**UPPER MIDWEST MARKETING AREA**

# ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL 2000

Staff Paper 01-02

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

**2000**

Rodney M. Sebastian

## 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 newly merged Upper Midwest Order during 2000. 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.

The value of milk pooled on the former Chicago Regional and Upper Midwest Orders had been determined on the basis of multiple component pricing (MCP) since 1996. In this study, component prices from 2000 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 2000 were 3.73% butterfat, 3.00% protein, 5.70% other solids, 8.70% SNF and 332,000 SCC.

2) For 2000, 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) In 2000, the range of monthly average component levels within one standard deviation of the mean was: 3.50% to 4.04% for butterfat; 2.85% to 3.17% for protein; 5.54% to 5.80% for other solids; 8.47% to 8.89% for SNF; and 184,000 to 544,000 for SCC.

4) Based on the data for 2000, the following regression equations were derived:

$$SNF = 7.22\% + 0.3882\ (BF)$$
$$SNF = 5.43\% + 1.0789\ (PRO)$$
$$PRO = 1.55\% + 0.3883\ (BF)$$

5) The annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $10.04 per cwt. for the market in 2000. Protein was the most valuable component, contributing a little more than half of the total value.

## TABLE OF CONTENTS

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

## 2000

Rodney M. Sebastian[1]

## I. INTRODUCTION

The data for this study were collected for milk marketed in 2000 from producers associated with the newly merged 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 MCP plan implemented, producer milk is priced on 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, Rodney M. Sebastian, 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 2000 reflect the change from crude protein to true protein testing methods. 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 for producers associated with the Upper Midwest Order. The data include pooled producer milk and milk associated with the order but not pooled in some months because of price relationships between classes and other Federal marketing orders. 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 marketings, 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 which 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 six primary states that are at least partially within the milk procurement area of the Upper Midwest Order. 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.

Ordinary Least Square (OLS) regression analysis was used to determine the relationship between individual components, for example, butterfat vs. SNF, butterfat vs. protein and protein vs. SNF.

The cumulative value of butterfat, protein and other solids, adjusted for SCC, on an annual per cwt. basis was examined to observe how milk values varied under differing constraints. Monthly Federal order component prices that apply to the Upper Midwest Order were used to calculate milk values for this study.

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

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

Seasonal changes in component levels for 2000 appeared to be relatively "normal". Beginning in January, component levels, with the exception of other solids, tapered off during the spring to low points in July, then rose to peak levels at some time in the late fall or winter. 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 2000 are summarized in Table 1 and miscellaneous annual statistics, in addition to weighted averages, are summarized in Table 2.

During the year, butterfat levels dropped from 3.82% in January to 3.58% in July, then rose to 3.85% by December. Protein and SNF showed similar seasonal patterns during the year by bottoming out in the summer and peaking by year end. The range of variation for butterfat, protein and SNF was 0.27, 0.18 and 0.15 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 June to a low of 5.67% in January. The seasonal high SCC of 379,000 was reached in August before dropping to 306,000 in November, a change of 73,000 during the year.

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 2000, the simple average SCC (364,000) was higher than the weighted average (332,000) indicating that larger producers tended to have, on average, lower SCC than their smaller counterparts. Moreover, the median SCC level (330,000) 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]

[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 1.115. 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 1**

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

**2000**

| Month | Butterfat | Protein | Other Solids | Solids-Not-Fat | Somatic Cell Count |
|---|---|---|---|---|---|
| | - % - | - % - | - % - | - % - | - 1,000 - |
| January | 3.82 | 3.05 | 5.67 | 8.71 | 306 |
| February | 3.79 | 3.02 | 5.68 | 8.70 | 316 |
| March | 3.76 | 3.00 | 5.71 | 8.71 | 326 |
| April | 3.76 | 2.99 | 5.72 | 8.71 | 320 |
| May | 3.67 | 2.95 | 5.73 | 8.69 | 328 |
| June | 3.64 | 2.95 | 5.74 | 8.69 | 350 |
| July | 3.58 | 2.91 | 5.72 | 8.63 | 374 |
| August | 3.59 | 2.92 | 5.69 | 8.62 | 379 |
| September | 3.67 | 3.00 | 5.69 | 8.69 | 356 |
| October | 3.77 | 3.06 | 5.69 | 8.75 | 316 |
| November | 3.82 | 3.07 | 5.70 | 8.77 | 306 |
| December | 3.85 | 3.08 | 5.68 | 8.76 | 307 |
| Minimum | 3.58 | 2.91 | 5.67 | 8.62 | 306 |
| Maximum | 3.85 | 3.08 | 5.74 | 8.77 | 379 |
| Annual Average | 3.73 | 3.00 | 5.70 | 8.70 | 332 |

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 1.73% and as high as 6.11%; protein levels ranged from 1.53% to 4.38%; other solids levels ranged from 2.80% to 6.39%; SNF levels ranged from 4.50% to 10.05%; and SCC ranged from 2,000 to 1,500,000.

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: 3.50% to 4.04% for butterfat; 2.85% to 3.17% for protein; 5.54% to 5.80% for other solids; 8.47% to 8.89% for SNF; and 184,000 to 544,000 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.

2000 data were within these ranges[7] (see also Appendix Table A-2 and Appendix Figures A-1 through A-5).

**Table 2**

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

**2000**

| Month | Weighted Average - % - | Simple Average - % - | Standard Deviation - % - | Median - % - | Minimum - % - | Maximum - % - |
|---|---|---|---|---|---|---|
| Butterfat | 3.73 | 3.77 | 0.27 | 3.78 | 1.73 | 6.11 |
| Protein | 3.00 | 3.01 | 0.16 | 3.00 | 1.53 | 4.38 |
| Other Solids | 5.70 | 5.67 | 0.13 | 5.67 | 2.80 | 6.39 |
| SNF | 8.70 | 8.68 | 0.21 | 8.69 | 4.50 | 10.05 |
| SCC (1,000's) | 332 | 364 | 180 | 330 | 2 | 1,500 |

**Variations in Milk Component Levels and Somatic Cell Counts Within the Marketing Area**

Milk component levels and SCC were examined for the six primary states in the procurement area for milk associated with the Upper Midwest Order during 2000. Differences in average component levels and SCC between the states were observed, however, those differences were not found to be statistically significant (see Table 3). Wisconsin had the highest average butterfat, while Iowa had the highest protein, other solids and SNF levels for the procurement area. Average SCC were lowest in Iowa, Illinois and Wisconsin and highest in Minnesota and South Dakota. Detailed state information by month for 2000 is presented in Table A-2 (see Appendix).

[7] The percentage of observations within one standard deviation of the mean in the 2000 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.

**Table 3**

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

**2000**

| State | Butterfat | Protein | Other Solids | Solids-Not-Fat | Somatic Cell Count |
|---|---|---|---|---|---|
| | - % - | - % - | - % - | - % - | - 1,000 - |
| Illinois | 3.72 | 3.01 | 5.70 | 8.71 | 318 |
| Iowa | 3.70 | 3.05 | 5.77 | 8.82 | 315 |
| Minnesota[1/] | 3.71 | 3.01 | 5.73 | 8.73 | 370 |
| North Dakota[2/] | 3.65 | 3.00 | 5.76 | 8.76 | 324 |
| South Dakota | 3.73 | 3.03 | 5.73 | 8.76 | 373 |
| Wisconsin[3/] | 3.74 | 3.00 | 5.69 | 8.68 | 316 |
| Market | 3.73 | 3.00 | 5.70 | 8.70 | 332 |
| Minimum | 3.65 | 3.00 | 5.69 | 8.68 | 315 |
| Maximum | 3.74 | 3.05 | 5.77 | 8.82 | 373 |

[1/] Includes producer milk from California.
[2/] Includes producer milk from Montana.
[3/] Includes producer milk from the Michigan Upper Peninsula.

## IV. STATISTICAL RELATIONSHIPS AMONG MILK COMPONENTS

Regression analysis was used to estimate the linear relationship between components. Results from the 2000 data were compared with results from previous Upper Midwest Order studies (1993-2000), 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:

$$Component\ A = c + b(Component\ B) + m(February) + \ldots + m(December) + e$$

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).

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 variation 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 4, 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 eleven 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 2000 data was within that range at 0.3882. No attempt was made to identify possible causes for the change in the butterfat coefficient.

The monthly regression equations generally performed as expected: all parameters were statistically significant and of the expected sign. The relationship between SNF and butterfat varied from month-to-month with respect to how the constants (c) for the equations varied inversely with the butterfat coefficients (b). As is shown in Table A-3 (see Appendix), the constant of the regression equations ranged from approximately 7.10 to 7.39 while the butterfat coefficient ranged from 0.35 to 0.41 during the year (see also Appendix Figure A-6).

**Table 4**

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

| Study (Region and Year) | Equation |
|---|---|
| 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 5). The 2000 results were not appreciably different from the results for previous years. Considering the change from crude protein to true protein testing methods, the slope of the equation was similar to those derived in previous studies while the higher constant was the primary difference.

Estimates for the relationship between protein and SNF on a monthly basis are presented in Table A-3 (see Appendix). Generally, these monthly regressions performed as expected, all parameters were statistically significant and of the expected sign. The R-squared statistics for the monthly regressions ranged from 0.63 to 0.71 and were very similar to those derived from monthly data in previous years. The regressions appeared to cycle through a seasonal pattern where the slope of the equation and the protein coefficient increased during the summer months, then returned to levels similar to those observed in early 2000. (See also Appendix Figure A-7).

**Table 5**

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

| Study (Region and Year) | Equation |
|---|---|
| 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 2000 data and those of Halverson/Kyburz (see Table 6). The primary observation from the equation derived for the 2000 data was that the constant of 1.55 was lower than the equations from previous studies. The lower constant reflects the change in testing for true protein rather than crude protein. Otherwise, the b coefficient of 0.3883 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 regressions were statistically significant and of the expected sign. The R-squared statistics for the monthly regressions ranged from 0.29 to 0.44, similar to those in the 1993 through 2000 studies. The equations showed seasonality with the constant and the butterfat coefficient varying inversely, i.e., when the constant rose, the butterfat coefficient fell, and vice versa. The constant in the monthly regressions rose from approximately 1.49 in February to 1.82 in May, and then fell back to 1.52 by December. The butterfat coefficient declined from approximately 0.40 in February to 0.31 in May, and then rose back to 0.40 by December. The pattern of change

observed in butterfat coefficients was similar to the variation of the R-squared statistics for the monthly regressions. These results indicate that butterfat levels explain less of the variability in protein levels during the summer months than in the winter (see also Appendix Figure A-8).

**Table 6**

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

| Study (Region and Year) | Equation |
|---|---|
| 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) |

**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.

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

[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.

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 component prices applied to producer milk associated with the Upper Midwest Order during 2000. 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 2000, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $10.04 per cwt. for the market. The value of each component comprised by the $10.04 per cwt. price was $4.66 for butterfat, $5.08 for protein, and $0.29 for other solids. The SCC adjustment for the year amounted to about +$2.7 million, or +1.4¢ per cwt., from aggregated component values of $1.5 billion.

Categorized by size range of delivery, average values of producer milk ranged from a low of $9.91 per cwt. for monthly producer milk deliveries of more than 400,000 pounds to a high of $10.33 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 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 2000. 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 2000 were: 3.73% butterfat, 3.00% protein, 5.70% other solids, 8.70% SNF and 332,000 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 January and November and highest in August. Approximately three-quarters of monthly average component levels ranged from: 3.50% to 4.04% for butterfat; 2.85% to 3.17% for protein; 5.54% to 5.80% for other solids; 8.47% to 8.89% for SNF; and 184,000 to 544,000 for SCC.

Based on the data for 2000, the following regression equations were derived:

$$SNF = 7.22\% + 0.3882\ (BF)$$
$$SNF = 5.43\% + 1.0789\ (PRO)$$
$$PRO = 1.55\% + 0.3883\ (BF)$$

Seasonality was present in comparisons made between the coefficients of most of the monthly regression equations. In comparisons with previous studies, small differences were observed between the estimates based on the 2000 data and those from previous Upper Midwest studies, Halverson/Kyburz, Jacobson and Jack et al.

Under MCP, the annual weighted average value of butterfat, protein, and other solids, adjusted for SCC, was $10.04 per cwt. for the market. Protein contributed slightly more than half of the total value.

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# APPENDIX

## TABLES



## FIGURES

**Table A-1**

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

**2000**

**Butterfat**

| Month | Weighted Average - % - | Mean - % - | Standard Deviation - % - | Median - % - | Minimum - % - | Maximum - % - | Number of Observations |
|---|---|---|---|---|---|---|---|
| January | 3.82 | 3.86 | 0.26 | 3.84 | 2.09 | 5.74 | 23,490 |
| February | 3.79 | 3.84 | 0.25 | 3.82 | 2.04 | 5.78 | 23,557 |
| March | 3.76 | 3.81 | 0.24 | 3.80 | 1.88 | 5.82 | 23,254 |
| April | 3.76 | 3.81 | 0.24 | 3.79 | 1.86 | 5.67 | 23,133 |
| May | 3.67 | 3.71 | 0.25 | 3.70 | 2.07 | 5.43 | 22,556 |
| June | 3.64 | 3.67 | 0.24 | 3.66 | 1.85 | 5.78 | 22,199 |
| July | 3.58 | 3.60 | 0.23 | 3.59 | 1.73 | 5.31 | 22,301 |
| August | 3.59 | 3.61 | 0.23 | 3.60 | 1.74 | 5.28 | 21,908 |
| September | 3.67 | 3.71 | 0.24 | 3.70 | 1.88 | 5.58 | 22,192 |
| October | 3.77 | 3.82 | 0.25 | 3.80 | 2.08 | 5.77 | 21,601 |
| November | 3.82 | 3.89 | 0.27 | 3.87 | 2.12 | 6.11 | 21,858 |
| December | 3.85 | 3.91 | 0.27 | 3.88 | 2.24 | 6.09 | 21,367 |
| For the Year | 3.73 | 3.77 | 0.27 | 3.76 | 1.73 | 6.11 | 269,416 |

**Protein**

| Month | Weighted Average - % - | Mean - % - | Standard Deviation - % - | Median % - | Minimum - % - | Maximum - % - | Number of Observations |
|---|---|---|---|---|---|---|---|
| January | 3.05 | 3.06 | 0.16 | 3.05 | 1.65 | 4.22 | 23,489 |
| February | 3.02 | 3.04 | 0.16 | 3.02 | 1.83 | 4.22 | 23,533 |
| March | 3.00 | 3.01 | 0.15 | 3.00 | 1.84 | 4.22 | 23,253 |
| April | 2.99 | 3.00 | 0.15 | 2.99 | 1.58 | 4.20 | 23,132 |
| May | 2.95 | 2.97 | 0.14 | 2.96 | 2.09 | 4.00 | 22,556 |
| June | 2.95 | 2.96 | 0.14 | 2.95 | 1.69 | 3.89 | 22,198 |
| July | 2.91 | 2.92 | 0.13 | 2.91 | 1.94 | 3.80 | 22,300 |
| August | 2.92 | 2.93 | 0.14 | 2.92 | 1.79 | 3.95 | 21,907 |
| September | 3.00 | 3.02 | 0.15 | 3.01 | 1.53 | 3.99 | 22,191 |
| October | 3.06 | 3.09 | 0.15 | 3.07 | 1.77 | 4.14 | 21,600 |
| November | 3.07 | 3.09 | 0.16 | 3.08 | 1.92 | 4.27 | 21,858 |
| December | 3.08 | 3.09 | 0.17 | 3.08 | 1.83 | 4.38 | 21,367 |
| For the Year | 3.00 | 3.01 | 0.16 | 3.00 | 1.53 | 4.38 | 269,384 |

**Table A-1 (continued)**

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

**2000**

**Other Solids**

| Month | Weighted Average - % - | Mean - % - | Standard Deviation - % - | Median - % - | Minimum - % - | Maximum - % - | Number of Observations |
|---|---|---|---|---|---|---|---|
| January | 5.67 | 5.63 | 0.13 | 5.65 | 3.11 | 6.18 | 23,489 |
| February | 5.68 | 5.65 | 0.12 | 5.67 | 3.47 | 6.09 | 23,531 |
| March | 5.71 | 5.69 | 0.12 | 5.71 | 3.43 | 6.04 | 23,253 |
| April | 5.72 | 5.69 | 0.12 | 5.71 | 2.92 | 6.39 | 23,131 |
| May | 5.73 | 5.71 | 0.11 | 5.73 | 3.85 | 6.03 | 22,531 |
| June | 5.74 | 5.71 | 0.11 | 5.73 | 2.80 | 6.03 | 22,198 |
| July | 5.72 | 5.67 | 0.12 | 5.70 | 3.70 | 6.06 | 22,300 |
| August | 5.69 | 5.65 | 0.12 | 5.67 | 3.98 | 6.06 | 21,907 |
| September | 5.69 | 5.65 | 0.12 | 5.67 | 3.91 | 5.97 | 22,191 |
| October | 5.69 | 5.65 | 0.13 | 5.67 | 3.73 | 5.98 | 21,600 |
| November | 5.70 | 5.66 | 0.13 | 5.68 | 3.90 | 6.26 | 21,858 |
| December | 5.68 | 5.64 | 0.14 | 5.66 | 3.61 | 5.99 | 21,367 |
| For the Year | 5.70 | 5.67 | 0.13 | 5.69 | 2.80 | 6.39 | 269,356 |

**Solids-Not-Fat**

| Month | Weighted Average - % - | Mean - % - | Standard Deviation - % - | Median - % - | Minimum - % - | Maximum - % - | Number of Observations |
|---|---|---|---|---|---|---|---|
| January | 8.71 | 8.69 | 0.21 | 8.70 | 4.76 | 9.86 | 23,489 |
| February | 8.70 | 8.69 | 0.21 | 8.69 | 5.30 | 9.90 | 23,531 |
| March | 8.71 | 8.70 | 0.20 | 8.71 | 5.27 | 9.84 | 23,253 |
| April | 8.71 | 8.69 | 0.20 | 8.70 | 4.50 | 10.05 | 23,131 |
| May | 8.69 | 8.68 | 0.20 | 8.69 | 6.02 | 9.74 | 22,531 |
| June | 8.69 | 8.67 | 0.20 | 8.68 | 4.50 | 9.68 | 22,198 |
| July | 8.63 | 8.60 | 0.21 | 8.61 | 5.67 | 9.53 | 22,300 |
| August | 8.62 | 8.59 | 0.21 | 8.60 | 5.77 | 9.65 | 21,907 |
| September | 8.69 | 8.67 | 0.20 | 8.68 | 5.81 | 9.67 | 22,191 |
| October | 8.75 | 8.74 | 0.21 | 8.74 | 5.51 | 9.74 | 21,600 |
| November | 8.77 | 8.75 | 0.22 | 8.76 | 5.82 | 9.95 | 21,858 |
| December | 8.76 | 8.73 | 0.23 | 8.74 | 5.44 | 9.90 | 21,367 |
| For the Year | 8.70 | 8.68 | 0.21 | 8.69 | 4.50 | 10.05 | 269,356 |

**Table A-1 (continued)**

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

**2000**

**Somatic Cell Count**

| Month | Weighted Average | Mean | Standard Deviation | Median | Minimum | Maximum | Number of Observations |
|---|---|---|---|---|---|---|---|
| | (1,000) | | | | | | |
| January | 306 | 338 | 175 | 302 | 27 | 1,475 | 23,310 |
| February | 316 | 348 | 183 | 310 | 2 | 1,479 | 23,378 |
| March | 326 | 361 | 185 | 326 | 16 | 1,476 | 23,105 |
| April | 320 | 353 | 176 | 320 | 14 | 1,486 | 22,989 |
| May | 328 | 355 | 170 | 325 | 4 | 1,347 | 22,555 |
| June | 350 | 380 | 180 | 349 | 11 | 1,485 | 22,197 |
| July | 374 | 408 | 187 | 378 | 10 | 1,500 | 22,300 |
| August | 379 | 414 | 188 | 383 | 16 | 1,480 | 21,799 |
| September | 356 | 385 | 176 | 356 | 5 | 1,466 | 22,083 |
| October | 316 | 342 | 164 | 313 | 25 | 1,460 | 21,495 |
| November | 306 | 340 | 174 | 305 | 13 | 1,494 | 21,743 |
| December | 307 | 345 | 183 | 308 | 3 | 1,449 | 21,260 |
| For the Year | 332 | 364 | 180 | 330 | 2 | 1,500 | 268,214 |

## Table A-2

## WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE
## 2000

### Butterfat

| | Illinois | No. * | Iowa | No. * | Minnesota | No. * | N. Dakota | No. * | S. Dakota | No. * | Wisconsin | No. * | Mkt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | - % - | | - % - | | - % - | | - % - | | - % - | | - % - | | - % - |
| January | 3.84 | 507 | 3.87 | 170 | 3.79 | 6,365 | 3.76 | 289 | 3.81 | 275 | 3.83 | 15,884 | 3.82 |
| February | 3.80 | 510 | 3.82 | 288 | 3.76 | 6,380 | 3.71 | 287 | 3.77 | 286 | 3.80 | 15,806 | 3.79 |
| March | 3.75 | 504 | 3.78 | 286 | 3.74 | 6,251 | 3.70 | 285 | 3.73 | 214 | 3.77 | 15,714 | 3.76 |
| April | 3.75 | 500 | 3.77 | 299 | 3.73 | 6,248 | 3.68 | 281 | 3.71 | 212 | 3.77 | 15,593 | 3.76 |
| May | 3.62 | 500 | 3.68 | 80 | 3.65 | 6,270 | 3.54 | 272 | 3.60 | 183 | 3.68 | 15,251 | 3.67 |
| June | 3.63 | 504 | 3.65 | 108 | 3.62 | 6,224 | 3.49 | 263 | 3.54 | 181 | 3.65 | 14,919 | 3.64 |
| July | 3.56 | 529 | 3.58 | 140 | 3.58 | 6,206 | 3.49 | 201 | 3.50 | 185 | 3.59 | 15,040 | 3.58 |
| August | 3.57 | 399 | 3.45 | 108 | 3.57 | 6,139 | 3.47 | 187 | 3.56 | 178 | 3.60 | 14,897 | 3.59 |
| September | 3.67 | 392 | 3.49 | 102 | 3.66 | 6,170 | 3.60 | 268 | 3.67 | 228 | 3.68 | 15,032 | 3.67 |
| October | 3.79 | 308 | 3.58 | 74 | 3.76 | 6,175 | 3.73 | 198 | 3.79 | 311 | 3.78 | 14,535 | 3.77 |
| November | 3.85 | 312 | 3.73 | 161 | 3.80 | 6,185 | 3.80 | 263 | 3.84 | 402 | 3.84 | 14,535 | 3.82 |
| December | 3.91 | 310 | 3.78 | 154 | 3.82 | 6,025 | 3.79 | 234 | 3.88 | 399 | 3.86 | 14,245 | 3.85 |
| For the Year | 3.72 | 5,275 | 3.70 | 1,970 | 3.71 | 74,638 | 3.65 | 3,028 | 3.73 | 3,054 | 3.74 | 181,451 | 3.73 |

### Protein

| | Illinois | No. * | Iowa | No. * | Minnesota | No. * | N. Dakota | No. * | S. Dakota | No. * | Wisconsin | No. * | Mkt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | - % - | | - % - | | - % - | | - % - | | - % - | | - % - | | - % - |
| January | 3.07 | 507 | 3.10 | 170 | 3.04 | 6,365 | 3.05 | 289 | 3.06 | 275 | 3.05 | 15,883 | 3.05 |
| February | 3.05 | 510 | 3.07 | 288 | 3.02 | 6,380 | 3.02 | 287 | 3.02 | 286 | 3.02 | 15,782 | 3.02 |
| March | 3.02 | 504 | 3.03 | 286 | 3.01 | 6,251 | 3.00 | 285 | 2.99 | 214 | 2.99 | 15,713 | 3.00 |
| April | 3.02 | 500 | 3.03 | 299 | 3.00 | 6,248 | 2.97 | 281 | 2.97 | 212 | 2.99 | 15,592 | 2.99 |
| May | 2.97 | 500 | 3.03 | 80 | 2.98 | 6,270 | 2.92 | 272 | 2.94 | 183 | 2.95 | 15,251 | 2.95 |
| June | 2.95 | 504 | 2.99 | 108 | 2.97 | 6,224 | 2.92 | 263 | 2.93 | 181 | 2.94 | 14,918 | 2.95 |
| July | 2.91 | 529 | 2.94 | 140 | 2.91 | 6,206 | 2.88 | 201 | 2.87 | 185 | 2.91 | 15,039 | 2.91 |
| August | 2.91 | 399 | 2.95 | 108 | 2.93 | 6,139 | 2.90 | 187 | 2.93 | 178 | 2.92 | 14,896 | 2.92 |
| September | 2.99 | 392 | 3.05 | 102 | 3.02 | 6,170 | 3.02 | 268 | 3.03 | 228 | 2.99 | 15,031 | 3.00 |
| October | 3.09 | 308 | 3.13 | 74 | 3.06 | 6,175 | 3.09 | 198 | 3.09 | 311 | 3.06 | 14,534 | 3.06 |
| November | 3.11 | 312 | 3.13 | 161 | 3.08 | 6,185 | 3.09 | 263 | 3.13 | 402 | 3.07 | 14,535 | 3.07 |
| December | 3.12 | 310 | 3.16 | 154 | 3.07 | 6,025 | 3.10 | 234 | 3.14 | 399 | 3.07 | 14,245 | 3.08 |
| For the Year | 3.01 | 5,275 | 3.05 | 1,970 | 3.01 | 74,638 | 3.00 | 3,028 | 3.03 | 3,054 | 3.00 | 181,419 | 3.00 |

* Number of observations with monthly average component levels.

## Table A-2 (Continued)

## WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE
## 2000

### Other Solids

| | Illinois | No. * | Iowa | No. * | Minnesota | No. * | N. Dakota | No. * | S. Dakota | No. * | Wisconsin | No. * | Mkt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | - % - | | - % - | | - % - | | - % - | | - % - | | - % - | | - % - |
| January | 5.66 | 507 | 5.68 | 170 | 5.71 | 6,365 | 5.72 | 289 | 5.74 | 275 | 5.65 | 15,883 | 5.67 |
| February | 5.68 | 510 | 5.71 | 288 | 5.72 | 6,380 | 5.74 | 287 | 5.74 | 286 | 5.66 | 15,780 | 5.68 |
| March | 5.72 | 504 | 5.74 | 286 | 5.74 | 6,251 | 5.78 | 285 | 5.74 | 214 | 5.70 | 15,713 | 5.71 |
| April | 5.72 | 500 | 5.74 | 299 | 5.75 | 6,248 | 5.80 | 281 | 5.74 | 212 | 5.70 | 15,591 | 5.72 |
| May | 5.75 | 500 | 5.78 | 80 | 5.76 | 6,270 | 5.77 | 272 | 5.74 | 183 | 5.72 | 15,226 | 5.73 |
| June | 5.74 | 504 | 5.80 | 108 | 5.76 | 6,224 | 5.78 | 263 | 5.75 | 181 | 5.73 | 14,918 | 5.74 |
| July | 5.71 | 529 | 5.80 | 140 | 5.75 | 6,206 | 5.76 | 201 | 5.75 | 185 | 5.70 | 15,039 | 5.72 |
| August | 5.70 | 399 | 5.83 | 108 | 5.72 | 6,139 | 5.73 | 187 | 5.73 | 178 | 5.68 | 14,896 | 5.69 |
| September | 5.67 | 392 | 5.79 | 102 | 5.70 | 6,170 | 5.74 | 268 | 5.71 | 228 | 5.68 | 15,031 | 5.69 |
| October | 5.64 | 308 | 5.79 | 74 | 5.70 | 6,175 | 5.76 | 198 | 5.71 | 311 | 5.68 | 14,534 | 5.69 |
| November | 5.67 | 312 | 5.78 | 161 | 5.70 | 6,185 | 5.75 | 263 | 5.72 | 402 | 5.69 | 14,535 | 5.70 |
| December | 5.64 | 310 | 5.79 | 154 | 5.70 | 6,025 | 5.77 | 234 | 5.73 | 399 | 5.66 | 14,245 | 5.68 |
| For the Year | 5.70 | 5,275 | 5.77 | 1,970 | 5.73 | 74,638 | 5.76 | 3,028 | 5.73 | 3,054 | 5.69 | 181,391 | 5.70 |

### Solids-Not-Fat

| | Illinois | No. * | Iowa | No. * | Minnesota | No. * | N. Dakota | No. * | S. Dakota | No. * | Wisconsin | No. * | Mkt. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | - % - | | - % - | | - % - | | - % - | | - % - | | - % - | | - % - |
| January | 8.73 | 507 | 8.79 | 170 | 8.75 | 6,365 | 8.77 | 289 | 8.79 | 275 | 8.69 | 15,883 | 8.71 |
| February | 8.73 | 510 | 8.77 | 288 | 8.73 | 6,380 | 8.76 | 287 | 8.75 | 286 | 8.68 | 15,780 | 8.70 |
| March | 8.74 | 504 | 8.77 | 286 | 8.75 | 6,251 | 8.77 | 285 | 8.73 | 214 | 8.69 | 15,713 | 8.71 |
| April | 8.74 | 500 | 8.77 | 299 | 8.75 | 6,248 | 8.77 | 281 | 8.71 | 212 | 8.69 | 15,591 | 8.71 |
| May | 8.71 | 500 | 8.81 | 80 | 8.73 | 6,270 | 8.69 | 272 | 8.68 | 183 | 8.67 | 15,226 | 8.69 |
| June | 8.69 | 504 | 8.79 | 108 | 8.73 | 6,224 | 8.70 | 263 | 8.68 | 181 | 8.67 | 14,918 | 8.69 |
| July | 8.62 | 529 | 8.73 | 140 | 8.67 | 6,206 | 8.64 | 201 | 8.62 | 185 | 8.62 | 15,039 | 8.63 |
| August | 8.61 | 399 | 8.78 | 108 | 8.64 | 6,139 | 8.64 | 187 | 8.65 | 178 | 8.60 | 14,896 | 8.62 |
| September | 8.66 | 392 | 8.84 | 102 | 8.72 | 6,170 | 8.77 | 268 | 8.74 | 228 | 8.67 | 15,031 | 8.69 |
| October | 8.73 | 308 | 8.92 | 74 | 8.77 | 6,175 | 8.84 | 198 | 8.80 | 311 | 8.73 | 14,534 | 8.75 |
| November | 8.78 | 312 | 8.92 | 161 | 8.78 | 6,185 | 8.84 | 263 | 8.85 | 402 | 8.76 | 14,535 | 8.77 |
| December | 8.77 | 310 | 8.95 | 154 | 8.77 | 6,025 | 8.87 | 234 | 8.87 | 399 | 8.74 | 14,245 | 8.76 |
| For the Year | 8.71 | 5,275 | 8.82 | 1,970 | 8.73 | 74,638 | 8.76 | 3,028 | 8.76 | 3,054 | 8.68 | 181,391 | 8.70 |

* Number of observations with monthly average component levels.

## Table A-2 (Continued)

## WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY STATE
## 2000

### Somatic Cell Counts

| | Illinois (1,000) | No. * | Iowa (1,000) | No. * | Minnesota (1,000) | No. * | N. Dakota (1,000) | No. * | S. Dakota (1,000) | No. * | Wisconsin (1,000) | No. * | Market (1,000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 292 | 507 | 345 | 170 | 334 | 6,186 | 281 | 289 | 310 | 275 | 295 | 15,883 | 306 |
| February | 306 | 510 | 287 | 288 | 348 | 6,201 | 308 | 287 | 320 | 286 | 303 | 15,806 | 316 |
| March | 321 | 504 | 302 | 286 | 360 | 6,105 | 328 | 283 | 350 | 214 | 314 | 15,713 | 326 |
| April | 306 | 500 | 294 | 299 | 356 | 6,105 | 316 | 281 | 364 | 212 | 307 | 15,592 | 320 |
| May | 314 | 500 | 340 | 80 | 374 | 6,269 | 317 | 272 | 379 | 183 | 309 | 15,251 | 328 |
| June | 345 | 504 | 346 | 108 | 400 | 6,223 | 320 | 263 | 389 | 181 | 331 | 14,918 | 350 |
| July | 356 | 529 | 363 | 140 | 426 | 6,206 | 375 | 201 | 451 | 185 | 354 | 15,039 | 374 |
| August | 349 | 399 | 342 | 108 | 431 | 6,031 | 381 | 187 | 488 | 178 | 359 | 14,896 | 379 |
| September | 338 | 392 | 322 | 102 | 394 | 6,062 | 350 | 268 | 426 | 228 | 341 | 15,031 | 356 |
| October | 292 | 308 | 276 | 74 | 349 | 6,070 | 300 | 198 | 355 | 311 | 302 | 14,534 | 316 |
| November | 276 | 312 | 293 | 158 | 339 | 6,079 | 310 | 263 | 339 | 402 | 290 | 14,529 | 306 |
| December | 291 | 310 | 325 | 154 | 340 | 5,920 | 331 | 234 | 370 | 399 | 288 | 14,243 | 307 |
| For the Year | 318 | 5,275 | 315 | 1,967 | 370 | 73,457 | 324 | 3,026 | 373 | 3,054 | 316 | 181,435 | 332 |

* Number of observations with monthly average component levels.

## Table A-3

## LINEAR RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

## 2000

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

SNF = c + b(BF)

| Month | c Constant | B Butterfat Coefficient | Standard Error of **b** | R-squared (Adjusted) | Standard Error | Number of Comparisons |
|---|---|---|---|---|---|---|
| January | 7.16176 | 0.39699 | 0.00469 | 0.23378 | 0.18576 | 23,489 |
| February | 7.09920 | 0.41330 | 0.00471 | 0.24639 | 0.18251 | 23,531 |
| March | 7.20954 | 0.39092 | 0.00486 | 0.21792 | 0.18109 | 23,253 |
| April | 7.23560 | 0.38307 | 0.00496 | 0.20512 | 0.18268 | 23,131 |
| May | 7.39637 | 0.34735 | 0.00484 | 0.18579 | 0.17836 | 22,531 |
| June | 7.32273 | 0.36756 | 0.00501 | 0.19513 | 0.17930 | 22,198 |
| July | 7.13741 | 0.40636 | 0.00536 | 0.20502 | 0.18527 | 22,300 |
| August | 7.11687 | 0.40722 | 0.00534 | 0.20961 | 0.18350 | 21,907 |
| September | 7.34406 | 0.35749 | 0.00509 | 0.18215 | 0.18442 | 22,191 |
| October | 7.27542 | 0.38255 | 0.00494 | 0.21761 | 0.18437 | 21,600 |
| November | 7.29781 | 0.37319 | 0.00480 | 0.21663 | 0.19043 | 21,858 |
| December | 7.19605 | 0.39267 | 0.00503 | 0.22194 | 0.20146 | 21,367 |
| For the Year | 7.21994 | 0.38823 | 0.00134 | 0.23857 | 0.18625 | 269,356 |

### 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 | Number of Comparisons |
|---|---|---|---|---|---|---|
| January | 5.43211 | 1.06601 | 0.00529 | 0.63335 | 0.12850 | 23,489 |
| February | 5.36416 | 1.09405 | 0.00520 | 0.65338 | 0.12378 | 23,531 |
| March | 5.28282 | 1.13450 | 0.00516 | 0.67521 | 0.11670 | 23,253 |
| April | 5.18819 | 1.16757 | 0.00517 | 0.68819 | 0.11441 | 23,131 |
| May | 5.21791 | 1.16685 | 0.00503 | 0.70529 | 0.10731 | 22,531 |
| June | 5.07907 | 1.21367 | 0.00539 | 0.69585 | 0.11022 | 22,198 |
| July | 4.89667 | 1.27070 | 0.00582 | 0.68098 | 0.11737 | 22,300 |
| August | 4.98043 | 1.22986 | 0.00601 | 0.65683 | 0.12091 | 21,907 |
| September | 5.27837 | 1.12220 | 0.00563 | 0.64150 | 0.12210 | 22,191 |
| October | 5.42800 | 1.07117 | 0.00564 | 0.62574 | 0.12751 | 21,600 |
| November | 5.42741 | 1.07476 | 0.00539 | 0.64515 | 0.12817 | 21,858 |
| December | 5.31707 | 1.10416 | 0.00561 | 0.64432 | 0.13621 | 21,367 |
| For the Year | 5.43058 | 1.07894 | 0.00151 | 0.65400 | 0.12555 | 269,356 |

**Table A-3 (continued)**

**LINEAR RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS**

**2000**

**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 | Number of Comparisons |
|---|---|---|---|---|---|---|
| January | 1.52083 | 0.39875 | 0.00304 | 0.42320 | 0.12033 | 23,489 |
| February | 1.49085 | 0.40254 | 0.00303 | 0.42813 | 0.11747 | 23,533 |
| March | 1.58374 | 0.37464 | 0.00313 | 0.38156 | 0.11663 | 23,253 |
| April | 1.63583 | 0.35903 | 0.00317 | 0.35694 | 0.11674 | 23,132 |
| May | 1.81510 | 0.31165 | 0.00326 | 0.28881 | 0.11995 | 22,556 |
| June | 1.79705 | 0.31691 | 0.00320 | 0.30709 | 0.11435 | 22,198 |
| July | 1.71936 | 0.33202 | 0.00321 | 0.32455 | 0.11091 | 22,300 |
| August | 1.72603 | 0.33420 | 0.00325 | 0.32511 | 0.11174 | 21,907 |
| September | 1.77425 | 0.33647 | 0.00332 | 0.31679 | 0.12031 | 22,191 |
| October | 1.63470 | 0.38069 | 0.00320 | 0.39517 | 0.11971 | 21,600 |
| November | 1.57258 | 0.39033 | 0.00308 | 0.42435 | 0.12200 | 21,858 |
| December | 1.51864 | 0.40252 | 0.00310 | 0.44131 | 0.12410 | 21,367 |
| For the Year | 1.55107 | 0.38831 | 0.00087 | 0.42483 | 0.12133 | 269,384 |

**Coefficients for Month Variables in Equations for 2000**

| Month ** | (**m** month coefficients) SNF=c+b(BF) | SNF=c+b(PRO) | PRO=c+b(BF) |
|---|---|---|---|
| February | * | 0.01856 | -0.01631 |
| March | 0.02418 | 0.06000 | -0.03072 |
| April | 0.02033 | 0.06466 | -0.03810 |
| May | 0.04881 | 0.09125 | -0.03402 |
| June | 0.05080 | 0.09066 | -0.03075 |
| July | 0.00646 | 0.07101 | -0.05077 |
| August | -0.01086 | 0.03725 | -0.03644 |
| September | 0.03400 | 0.01834 | 0.01708 |
| October | 0.05815 | 0.00952 | 0.04343 |
| November | 0.04393 | 0.01983 | 0.02000 |
| December | 0.01809 | * | 0.01400 |

* Not all months entered into the final equations due to lack of statistical significance.

** January was excluded as a dummy variable to provide a base line for comparison. Including January does not provide additional information to the analysis that is not provided by the other eleven months.

**Table A-4**

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

**2000**

| Month | Butterfat Price | Protein Price | Other Solids Price | Somatic Cell Adjustment Rate |
|---|---|---|---|---|
| | ($/Pound) | | | ($/cwt. Per 1,000 SCC) |
| January | $0.9366 | $2.1677 | $0.0503 | $0.00058 |
| February | 0.9588 | 1.9849 | 0.0432 | 0.00055 |
| March | 1.0191 | 1.9166 | 0.0424 | 0.00055 |
| April | 1.1352 | 1.7399 | 0.0408 | 0.00055 |
| May | 1.2854 | 1.5514 | 0.0403 | 0.00055 |
| June | 1.4128 | 1.4278 | 0.0438 | 0.00056 |
| July | 1.2691 | 1.9726 | 0.0557 | 0.00061 |
| August | 1.2659 | 1.7952 | 0.0577 | 0.00058 |
| September | 1.2707 | 2.0137 | 0.0502 | 0.00062 |
| October | 1.2444 | 1.8028 | 0.0471 | 0.00058 |
| November | 1.5745 | 0.9149 | 0.0565 | 0.00051 |
| December | 1.6534 | 1.0378 | 0.0829 | 0.00054 |
| Simple Average | $1.2522 | $1.6938 | $0.0509 | $0.00057 |

**Table A-5**

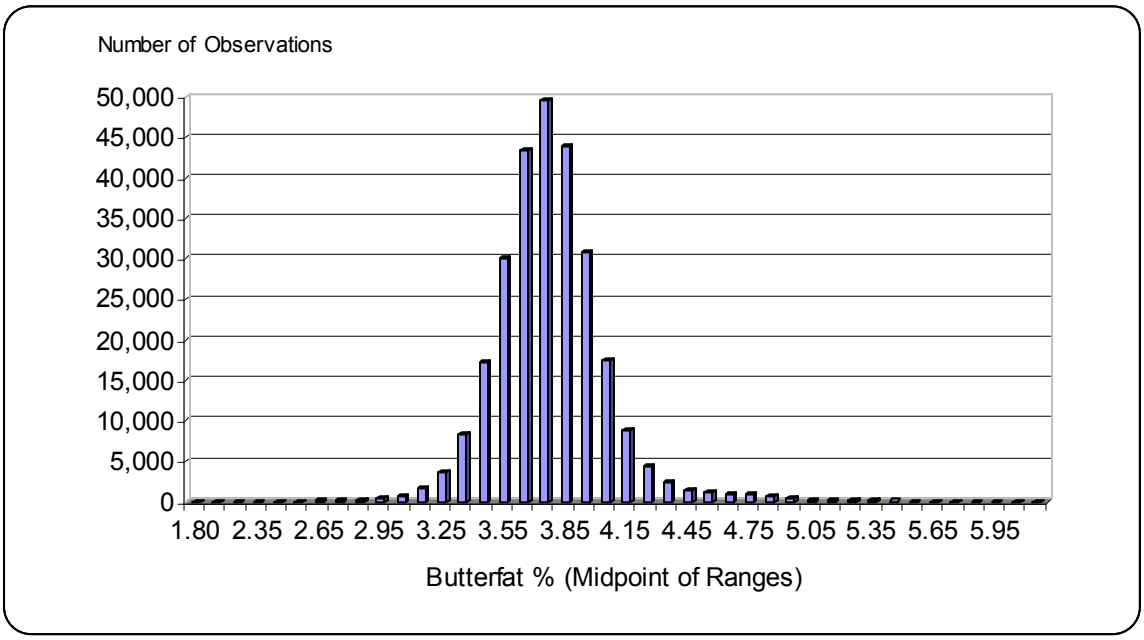
## AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

**2000**

| Size Range | | Aggregated Component Values* | Producer Milk | Weighted Average Value |
|---|---|---|---|---|
| Equal to or more than (Pounds) | Less than | ($) | (Pounds) | ($/Cwt.) |
| | 20,000 | $15,335,166.53 | 148,459,739 | $10.330 |
| 20,000 | 30,000 | 37,628,465.26 | 368,051,556 | 10.224 |
| 30,000 | 50,000 | 184,165,178.11 | 1,816,042,064 | 10.141 |
| 50,000 | 70,000 | 304,926,281.93 | 3,018,417,572 | 10.102 |
| 70,000 | 100,000 | 493,488,636.69 | 4,904,636,503 | 10.062 |
| 100,000 | 150,000 | 574,697,014.34 | 5,718,461,254 | 10.050 |
| 150,000 | 250,000 | 484,119,486.56 | 4,811,990,286 | 10.061 |
| 250,000 | 400,000 | 262,341,411.66 | 2,604,160,680 | 10.074 |
| 400,000 | | 670,524,690.21 | 6,767,438,186 | 9.908 |
| Total | | $3,027,226,331.29 | 30,157,657,840 | |
| Weighted Average | | | | $10.038 |

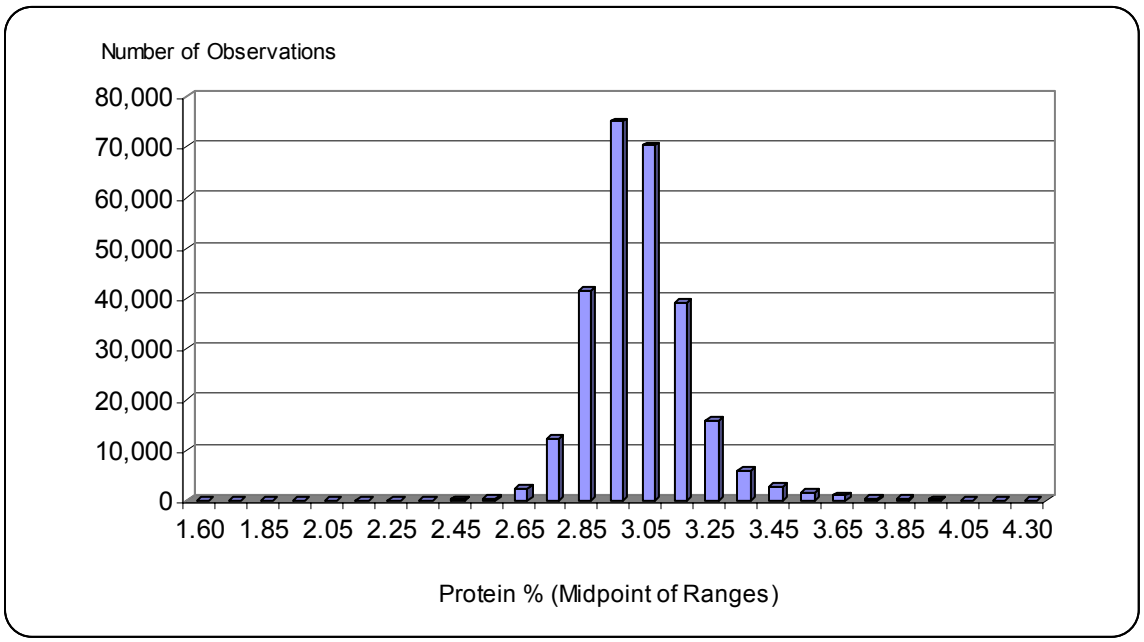
* Total value of pounds of butterfat, protein, and other solids, adjusted for SCC.

**Figure A-1**
**FREQUENCY DISTRIBUTION OF**
**MONTHLY AVERAGE BUTTERFAT LEVELS, 2000**



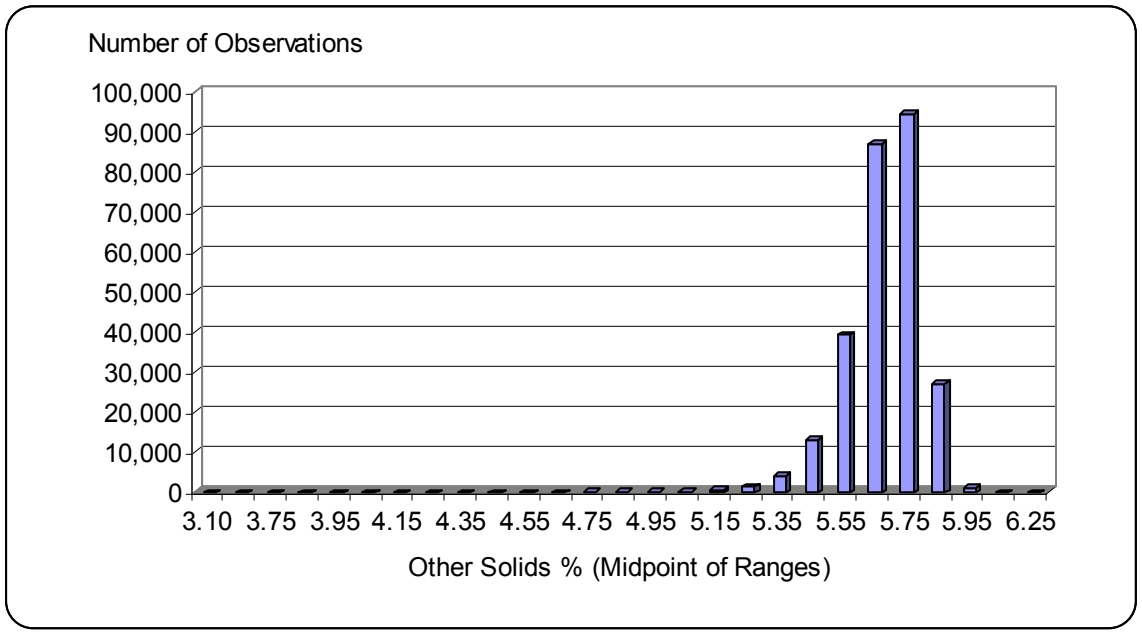

Skewness statistic: 0.890
Kurtosis statistic: 4.368

**Figure A-2**
**FREQUENCY DISTRIBUTION OF**
**MONTHLY AVERAGE PROTEIN LEVELS, 2000**



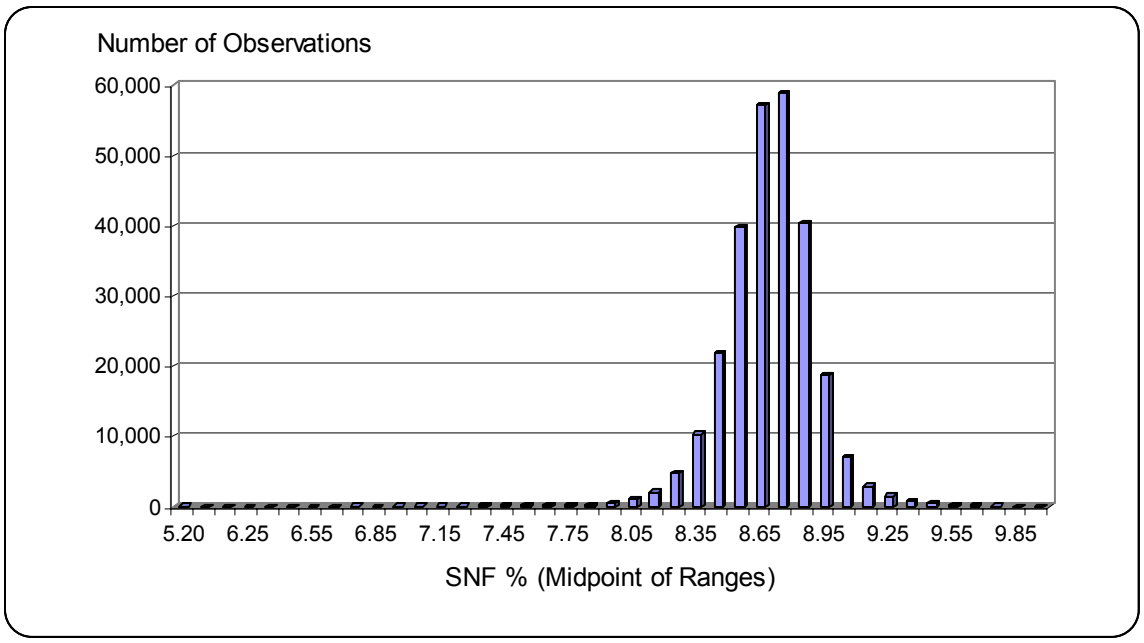

Skewness statistic: 0.917
Kurtosis statistic: 3.686

**Figure A-3**
**FREQUENCY DISTRIBUTION OF**
**MONTHLY AVERAGE OTHER SOLIDS LEVELS, 2000**



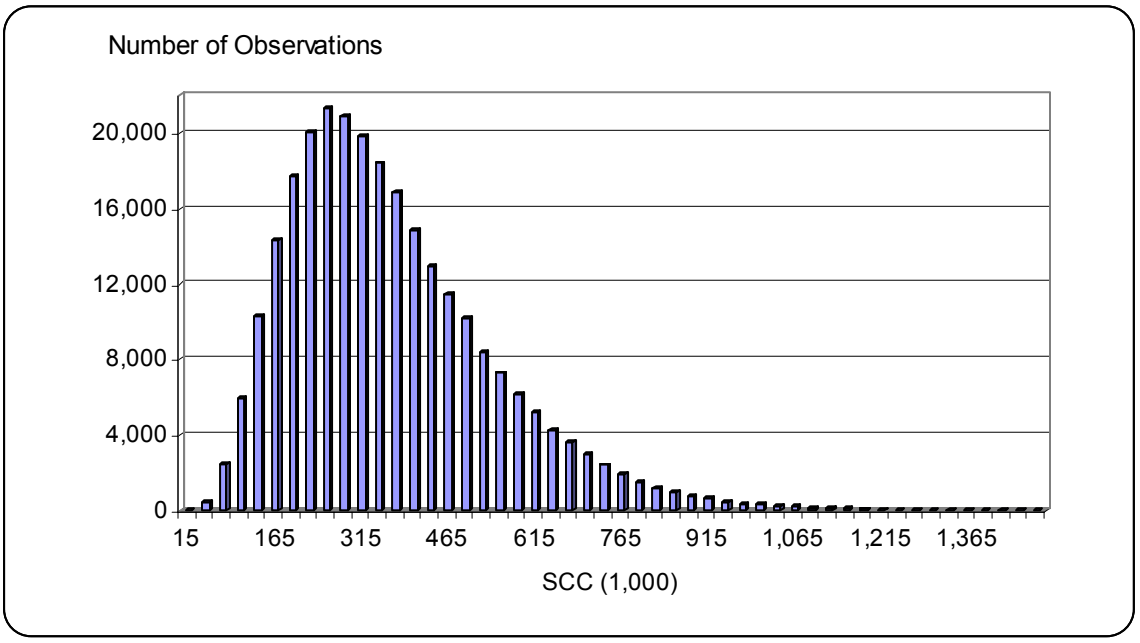

Skewness statistic: -2.357
Kurtosis statistic: 19.344

**Figure A-4**
**FREQUENCY DISTRIBUTION OF**
**MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS, 2000**




Skewness statistic: -0.977
Kurtosis statistic: 10.913

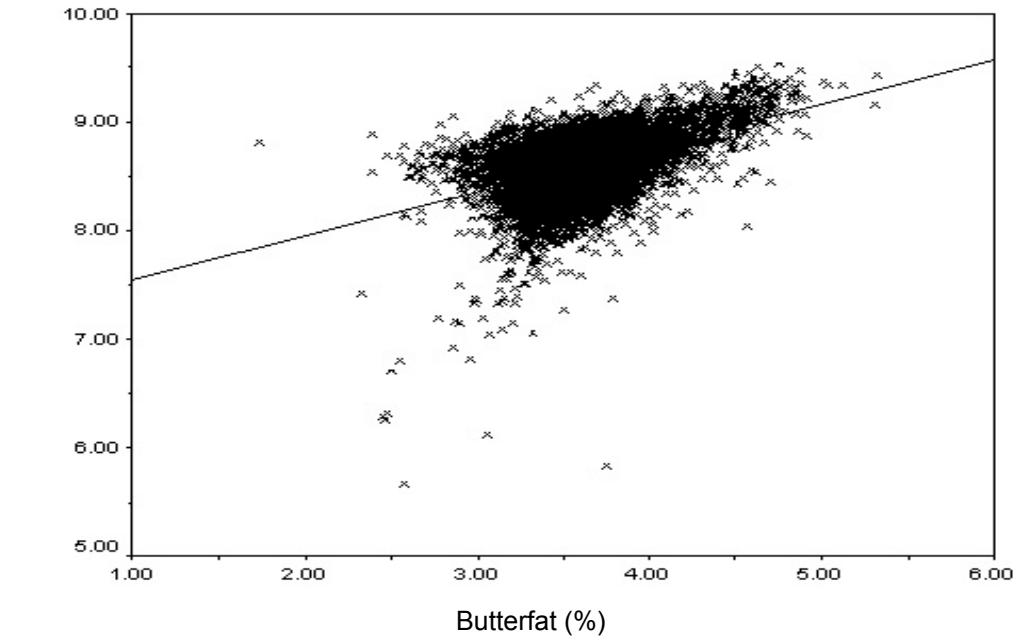
**Figure A-5**
**FREQUENCY DISTRIBUTION OF**
**MONTHLY AVERAGE SOMATIC CELL COUNT, 2000**




Skewness statistic: 1.115
Kurtosis statistic: 1.857

**Figure A-6**
**SCATTERPLOT OF SOLIDS-NOT-FAT AND BUTTERFAT**
**JULY AND NOVEMBER 2000**

July (22,300 observations: SNF = 7.13741 + 0.40636 (Butterfat))




November (21,858 observations: SNF = 7.29781 + 0.37319 (Butterfat))

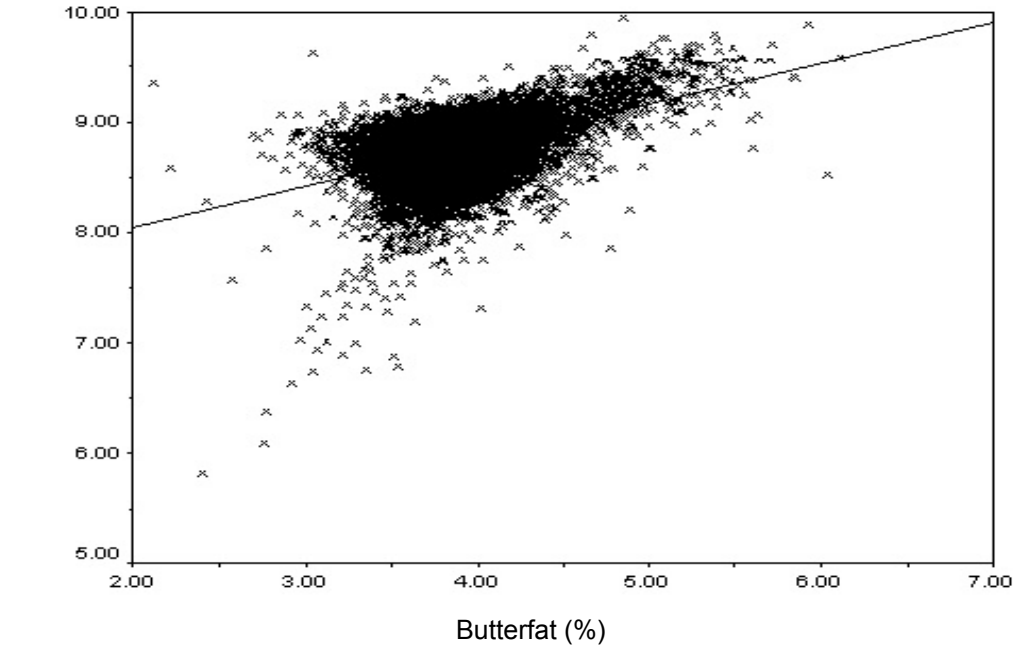
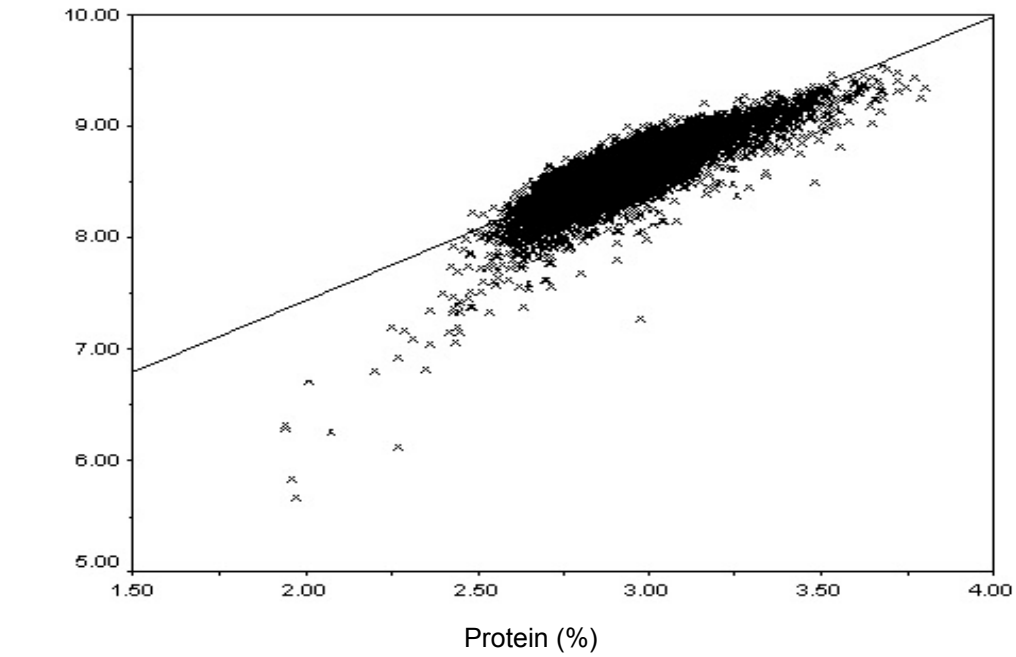


**Figure A-7**
**SCATTERPLOT OF SOLIDS-NOT-FAT AND PROTEIN**
**JULY AND NOVEMBER 2000**

July (22,300 observations: SNF = 4.89667 + 1.27070 (Protein))




November (21,858 observations: SNF = 5.42741 + 1.07476 (Protein))

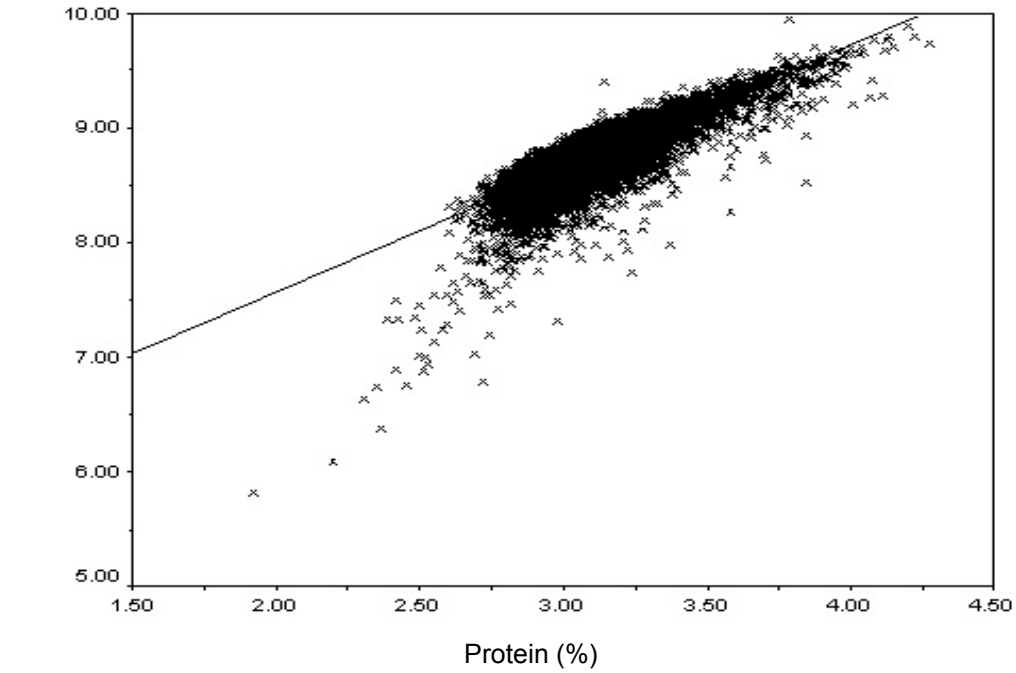
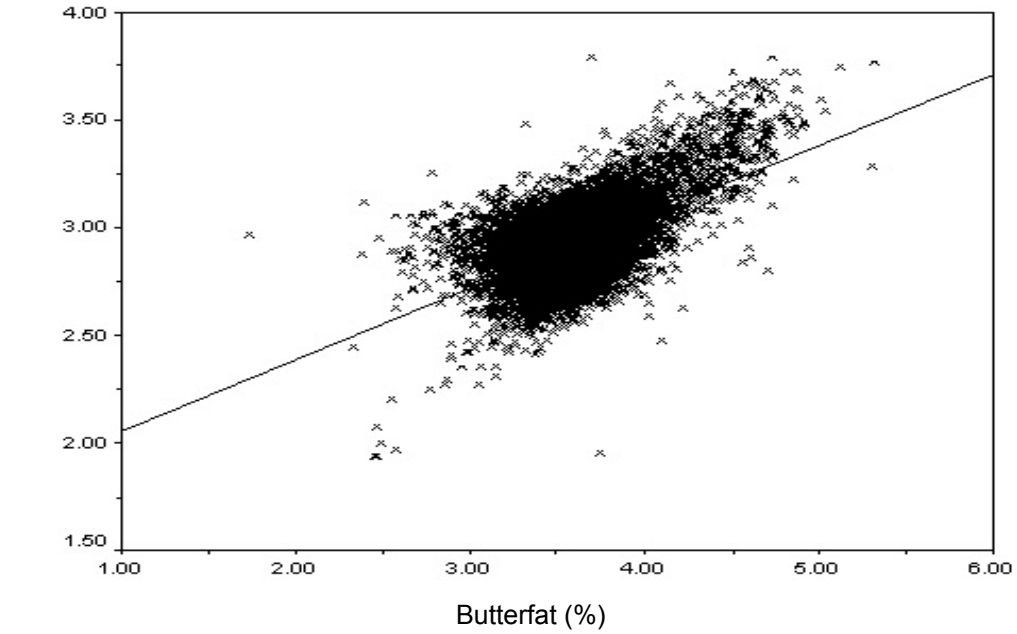


**Figure A-8**
**SCATTERPLOT OF PROTEIN AND BUTTERFAT**
**JULY AND NOVEMBER 2000**

July (22,300 observations: Protein = 1.71936 + 0.33202 (Butterfat))




November (21,858 observations: Protein = 1.57258 + 0.39033 (Butterfat))