UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL 2001

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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 2001. 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 2001 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 2001 were 3.70% butterfat, 3.01% protein, 5.70% other solids, 8.71% SNF and 336,000 SCC.

2) For 2001, 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 2001, the range of monthly average component levels within one standard deviation of the mean was: 3.49% to 4.03% for butterfat; 2.85% to 3.19% for protein; 5.53% to 5.79% for other solids; 8.45% to 8.91% for SNF; and 184,000 to 572,000 for SCC.

5) Based on the data for 2001, the following regression equations were derived:

$$SNF = 7.06534\% + 0.42925\ (BF)$$
$$SNF = 5.38415\% + 1.09176\ (PRO)$$
$$PRO = 1.47804\% + 0.40962\ (BF)$$

5) The annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $13.53 per cwt. for the market in 2001. Butterfat 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 2001 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 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.

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

[3] Protein tests for 2001 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 State of California. 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 2001, 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 2001 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 2001 are summarized in Table 2 and miscellaneous annual statistics, in addition to weighted averages, are summarized in Table 3.

During the year, butterfat levels dropped from 3.80% in January to 3.55% in July, then rose to 3.81% by December. Protein and SNF showed similar seasonal patterns during the year by bottoming out in the summer and peaking by year end. The range of variation for butterfat, protein and SNF was 0.26, 0.21 and 0.19 percentage points, respectively. Other solids demonstrated the narrowest range of variation with no apparent seasonal pattern. Other solids levels ranged from a high of 5.73% in May to a low of 5.67% in March. The seasonal high SCC of 390,000 was reached in August before dropping to 306,000 in November, a change of 84,000 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 2001, the simple average SCC (378,000) was higher than the weighted average (336,000) indicating that larger producers tended to have, on average, lower SCC than their smaller counterparts. Moreover, the median SCC level (342,000) was also lower than the simple average SCC, indicating that the distribution of SCC levels for the market were skewed toward higher SCC levels (see Appendix Figure A-5).[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 milk marketed, and milk component levels. Producers with marketings for each month of 2001 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 1. The range of average monthly production and total production by group are also shown in Table 1.

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 23,000 pounds per month had an average butterfat test of 3.83% while producers averaging 559,000 pounds averaged a 3.69% butterfat test. The butterfat test declined steadily from 3.83% to 3.74% and remained relatively constant for groups 5-9 (monthly averages from 71,000 to 165,000) when the butterfat test dropped to 3.69%. The SCC declined steadily from an average of 432,000 for producers averaging 23,000 to an average of 309,000 for producers averaging 559,000 pounds per month, a decline of 123,000.

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 23,000 pounds per month to 3.00% percent for producers averaging 559,000 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 5.73% percent while solids-not-fat tests increased steadily from 8.62% to 8.73% as monthly average production increased from 23,000 pounds to 559,000 pounds.

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 1.705. 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.

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 44 percent of the milk in the market. There are approximately 75 percent of the producers with monthly production below the monthly average market production of 127,210 pounds.

Table 1

Weighted Average Component Tests by Monthly Average Producer Milk Production

Percentile	Monthly Average Pounds	Butterfat Test	Protein Test	Other Solids Test	SNF Test	Somatic Cell Count
		- % -	- % -	- % -	- % -	- 1,000 -
1	23,208	3.83	3.04	5.58	8.62	432
2	39,178	3.79	3.02	5.62	8.63	414
3	50,012	3.77	3.02	5.64	8.66	405
4	60,375	3.77	3.01	5.66	8.67	386
5	71,232	3.74	3.01	5.68	8.69	374
6	83,347	3.74	3.00	5.68	8.68	359
7	99,090	3.74	3.00	5.69	8.70	352
8	121,709	3.73	3.00	5.70	8.70	342
9	165,293	3.73	3.00	5.71	8.71	330
10	558,683	3.69	3.00	5.73	8.73	309
Average	127,210	3.75	3.01	5.67	8.68	370

Monthly Average Producer Milk by Producer Size

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	1,826	23,208	1,897	32,897	508,533,696	1.82	
2	1,826	39,178	32,897	44,873	858,468,336	3.08	4.90
3	1,826	50,012	44,874	55,077	1,095,862,944	3.93	8.84
4	1,826	60,375	55,078	65,759	1,322,937,000	4.75	13.58
5	1,826	71,232	65,762	76,801	1,560,835,584	5.60	19.18
6	1,827	83,347	76,802	90,503	1,827,299,628	6.56	25.74
7	1,826	99,090	90,513	108,872	2,171,260,080	7.79	33.52
8	1,826	121,709	108,877	137,638	2,666,887,608	9.57	43.09
9	1,826	165,293	137,674	206,901	3,621,900,216	12.99	56.08
10	1,826	558,683	206,982	15,559,671	12,241,861,896	43.92	100.00
Total or Average	18,261	127,210			27,875,846,988		

Table 2

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

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	3.65	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
Minimum	3.55	2.90	5.67	8.61	306
Maximum	3.81	3.11	5.73	8.80	390
Annual Average	3.70	3.01	5.70	8.71	336

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 1.36% and as high as 6.16%; protein levels ranged from 1.08% to 5.75%; other solids levels ranged from 2.05% to 7.46%; SNF levels ranged from 3.12% to 10.86%; and SCC ranged from 0 to 7,822,000.

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 range of component levels within one standard deviation of the mean were: 3.49% to 4.03% for butterfat; 2.85% to 3.19% for protein; 5.53% to 5.79% for other solids; 8.45% to 8.91% for SNF; and 184,000 to 572,000 for SCC. Approximately three-quarters of the observed component levels and SCC in the

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

2001 data were within these ranges[7] (see also Appendix Table A-2 and Appendix Figures A-1 through A-5).

Table 3

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

2001

Month	Weighted Average	Simple Average	Standard Deviation	Median	Minimum	Maximum
	- % -	- % -	- % -	- % -	- % -	- % -
Butterfat	3.70	3.76	0.27	3.75	1.36	6.16
Protein	3.01	3.02	0.17	3.00	1.08	5.75
Other Solids	5.70	5.66	0.13	5.68	2.05	7.46
SNF	8.71	8.68	0.23	8.69	3.12	10.86
SCC (1,000's)	336	378	194	342	0	7,822

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. California is also reported separately due to the relatively large percentage of the milk on the market from California in 2001. 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 (see Table 4).

[7] The percentage of observations within one standard deviation of the mean in the 2001 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.

South Dakota had the highest average butterfat, while Iowa had the highest protein, other solids and SNF levels for the marketing area. California had the highest protein test of the states shown. The weighted average SCC was lowest in the Upper Peninsula of Michigan and Wisconsin and highest in Minnesota and South Dakota. Detailed state information by month for 2001 is presented in Table A-2 (see Appendix).

Table 4

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

2001

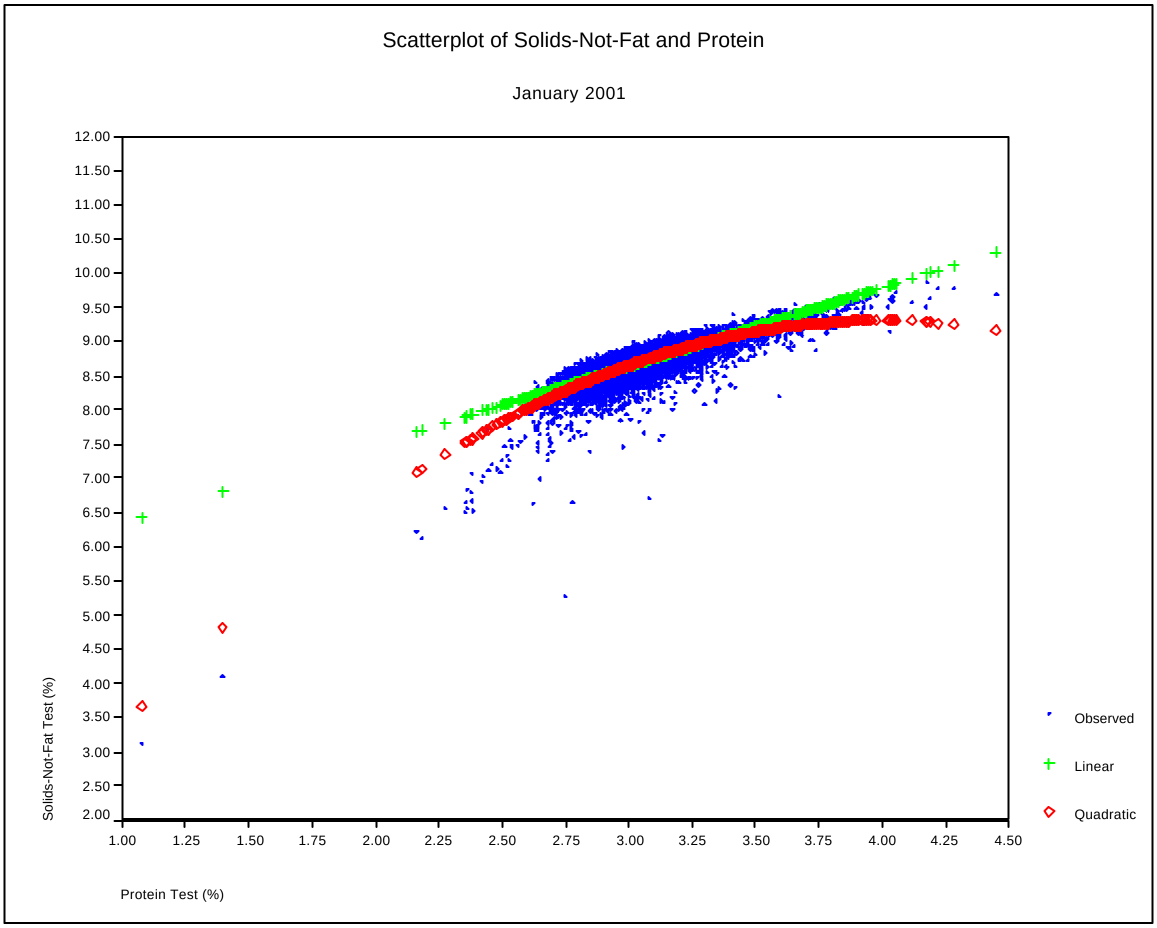
State	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
California	3.67	3.09	5.66	8.74	315
Illinois	3.71	3.01	5.68	8.69	335
Iowa	3.65	3.06	5.78	8.83	380
Michigan U.P.	3.69	3.03	5.72	8.73	294
Minnesota	3.70	3.01	5.72	8.73	394
North Dakota	3.64	3.01	5.73	8.74	332
South Dakota	3.73	3.02	5.73	8.75	404
Wisconsin	3.72	3.00	5.70	8.69	317
All Other States[1/]	3.62	3.07	5.74	8.81	273
Market	3.70	3.01	5.70	8.71	336
Minimum	3.62	3.00	5.66	8.69	273
Maximum	3.73	3.09	5.78	8.83	404

[1/] Includes producer milk from Idaho, Indiana, Kansas, Missouri, Montana, Nebraska, Ohio and Utah.

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 but also 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 2001 data were compared with results from previous Upper Midwest Order studies (1993-2001), 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 2001 data was within that range at 0.42925. 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 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 from 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. In fact, in many months the adjusted R-squared values of the quadratic models and the linear models were identical.

Table 5

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

Study (Region and Year)	**Equation**
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 2001 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 January to May 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 2001. The line represented by the + is the result of the linear model for January while the line represented by the ? is the result of the quadratic model for January. The equation for January, for the linear model is:

$$\text{Solids-not-fat Test} = 5.2053 + 1.1450 * \text{Protein Test},$$

while the equation for the quadratic model is:

$$\text{Solids-not-fat Test} = -1.2690 + (5.2940 * \text{Protein Test}) + (-0.6625 * (\text{Protein Test})^2).$$

The R-squared for the linear model is .641 while the R-squared for the quadratic model is .680. The quadratic model has a slightly better fit than the linear model and is concave upward.

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 (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 2001 data and those of Halverson/Kyburz (see Table 7). The primary observation from the equation derived for the 2001 data was that the constant of 1.47804 was lower than the equations from previous studies. The lower constant, in 2001, reflected the change in testing for true protein rather than crude protein. Otherwise, the b coefficient of 0.40962 was within the general range of slopes for the equations derived in previous studies.

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 (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 2001. The line represented by the + is the result of the linear model for January while the line represented by the ? is the result of the quadratic model for January. The equation for January, for the linear model is:

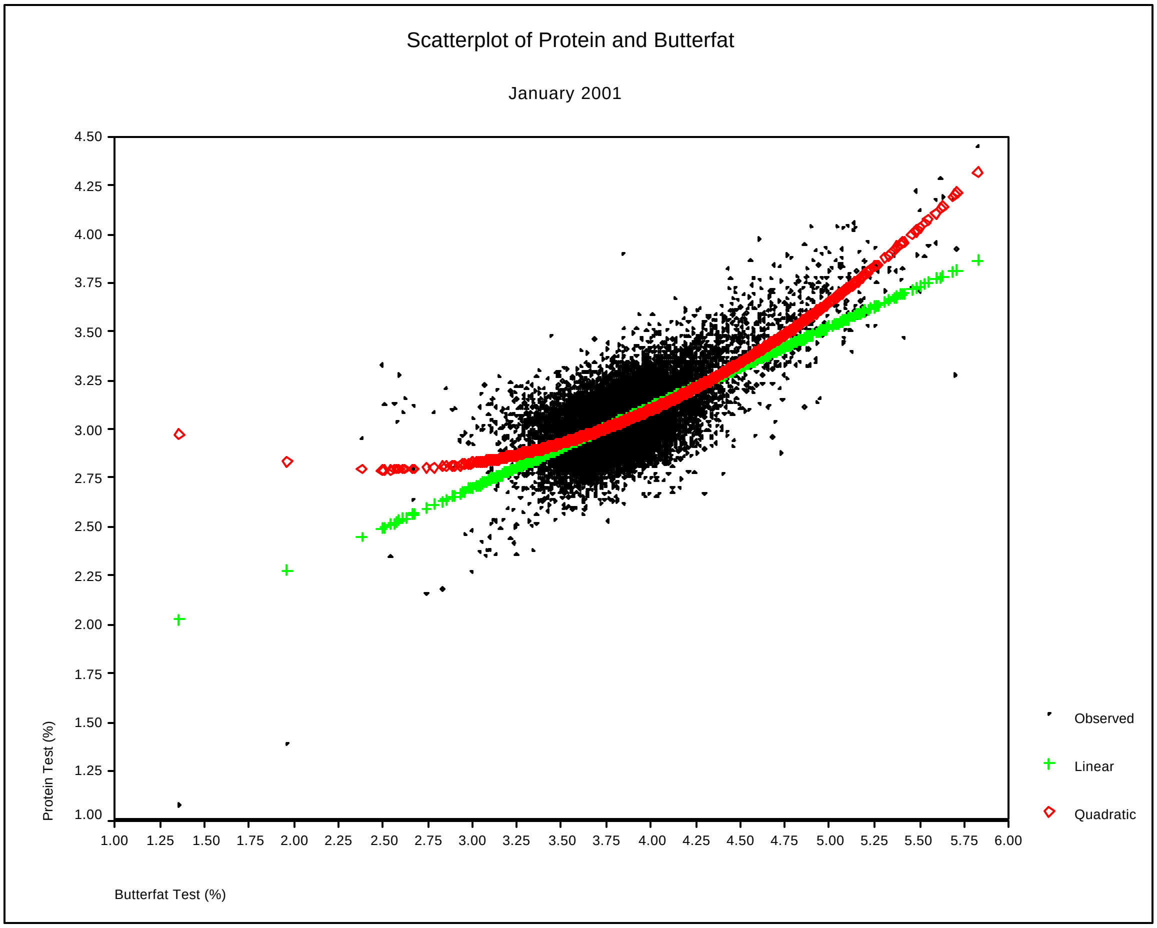
$$\textit{Protein Test} = 1.4669 + 0.4117 * \textit{Butterfat Test},$$

while the equation for the quadratic model is:

$$\textit{Protein Test} = 3.6650 + (-0.6942 * \textit{Butterfat Test}) + (0.1383 * (\textit{Butterfat Test})^2).$$

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 2001, has a slightly higher adjusted R-squared 0.460, versus 0.437 for the linear model, suggesting a slightly better fit. The remaining months of 2001 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 0.67 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 2001. 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 2001, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $13.53 per cwt. for the market. The value of each component comprised by the $13.53 per cwt. price was $6.83 for butterfat, $5.92 for protein, and $0.77 for other solids. The SCC adjustment for the year amounted to about .104¢ per cwt.

Categorized by size range of delivery, average values of producer milk ranged from a low of $13.47 per cwt. for monthly producer milk deliveries of between 100,000 and 150,000 to a high of $13.70 per cwt. for monthly producer milk deliveries of between 20,000 and 30,000 (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 mean and weighted average component levels in Part III of this paper.

VI. SUMMARY

This staff paper analyzes milk components and SCC in producer milk associated with the Upper Midwest Order during 2001. 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 2001 were: 3.70% butterfat, 3.01% protein, 5.70% other solids, 8.71% SNF and 336,000 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 May and lowest in January and exhibited less variation during the year relative to the three other components. Weighted average SCC were lowest in November and highest in August. Approximately three-quarters of monthly average component levels ranged from: 3.49% to 4.03% for butterfat; 2.85% to 3.19% for protein; 5.53% to 5.79% for other solids; 8.45% to 8.91% for SNF; and 184,000 to 572,000 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 44 percent of the milk. The monthly average pounds of milk marketed were 127,210 pounds, however almost 75 percent of the producers had average marketings below the market average.

Based on the data for 2001, the following regression equations were derived:

$$SNF = 7.06534\% + 0.42925\ (BF)$$
$$SNF = 5.38415\% + 1.09176\ (PRO)$$
$$PRO = 1.47804\% + 0.40962\ (BF)$$

Under MCP, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $13.53 per cwt. for the market. Butterfat contributed slightly more than half of the total value.

BIBLIOGRAPHY

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

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

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

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

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

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

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

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

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

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

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

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

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

SPSS Release 11.5. SPSS, Inc. 2002.

APPENDIX

TABLES

FIGURES

Table A-1

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

2001

Butterfat

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	3.80	3.85	0.26	3.83	1.36	5.83	21,193
February	3.78	3.84	0.25	3.82	1.62	5.69	20,944
March	3.76	3.83	0.25	3.81	1.58	5.66	21,094
April	3.73	3.80	0.25	3.78	1.59	5.46	20,779
May	3.65	3.71	0.24	3.70	1.89	5.35	20,598
June	3.61	3.66	0.23	3.65	2.10	5.34	20,509
July	3.55	3.56	0.22	3.55	1.79	5.19	20,409
August	3.55	3.56	0.23	3.55	1.70	5.57	20,548
September	3.66	3.72	0.24	3.71	1.67	5.75	20,697
October	3.77	3.85	0.26	3.84	2.10	5.68	20,689
November	3.80	3.87	0.26	3.85	2.39	5.87	20,614
December	3.81	3.86	0.27	3.84	1.99	6.16	20,565
For the Year	3.70	3.76	0.27	3.75	1.36	6.16	248,639

Protein

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	% -	- % -	- % -	
January	3.05	3.05	0.16	3.04	1.08	4.45	21,193
February	3.04	3.05	0.16	3.03	1.31	4.16	20,944
March	3.06	3.04	0.16	3.02	1.21	4.20	21,094
April	2.99	2.98	0.15	2.97	1.24	4.24	20,779
May	2.96	2.97	0.14	2.96	1.56	3.96	20,598
June	2.94	2.95	0.14	2.93	1.83	4.62	20,509
July	2.90	2.88	0.14	2.88	1.55	3.94	20,409
August	2.92	2.91	0.14	2.90	1.70	3.85	20,548
September	3.03	3.04	0.15	3.03	1.60	4.02	20,697
October	3.11	3.14	0.16	3.12	1.93	5.75	20,689
November	3.10	3.12	0.17	3.10	1.85	5.14	20,614
December	3.08	3.09	0.17	3.07	1.88	4.61	20,565
For the Year	3.01	3.02	0.17	3.00	1.08	5.75	248,639

Table A-1 (continued)

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

2001

Other Solids

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	5.69	5.65	0.14	5.67	2.05	5.99	21,193
February	5.70	5.66	0.14	5.68	2.59	6.29	20,944
March	5.67	5.66	0.13	5.68	2.63	6.02	21,094
April	5.72	5.69	0.12	5.71	2.75	6.10	20,779
May	5.73	5.71	0.12	5.72	3.32	6.74	20,598
June	5.70	5.68	0.12	5.69	3.73	6.94	20,509
July	5.71	5.67	0.13	5.69	2.35	6.31	20,409
August	5.69	5.64	0.14	5.66	3.60	6.09	20,548
September	5.70	5.65	0.14	5.67	2.95	7.46	20,697
October	5.69	5.65	0.14	5.67	3.65	6.02	20,689
November	5.69	5.64	0.14	5.66	3.41	6.36	20,614
December	5.69	5.65	0.14	5.67	2.79	6.53	20,565
For the Year	5.70	5.66	0.13	5.68	2.05	7.46	248,639

Solids-Not-Fat

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	
January	8.73	8.70	0.23	8.71	3.12	9.86	21,193
February	8.74	8.71	0.23	8.72	3.92	9.85	20,944
March	8.73	8.70	0.22	8.71	3.84	9.80	21,094
April	8.71	8.67	0.21	8.69	3.99	9.69	20,779
May	8.70	8.68	0.20	8.69	4.88	9.82	20,598
June	8.65	8.62	0.20	8.63	5.56	10.60	20,509
July	8.61	8.55	0.21	8.57	4.92	9.75	20,409
August	8.62	8.55	0.22	8.57	5.36	9.57	20,548
September	8.73	8.69	0.22	8.70	4.87	10.55	20,697
October	8.80	8.78	0.22	8.79	5.58	9.98	20,689
November	8.78	8.76	0.23	8.76	5.26	10.86	20,614
December	8.77	8.73	0.23	8.74	5.41	10.02	20,565
For the Year	8.71	8.68	0.23	8.69	3.12	10.86	248,639

Table A-1 (continued)

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

2001

Somatic Cell Count

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	---------- (1,000) ----------						
January	328	362	197	319	0	1,486	21,193
February	321	354	192	315	0	1,480	20,944
March	325	355	187	317	0	1,500	21,094
April	323	361	187	326	0	1,500	20,779
May	326	368	184	334	0	2,321	20,598
June	341	387	199	352	2	7,822	20,509
July	371	421	204	385	0	4,064	20,409
August	390	449	210	419	0	3,707	20,548
September	360	402	189	372	11	2,503	20,697
October	318	364	180	333	0	2,824	20,689
November	306	350	182	315	16	6,657	20,614
December	319	364	188	328	0	3,352	20,565
For the Year	336	378	194	342	0	7,822	248,639

Table A-2

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE 2001

Butterfat

	California	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.81	3.84	3.73	3.84	3.77	3.70	3.81	3.81	3.51	3.80
February	3.79	3.80	3.71	3.86	3.75	3.69	3.80	3.80	3.47	3.78
March	3.70	3.79	3.71	3.84	3.74	3.72	3.78	3.79	3.35	3.76
April	3.65	3.74	3.67	3.77	3.71	3.68	3.74	3.76	3.54	3.73
May	3.58	3.61	3.57	3.57	3.63	3.56	3.66	3.68	3.51	3.65
June	3.55	3.57	3.53	3.63	3.62	3.51	3.62	3.63	3.51	3.61
July	3.55	3.52	3.49	3.52	3.54	3.45	3.56	3.55	3.51	3.55
August	3.58	3.51	3.51	3.52	3.55	3.47	3.58	3.54	3.51	3.55
September	3.62	3.68	3.60	3.69	3.67	3.58	3.69	3.67	3.58	3.66
October	3.68	3.81	3.75	3.86	3.79	3.75	3.81	3.80	3.69	3.77
November	3.78	3.84	3.76	3.89	3.80	3.77	3.83	3.81	3.75	3.80
December	3.84	3.82	3.75	3.90	3.79	3.81	3.85	3.80	3.80	3.81
For the Year	3.67	3.71	3.65	3.69	3.70	3.64	3.73	3.72	3.62	3.70

Protein

	California	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	3.13	3.07	3.11	3.06	3.05	3.06	3.08	3.03	3.04	3.05
February	3.09	3.05	3.11	3.08	3.05	3.06	3.07	3.03	3.08	3.04
March	3.24	3.03	3.10	3.05	3.03	3.04	3.07	3.02	3.05	3.06
April	3.06	2.97	3.04	3.00	2.98	2.98	3.00	2.97	3.07	2.99
May	3.01	2.96	3.00	3.00	2.96	2.93	2.96	2.95	3.01	2.96
June	3.00	2.93	2.98	2.95	2.94	2.93	2.94	2.92	3.02	2.94
July	3.00	2.84	2.92	2.91	2.89	2.89	2.88	2.87	2.99	2.90
August	3.02	2.89	2.94	2.93	2.91	2.90	2.90	2.90	3.04	2.92
September	3.07	3.04	3.07	3.06	3.03	3.02	3.03	3.01	3.03	3.03
October	3.13	3.13	3.16	3.13	3.11	3.11	3.12	3.10	3.13	3.11
November	3.15	3.12	3.14	3.15	3.09	3.10	3.11	3.08	3.14	3.10
December	3.18	3.08	3.11	3.11	3.07	3.08	3.09	3.05	3.14	3.08
For the Year	3.09	3.01	3.06	3.03	3.01	3.01	3.02	3.00	3.07	3.01

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE 2001

Other Solids

	California	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	5.69	5.64	5.78	5.65	5.72	5.73	5.74	5.67	5.62	5.69
February	5.71	5.66	5.78	5.93	5.73	5.74	5.75	5.68	5.72	5.70
March	5.50	5.66	5.77	5.67	5.72	5.73	5.74	5.69	5.74	5.67
April	5.69	5.69	5.79	5.70	5.75	5.74	5.75	5.72	5.69	5.72
May	5.68	5.73	5.81	5.73	5.74	5.75	5.76	5.74	5.76	5.73
June	5.67	5.69	5.80	5.72	5.72	5.76	5.75	5.71	5.62	5.70
July	5.67	5.72	5.77	5.74	5.70	5.71	5.71	5.72	5.74	5.71
August	5.67	5.68	5.74	5.73	5.67	5.70	5.68	5.70	5.79	5.69
September	5.67	5.68	5.77	5.71	5.70	5.71	5.71	5.70	5.72	5.70
October	5.65	5.68	5.77	5.70	5.70	5.74	5.70	5.69	5.75	5.69
November	5.66	5.64	5.76	5.67	5.71	5.74	5.71	5.68	5.76	5.69
December	5.65	5.66	5.78	5.67	5.72	5.75	5.73	5.68	5.77	5.69
For the Year	5.66	5.68	5.78	5.72	5.72	5.73	5.73	5.70	5.74	5.70

Solids-Not-Fat

	California	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	8.81	8.71	8.89	8.71	8.77	8.79	8.82	8.70	8.67	8.73
February	8.80	8.71	8.89	8.73	8.78	8.80	8.82	8.71	8.80	8.74
March	8.75	8.69	8.88	8.72	8.76	8.77	8.80	8.70	8.79	8.73
April	8.75	8.66	8.83	8.71	8.73	8.72	8.76	8.69	8.76	8.71
May	8.69	8.69	8.81	8.74	8.70	8.68	8.72	8.69	8.77	8.70
June	8.67	8.62	8.78	8.67	8.66	8.69	8.68	8.63	8.64	8.65
July	8.67	8.56	8.69	8.65	8.59	8.59	8.58	8.59	8.73	8.61
August	8.69	8.58	8.69	8.65	8.58	8.61	8.58	8.59	8.83	8.62
September	8.74	8.71	8.84	8.77	8.73	8.73	8.74	8.71	8.75	8.73
October	8.78	8.81	8.93	8.83	8.81	8.85	8.82	8.79	8.88	8.80
November	8.81	8.76	8.90	8.82	8.80	8.83	8.83	8.76	8.90	8.78
December	8.83	8.74	8.89	8.78	8.79	8.83	8.82	8.73	8.91	8.77
For the Year	8.74	8.69	8.83	8.73	8.73	8.74	8.75	8.69	8.81	8.71

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE
2001

Somatic Cell Counts

	California	Illinois	Iowa	Michigan U.P.	Minnesota	N. Dakota	S. Dakota	Wisconsin	All Other States	Market
	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -	- % -
January	303	336	376	332	382	345	401	304	240	328
February	332	331	367	324	378	337	390	291	242	321
March	367	330	376	328	368	325	392	293	233	325
April	325	326	386	337	375	331	394	298	287	323
May	320	319	380	228	386	325	394	309	206	326
June	321	328	393	324	407	339	415	321	284	341
July	342	364	409	372	437	367	465	353	290	371
August	308	398	451	365	462	380	470	388	291	390
September	327	358	403	313	425	338	430	348	265	360
October	256	314	350	303	385	305	380	310	265	318
November	268	301	333	296	363	295	353	294	269	306
December	304	314	339	299	371	307	366	302	306	319
For the Year	315	335	380	294	394	332	404	317	273	336

Table A-3

LINEAR RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2001

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)	7.06534	.00547	1,291.390	.260
Butterfat (b)	.42925	.00145	295.762	
SNF = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	7.1542	.006	1,157.354	.278
Butterfat (b)	.4014	.002	255.794	
February	.0121	.002	6.381	
March	.0039	.002	2.057	
April	-.0039	.002	-2.028	
May	.0354	.002	18.459	
June	.0005	.002	.237	
July	-.0296	.002	-15.112	
August	-.0291	.002	-14.860	
September	.0460	.002	24.047	
October	.0808	.002	42.525	
November	.0470	.002	24.689	
December	.0282	.002	14.821	

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)	5.38415	.00475	1132.582	.660
Protein (b)	1.09176	.00157	694.245	
SNF = c + b(PRO) + m(February) + . . . + m(December)				
Constant (c)	5.2043	.005	977.212	.672
Protein (b)	1.1453	.002	665.574	
February	.0127	.001	9.923	
March	.0126	.001	9.916	
April	.0535	.001	54.240	
May	.0699	.001	41.659	
June	.0442	.001	34.125	
July	.0455	.001	34.540	
August	.0148	.001	11.341	
September	.0026	.001	2.019	
October	-.0133	.001	-10.330	
November	-.0172	.001	-13.360	
December	-.0053	.001	-4.164	

Table A-3 (continued)

LINEAR RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2001

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)	1.47804	.00358	413.041	.428
Butterfat (b)	.40962	.00095	431.516	
PRO = c + b(BF) + m(February) + . . . + m(December)				
Constant (c)	1.6311	.004	420.174	.485
Butterfat (b)	.3690	.001	374.483	
February	-.0004	.001	-.304	
March	-.0074	.001	-6.196	
April	-.0492	.001	-41.234	
May	-.0277	.001	-23.023	
June	-.0347	.001	-28.691	
July	-.0603	.001	-48.944	
August	-.0330	.001	-26.861	
September	.0403	.001	33.536	
October	.0821	.001	68.758	
November	.0555	.001	46.470	
December	.0290	.001	24.246	

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2001

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	5.2053	1.1450	.0059	.6407	.1381
February	5.1522	1.1666	.0058	.6584	.1326
March	5.2423	1.1369	.0056	.6577	.1298
April	5.1084	1.1954	.0055	.6917	.1192
May	5.2018	1.1697	.0057	.6705	.1167
June	5.0949	1.1974	.0057	.6841	.1147
July	4.9085	1.2636	.0062	.6727	.1223
August	4.8798	1.2618	.0067	.6343	.1323
September	5.2325	1.1369	.0065	.5997	.1366
October	5.5462	1.0320	.0060	.5881	.1412
November	5.4345	1.0659	.0059	.6092	.1409
December	5.4287	1.0708	.0058	.6206	.1392

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	-1.2690	5.2940	.0810	-.6625	.0129	.6805	.1302
February	-2.2423	5.9244	.0850	-.7629	.0136	.7029	.1236
March	-1.7641	5.6585	.0857	-.7272	.0138	.6977	.1220
April	-1.3805	5.4779	.0858	-.7046	.0141	.7248	.1127
May	-1.2703	5.4471	.0970	-.7049	.0160	.6990	.1116
June	-0.1613	4.6923	.0983	-.5794	.0163	.7025	.1113
July	-2.1106	6.0553	.1082	-.8157	.0184	.7014	.1168
August	-3.0146	6.5980	.1174	-.8995	.0198	.6677	.1261
September	-2.0971	5.8650	.1083	-.7605	.0174	.6335	.1307
October	0.8145	3.9622	.0761	-.4520	.0117	.6157	.1364
November	0.6455	4.0610	.0890	-.4666	.0138	.6296	.1372
December	-0.6270	4.8910	.0939	-.6003	.0147	.6490	.1339

Table A-3 (continued)

RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

2001

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	1.4669	.4117	.0032	.4370	.1209
February	1.5035	.4022	.0033	.4216	.1200
March	1.5882	.3783	.0034	.3661	.1260
April	1.6397	.3538	.0034	.3419	.1212
May	1.7937	.3177	.0035	.2912	.1198
June	1.7806	.3187	.0036	.2811	.1195
July	1.6043	.3596	.0036	.3320	.1134
August	1.7809	.3177	.0036	.2750	.1176
September	1.7717	.3420	.0034	.3221	.1211
October	1.6633	.3820	.0034	.3743	.1293
November	1.5528	.4035	.0033	.4172	.1260
December	1.5311	.4024	.0033	.4202	.1266

Butterfat Levels as a Predictor of Protein Levels

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

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	3.6650	-.6942	.0373	.1383	.0047	.4596	.1184
February	3.6946	-.7049	.0400	.1391	.0050	.4422	.1178
March	3.9947	-.8438	.0427	.1544	.0054	.3899	.1236
April	4.1033	-.9125	.0426	.1619	.0054	.3689	.1187
May	5.0079	-1.3776	.0426	.2225	.0056	.3422	.1154
June	5.0948	-1.4544	.0457	.2361	.0061	.3305	.1153
July	4.3213	-1.1405	.0474	.2062	.0065	.3633	.1107
August	4.4355	-1.1514	.0430	.2024	.0059	.3141	.1143
September	4.4914	-1.0900	.0396	.1876	.0052	.3626	.1174
October	4.7886	-1.1951	.0415	.1979	.0052	.4153	.1250
November	4.3815	-1.0114	.0410	.1759	.0051	.4492	.1225
December	4.3880	-1.0274	.0381	.1778	.0047	.4576	.1225

Table A-4

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

2001

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	($/Pound)			($/cwt. Per 1,000 SCC)
January	$1.2896	$1.6181	$0.1120	$0.00056
February	1.4626	1.4951	0.1199	0.00057
March	1.6820	1.6498	0.1039	0.00064
April	1.9483	1.5443	0.1081	0.00067
May	2.1191	1.9108	0.1229	0.00076
June	2.2089	2.1670	0.1409	0.00081
July	2.1883	2.3175	0.1510	0.00083
August	2.2976	2.2188	0.1535	0.00083
September	2.4449	2.1647	0.1520	0.00085
October	1.6526	2.6664	0.1482	0.00078
November	1.4500	1.8045	0.1470	0.00062
December	1.4322	1.9782	0.1517	0.00064
Simple Average	$1.8480	$1.9613	$0.1343	$0.00071

Table A-5

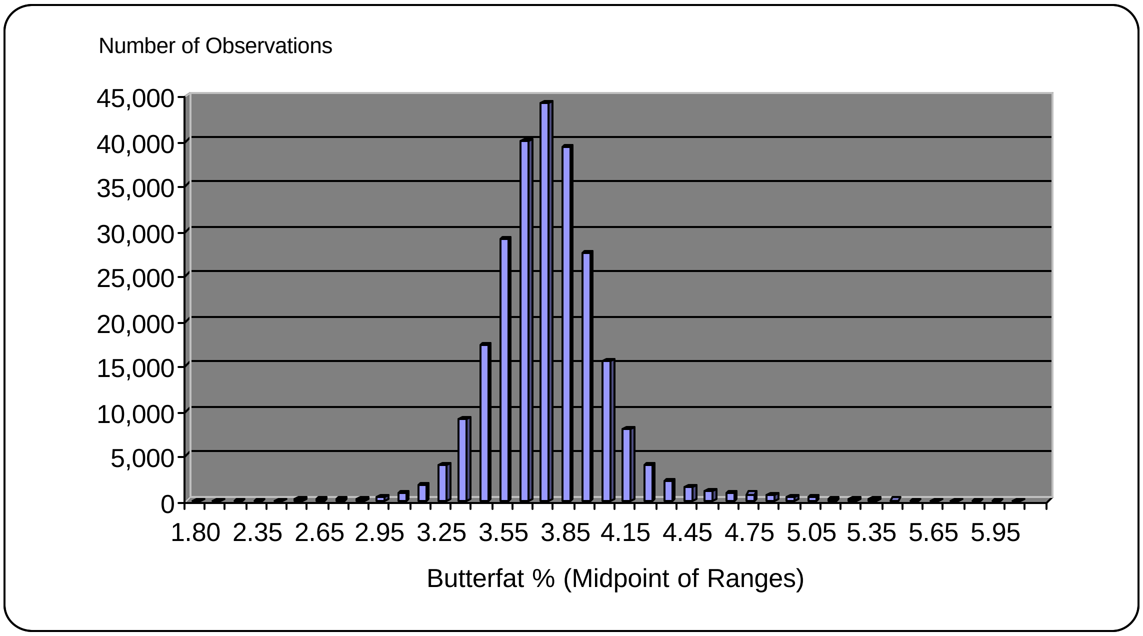
AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

2001

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	$20,696,061.96	151,273,562	$13.68
20,000	30,000	50,629,816.57	369,692,051	13.70
30,000	50,000	230,548,324.64	1,690,264,171	13.64
50,000	70,000	365,981,107.85	2,698,087,378	13.56
70,000	100,000	581,483,679.09	4,307,040,924	13.50
100,000	150,000	660,836,748.47	4,907,745,787	13.47
150,000	250,000	589,108,256.13	4,367,258,071	13.49
250,000	400,000	364,608,924.01	2,696,711,380	13.52
400,000		1,625,674,676.29	12,004,413,282	13.54
Total		$4,489,567,595.00	33,192,486,606	
Weighted Average				$13.53

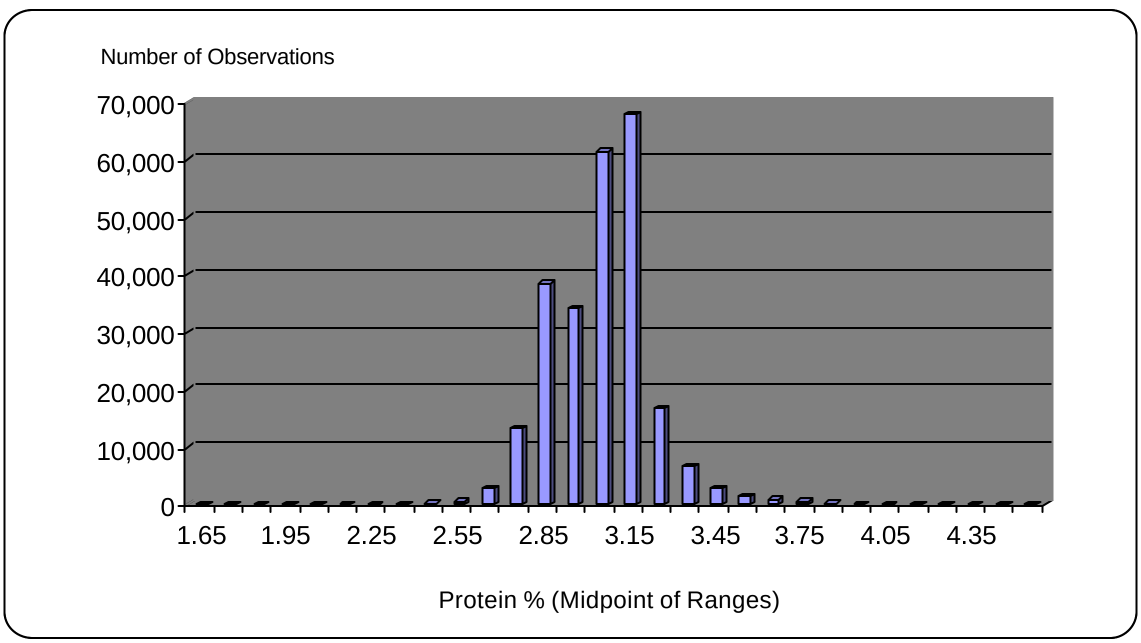
* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

Figure A-1
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE BUTTERFAT LEVELS, 2001



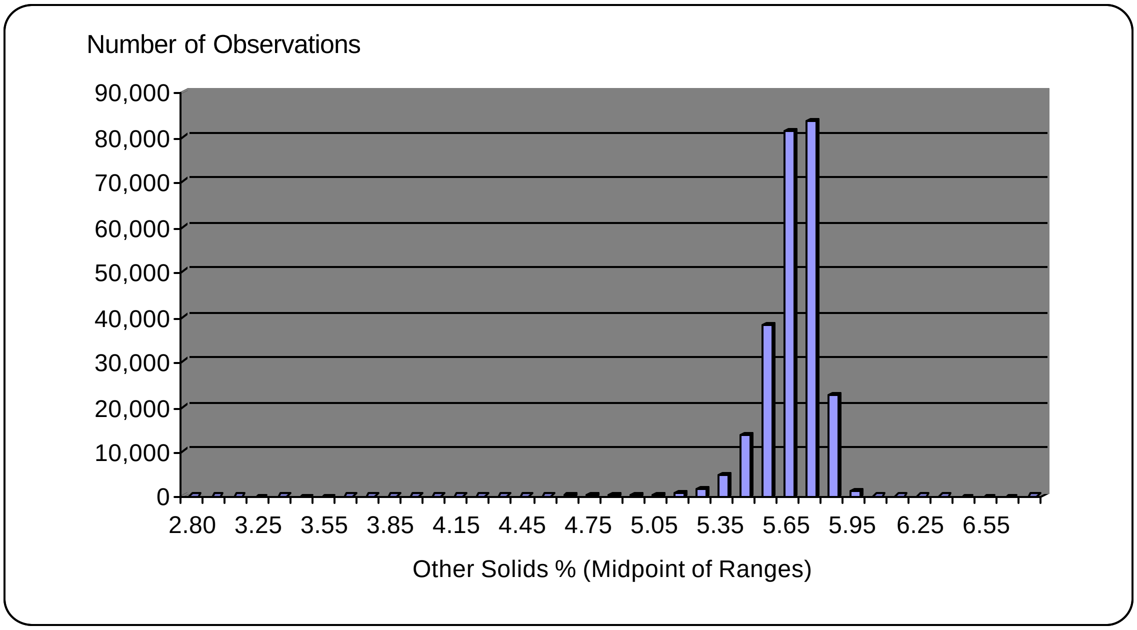
Skewness statistic: 0.799
Kurtosis statistic: 4.017

Figure A-2
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE PROTEIN LEVELS, 2001



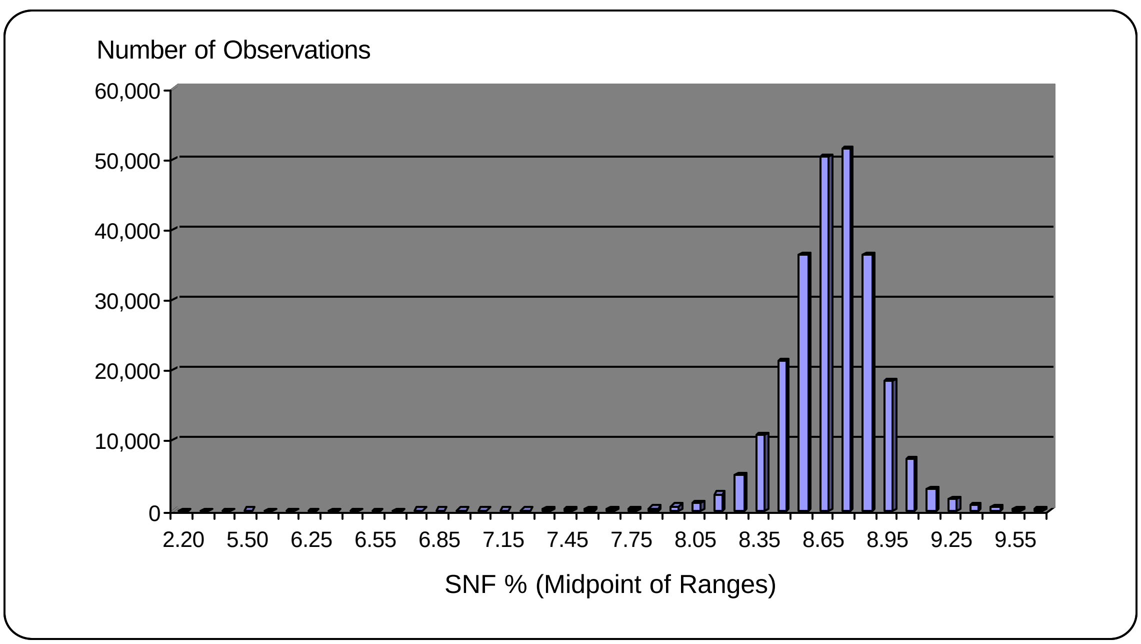
Skewness statistic: 0.822
Kurtosis statistic: 3.911

Figure A-3
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE OTHER SOLIDS LEVELS, 2001



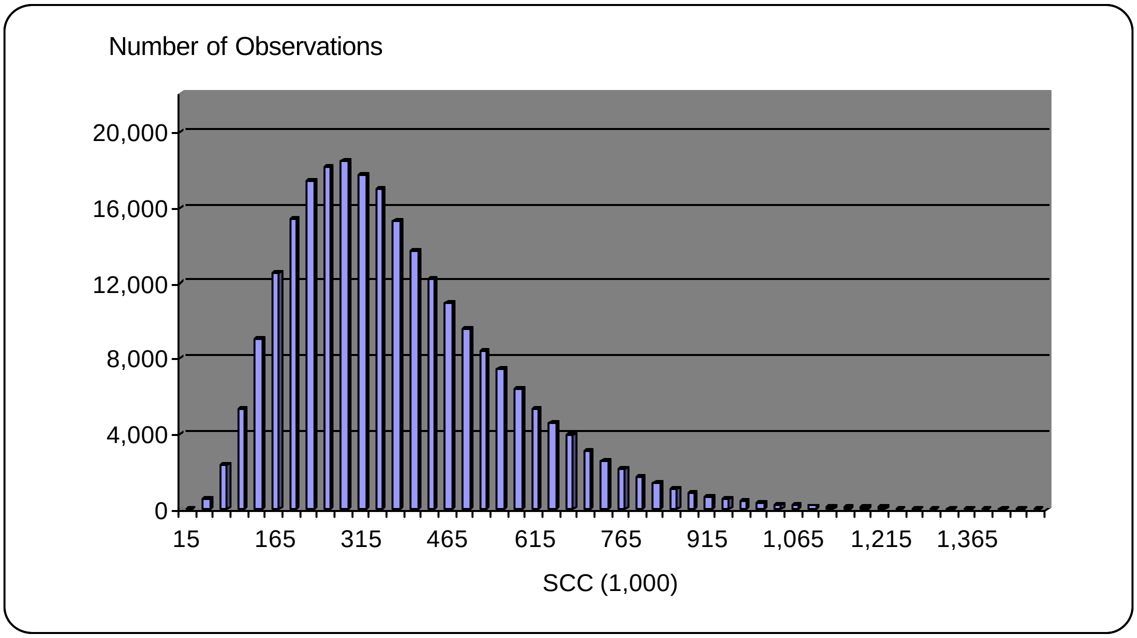
Skewness statistic: -2.941
Kurtosis statistic: 31.009

Figure A-4
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS, 2001



Skewness statistic: -1.261
Kurtosis statistic: 15.506

Figure A-5
FREQUENCY DISTRIBUTION OF
MONTHLY AVERAGE SOMATIC CELL COUNT, 2001



Skewness statistic: 1.705
Kurtosis statistic: 17.978