UPPER MIDWEST MARKETING AREA

ANALYSIS OF COMPONENT LEVELS AND SOMATIC CELL COUNT IN INDIVIDUAL HERD MILK AT THE FARM LEVEL
1998

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ABSTRACT

Butterfat, protein, other solids and solids-not-fat (SNF) levels and somatic cell count (SCC) in producer milk associated with the Upper Midwest Order during 1998 were analyzed to determine: average levels, regional and seasonal variation in component levels and SCC, and statistical relationships among the four components in individual herd milk at the farm level.

Milk pooled on the Upper Midwest Order in 1998 was valued on the basis of multiple component pricing (MCP). In this study, Federal order component prices were applied to producer milk allowing for an analysis of milk values based on component levels.

Major findings of the analysis include:

1) Weighted average component levels and SCC for 1998 were 3.70% butterfat, 3.17% protein, 5.53% other solids, 8.70% SNF and 355,000 SCC.

2) For 1998, weighted average butterfat, protein and SNF levels were lowest in July and highest during the late fall and winter. In contrast, other solids levels varied little during the year. Weighted average SCC were lowest in December and highest in July.

3) In 1998, the range of monthly average component levels within one standard deviation of the mean was: 3.46% to 4.00% for butterfat; 3.02% to 3.34% for protein; 5.39% to 5.61% for other solids; 8.47% to 8.89% for SNF; and 201,000 to 557,000 for SCC.

4) Based on the data for 1998, the following regression equations were derived:

$$SNF = 7.13\% + 0.4148\,(BF)$$
$$SNF = 5.27\% + 1.0711\,(PRO)$$
$$PRO = 1.66\% + 0.4080\,(BF)$$

5) The annual weighted average value of butterfat, protein, and other solids adjusted for SCC, was $14.53 per cwt. for the market in 1998. Butterfat was the most valuable component, contributing half of the total value.

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Rodney M. Sebastian[1]

I. INTRODUCTION

The data for this study were collected for milk marketed in 1998 from producers on the Upper Midwest Milk Marketing Order. 1998 was the third year that multiple component pricing (MCP) was in effect for payments to producers under the order. MCP was adopted in five midwestern Federal milk orders, including the Upper Midwest, effective January 1, 1996. Under the MCP plan implemented, producer milk is priced primarily on the basis of butterfat, protein and other solids[2] with adjustments for somatic cell count (SCC). Prior to the introduction of MCP, earlier studies on component levels in individual herd milk were conducted for a sample of producers on the Upper Midwest Order. In those studies, butterfat, protein, lactose and solids-not-fat (SNF) levels and SCC in milk were analyzed to determine: average levels, regional and seasonal variation in component levels and SCC, and statistical relationships among the four components in individual herd milk at the farm level. In the study completed for 1995, for example, about 68% of the producers and 65% of the producer milk in the market were included. In this study, monthly payroll records for all producers associated with the Upper Midwest Order were used to determine monthly and annual average: butterfat, protein, other solids and solids-not-fat levels and SCC. Seasonal and regional variations of component levels and SCC were noted and analyses were conducted to evaluate the strength of relationships among components.

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.

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 all pooled producer milk and milk associated with the order but not pooled in some months because of unusual price relationships and/or qualification circumstances. 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 each producer, total monthly milk marketings and simple monthly average component levels and SCC from payrolls submitted to the Market Administrator's office were used to calculate "weighted" average component levels and SCC 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, government programs, 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.[3] In addition, component levels were analyzed on a regional basis by examining six geographic regions within the milk procurement area generally defined as: northeastern Minnesota-northwestern Wisconsin (Region 1); central to southeastern Minnesota-west central Wisconsin (Region 2); southwestern Minnesota-northern Iowa (Region 3); northwestern Minnesota, eastern North Dakota and a small portion of northeastern South Dakota (Region 4); western North Dakota (Region 5); and the western portion of the procurement area in South Dakota (Region 6). These regions were chosen so as to generally reflect geographically homogeneous production regions.

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.

[3] 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 AND REGIONAL VARIATION IN MILK COMPONENT LEVELS AND SOMATIC CELL COUNT

Seasonal Variation in Milk Component Levels and Somatic Cell Count

Seasonal changes in component levels for 1998 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 1998 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 3.79% in January to 3.54% in July, then rose to 3.85% in November. Protein and SNF showed similar seasonal patterns during the year by bottoming out in July and peaking in November. The range of variation for protein and SNF was 0.20 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 5.54% in February through June to a low of 5.50% in September. The seasonal high SCC of 394,000 was reached in July before dropping to 332,000 in December, a change of 62,000 during the year.

For the year, the mean butterfat and protein levels were higher than the weighted average for each respective component. The relative level of the means versus 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 means for other solids and SNF were lower than the weighted averages for the respective components. This indicates that larger producers tended to have higher levels of these components than those with smaller deliveries. For the year, the mean SCC (379,000) for 1998 was higher than the weighted average (355,000) indicating that larger producers tended to have, on average, lower SCC than their smaller counterparts.

Table 1

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

1998

Month	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
January	3.79	3.23	5.51	8.74	336
February	3.75	3.19	5.54	8.73	333
March	3.75	3.18	5.54	8.72	341
April	3.71	3.15	5.54	8.70	355
May	3.62	3.12	5.54	8.67	356
June	3.60	3.11	5.54	8.65	365
July	3.54	3.06	5.53	8.59	394
August	3.56	3.10	5.53	8.62	392
September	3.64	3.17	5.50	8.67	377
October	3.81	3.25	5.51	8.76	342
November	3.85	3.26	5.51	8.78	334
December	3.81	3.23	5.52	8.75	332
Minimum	3.54	3.06	5.50	8.59	332
Maximum	3.85	3.26	5.54	8.78	394
For: 1998	3.70	3.17	5.53	8.70	355
1997	3.74	3.18	5.50	8.69	370

Moreover, the median SCC level (351,000) was lower than the weighted average (355,000), indicating that the producer tests in the distribution were skewed toward higher SCC levels (see Appendix Figure A-5).[4]

The range of component levels observed in the data was fairly wide. Individual monthly average butterfat levels in the data were as low as 2.15% and as high as 5.70%; protein levels ranged from 2.21% to 4.81%; other solids levels ranged from 3.90% to 6.01%; SNF levels ranged from 6.15% to 10.26%; and SCC ranged from 14,000 to 1,497,000. However, during the year, most producers had component test levels and SCC levels that were within

[4] 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 0.956. 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.

one standard deviation of the mean.[5] The range of component levels within one standard deviation of the mean were: 3.46% to 4.00% for butterfat; 3.02% to 3.34% for protein; 5.39% to 5.61% for other solids; 8.47% to 8.89% for SNF; and 201,000 to 557,000 for SCC. Approximately three-quarters of the observed component levels in the 1998 data were within these ranges[6] (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 and Total Range

1998

Month	Weighted Average - % -	Mean - % -	Standard Deviation - % -	Median - % -	Minimum - % -	Maximum - % -
Butterfat	3.70	3.73	0.27	3.72	2.15	5.70
Protein	3.17	3.18	0.16	3.17	2.21	4.81
Other Solids	5.53	5.50	0.11	5.51	3.90	6.01
SNF	8.70	8.68	0.21	8.69	6.15	10.26
SCC (1,000's)	355	379	178	351	14	1,497

Regional Variation in Milk Component Levels and Somatic Cell Count

Milk component levels and SCC were examined by region. The procurement area for milk associated with the Upper Midwest Order during 1998 was divided into six relatively homogeneous geographic regions, which were examined for differences in component levels and SCC. The county boundaries of these regions and weighted average component levels and SCC for the respective regions are shown in Figure 1. Yearly average component levels for 1998 are noted for each region on the map and are also summarized in Table 3.

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

6 The percentage of observations within one standard deviation of the mean in the 1998 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.

Procurement area as of December 1992; Component and SCC averages

FIGURE 1

UPPER MIDWEST ORDER MILK PROCUREMENT AREA

WEIGHTED AVERAGE COMPONENT LEVELS

AND SOMATIC CELL COUNTS

1998

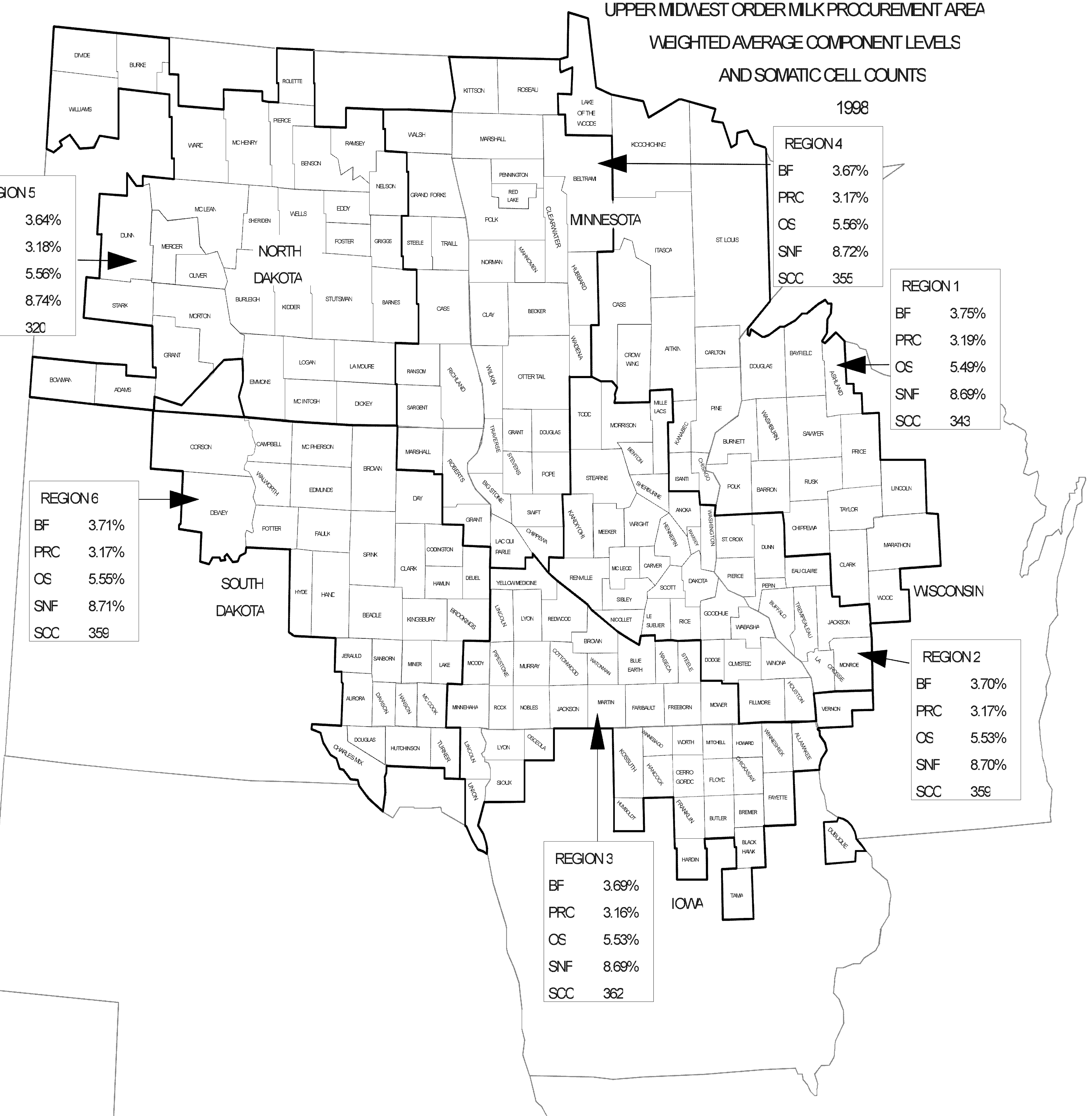

Table 3

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

1998

Region	Butterfat	Protein	Other Solids	Solids-Not-Fat	Somatic Cell Count
	- % -	- % -	- % -	- % -	- 1,000 -
Region 1	3.75	3.19	5.49	8.69	343
Region 2	3.70	3.17	5.53	8.70	359
Region 3	3.69	3.16	5.53	8.69	362
Region 4	3.67	3.17	5.56	8.72	355
Region 5	3.64	3.18	5.56	8.74	320
Region 6	3.71	3.17	5.55	8.71	359
Market	3.70	3.17	5.53	8.70	355
Minimum	3.64	3.16	5.49	8.69	320
Maximum	3.75	3.19	5.56	8.74	362

Differences in average component levels and SCC between the six regions were observed, however, those differences were not found to be statistically significant (see Table 3). Region 1 showed the highest average butterfat and protein levels for the third consecutive year for 1998, while Region 5 had the lowest butterfat level and Region 3 had the lowest protein level. Other solids levels did not exhibit a consistent pattern and generally varied little from the average for the procurement area. Average SCC were lowest in Region 5 and highest in Region 3. Detailed regional information by month for 1998 is presented in Table A-2 (see Appendix).

IV. STATISTICAL RELATIONSHIPS AMONG MILK COMPONENTS

Regression analysis was used to estimate the linear relationship between components. Results from the 1998 data were compared with results from previous Upper Midwest Order studies (1993-1998), 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.

The monthly variation between component levels was also examined by introducing "month" variables into the equation to reflect seasonality. Generally, month variables in the equation did not significantly improve the equation's ability to explain the relationship between components. However, nearly all of the month variables were statistically significant in the 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. These equations are of the following general form:

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).

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 ten 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 1998 data was within that range at 0.4148. 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 7.09 to 7.35 while the butterfat coefficient ranged from 0.36 to 0.42 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 (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 1998 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). 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 0.64 to 0.75 and were very similar to those derived from the 1996 and 1997 data on a monthly basis. While the regressions did not show an identifiable seasonality, the constant and the protein coefficient varied inversely, i.e., when the constant rose, the protein coefficient fell, and vice versa. (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 (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 1998 data and those derived by Halverson/Kyburz (see Table 6). The eight sets of results were not appreciably different other than the fact that the parameters, the constant and the butterfat coefficient, moved in opposite directions of each other when compared to the results derived from the previous studies.

Estimates of the relationship between butterfat and protein 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 0.29 to 0.43, similar to those in the 1993 through 1998 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 1.62 in January to 1.97 in May, then fell to 1.66 by December. The butterfat coefficient fell from approximately 0.42 in January to 0.32 in May, then rose to 0.41 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 (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

Under the MCP plan implemented for the Upper Midwest Order, the other solids price is the residual value of the basic formula price after removing the value of the butterfat and protein. Pounds of other solids in producer milk are reported monthly to the Market Administrator from which the other solids content of milk is 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 statistical relationships are very weak at best. The correlation coefficient for other solids and SNF of 0.62 suggests that a moderately strong linear relationship exists, and protein and SNF also appears to have a strong relationship with a coefficient of 0.84. However, these results 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, showed that neither butterfat nor protein represent suitable predictors for estimating other solids levels. These results do, however, suggest that the protein portion, rather than 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 of milk pooled on the Upper Midwest Order presents an opportunity to view component levels in terms of the value of one hundred pounds of 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 1998. 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 1998, the cumulative value of butterfat, protein, other solids and an adjustment for SCC averaged $14.535 per cwt. for the market. The value of each component comprised by the $14.535 per cwt. price was $7.322 for butterfat, $5.939 for protein, and $1.278 for the other solids. The SCC adjustment for the year amounted to about -$397,102, or -0.4¢ per cwt., from aggregated component values of nearly $1.7 billion.

The value of producer milk categorized by size range of delivery is summarized in Table A-5. The highest observed average value was $14.82 per cwt. for monthly producer milk deliveries of 20,000 to 30,000 pounds while the lowest average value of $14.43 was observed for monthly producer milk deliveries of more than 400,000 pounds. In general, the average value of producer milk was greater for monthly deliveries of less than 70,000 pounds than for monthly deliveries of more than 70,000 pounds. These results correspond well to comparisons between means and weighted averages in Part III of this paper. It was noted that mean levels of butterfat and protein relative to the weighted averages indicated that smaller producers tended to have higher levels of these components than larger producers. The higher value of butterfat relative to other solids, in addition to higher butterfat and protein levels, resulted in higher milk values for smaller producers than for larger producers.

VI. SUMMARY

This staff paper analyzes milk components and SCC in producer milk associated with the Upper Midwest Order during 1998. 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, with the implementation of MCP for milk pooled on the Upper Midwest Order, component levels were analyzed on the basis of differing values based on milk composition.

Weighted average component levels and SCC for 1998 were: 3.70% butterfat, 3.17% protein, 5.53% other solids, 8.70% SNF and 355,000 SCC. Weighted average butterfat, protein and SNF levels were lowest in July and highest in November. The weighted monthly average levels of other solids were highest in February through June and lowest in September and exhibited less variation during the year relative to the three other components. Weighted average SCC were lowest in December and highest in July. Approximately three-quarters of monthly average component levels ranged from: 3.46% to 4.00% for butterfat; 3.02% to 3.34% for protein; 5.39% to 5.61% for other solids; 8.47% to 8.89% for SNF; and 201,000 to 557,000 for SCC.

Based on the data for 1998, the following regression equations were derived:

$$SNF = 7.13\% + 0.4148\,(BF)$$
$$SNF = 5.27\% + 1.0711\,(PRO)$$
$$PRO = 1.66\% + 0.4080\,(BF)$$

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 1998 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 $14.53 per cwt. for the market. Butterfat contributed half of the total value due primarily to the level of butterfat prices relative to protein and other solids prices.

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APPENDIX

TABLES

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FIGURES

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Table A-1

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

1998

Butterfat

Month	Weighted Average - % -	Mean - % -	Standard Deviation - % -	Median - % -	Minimum - % -	Maximum - % -	Number of Observations (1,000)
January	3.79	3.83	0.25	3.81	2.65	5.70	12,962
February	3.75	3.79	0.25	3.77	2.59	5.47	12,959
March	3.75	3.79	0.25	3.78	2.57	5.50	12,957
April	3.71	3.75	0.24	3.74	2.30	5.54	12,653
May	3.62	3.64	0.24	3.63	2.22	5.30	12,566
June	3.60	3.62	0.23	3.61	2.26	5.12	12,912
July	3.54	3.56	0.23	3.55	2.24	5.14	12,917
August	3.56	3.58	0.22	3.57	2.15	5.23	12,843
September	3.64	3.67	0.23	3.66	2.29	5.38	12,773
October	3.81	3.85	0.25	3.83	2.28	5.57	12,801
November	3.85	3.89	0.26	3.87	2.42	5.67	12,773
December	3.81	3.85	0.25	3.83	2.38	5.67	12,639
For the Year	3.70	3.73	0.27	3.72	2.15	5.70	153,755

Protein

Month	Weighted Average - % -	Mean - % -	Standard Deviation - % -	Median % -	Minimum - % -	Maximum - % -	Number of Observations (1,000)
January	3.23	3.24	0.16	3.22	2.24	4.59	12,962
February	3.19	3.20	0.16	3.19	2.54	4.81	12,959
March	3.18	3.19	0.15	3.18	2.46	4.17	12,957
April	3.15	3.16	0.15	3.15	2.32	4.31	12,653
May	3.12	3.13	0.14	3.12	2.38	4.11	12,566
June	3.11	3.12	0.13	3.11	2.23	3.98	12,912
July	3.06	3.07	0.13	3.06	2.21	3.97	12,917
August	3.10	3.11	0.14	3.10	2.25	4.03	12,843
September	3.17	3.18	0.14	3.17	2.28	3.99	12,773
October	3.25	3.27	0.15	3.26	2.39	4.23	12,801
November	3.26	3.28	0.16	3.27	2.25	4.34	12,773
December	3.23	3.24	0.16	3.23	2.59	4.32	12,639
For the Year	3.17	3.18	0.16	3.17	2.21	4.81	153,755

Table A-1 (continued)

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

1998

Other Solids

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	(1,000)
January	5.51	5.48	0.11	5.50	4.18	5.78	12,962
February	5.54	5.52	0.11	5.53	4.16	5.79	12,959
March	5.54	5.51	0.11	5.53	4.09	5.84	12,957
April	5.54	5.52	0.10	5.53	4.48	5.79	12,653
May	5.54	5.52	0.10	5.53	4.09	5.89	12,566
June	5.54	5.52	0.10	5.53	3.92	6.00	12,912
July	5.53	5.50	0.11	5.51	4.37	6.01	12,917
August	5.53	5.49	0.11	5.51	4.39	5.98	12,843
September	5.50	5.47	0.11	5.49	4.12	5.80	12,773
October	5.51	5.48	0.12	5.50	4.06	5.97	12,801
November	5.51	5.48	0.12	5.50	3.90	5.81	12,773
December	5.52	5.50	0.11	5.51	4.12	5.80	12,639
For the Year	5.53	5.50	0.11	5.51	3.90	6.01	153,755

Solids-Not-Fat

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	- % -	- % -	- % -	- % -	- % -	- % -	(1,000)
January	8.74	8.72	0.21	8.73	6.84	10.22	12,962
February	8.73	8.71	0.20	8.72	7.19	10.26	12,959
March	8.72	8.70	0.20	8.71	6.57	9.73	12,957
April	8.70	8.68	0.20	8.69	7.07	9.69	12,653
May	8.67	8.65	0.19	8.66	6.47	9.72	12,566
June	8.65	8.64	0.19	8.65	6.15	9.60	12,912
July	8.59	8.57	0.20	8.58	6.58	9.48	12,917
August	8.62	8.60	0.20	8.61	6.63	9.43	12,843
September	8.67	8.65	0.19	8.66	6.40	9.48	12,773
October	8.76	8.75	0.19	8.76	6.45	9.66	12,801
November	8.78	8.76	0.20	8.77	6.16	9.71	12,773
December	8.75	8.74	0.20	8.74	6.77	9.74	12,639
For the Year	8.70	8.68	0.21	8.69	6.15	10.26	153,755

Table A-1 (continued)

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

1998

Somatic Cell Count

Month	Weighted Average	Mean	Standard Deviation	Median	Minimum	Maximum	Number of Observations
	(1,000)						
January	336	363	180	332	24	1,407	12,962
February	333	359	175	331	24	1,497	12,959
March	341	368	178	337	15	1,494	12,957
April	355	382	181	352	21	1,466	12,653
May	356	378	175	352	29	1,422	12,566
June	365	387	175	360	28	1,419	12,912
July	394	420	184	395	22	1,413	12,917
August	392	416	183	390	14	1,474	12,843
September	377	395	172	371	28	1,335	12,773
October	342	361	165	335	30	1,435	12,801
November	334	359	173	330	40	1,459	12,773
December	332	359	176	328	30	1,440	12,639
For the Year	355	379	178	351	14	1,497	153,755

Table A-2

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY REGION 1998

Butterfat

	Region 1 - % -	No. *	Region 2 - % -	No. *	Region 3 - % -	No. *	Region 4 - % -	No. *	Region 5 - % -	No. *	Region 6 - % -	No. *	Mkt. - % -
January	3.83	2,645	3.78	7,267	3.79	807	3.75	1,686	3.79	310	3.85	247	3.79
February	3.80	2,632	3.74	7,286	3.75	815	3.70	1,678	3.72	301	3.78	247	3.75
March	3.82	2,626	3.74	7,301	3.76	828	3.70	1,678	3.74	303	3.83	221	3.75
April	3.78	2,571	3.70	7,244	3.71	696	3.66	1,645	3.67	303	3.77	194	3.71
May	3.68	2,585	3.61	7,148	3.59	703	3.58	1,630	3.52	304	3.62	196	3.62
June	3.63	2,593	3.60	7,201	3.58	811	3.58	1,681	3.50	305	3.57	321	3.60
July	3.55	2,625	3.55	7,195	3.51	814	3.54	1,664	3.43	305	3.50	314	3.54
August	3.59	2,626	3.57	7,157	3.54	799	3.54	1,651	3.45	302	3.51	308	3.56
September	3.67	2,624	3.64	7,155	3.63	735	3.63	1,640	3.56	303	3.61	316	3.64
October	3.87	2,604	3.80	7,270	3.80	694	3.78	1,621	3.80	291	3.82	321	3.81
November	3.90	2,610	3.84	7,261	3.85	689	3.78	1,603	3.86	292	3.88	318	3.85
December	3.86	2,593	3.80	7,206	3.81	704	3.76	1,598	3.82	243	3.82	295	3.81
For the Year	3.75	31,334	3.70	86,691	3.69	9,095	3.67	19,775	3.64	3,562	3.71	3,298	3.70

Protein

	Region 1 - % -	No. *	Region 2 - % -	No. *	Region 3 - % -	No. *	Region 4 - % -	No. *	Region 5 - % -	No. *	Region 6 - % -	No. *	Mkt. - % -
January	3.25	2,645	3.22	7,267	3.23	807	3.21	1,686	3.25	310	3.24	247	3.23
February	3.21	2,632	3.19	7,286	3.18	815	3.18	1,678	3.20	301	3.20	247	3.19
March	3.20	2,626	3.18	7,301	3.18	828	3.17	1,678	3.21	303	3.21	221	3.18
April	3.17	2,571	3.15	7,244	3.15	696	3.15	1,645	3.14	303	3.17	194	3.15
May	3.14	2,585	3.12	7,148	3.12	703	3.12	1,630	3.10	304	3.10	196	3.12
June	3.13	2,593	3.11	7,201	3.10	811	3.11	1,681	3.13	305	3.09	321	3.11
July	3.09	2,625	3.06	7,195	3.05	814	3.06	1,664	3.07	305	3.02	314	3.06
August	3.11	2,626	3.10	7,157	3.08	799	3.10	1,651	3.10	302	3.05	308	3.10
September	3.20	2,624	3.16	7,155	3.15	735	3.17	1,640	3.19	303	3.13	316	3.17
October	3.28	2,604	3.24	7,270	3.25	694	3.24	1,621	3.30	291	3.26	321	3.25
November	3.29	2,610	3.25	7,261	3.26	689	3.26	1,603	3.32	292	3.28	318	3.26
December	3.25	2,593	3.22	7,206	3.23	704	3.22	1,598	3.27	243	3.24	295	3.23
For the Year	3.19	31,334	3.17	86,691	3.16	9,095	3.17	19,775	3.18	3,562	3.17	3,298	3.17

* Number of producers with monthly average component levels.

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY REGION
1998

Other Solids

	Region 1 - % -	No. *	Region 2 - % -	No. *	Region 3 - % -	No. *	Region 4 - % -	No. *	Region 5 - % -	No. *	Region 6 - % -	No. *	Mkt. % -
January	5.48	2,645	5.52	7,267	5.52	807	5.54	1,686	5.55	310	5.54	247	5.51
February	5.50	2,632	5.55	7,286	5.55	815	5.58	1,678	5.57	301	5.58	247	5.54
March	5.51	2,626	5.54	7,301	5.54	828	5.57	1,678	5.57	303	5.57	221	5.54
April	5.51	2,571	5.55	7,244	5.55	696	5.58	1,645	5.58	303	5.58	194	5.54
May	5.50	2,585	5.54	7,148	5.55	703	5.57	1,630	5.59	304	5.59	196	5.54
June	5.52	2,593	5.54	7,201	5.53	811	5.57	1,681	5.58	305	5.56	321	5.54
July	5.50	2,625	5.53	7,195	5.52	814	5.56	1,664	5.57	305	5.55	314	5.53
August	5.50	2,626	5.53	7,157	5.52	799	5.55	1,651	5.56	302	5.53	308	5.53
September	5.47	2,624	5.50	7,155	5.49	735	5.53	1,640	5.51	303	5.49	316	5.50
October	5.47	2,604	5.51	7,270	5.52	694	5.55	1,621	5.53	291	5.52	321	5.51
November	5.48	2,610	5.52	7,261	5.50	689	5.55	1,603	5.53	292	5.52	318	5.51
December	5.48	2,593	5.53	7,206	5.52	704	5.56	1,598	5.53	243	5.54	295	5.52
For the Year	5.49	31,334	5.53	86,691	5.53	9,095	5.56	19,775	5.56	3,562	5.55	3,298	5.53

Solids-Not-Fat

	Region 1 - % -	No. *	Region 2 - % -	No. *	Region 3 - % -	No. *	Region 4 - % -	No. *	Region 5 - % -	No. *	Region 6 - % -	No. *	Mkt. - % -
January	8.73	2,645	8.74	7,267	8.75	807	8.75	1,686	8.81	310	8.78	247	8.74
February	8.71	2,632	8.73	7,286	8.74	815	8.75	1,678	8.78	301	8.78	247	8.73
March	8.71	2,626	8.72	7,301	8.72	828	8.74	1,678	8.78	303	8.78	221	8.72
April	8.67	2,571	8.70	7,244	8.70	696	8.72	1,645	8.72	303	8.75	194	8.70
May	8.65	2,585	8.67	7,148	8.67	703	8.69	1,630	8.70	304	8.69	196	8.67
June	8.65	2,593	8.65	7,201	8.63	811	8.69	1,681	8.71	305	8.65	321	8.65
July	8.59	2,625	8.59	7,195	8.56	814	8.62	1,664	8.64	305	8.57	314	8.59
August	8.61	2,626	8.63	7,157	8.60	799	8.64	1,651	8.66	302	8.58	308	8.62
September	8.67	2,624	8.66	7,155	8.64	735	8.70	1,640	8.70	303	8.63	316	8.67
October	8.75	2,604	8.76	7,270	8.76	694	8.79	1,621	8.84	291	8.79	321	8.76
November	8.77	2,610	8.77	7,261	8.77	689	8.81	1,603	8.85	292	8.80	318	8.78
December	8.74	2,593	8.74	7,206	8.75	704	8.78	1,598	8.80	243	8.78	295	8.75
For the Year	8.69	31,334	8.70	86,691	8.69	9,095	8.72	19,775	8.74	3,562	8.71	3,298	8.70

* Number of producers with monthly average component levels.

Table A-2 (Continued)

WEIGHTED AVERAGE COMPONENT LEVELS AND SOMATIC CELL COUNT BY REGION
1998

Somatic Cell Counts

	Region 1 (1,000)	No. *	Region 2 (1,000)	No. *	Region 3 (1,000)	No. *	Region 4 (1,000)	No. *	Region 5 (1,000)	No. *	Region 6 (1,000)	No. *	Market (1,000)
January	332	2,645	338	7,267	338	807	336	1,686	285	310	335	247	336
February	329	2,632	335	7,286	339	815	326	1,678	298	301	350	247	333
March	337	2,626	344	7,301	350	828	331	1,678	314	303	355	221	341
April	346	2,571	358	7,244	366	696	355	1,645	323	303	370	194	355
May	342	2,585	362	7,148	352	703	362	1,630	310	304	340	196	356
June	344	2,593	371	7,201	369	811	372	1,681	312	305	368	321	365
July	377	2,625	400	7,195	406	814	394	1,664	356	305	407	314	394
August	369	2,626	400	7,157	405	799	390	1,651	359	302	402	308	392
September	352	2,624	384	7,155	392	735	379	1,640	339	303	384	316	377
October	329	2,604	346	7,270	357	694	342	1,621	310	291	340	321	342
November	328	2,610	334	7,261	338	689	343	1,603	319	292	331	318	334
December	332	2,593	332	7,206	332	704	334	1,598	307	243	322	295	332
For the Year	343	31,334	359	86,691	362	9,095	355	19,775	320	3,562	359	3,298	355

***** Number of producers with monthly average component levels.

Table A-3

LINEAR RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS

1998

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	7.09332	0.42489	0.00612	0.27112	0.17650	12,962
February	7.16777	0.40869	0.00621	0.25073	0.17610	12,959
March	7.14221	0.41093	0.00615	0.25595	0.17465	12,957
April	7.26618	0.37629	0.00641	0.21398	0.17539	12,653
May	7.34993	0.35788	0.00649	0.19461	0.17148	12,566
June	7.22382	0.39089	0.00640	0.22388	0.16568	12,912
July	7.08743	0.41686	0.00666	0.23247	0.17093	12,917
August	7.11486	0.41428	0.00686	0.22113	0.17429	12,843
September	7.22011	0.39018	0.00653	0.21836	0.17030	12,773
October	7.32817	0.37048	0.00608	0.22491	0.17137	12,801
November	7.29284	0.37736	0.00608	0.23187	0.17897	12,773
December	7.24261	0.38852	0.00603	0.24744	0.17206	12,639
For the Year	7.13236	0.41482	0.00167	0.28708	0.17407	153,755

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	5.26228	1.06841	0.00600	0.70982	0.11137	12,962
February	5.28689	1.07145	0.00626	0.69328	0.11267	12,959
March	5.10684	1.12648	0.00610	0.72438	0.10629	12,957
April	5.01548	1.16002	0.00601	0.74672	0.09956	12,653
May	4.99813	1.16682	0.00636	0.72827	0.09961	12,566
June	4.86056	1.21113	0.00634	0.73843	0.09618	12,912
July	4.79050	1.23140	0.00668	0.72454	0.10240	12,917
August	4.87045	1.20055	0.00706	0.69236	0.10954	12,843
September	5.06229	1.12704	0.00717	0.65891	0.11250	12,773
October	5.41355	1.02039	0.00680	0.63748	0.11720	12,801
November	5.40962	1.02178	0.00651	0.65846	0.11934	12,773
December	5.40139	1.02891	0.00627	0.68037	0.11213	12,639
For the Year	5.27270	1.07108	0.00175	0.70999	0.11102	153,755

Table A-3 (continued)

LINEAR RELATIONSHIPS BETWEEN VARIOUS MILK COMPONENTS
1998
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	1.61723	0.42291	0.00426	0.43198	0.12287	12,962
February	1.64112	0.41164	0.00424	0.42124	0.12027	12,959
March	1.69454	0.39440	0.00413	0.41306	0.11720	12,957
April	1.80279	0.36105	0.00433	0.35504	0.11835	12,653
May	1.97204	0.31867	0.00446	0.28848	0.11789	12,566
June	1.93496	0.32725	0.00428	0.31173	0.11070	12,912
July	1.85376	0.34178	0.00431	0.32707	0.11064	12,917
August	1.84555	0.35175	0.00440	0.33190	0.11188	12,843
September	1.91027	0.34738	0.00434	0.33368	0.11325	12,773
October	1.78601	0.38655	0.00418	0.39995	0.11799	12,801
November	1.70432	0.40498	0.00418	0.42347	0.12314	12,773
December	1.66459	0.41008	0.00421	0.42898	0.12015	12,639
For the Year	1.65909	0.40796	0.00115	0.44865	0.12043	153,755

Coefficients for Month Variables in Equations for 1998*

Month **	(**m** month coefficients) SNF=c+b(BF)	SNF=c+b(PRO)	PRO=c+b(BF)
February	0.01533	0.03591	-0.02021
March		0.03176	-0.03190
April	-0.00824	0.04570	-0.04948
May	0.01043	0.04849	-0.03291
June	0.00456	0.04841	-0.03766
July	-0.03926	0.03544	-0.06409
August	-0.02047	0.02405	-0.03749
September		-0.01112	0.00917
October	0.02958	-0.00750	0.03038
November	0.02001	-0.00745	0.02083
December	0.01347	0.01083	

* 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

1998

Month	Butterfat Price	Protein Price	Other Solids Price	Somatic Cell Adjustment Rate
	---------------------($/Pound)--------------------			($/cwt. Per 1,000 SCC)
January	$1.2326	$1.8698	$0.5298	$0.00071
February	1.4842	1.8695	0.3879	0.00071
March	1.4309	1.8207	0.3657	0.00069
April	1.4904	1.7255	0.2457	0.00065
May	1.7976	1.4524	0.0000	0.00060
June	2.2251	1.6953	0.0000	0.00070
July	2.2997	2.0666	0.0688	0.00078
August	2.5142	2.0014	0.0000	0.00082
September	3.2873	1.1214	0.0000	0.00083
October	2.7949	1.8947	0.0000	0.00088
November	1.8861	2.4178	0.4090	0.00092
December	1.4472	2.4693	0.7556	0.00094
Simple Average	$1.9909	$1.8670	$0.2302	$0.00077

Table A-5

AGGREGATED COMPONENT VALUES BY SIZE RANGE OF MONTHLY PRODUCER MILK DELIVERIES

1998

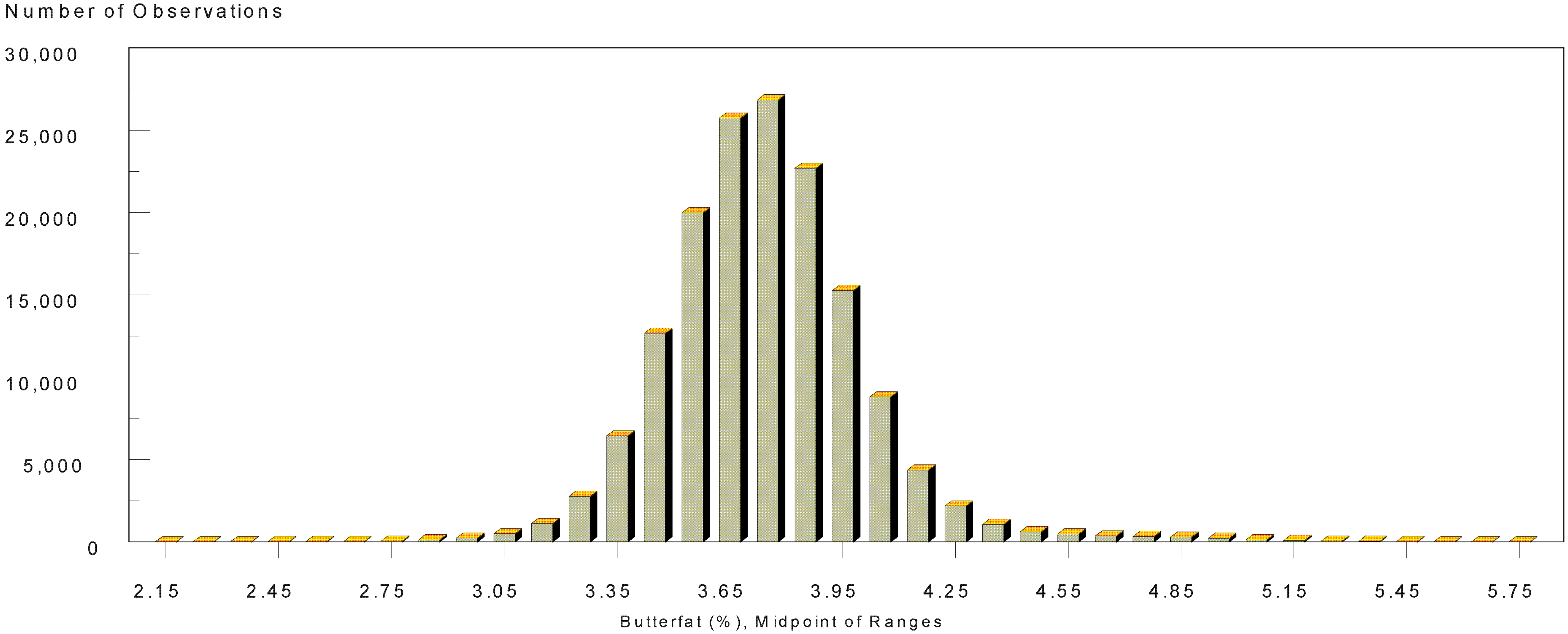
Size Range: Equal to or more than (Pounds)	Size Range: Less than (Pounds)	Aggregated Component Values* ($)	Producer Milk (Pounds)	Weighted Average Value ($/Cwt.)
	20,000	$39,775,684.89	270,427,459	$14.708
20,000	30,000	42,261,525.11	285,138,371	14.821
30,000	50,000	167,057,758.91	1,140,492,435	14.648
50,000	70,000	238,790,025.04	1,643,856,171	14.526
70,000	100,000	336,321,906.14	2,321,613,047	14.487
100,000	150,000	319,159,209.53	2,199,131,451	14.513
150,000	250,000	227,814,234.00	1,565,322,540	14.554
250,000	400,000	102,464,590.00	702,734,166	14.581
400,000		198,445,507.10	1,375,315,176	14.429
Total		$1,672,090,440.72	11,504,030,816	
Weighted Average				$14.535

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

Figure A-1

FREQUENCY DISTRIBUTION OF

MONTHLY AVERAGE BUTTERFAT LEVELS: 1998



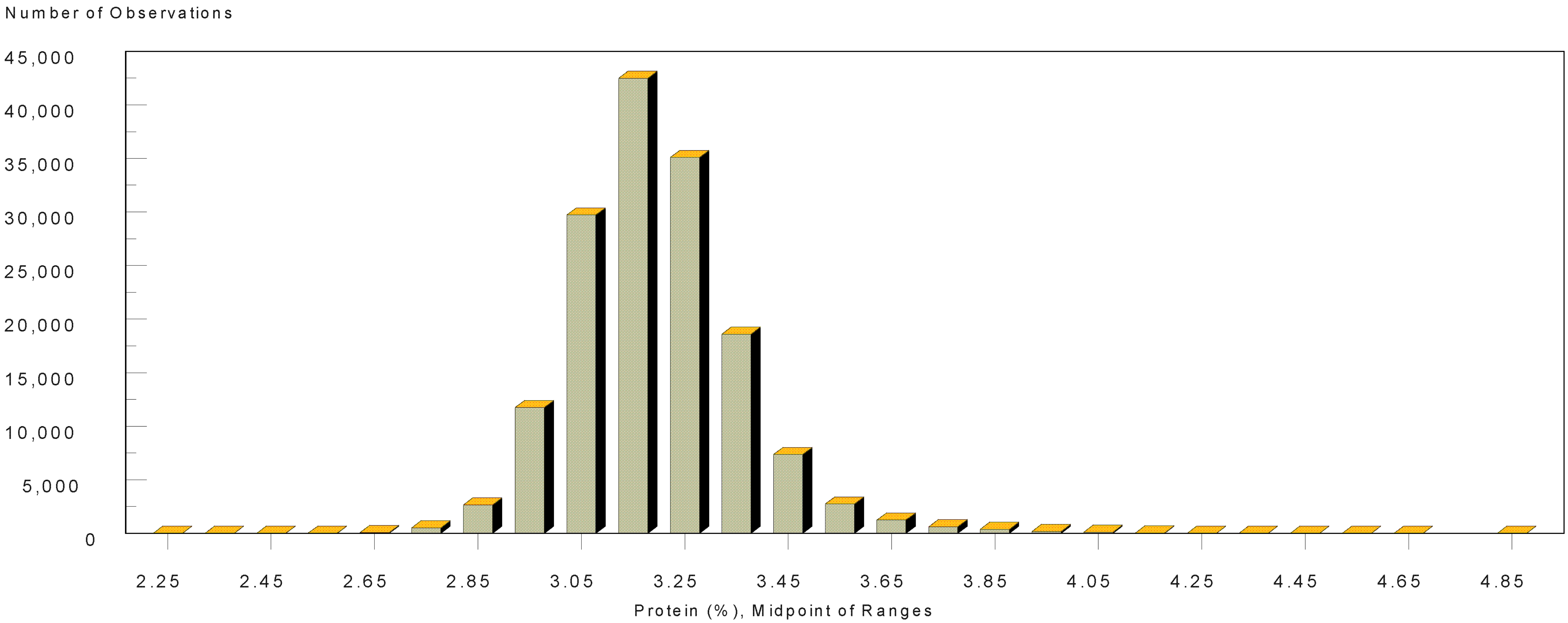
Skewness statistic: 0.859

Kurtosis statistic: 4.012

Figure A-2

FREQUENCY DISTRIBUTION OF

MONTHLY AVERAGE PROTEIN LEVELS: 1998



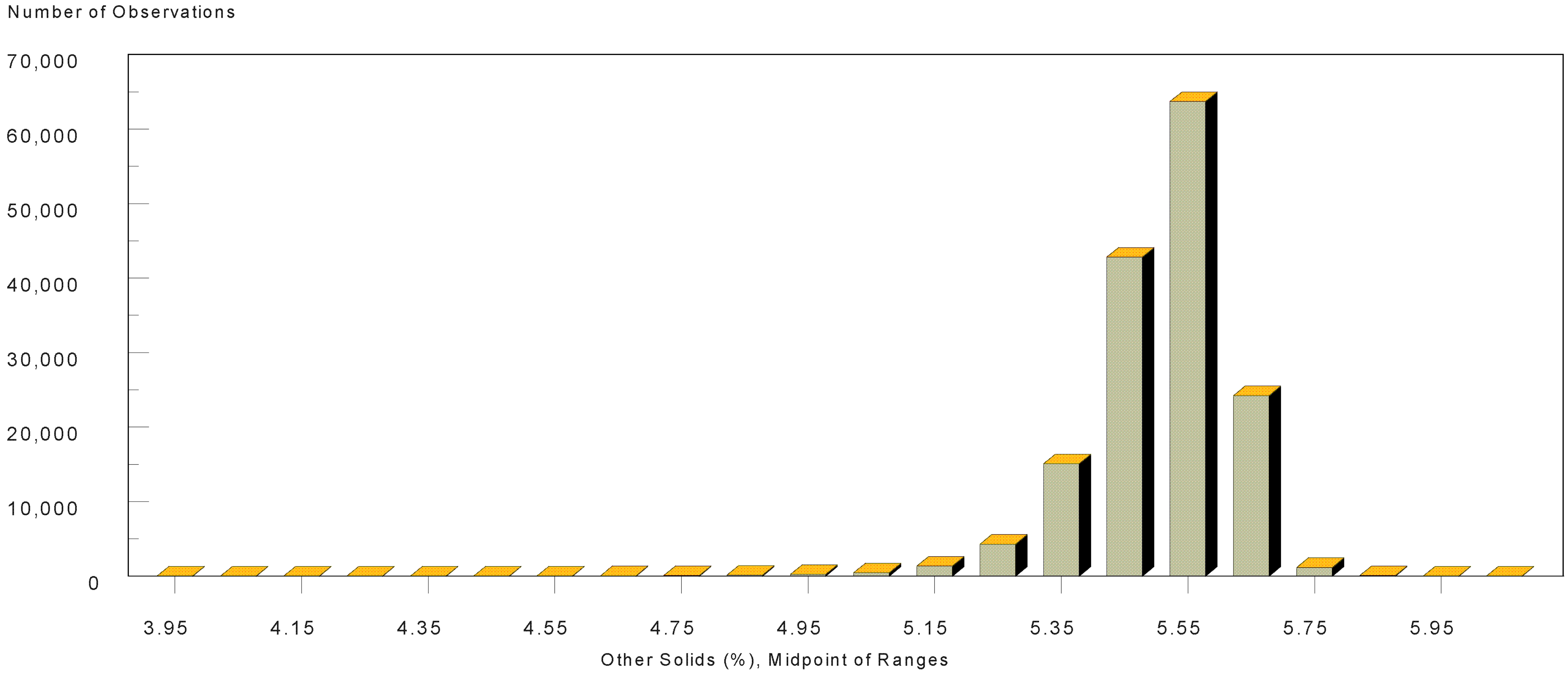
Skewness statistic: 0.827

Kurtosis statistic: 2.987

Figure A-3

FREQUENCY DISTRIBUTION OF

MONTHLY AVERAGE OTHER SOLIDS LEVELS: 1998



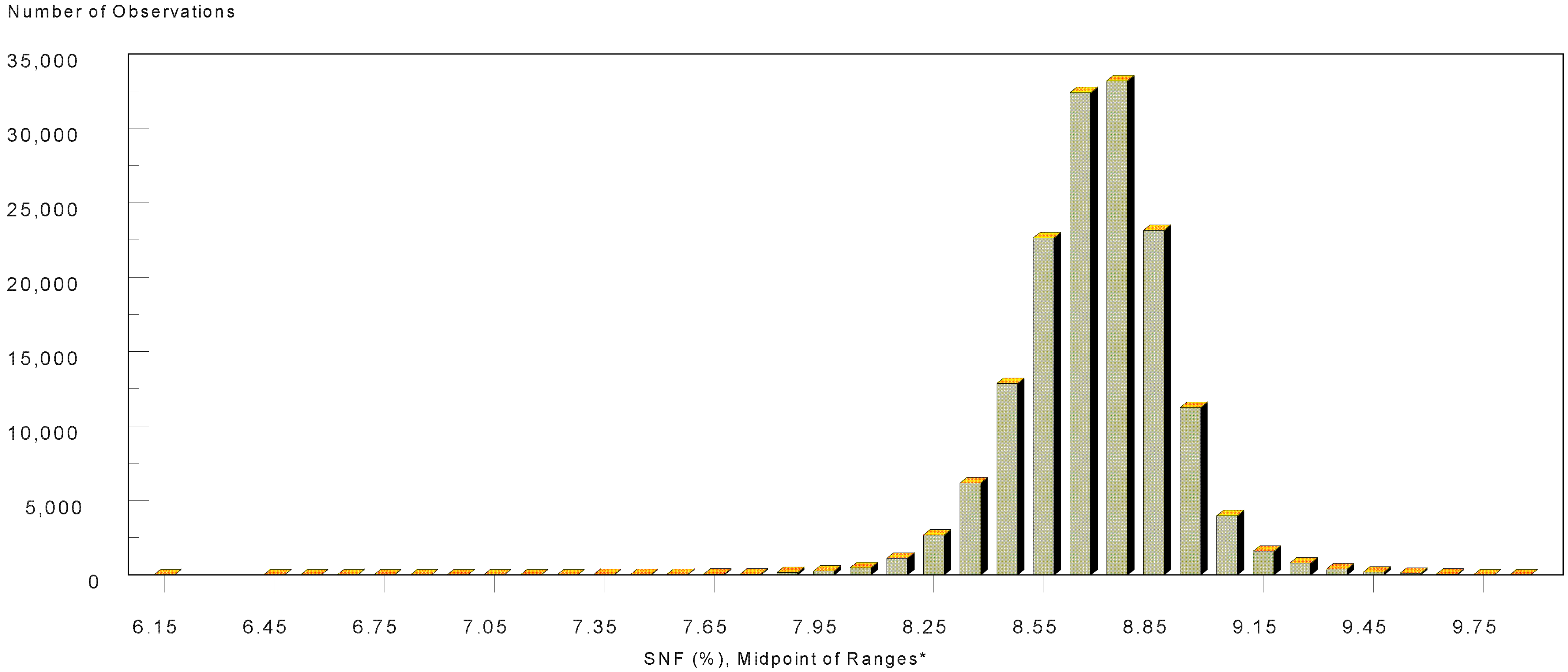
Skewness statistic: -1.688

Kurtosis statistic: 8.974

Figure A-4

FREQUENCY DISTRIBUTION OF

MONTHLY AVERAGE SOLIDS-NOT-FAT LEVELS: 1998



Skewness statistic: -0.469

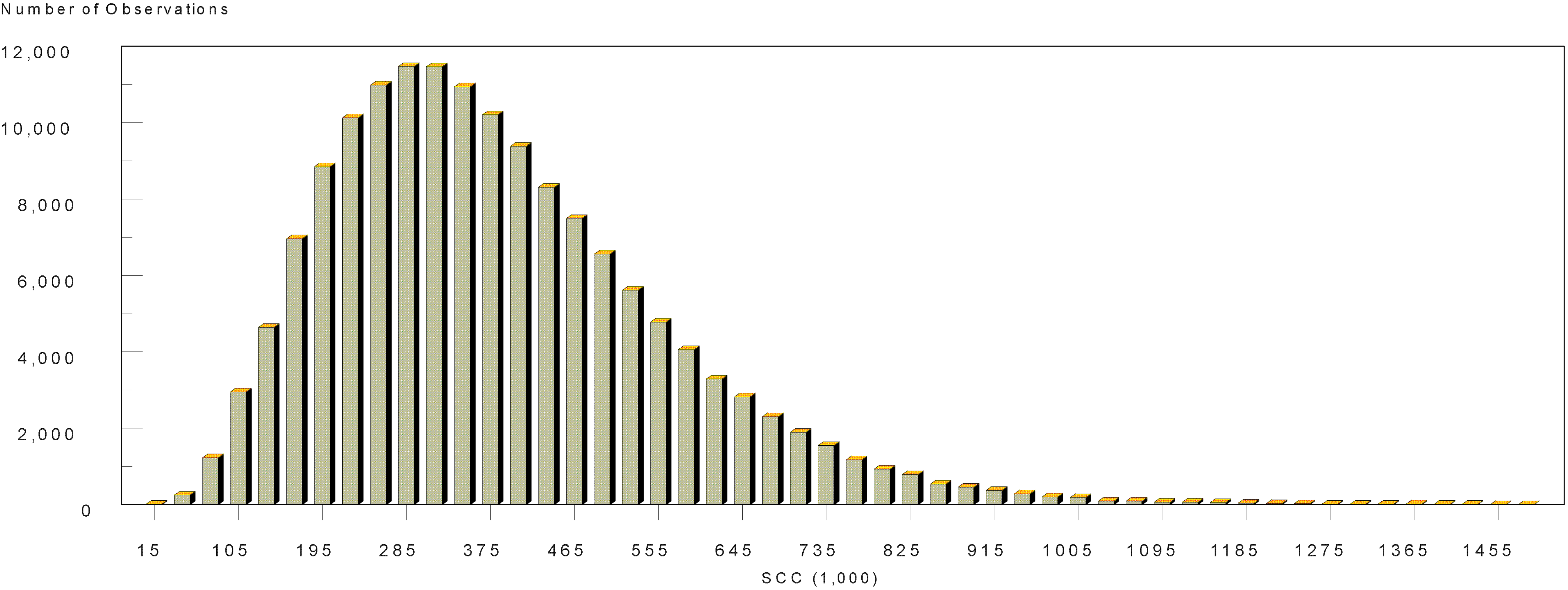
Kurtosis statistic: 4.283

* Several maximum values were not graphically represented in Figure A-4.

Figure A-5

FREQUENCY DISTRIBUTION OF

MONTHLY AVERAGE SOMATIC CELL COUNT: 1998

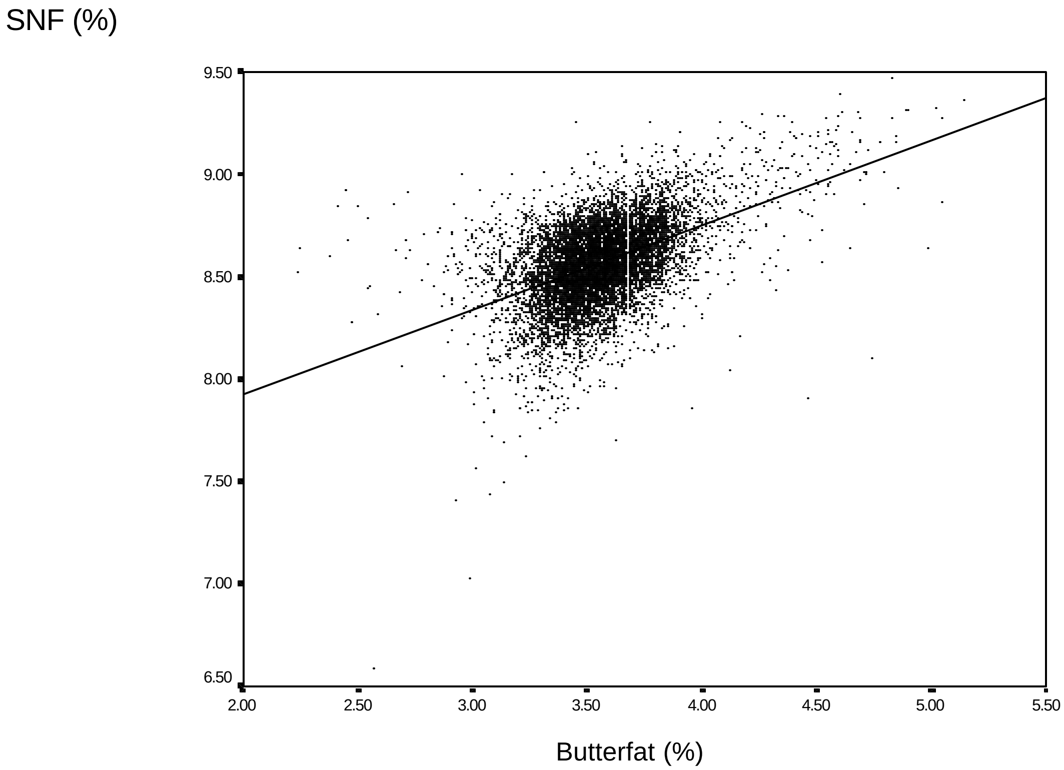


Skewness statistic: 0.956

Kurtosis statistic: 1.437

Figure A-6
SCATTERPLOT OF SOLIDS-NOT-FAT AND BUTTERFAT
JULY AND NOVEMBER 1998

July (12,917 observations: SNF=7.08743 + 0.41686 (Butterfat))



November (12,773 observations: SNF= 7.29284 + 0.37736 (Butterfat))

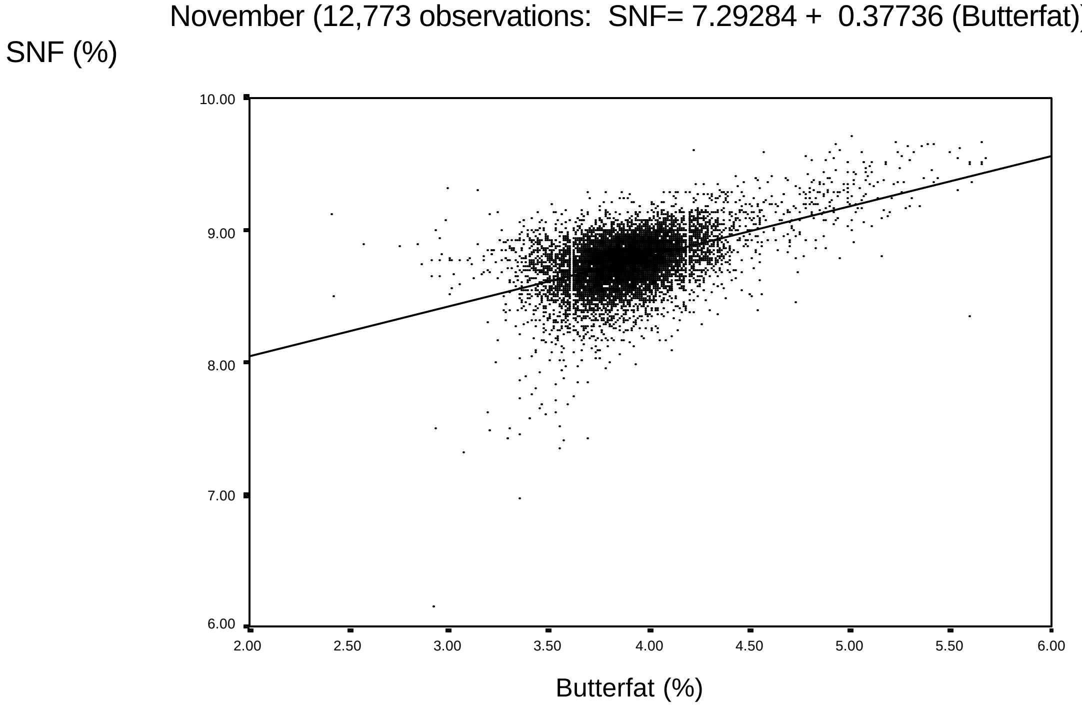
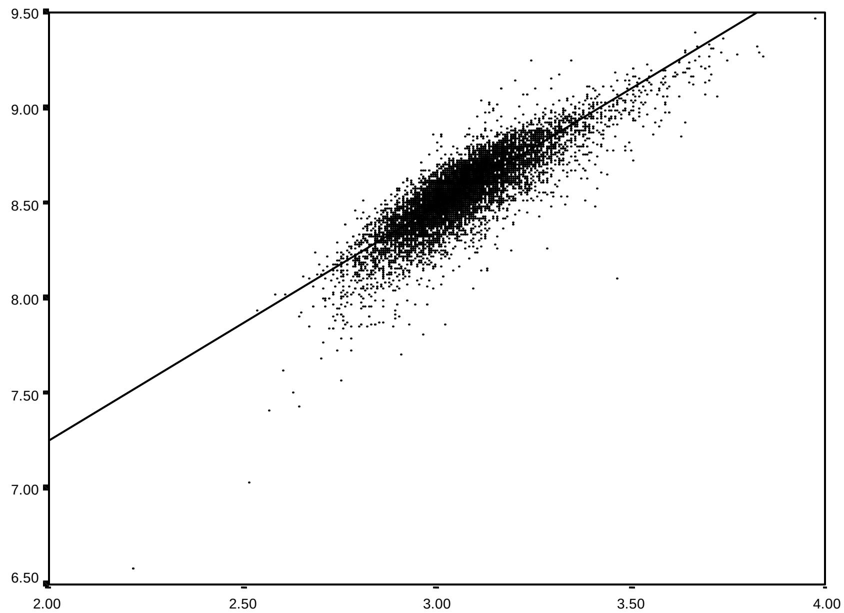


Figure A-7
SCATTERPLOT OF SOLIDS-NOT-FAT AND PROTEIN
JULY AND NOVEMBER 1998

July (12,917 observations: SNF=4.79050 + 1.23140 (Protein))

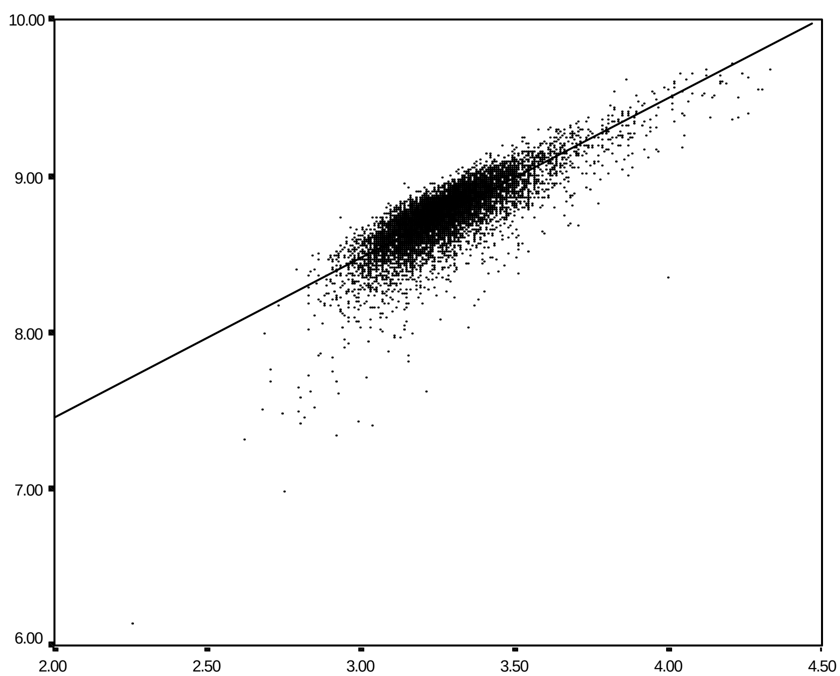
SNF (%)



Protein (%)

November (12,773 observations: SNF= 5.40962 + 1.02178 (Protein))

SNF (%)

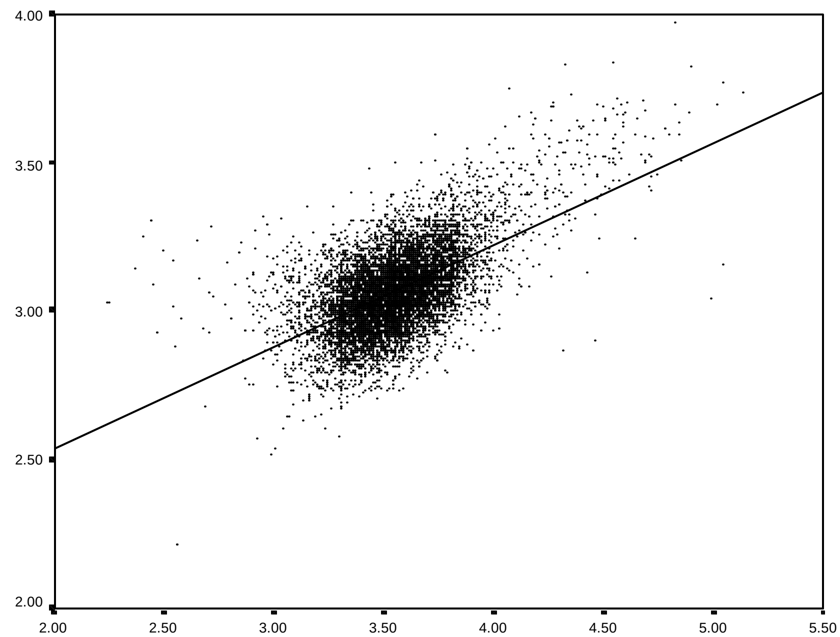


Protein (%)

Figure A-8
SCATTERPLOT OF PROTEIN AND BUTTERFAT
JULY AND NOVEMBER 1998

July (12,917 observations: Protein=1.85375 + 0.34178 (Butterfat))

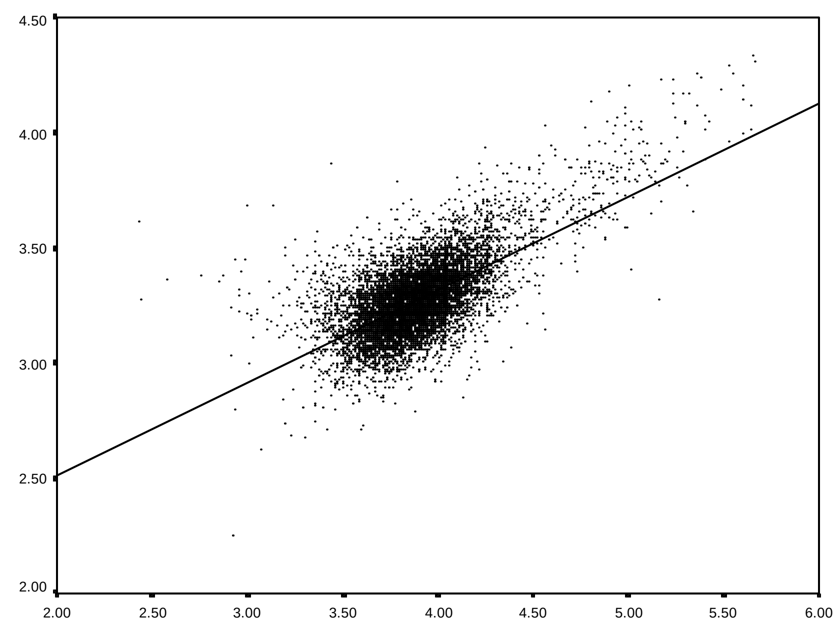
Protein (%)



Butterfat (%)

November (12,773 observations: Protein= 1.70432 + 0.40498 (Butterfat))

Protein (%)



Butterfat (%)