	171,181,035.07	1,580,061,956	10.83
50,000	70,000	270,309,918.93	2,504,075,216	10.79
70,000	100,000	430,161,229.64	3,997,906,099	10.76
100,000	150,000	509,957,969.69	4,745,635,628	10.75
150,000	250,000	454,217,584.80	4,220,997,477	10.76
250,000	400,000	300,218,274.62	2,787,645,667	10.77
400,000		1,263,364,896.67	11,770,940,608	10.73
Total		$3,455,347,682.26	32,118,069,161	
Weighted Average				$10.76

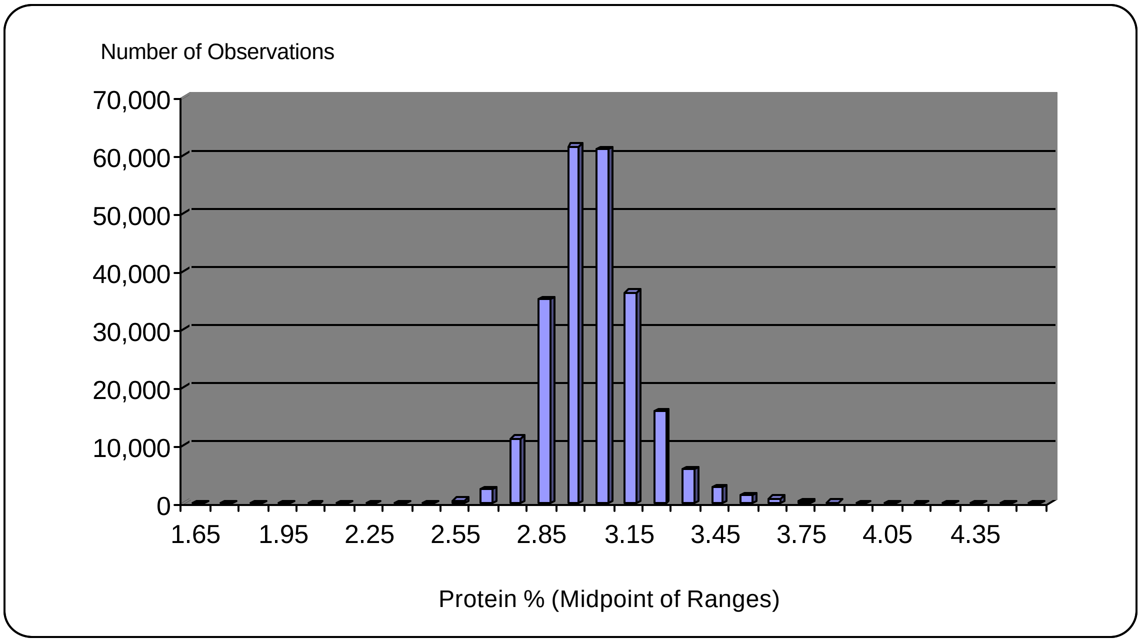
* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

Figure A-1
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE BUTTERFAT LEVELS, 2002



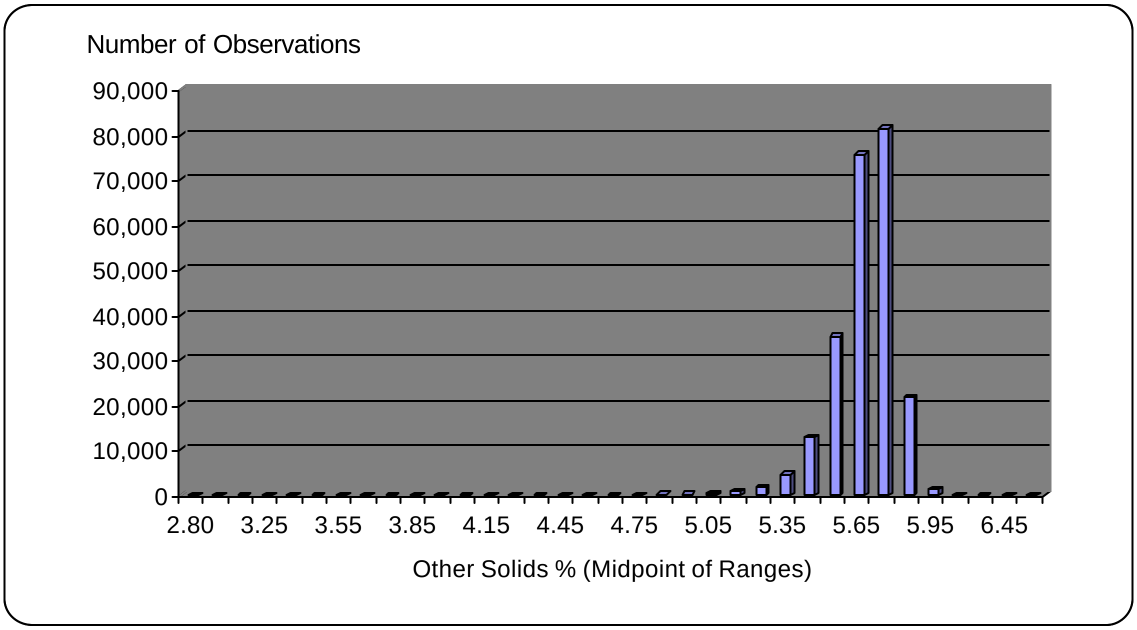
Skewness statistic: 0.793
Kurtosis statistic: 4.030

Figure A-2
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE PROTEIN LEVELS, 2002



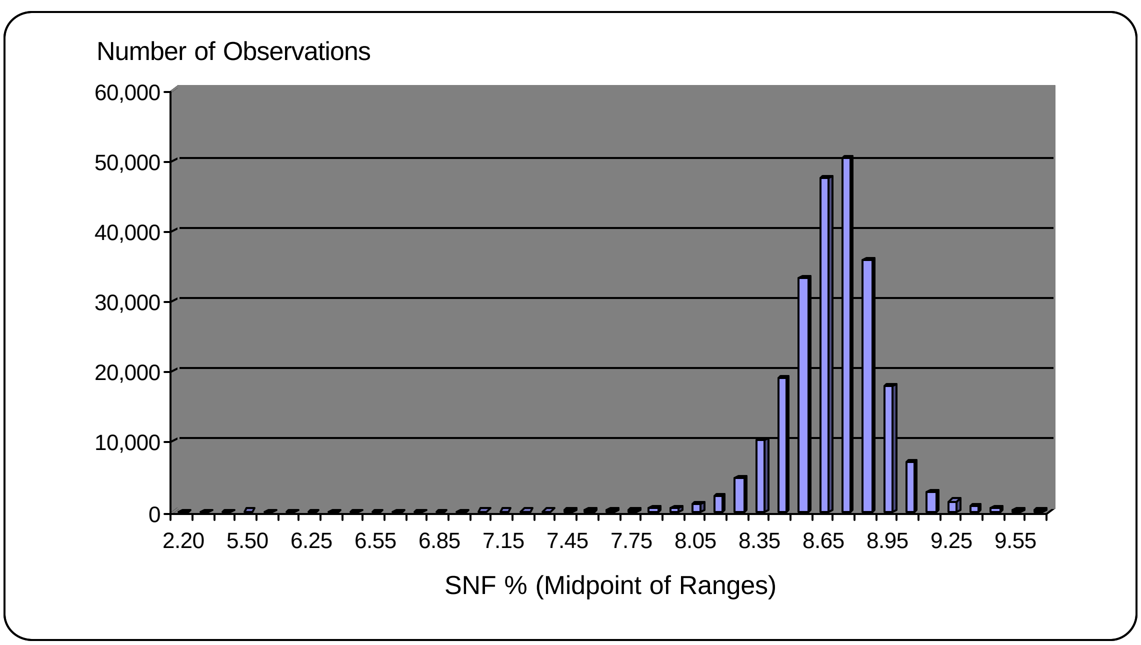
Skewness statistic: 0.962
Kurtosis statistic: 4.550

Figure A-3
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE OTHER SOLIDS LEVELS, 2002



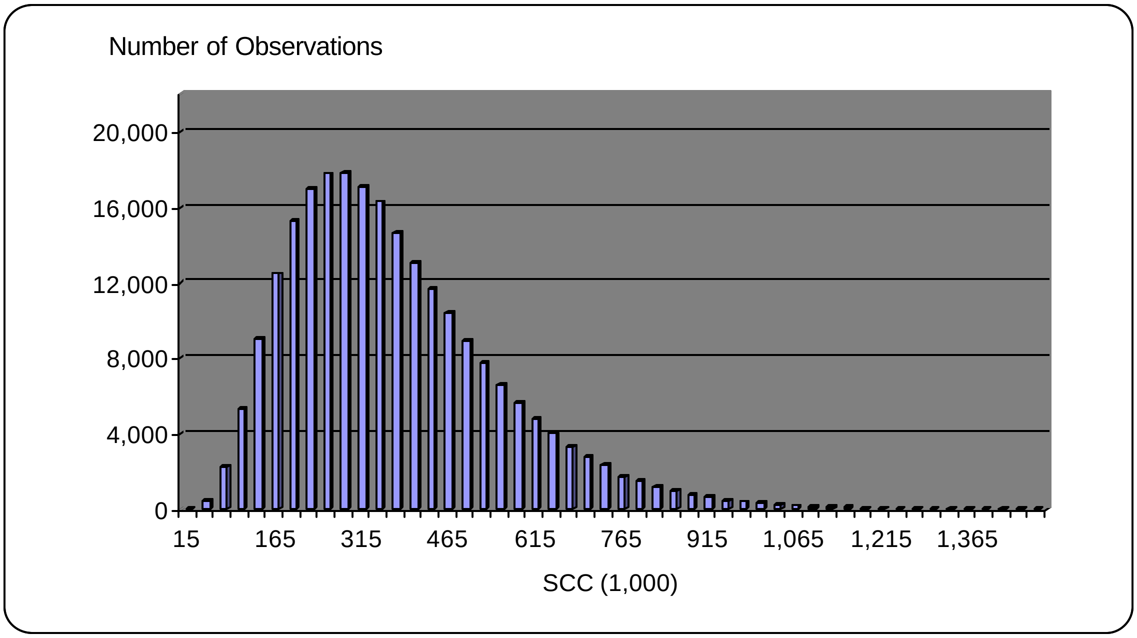
Skewness statistic: -2.602
Kurtosis statistic: 35.613

Figure A-4
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS, 2002



Skewness statistic: -0.899
Kurtosis statistic: 13.374

Figure A-5
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOMATIC CELL COUNT, 2002



Skewness statistic: 1.836
Kurtosis statistic: 21.371

Figure A-6
WEIGHTED AVERAGE MONTHLY BUTTERFAT TESTS
2000, 2001 & 2002

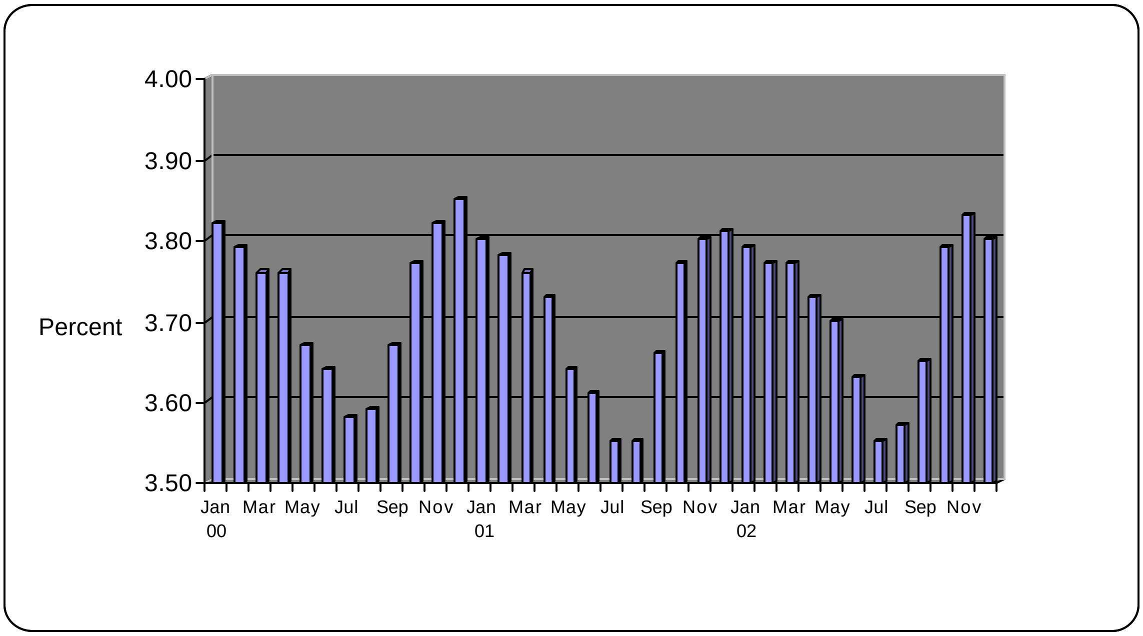


Figure A-7
WEIGHTED AVERAGE MONTHLY PROTEIN TESTS
2000, 2001 & 2002

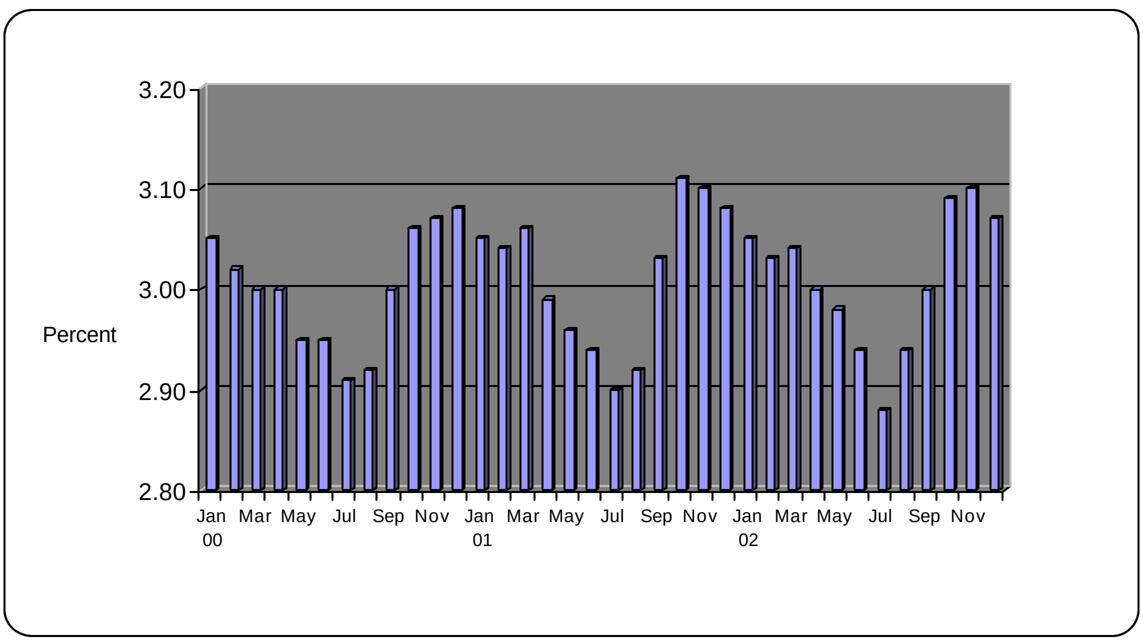


Figure A-8
WEIGHTED AVERAGE MONTHLY OTHER SOLIDS TESTS
2000, 2001 & 2002

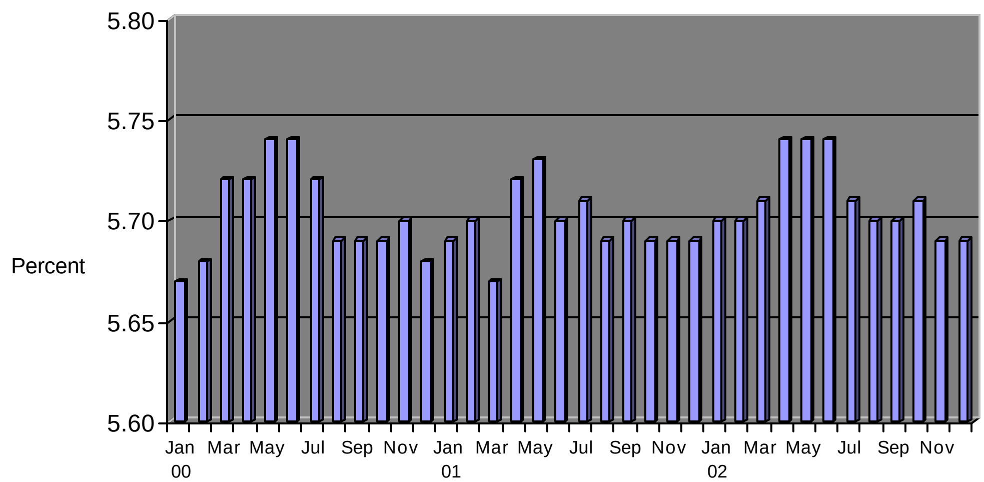


Figure A-9
WEIGHTED AVERAGE MONTHLY SOLIDS-NOT-FAT TESTS
2000, 2001 & 2002

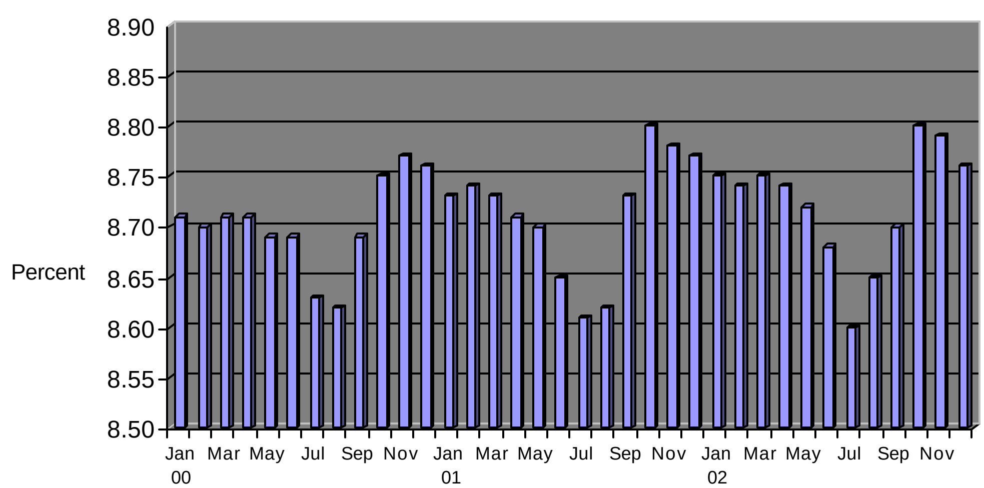


Figure A-10
WEIGHTED AVERAGE MONTHLY SOMATIC CELL COUNTS
2000, 2001 & 2002