Class III Milk Pricing: An Evaluation of Assumptions and Calculations

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The information contained in this document will be presented at the USDA Price Hearing that starts on May 8, 2000.

My areas of expertise are in cheese and whey processing technology, milk component analysis, cheese characteristics, milk composition and quality, cheese yield formulas, factors influencing cheese yield, and cheese manufacturing costs. I teach a course on the chemistry of dairy products and carry out research on these topics as part of my responsibilities as a faculty member at Cornell University. I received my Ph.D. in Food Science from Cornell University in 1978 and I have been on the faculty at Cornell University since 1980. I am not representing any company or producer group at this hearing. I do not own or operate a farm, cheese company, or any other dairy product manufacturing business. My purpose in presenting this information is 1) to provide the dairy industry and USDA with a critical review of the current system of Class III price calculation and assumptions used in the calculation and 2) to offer a different approach and some new ideas for calculating the Class III price. The approach that I will present is derived from the VanSlyke Cheddar cheese yield formula. The objective of this approach is to provide better economic signals between processors and milk producers. Hopefully, a more fair and equitable reflection of changes in milk values for both producers and processors can be achieved.

Introduction:

Historically, the basis for a national Class III milk price was the Minnesota-Wisconsin Price Series for manufacturing grade milk. When there was a large volume of "unregulated" milk for manufacturing being sold for cheese manufacturing, this price reflected the unregulated "free market value" of milk for cheese making. Milk used for Class II or Class I products would have a higher value. Over the years the quantity of milk represented by the Minnesota-Wisconsin Price Series decreased. In the 1990's the validity of using the Minnesota-Wisconsin Price Series as the basis for setting the uniform Class III milk price throughout the USDA Federal Milk Marketing Orders was questioned.

Because of changes in industry structure within the US, the US Congress mandated that the USDA Federal Milk Marketing Orders reorganize to better reflect the current milk marketing areas within the US in the 1996 Farm Bill. At the same time, the Congress provided that USDA may make revisions to the milk pricing system to ensure that fair and equitable prices are paid to milk producers in all regions of the country and to harmonize the provisions of the system of milk pricing in different regions of the country. In doing this, a fundamental change was made to the method for establishing the Class III price for milk within the Federal Orders. Milk in Class III would be priced based on component values. The VanSlyke cheese yield formula was used to calculate the butterfat and protein factors (i.e., 1.582 and 1.405) used to arrive at a protein value in the Class III price calculation (1).

Starting January 1, 2000, the monthly Class III price has been calculated as follows:

A. True Protein Price ($/lb) is determined in two steps:

1. Calculation of the Value of the Protein in Cheese:

   (NASS Monthly Cheddar Price) minus (Cheddar Make Allowance) x (1.405)

   The 1.405 factor is derived from the VanSlyke Cheddar cheese yield formula and is designed to reflect the expected increase in Cheddar cheese yield that would occur for a unit increase in true protein content of milk. To calculate this factor the following parameters used in the VanSlyke formula calculation are needed: fat and true protein content of the milk, the percentage fat recovery in the cheese, the proportion of true protein that is casein, and the moisture content of the cheese. Selection of a different set of assumptions for these parameters will produce a different factor than 1.405.

2. Calculation of the Extra Value of Protein Due to Fat:

   [(NASS Monthly Cheddar Price) minus (Cheddar Make Allowance) x (1.582)] minus (the butterfat price) x (1.28).

   It is my understanding that the primary reason this calculation is done is to reflect the added value of milk fat in cheese in the absence of a discreet price for milk fat used in Class III.

   The 1.582 factor is also derived from the VanSlyke Cheddar cheese yield formla and is designed to reflect the increase in cheese yield from a unit increase in milkfat. Again, to calculate this factor the following parameters used in the VanSlyke formula calculation are needed: fat and true protein content of the milk, the percentage of fat recovered in the cheese, the proportion of true protein that is casein, and the moisture content of the cheese. Selection of a different set of assumptions for these parameters will produce a different factor than 1.582.

   The 1.28 is not derived directly from the Van Slyke cheese yield formula. It is my understanding that this factor is supposed to reflect the amount of milk fat that one pound of true protein in milk can hold in Cheddar cheese. For the purpose of calculations in Federal Order Reform and calculation of the Class III price, a milk containing 3.5% fat, 2.9915% true protein, and 5.6935% other solids (i.e., 3.10% true protein and 5.90% other solids in the skim portion) has been used for calculations of the Class III price. However, relative to the 1.28 assumption in the calculation of the extra value of protein due to fat, the average ratio of fat to true protein that exists in the milk supply will probably be lower than this value all year. In a national milk composition study of commingled milks in cheese factories in the US in 1984, it was found that the ratio of fat to true protein varied throughout the year with values ranging from 1.145 to 1.18. Generally, the fat to casein ratio is lowest in June, July, and August.

These two values (i.e., Value of Protein in Cheese and the Extra Value of Protein due to Fat) are added together to arrive at the true protein price. The 1.405 and the 1.582 factors were derived from the Van Slyke Cheese Yield Formula.

Sample Calculation: (March 1999 Prices)
NASS Cheese Price $1.3064/lb
Cheddar Make Allowance $0.1702/lb
NASS Whey Powder Price $0.1917 /lb
Whey Powder Make Allowance $0.137/lb

Calculate True Protein Price
1. ($1.3064/lb) - ($0.1702) x (1.405) = $1.5964/lb
2. (($1.3064/lb) - ($0.1702) x 1.582) - ($1.4487) x (1.28) = $0.4464/lb
3. $1.5964 + $0.4464 = $2.0428/lb of true protein

B. <u>Other Solids Price Calculation</u>
1. (NASS Dry Whey, $/lb) minus (whey make allowance)/(0.968)
($0.1917) - ($0.137)/(0.968) = $0.0565/lb
The 0.968 factor is used to reflect that on average dry whey is 3.2% by weight moisture.

C. <u>Class III Skim Price is Calculated (at 3.1% true protein and 5.9% other solids) As Follows</u>:
(True Protein Price) x (3.1) = $2.0428 x 3.1 = $6.3330
(Other Solids Price) x (5.9) = $0.0565 x 5.9 = $0.3334
($6.3327 + $0.3334) = $6.6664 per hundred weight

D. <u>Class III Price at 3.5% fat is calculated As Follows</u>:

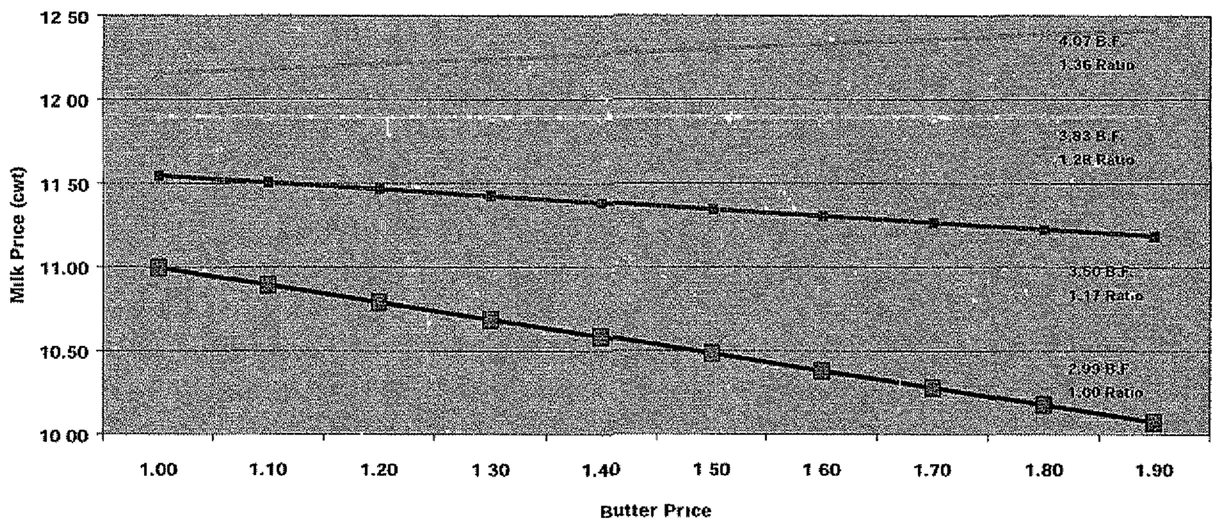
Class III Skim Price	$6.6664 x 0.965	$ 6.4331	(Skim portion)
Butterfat Price	$1.4487 x 3.5	+ <u>$ 5.0705</u>	(Fat portion)
Class III Milk Price at 3.5% fat		$11.5036	

Behavior of Class III Whole Milk and Skim Prices When Fat Value Changes.

In my opinion, when the Class III milk price calculation (described above) is used to calculate the whole and skim milk values in Class III with changing butterfat prices and milk compositions, the changes in the milk prices in relation to changes in milk fat price do not give sensible economic signals to milk producers. The fundamental problem (in the current Class III price calculation) is that when the value of milk fat goes up (driven by an increasing butter price), the calculated true protein value in dollars per pound of protein goes down, and it goes decreases at a faster rate than the value of milk fat increases. Thus, when the price of butter increases, the Class III milk price (i.e., milk price paid by cheese makers) for a milk that has a fat to protein ratio of less than 1.28 will go down. I will use several examples to illustrate this point.

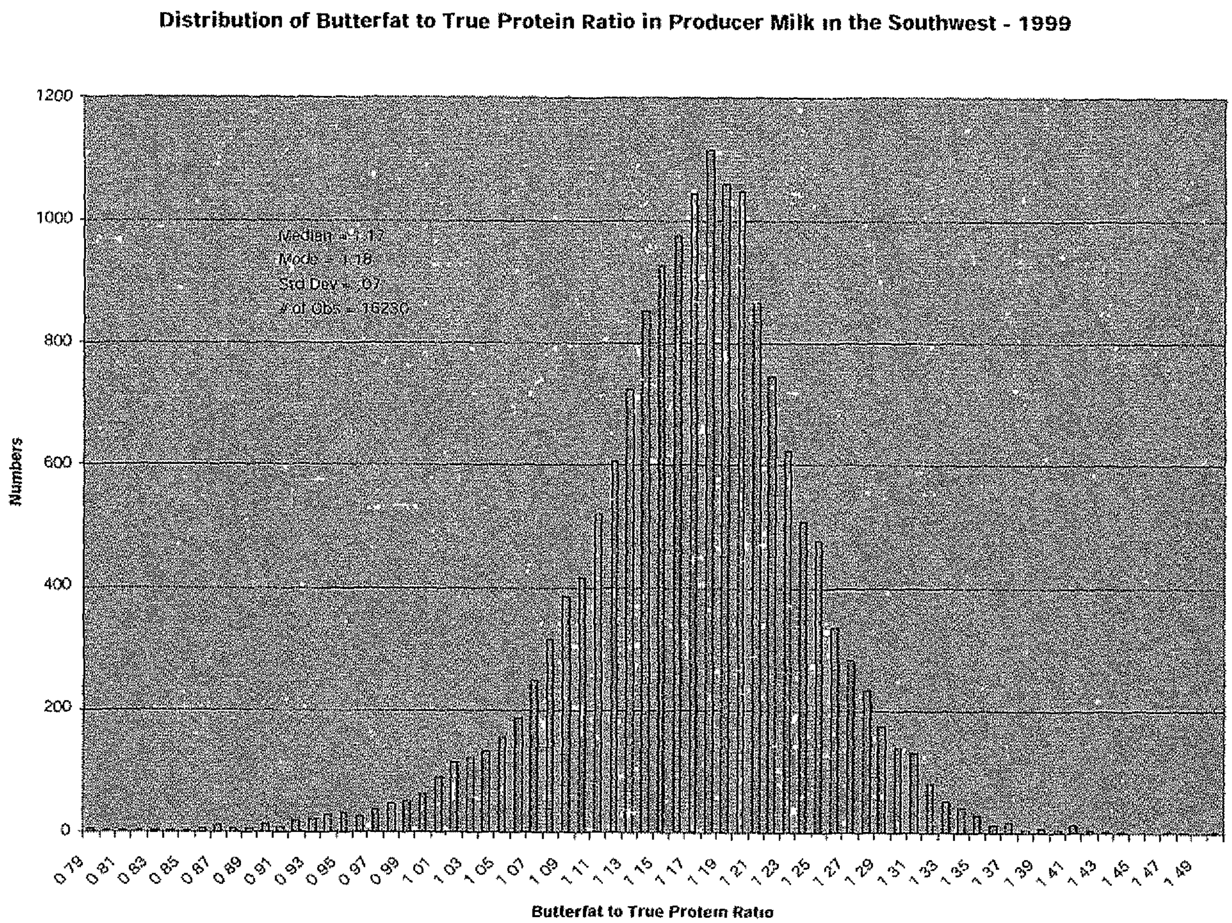
In Figure 1, the butter price is increased from $1.00 per pound to $1.90 per pound. For a producer with a milk that contains 3.83% fat, 2.99 true protein, and 5.68% other solids, the price paid for milk by the cheese maker will remain constant as the butter price increases from $1.00 to $1.90 per pound. This means that the price for the skim portion paid to this producer is going down at the same rate the fat value in that milk is increasing. Thus, despite the fact that butter is short and the price is high, the price (at constant milk composition) that a farmer (with a ratio of milk fat to true protein of less than 1.28) receives for milk decreases with increasing price of butter fat. As seen from Figure 1, a producer with a 1.36 ratio of fat to true protein, the milk price goes up by about $0.30 /cwt when the butter price increases from $1.00 to $1.90 per pound. However, for the producer with a 1.00 ratio of fat to protein and a 2.99% fat test, the price of milk goes down by about $1.00 /cwt as the butter price increases from $1.00 to $1.90 per pound. This is not the correct economic signal to send to dairy farmers in this situation. If a plot of skim milk value instead of whole milk value is made, the decrease in skim milk value as butter price increases (and cheese price remains constant) is even more dramatic than that shown for whole milk in **Figure 1** (shown below).

Producer Milk Values(cwt) at Various Butter Prices Assuming $1.30/lb Cheese Price and 19¢/lb Dry Whey and Components for Producers of Varing B.F, 2.99 Protein and 5.68 O.S.



How does this impact producers in a market? Figure 2 is a frequency distribution of fat to true protein ratio for producer milk from the Southwest Federal Milk Market Order (provided by the market administrator). The distribution represents 16,230 observations in one federal order in 1999 for the average fat to true protein ratio. The distribution of fat to casein ratios is relatively normal in shape, but the median ratio of milk fat to true protein is 1.17. Only about 5% of the producer milk samples had a fat to true protein ratio that was higher than 1.28. Thus, when butter price increases, the average class III price for the group of producers with a fat to true protein ratio less than 1.28 will decrease at constant cheese and whey powder price. At first glance, one might say moving the 1.28 factor to 1.17 will fix the problem for this population of producers. However, what this will do is make the price paid to half the producers go up and half the producers go down when butter price increases. When milk fat value (NASS AA butter price) increases, the price paid to every producer for milk should go up to reflect the increased value of the fat portion of the milk.

Figure 2



While the current system for Class III price calculation represents a tremendous amount of thinking and development by the industry and USDA staff, in my opinion, the current system for the Class III price calculation is not providing the correct signals from processor to producer when the market prices of various products change, particularly milk fat. There are additional and more subtle issues in the current Class III price calculation that trouble me, but in my view the one illustrated in Figures 1 and 2 is the major one and it needs to be corrected. Thus, I have come to this hearing to present some ideas on how to eliminate some of the short comings of the current method of calculation of the Class III price for milk within the Federal Milk Market Orders.

How Should The Dairy Industry Modify the Class III Price Calculation to Eliminate these Short Comings?

The approach that I propose is also based on the VanSlyke Cheddar cheese yield formula. The VanSlyke formula works well for full fat Cheddar cheese made from milk that is not fortified with nonfat milk solids. For other cheeses and cheeses made using fortified milks, other yield formulas would be more appropriate (2) for prediction of cheese yield. In my opinion, the selection of Cheddar cheese made without nonfat solids fortification of milk for cheese making is the right choice as the basis for the Class III <u>minimum</u> uniform milk price calculation. Below I will provide the full detail for the basis of a different method of Class III uniform minimum price calculation.

First, I would like to explain the VanSlyke Cheddar Cheese Yield Formula.

$$\text{Cheddar cheese yield} = \frac{[(\%\text{ fat recovery x }\%\text{ fat}) + (0.78\text{ x crude protein} - 0.1)]1.09}{1 - (\text{cheese moisture}/100)}$$

The value selected for % fat recovery (in the cheese) for the calculation can be debated, however a 93% fat recovery in the cheese is achievable with modern cheese making equipment and was achievable in the mid 1890's when VanSlyke developed his cheese yield formula based on observations of Cheddar cheese making practice in many factories in central New York over a two year period.

The 0.78 times crude protein is a substitute for a measurement of the casein content of the milk. The original VanSlyke formula uses percent milk casein. The industry has used an assumption that 78.00% of the crude protein content of milk is casein. For a 3.67% fat milk with a 3.1762 crude protein (3.1% true protein in the skim portion) and 2.9862 true protein, the multiplier (mathematically equivalent to 0.78) for estimation of casein from true protein is 0.8295.

The minus 0.1 used in the equation reflects an expected fixed loss of casein into whey that will occur during cheese making, regardless of starting milk composition.

The 1.09 factor accounts for the nonfat, noncasein milk solids expected to be retained in the moisture phase of the cheese and the added salt in the cheese. The constant 1.09 value assumes that the final cheese contains about 1.7% salt. Thus, the numerator in the VanSlyke equation calculates the weight of milk solids plus added salt that is expected to be collected as cheese given the milk composition values used in the calculation.

The denominator of the VanSlyke equation simply adjusts the calculated total yield of Cheddar cheese to the target moisture percentage used in the formula. Thus, the formula can predict expected Cheddar cheese yields from milks of different fat and protein contents at selected moisture contents.

The following are all the parameters where assumptions and values are needed in the calculation of Class III price that I propose. These values and this format are part of a spreadsheet that I have used to summarize all the values used in the calculation. The values in blue are values that can be varied (for sensitivity analysis) and the numbers in black are fixed values that are calculated as intermediates in my calculations.

I have been told that different values than the ones I have mentioned above were used in the VanSlyke Cheese Yield Formula when the protein and fat factors (i.e., 1.405 and 1.582) were derived to use as the basis for calculation of protein value in the pricing system initiated on January 1, 2000. It is my understanding that for the current pricing system, the value used for fat recovery in the cheese is 90%, the value for casein as a percentage of crude protein is 0.75 and the value for moisture content of Cheddar cheese is 38%.

Table 1. Composition Assumptions and Values Used in the Current Class III Price Calculation (March 1999 data used for this example).

Milk Fat Content, %	3.5000
Crude Protein, %	3.1815
Casein as percentage of crude protein,%	75.0000
True Protein, %	2.9915
Casein as percentage of true protein,%	79.7635
Milk Casein, %	2.3861
Milk Serum Protein, %	0.6054
Milk Other Solids Content, %	5.6935
Milk Total Solids Content, %	12.1850
Fat Recovery in Cheese	0.9000
NonFat,NonCasein Solids Factor for VanSlyke Yield	1.0900
VanSlyke Cheddar Cheese Yield at target % moisture, lb/cwt	9.5571
Fat in the Cheddar cheese, lbs	3.1500
True Protein in the cheese, lbs	2.2861
True Protein not in the cheese, lbs	0.7054
NASS Cheddar Price, $/lb	1.3064
Cheddar Cheese Make Allowance, $/lb of cheese	0.1702
Cheddar Cheese Composition	
Fat, %	32.9599
Protein, %	*23.9208*
Skim Portion, %	67.0401
Moisture, %	38.0000
Fat on Dry Basis, %	53.1612
Other Solids, %	0.3268
NASS Whey Powder Price, $/lb	0.1917
Moisture Test of Whey Powder,%	3.2000
Whey Powder Make Allowance, $/lb of whey powder	0.1370
Yield of Whey Powder at 3.2% moisture	6.2728
pounds of true protein in whey powder	0.7054
pounds of other solids in whey powder	5.3667

EXPLANATION OF VALUES IN TABLE 1.

Milk Composition:

The basis for the milk composition values shown in Table 1 are as follows: The true protein and other solids values are values from the Federal Orders that are thought to represent the annual average skim milk composition in the United States. The true protein (2.9915%) and other solids (5.6935%) values for the 3.50% fat milk correspond to a 3.1% true protein and a 5.9% other solids content in the skim portion. The crude protein value is calculated assuming that there is 0.19% protein equivalent as nonprotein nitrogen in the average milk. A value of 75% of the crude protein was used by AMS for calculation of the casein content of milk in the current pricing system, so I have used this as a default value for my first calculations. This value was used to calculate the equivalent value of casein as a percentage of true protein. For this example, the casein as a percentage of true protein is 79.7635%. I show both values because the industry has only recently started working with true protein as the basis for payment and there is a need to show how a value equivalent to the 75% casein as a percentage of crude protein was derived.

In Table 1, the milk serum protein percentage is simply the true protein minus the casein percentage. The milk total solids content is calculated from the sum of fat, true protein, and other solids.

Cheese Yield Formula:

The VanSlyke formula is as described above. The value for fat recovery in the cheese used in this example is 90%. The nonfat, noncasein milk solids plus salt retention factor in the cheese is 1.09. The cheese yield value given is the value calculated at this milk composition for a cheese with 38% moisture. The pounds of fat in the cheese and pounds of true protein in the cheese come directly from the numerator of the cheese yield equation. The pounds of true protein not in the cheese is calculated as the difference between the pounds of true protein in the milk minus the pounds of true protein retained in the cheese. This will be the pounds of true protein that goes into whey powder.

NASS Prices:

The NASS Cheddar cheese price is a value calculated by the USDA Dairy Programs based on the weekly survey of cheese prices. The price survey data has the following characteristics.

Block Cheddar: The moisture content of block cheese reported in the survey is not reported to NASS. One can assume that it is less than the legal maximum moisture for Cheddar of 39%. NASS specifies that the moisture content of the blocks shall not be less than 36.5%. It is assumed that the cheese meets the minium requirement for full fat Cheddar of 50% fat on dry basis. The price reported by NASS blocks includes the cost of packaging the 40 lb blocks as described in the instructions and the cheese is colored to between 6 and 8 on the National Cheese Institute Color chart. The price should reflect cheese wrapped in sealed, airtight package in corrugated or solid fiberboard containers with reinforcing inner liner or sleeve. All other packaging costs are excluded from the reported prices. The sale is when a transaction is complete (i.e., cheese is shipped out and title transfer occurs). Intra-company sales, resale of cheese, transportation, and clearing charges are not included in the price. Price is f.o.b. the processing plant or storage center. Blocks must meet Wisconsin State Brand, UDSA Grade A or better. Blocks of cheese made for aging are not included in the survey.

Barrel Cheddar: Cheese reported as barrel cheese cannot exceed 37.7% moisture content. This is based on a Chicago Mercantile Exchange rules which state that cheese exceeding this moisture content cannot be invoiced on a moisture basis. The moisture content of barrel cheese is known and reported in the NASS survey results. The fat on a dry basis for the barrel cheese is not known, but it must exceed 50% to comply with standard of identity for Cheddar cheese. The reported cheese price by the manufacturer for barrel cheese is at the actual moisture test of the cheese reported and this price includes no packaging costs. NASS calculates a moisture adjustment to bring all prices to a 39% moisture basis for barrel cheese. The cheese is white and must meet Wisconsin State Brand, USDA Extra Grade, or better. The sale is when a transaction is complete (i.e., cheese is shipped out and title transfer occurs). Intra-company sales, resale of cheese, transportation, and clearing charges are not included in the price. Price is f.o.b. the processing plant or storage center.

Monthly NASS Price Used In the Class III Milk Price Calculation: The weighted average monthly Cheddar cheese price used in the Class III price formula is computed by the USDA Agricultural Marketing Service per the provisions of the order. A weighted average is computed for blocks and barrels each, using the applicable weekly prices and weights. The prices are computed to 4 decimal points. No adjustments are made to the published NASS prices. Three cents are added to the barrel average and then the block and barrel averages are weighted using the monthly weights. This price is rounded to four decimal places and is used in the Class III price calculation. The average moisture test of the cheese that corresponds to the combined block plus barrel Cheddar cheese price is not known, but given the instructions in the survey it must be between 36.5 and 39%. If the amount of barrel cheese in the survey for a month is about 62% of the total weight of cheese in the survey and we assume all the block cheese is at the minimum moisture, then the moisture content of the cheese represented by this price would be about 38.05%.

In my opinion it would be of benefit to the dairy industry if moisture data were collected for the block Cheddar represented in the NASS survey. This would allow the cheese price produced by the NASS survey to be associated with a specific moisture content that wold be known. With this information, the moisture content in the cheese yield formula used to calculate the Class III price would produce prices for fat and protein in Cheddar cheese that are in harmony with the moisture basis for the NASS cheese price.

NASS Whey Powder Price Used in the Class III Milk Price Calculation:

The product is USDA Extra Grade edible nonhygroscopic dry whey. The price is f.o.b. the processing plant/storage center. Prices are reported for all 25 kilogram, 50 lb bag, tote, and tanker sales. The following are excluded: transportation charges, sales of Grade A dry whey, sales of dry whey more than 180 days old, intra-company sales, resales of purchased dry whey. The current Class III price calculation for other solids value assumes that whey powder contains 3.2% moisture.

Cheddar Cheese Composition:

A value for Cheddar cheese moisture content must be selected for use in the cheese yield calculation. In the default values used in Table 1, the value is set at 38% moisture. This value was used by USDA to calculate the protein and fat factors in the current pricing system. However, as already mentioned in the discussion of NASS cheese prices, the moisture content selected for use in the yield calculation should be consistent with the moisture content of the cheese included in the NASS survey. Once a target moisture value is established, then the Cheddar cheese composition can be calculated from the milk composition values and the cheese yield formula. The fat and true protein content of the cheese (Table 1) is the pounds of fat and true protein retained in the cheese divided by the cheese yield and multiplied by 100. The salt content assumed (as part of the 1.09 value) in the VanSlyke Cheddar cheese yield formula is 1.7%. The skim portion of the Cheddar cheese (Table 1) is 100% minus the percent fat plus percent salt in the cheese.

Whey powder yield:

The weight of true protein in the whey powder (Table 1) is the weight of true protein contained in the milk minus the weight of true protein contained in the cheese. The weight of other solids in the whey powder (Table 1) is the weight of other solids in the milk minus the weight of other solids retained in the cheese. The weight of other solids in the cheese (Table 1) is calculated by taking weight of solids in the cheese minus the weight of fat plus true protein plus salt in the cheese. The calculation assumes that the cheese contains 1.7% by weight of salt. This number is the amount of other solids retained as dissolved solids in the water portion of the cheese. The sum of other solids plus true protein in the whey powder divided by one minus the percent moisture in the whey powder [e.g., (1 - (3.2/100)] provides an estimate of whey powder yield at 3.2% moisture.

Cheddar Cheese and Dry Whey Make Allowances:

These values (Table 1) are defined as fixed values that are used in the calculation of the Class III price by USDA. They are based on input from industry data for Cheddar cheese manufacturing costs. Dry whey manufacturing costs are based on a study conducted at Cornell University. It would be useful to have a clear and complete description of what is included and what is not included in the cheese and whey make allowances.

The make allowances are expressed as $/lb of cheese. However, a high percentage of the make costs are fixed and relate better to hundred weight of liquid in the vat not directly to a pound of cheese. Thus, when milk composition varies within normal ranges and produces calculated changes in cheese yield the true make costs for cheese do not increase or decrease as much with change as cheese yield as one would calculate. Thus, caution must be used when calculating returns to a cheese maker when milk composition (and therefore theoretical cheese yield) varies with changing milk composition.

METHOD PROPOSED BY DAVID BARBANO FOR CALCULATION OF THE CLASS III MILK PRICE

The input data shown in Table 1 are used as current default values for the purpose of comparison of the Class III price at 3.5% fat by the calculation I proposed versus the Class III price calculated under the current milk pricing system at the same milk composition. To the best of knowledge, the default values shown in Table 1 represent the values currently used by USDA and the prices are from March 1999. This does not mean that I agree with the current default values being used by USDA. That issue will be addressed later in my discussion.

The new method of calculation that I propose has three steps. These steps and a sample calculation are shown on the spread sheet that is provided with this description.

Step 1. Class III Fat Value Equals NASS Cheddar Cheese Price (for this example the value would be $1.3064). The current Class III milk pricing system initiated as a result of Federal Order Reform struggles with this issue. The current system does not establish a separate Class III price for butterfat, but instead adds a fat value to the protein price. This is the fundamental cause of the problem with the current pricing system that was demonstrated in Figures 1 and 2. Therefore, in Step 1 of the proposed calculation, the milk fat used in Class III is priced at the same value in $/lb as the NASS price for cheese. ***This is the key new step used in my approach to calculate a Class III price based on the price of cheese.*** Once a price per pound of cheese is established all parts of that cheese have that value in the market place when it is sold. Therefore, I assign the cheese price per pound to the fat and calculate the portion of the total value of a pound of cheese that is fat. The residual weight of the nonfat portion of the chees, takes on the remainder of the value per pound of cheese and all of this value (minus a make allowance) is allocated to the protein retained in the cheese.

Cheddar cheese has a defined minium fat content of 50% on dry basis. In reality Cheddar cheese of acceptable quality for processing can be made in the range from 50 to about 55% fat on dry basis. Thus, the selling price of the cheese is the price that the cheese maker receives for the fat sold in the cheese. If milk fat has a higher value in other utilization classes, then the cheese maker will have a signal to remove fat from milk, as cream, in excess of that needed to achieve 50% fat on dry basis. If milk fat has a lower value in other utilization classes than Class III, then the cheese maker will have a signal to keep more fat in the cheese, up to the limit that acceptable cheese quality will allow. This should contribute to the development of reduced volatility of fat prices in the long run. With respect to the use of whey cream in the manufacture of Cheddar cheese for processing, when the price of milk fat in other classes is low, there will be an incentive for the cheese maker to try to recover fat from whey cream and incorporate it in the cheese. If the value of fat in other classes is higher and if the value of whey cream that could be sold outside the plant exceeds its use value as cheese, then whey cream will move into the market to provide an increased supply of fat for utilization in products (e.g., ice cream, cream cheese, etc.) in other classes when cream is tight.

Step 2. The Value of the True Protein in the Milk Equals the Value of the True Protein in the Cheese Plus the Value of True Protein in Dry Whey. First, the value of the skim portion of the cheese is calculated. The skim portion in a pound of cheese is the fat and salt portion in a pound of cheese subtracted from 1. In the example (Table 1) the skim portion of the cheese is 67.0401% of the cheese. This value is divided by 100 and multiplied by the NASS cheese price per pound [i.e., (67.0401/100) x $1.3064], or $0.8758 per pound of protein. The full Cheddar cheese make allowance ($/lb) is subtracted from this value ($0.8758 - $0.1702) to give a value of the true protein in one pound of cheese as $0.7056. The value of protein in a pound of cheese divided by the pounds of true protein in a pound of cheese ($0.7056/.239208 lb) equals the true protein value ($2.9498) per pound.

Like the value of fat in cheese, the value of true protein per pound in the whey powder is assigned the same value as the NASS whey powder price (i.e., $0.1917/lb in this example). Again, this is an important assumption, that relates the value of true protein in dry whey directly to the changes in value of whey powder in the market place. The remaining value of the whey powder is assigned to the other solids fraction of milk.

The value of true protein in the milk is calculated as the sum of the value of true protein in the cheese plus the true protein in the whey. The weight of true protein in the cheese (2.2861 lb) divided by the weight of true protein in the milk (2.9915 lb) multiplied by the true protein value in the cheese ($2.9498 per pound) plus the weight of true protein in the whey (i.e., true protein not in the cheese = 0.7054 lb) divided by the weight of true protein in the milk (2.9915 lb) multiplied by the value of true protein per pound in the dry whey ($0.1917 per pound) equals the value per pound of true protein in the milk ($2.2994).

Step 3. Calculation of the Other Solids Value. The method of calculation of the other solids value is also different than in the current system. First, the yield (6.2728 lb) of whey powder (the calculations as described earlier in the description of values in Table 1) is multiplied by the price per pound ($0.1917/lb) of whey powder. This provides the total dollar value ($1.2025) of the whey powder produced per hundred weight of milk. Second, the manufacturing cost per pound ($0.137/lb) of whey powder multiplied by the yield (6.2728 lb) of whey powder is equal to $0.8594 and this is subtracted from the total value ($1.2025) of the whey powder. This provides a net value ($0.3431) of the whey powder after removal of manufacturing cost. The value of protein in the whey powder was previously assigned (in Step 2, above) the value per pound of the whey powder ($0.1917). This is multiplied by the weight (0.7054 lb) of true protein in the whey powder to give a total value ($0.1352) of the true protein in the whey powder, which is subtracted from the net value of the whey powder ($0.3431) after removal of manufacturing cost. This provides the residual value in the whey powder for other solids ($0.2079). The residual value of the other solids is divided by the original pounds of other solids in the milk (5.6935 lbs) to give the value per pound of other solids ($0.0365/lb).

The values per pound of each component (fat, true protein, and other solids) calculated in steps 1, 2, and 3 provide the values used to calculate the Class III price for milk of any

composition in that month. A calculation of net return to the cheese maker for milk with 3.5% fat, 2.9915% protein, and 5.6935% other solids is also shown in my example. The purpose of showing the calculation net returns to a cheese maker is to ensure that the new system is working correctly. When the calculation of the fat, protein, and other solids prices is working correctly, it produces a net revenue of zero when the Class III price is calculated. The net revenues on milks of other compositions other than the milk composition used in the calculation of the fat, true protein, other solids prices will not be zero. This will be explained later.

This calculation (rounded to two decimal places) arrives at a Class III Price at 3.5% fat, 2.9915% true protein, and 5.6935% other solids of $11.66, while the current system arrives at a uniform milk price of $11.51 using March 1999 data and the same default assumptions. The difference between the current system Class III prices and the system that I have proposed in this presentation will vary from month to month (when using all the same default values), but for the most part on average they will track about the same. **Thus, the two calculations produce a similar Class III milk price when the same assumptions are used in both the proposed and current methods of calculation. I will leave it to others to calculate the comparison of the Class III prices under the current system and my proposed calculation across a period of time using different monthly prices.**

At a fat test of 3.67% (with 3.1% true protein and 5.9% other solids in the skim portion) the current system produces a Class III price of $11.74/cwt (when using the March 1999 data), while the proposed new calculation produces a price of $11.88/cwt (a smaller difference). This is caused by the fact that the price per pound of fat in the current system is ($1.4487/lb) higher than the price per pound of fat ($1.3064) in the calculation that I have proposed (when using the March 1999 data). This relationship will vary from month to month. When data from other months are used for the calculation, this relationship between the two methods of calculations will change because in the current system of calculation the variation in the butter fat price used in the Class III calculation is not determined by, and does not vary in direct proportion to, variation in the cheese price.

An important point is that the system that I have proposed will reduce volatility in the protein and fat prices compared to the current system. The new system solves the problem described earlier in the current system as it will not produce a reduction in protein price per pound and skim value, when fat value increases. The fat and protein prices for Class III will move together with the cheese price. The sensitivity analysis presented in the next section will provide an evaluation the default values that have been assumed in both methods of calculation.

A copy of the spreadsheet used for these calculations is provided.

Version 4/24/00
Prices = March 1999

Barbano's Calculation for Class III Minimum Milk Price - Based on Cheddar and Whey Powder
With Current Defaults

[Blue Cells are unprotected]

		Current	Barbano
3.5% Price	*Current/Barbano*	*$11 51*	*$11 66*
3 67% Price	Current/Barbano	$11.74	$11.88

Given Information (cells in blue are not protected)	Current Defaults Calculation of Fat, Protein and Other Solids Prices	Current Defaults *Adjust Cheese* Moisture to 36% Adjust Price to 36%	Change Casein%TP *Adjust Cheese* Moisture to 36% Adjust Price to 36%	Change Fat Recovery from 90 to 915	Change to Average US Milk Compo As the Base
Milk Fat Content %	3 5000	3 5000	3 5000	3 5000	3 6700
Crude Protein %	3 1815	3 1815	3 1815	3 1815	3 1762
Casein as percentage of crude protein %	75 0000	75 0000	77 3000	77 3000	77 2828
True Protein, %	2 9915	2 9915	2 9915	2 9915	2 9862
Casein as percentage of true protein,%	79 7635	79 7635	82 2096	82 2096	82 2000
Milk Casein, %	2 3861	2 3861	2 4593	2 4593	2 4547
Milk Serum Protein, %	0 6054	0 6054	0 5322	0 5322	0 5315
Milk Other Solids Content %	5 6935	5 6935	5 6935	5 6935	5 6835
Milk Total Solids Content, %	12 1850	12 1850	12 1850	12 1850	12 3397
Fat Recovery in Cheese	0 9000	0 9000	0 9000	0 9150	0 9150
NonFat NonCasein Solids Factor for VanSlyke Yield	1 0900	1 0900	1 0900	1 0900	1 0900
Casein to Fat Ratio	0 6818	0 6818	0 7027	0 7027	0 6689
VanSlyke Cheddar Cheese Yield at target % moisture, lb/cwt	9 5571	9 2584	9 3830	9 4724	9 7295
Fat in the Cheddar cheese, lbs	3 1500	3 1500	3 1500	3 2025	3 3581
True Protein in the cheese, lbs	2 2861	2 2861	2 3593	2 3593	2 3547
True Protein not in the cheese, lbs	0 7054	0 7054	0 6322	0 6322	0 6315
NASS Cheddar Price, $/lb	1 3064	1 3485	1 3485	1 3485	1 3485
Cheddar Cheese Make Allowance, $/lb of cheese	0 1702	0 1702	0 1702	0 1702	0 1702
Cheddar Cheese Composition					
Fat %	32 9599	34 0232	33 5713	33 8086	34 5141
Protein %	23 9208	24 6924	25 1443	24 9070	24 2015
Skim Portion, %	67 0401	65 9768	66 4287	66 1914	65 4859
Moisture,%	38 0000	36 0000	36 0000	36 0000	36 0000
Fat on Dry Basis, %	53 1612	53 1612	52 4551	52 8259	53 9283
Whey Solids Retained in the Cheese, %	0 3268	0 3319	0 3363	0 3395	0 3487
NASS Whey Powder Price, $/lb	0 1917	0 1917	0 1917	0 1917	0 1917
Moisture Test of Whey Powder,%	3 2000	3 2000	3 2000	3 2000	3 2000
Whey Powder Make Allowance, $/lb of whey powder	0 1370	0 1370	0 1370	0 1370	0 1370
Yield of Whey Powder at 3 2% moisture	6 2728	6 2676	6 1874	6 1841	6 1635
pounds of true protein in whey powder	0 7054	0 7054	0 6322	0 6322	0 6315
pounds of other solids in whey powder	5 3667	5 3616	5 3572	5 3540	5 3347
Price of a pound of Fat, $/lb	1.3064	1 3485	1.3485	1.3485	1.3485
Price of a pound of True Protein, $/lb	2.2994	2 2720	2 3164	2 3279	2 3632
Price of a pound of Other Solids, $/lb	0 0365	0.0365	0 0382	0.0381	0 0380
Total Class III Price at 3 5000 % fat, $/cwt	11.6591	11.7240	11.8664	11.9008	
Total Class III Price at 3 6700 % fat, $/cwt					12.2221
Milk Price Calculator Price					
Total Class III Price 3 5000 % fat 2 9915 % protein					
Total Returns, $/cwt (cheese, whey, and whey cream)	14 1451	14 1584	14 3111	14.3602	14 7224
Make Allowance for cheese (yield x make allowance), $	1.6266	1.5758	1.5970	1.6122	1.6560
Make Allowance for whey powder (yield x make allowance), $	0.8594	0 8587	0.8477	0.8472	0.8444
Net Returns, $/cwt	0 0000	0.0000	0.0000	0.0000	0 0000

Calculation of Class III Minimum Price Per Pound for Fat, True Protein, and Other Solids

		Current Defaults Calculation of Fat Protein, and Other Solids Prices	Current Defaults Adjust Cheese Moisture to 36% Adjust Price to 36%	Change Casein%TP Adjust Cheese Moisture to 36% Adjust Price to 36% and defaults	Change Fat Recovery from 90 to 915	Change to Average US Milk Compo As the Base
Step 1 Class III Price Calculation - Class III fat value per pound of fat						
The Class III Fat Value equals the NASS cheese price in $ per pound		$1.3064	$1.3485	$1.3485	$1.3485	$1.3485
Step 2 Class III Price Calculation - calculate value of a pound of true protein in cheese and in whey powder						
The Class III *true protein* value equals the sum of the value of protein in the cheese and protein in the whey powder						
Value of skim portion in one pound of cheese = (percent skim portion in a pound of cheese/100) x (NASS Cheese Price)		$0.8758	$0.8897	$0.8958	$0.8926	$0.8831
Subtract the Cheddar Cheese Make Allowance		<u>$0.1702</u>	<u>$0.1702</u>	<u>$0.1702</u>	<u>$0.1702</u>	<u>$0.1702</u>
Value of protein in a pound of cheese (67.0401 /100) x 1.3064) - 0.1702 =		$0.7056	$0.7195	$0.7256	$0.7224	$0.7129
True Protein Value in Cheese,$/lb = **(value of protein in a pound of cheese/pounds of protein in a pound of cheese)** =		$2.9498	$2.9138	$2.8857	$2.9004	$2.9456
True Protein Value in Whey Powder $/lb = **(whey powder price per pound)**		$0.1917	$0.1917	$0.1917	$0.1917	$0.1917
True Protein Value in Milk, $/lb of True Protein **(True Protein in Cheese/True Protein in Milk) x (true protein value in cheese)) plus (True Protein in Whey/True Protein in Milk) x (dry whey price)) equals True Protein Value in Milk, $/lb of True Protein**		$2.2994	$2.2720	$2.3164	$2.3279	$2.3632
Step 3 Calculation of Class III - calculate other solids value per pound in Class III						
Yield of Whey Powder x NASS Price per pound of Whey Powder (example .1917 x 6.2728)		$1.2025	$1.2015	$1.1861	$1.1855	$1.1815
Minus Manufacturing Cost per Pound times Whey Powder Yield) (example .137 x 6.2728)	minus	<u>$0.8594</u>	<u>$0.8587</u>	<u>$0.8477</u>	<u>$0.8472</u>	<u>$0.8444</u>
Value left to be allocated between True Protein and Other Solids in the Whey Powder		$0.3431	$0.3428	$0.3384	$0.3383	$0.3371
Value of Protein in Whey Powder = (true protein value in whey powder x weight of true protein in whey powder, .1917 x .7054) -		<u>$0.1352</u>	<u>$0.1352</u>	<u>$0.1212</u>	<u>$0.1212</u>	<u>$0.1211</u>
Residual Value in Whey Powder to be Allocated to Other Solids Value		$0.2079	$0.2076	$0.2173	$0.2171	$0.2161
Other Solids Value is Residual Value divided by pounds of other solids in the milk **The Class III Other Solids Value, $ per pound of other solids**		$0.0365	$0.0365	$0.0382	$0.0381	$0.0380
Calculation of the Class III Price Per Hundred Weight — Values shown below only apply to the first column (to the right) as example calculation						
Fat Value — 3.5000 lbs of fat multiplied by $1.3064 per pound equals		$4.5724	$4.7198	$4.7198	$4.7198	$4.9490
Protein Value — 2.9915 lbs of true protein multiplied by $2.2994 equals		$6.8788	$6.7966	$6.9294	$6.9640	$7.0570
Other Solids Value — 5.6935 lbs of other solids multiplied by $0.0365 equals	+	<u>$0.2079</u>	<u>$0.2076</u>	<u>$0.2173</u>	<u>$0.2171</u>	<u>$0.2161</u>
Total Class III Price at fat test $/cwt — **Total Class III Price at** 3.5000 % fat 2.9915 % protein 5.6935 % other solids — **Total Class III Price at 3.5% fat, $/cwt**		$11.6591	$11.7240	11.8664	$11.9008	$12.2221
Skim Milk Value, $/cwt of skim		$7.3437	$7.2583	$7.4059	$7.4415	$7.5502

Calculation of Total Returns — Values shown below only apply to the first column (to the right) as example calculation

	Price $ per pound		Amount pounds			Current Defaults Calculation of Fat Protein, and Other Solids Prices	Current Defaults Adjust Cheese Moisture to 36% Adjust Price to 36%	Change Casein%TP Adjust Cheese Moisture to 36% Adjust Price to 36% and defaults	Change Fat Recovery from 90 to 915	Change to Average US Milk Compo As the Base
Cheese	$1.3064	times	9.5571	equals		$12.4853	$12.4850	$12.6530	$12.7736	$13.1202
Whey Powder	$0.1917	times	6.2728	equals	+	$1.2025	$1.2015	$1.1861	$1.1855	$1.1815
Whey Cream, lbs of fat	$1.3064	times	0.3500	equals	+	<u>0.4572</u>	<u>0.4720</u>	<u>0.4720</u>	<u>0.4012</u>	<u>0.4207</u>
Total Returns from Milk, $/cwt						$14.1451	$14.1584	$14.3111	$14.3602	$14.7224
Cheese Manufacturing Cost, (yield x make allowance), $					-	$1.6266	$1.5758	$1.5970	$1.6122	$1.6560
Whey Manufacturing Cost, (yield x make allowance), $					-	<u>$0.8594</u>	<u>$0.8587</u>	<u>$0.8477</u>	<u>$0.8472</u>	<u>$0.8444</u>
Cheesemaker **Net Returns from Milk, $/cwt**					Net Return $/cwt	$0.0000	$0.0000	$0.0000	$0.0000	$0.0000

SENSITIVITY ANALYSIS OF FACTORS INCLUDED IN THE CLASS III PRICE CALCULATION THAT I HAVE PRESENTED.

When the uniform price is calculated for Class III milk at 3.5% milk fat, 2.9915% true protein, and 5.6935% solids not fat, the uniform 3.50% fat milk price is established in dollars per hundred weight and a value of a pound of fat, a pound of true protein, and a pound of other solids are established for that time period based on the NASS Cheddar cheese price and the NASS dry whey price. The VanSlyke theoretical cheese yield equation is used in these calculations. The VanSlyke formula was designed for full fat Cheddar cheese with a moisture of about 36 to 37%. Other cheese yield equations are available that have been optimized to work with other cheese varieties and under conditions of milk fortification (2). The factors that influence the calculated Class III price and the values of fat, true protein, and other solids can be separated into three different categories: 1) technical factors in the VanSlyke cheese yield equation that influence the calculation of protein value in the cheese, 2) make allowances, and 3) NASS cheese and whey prices. Once the Class III value for a pound of each of the components is determined, then the Class III price for any milk can be calculated.

In this sensitivity analysis, I look at sensitivity of the milk price to changes in various factors and prices. A comparison of the sensitivity of the Class III price to variation for different parameters may help direct the attention of the industry to those that are the most important and avoid too much time being spent on factors that have little impact.

Technical Factors in the Cheese Yield Equation and Calculation of the Protein Price.

The VanSlyke Cheddar cheese yield formula is used for calculations in the current Class III milk pricing system and I have used the same formula in the system described in this presentation. A review of cheese yield formulas has been presented elsewhere (reference).

The VanSlyke Theoretical Cheddar cheese yield formula is as follows:

$$\text{cheese yield} = \frac{[(0.93 \times \%\ \text{fat in milk}) + (\%\ \text{casein in milk} - 0.1)]\ 1.09}{1 - (\text{target cheese moisture}/100)}$$

The casein content of milk is not as easily measured as the fat content of milk. However, in recent time both the crude protein and more recently the true protein content of milk have been routinely measured with both chemical reference methods and electronic milk testing equipment. It has been common industry practice to use a factor multiplied by the crude protein content of milk to estimate the casein content of milk. The most commonly used factor seems to be 0.78 times crude protein. However, the average value for the US milk supply is probably between 0.77 and 0.78. In a National Milk Composition Study that I conducted in 1984 for the US milk supply (3), the average casein as a percentage of crude protein was 77.93% and the average casein as a percentage of true protein was 81.95%. At the time of the 1984 study, the current official AOAC methods for casein and nonprotein nitrogen were not in place and the methodology was a little different than that used in a more recent study. Since 1992, my laboratory has monitored the casein as percentage of crude protein and true protein for milk from several factories that participated in the 1984 study. I have seen no trend for a decrease in the casein as a percentage of true protein in these milk supplies. If anything there has been a slight tendency for the casein as a percentage of protein to increase. This increase has probably been due to the attention that has been focused on improving milk quality (e.g., reducing psychrotrophic bacteria counts and somatic cell count) for cheese making. Improvement in these quality parameters for a milk supply would tend to increase the casein as a percentage of protein, because of reduced enzymatic damage to casein. More recently, my laboratory has monitored the casein as a percentage of true protein in bulk milk supplies in NYS at three large cheese factories. These data were reported in October 1999 at the Cornell University Animal Nutrition Conference (4). Test values reported for the 1992 to 1998 period below were determined using the official AOAC Kjeldahl methods that are in place today (5,6,7). Composite monthly raw silo milk samples were tested monthly for crude protein, true protein, nonprotein nitrogen, and casein for each factory from 1992 through 1998. Over that seven year period, the average nonprotein nitrogen content of the milk was 0.192%. The average annual casein as a percentage of true protein for the milk supplies in the three factories was 82.17, 82.17, 82.42, 82.15, 82.12, 82.31, and 82.19 for a seven year average of 82.22% casein as a percentage of true protein.

The influence of the selection of constants for use in the VanSlyke cheese yield equation (for fat recovery in the cheese, the nonfat, noncasein solids retention factor in the cheese, moisture content of the cheese, and casein as percentage of true protein in the milk) on the calculated Class III uniform price and the net returns to a Cheddar cheese maker are shown in Table 2.

Fat Recovery in the Cheese. An expected fat recovery in Cheddar cheese is used as an input value in the VanSlyke cheese yield formula. The current pricing system uses a value of 90% fat recovery in the cheese for calculation of the base price. As is shown in Table 2, an increase in fat recovery value assumption of 1% causes an increase in the Class III milk price of $0.024. Fat recovery in the cheese is a parameter in cheese making that the cheese industry monitors closely. In many factories, the fat content of the whey as it is being removed from the cheese vat is determined as an index of fat loss. A value of 93% fat recovery in the cheese is achievable at a commercial level, however not all factories achieve this. Recent advances in design of large scale, enclosed cheese vats have been able to achieve fat recoveries in the cheese that approach 93%. **The value of 90% fat recovery in the cheese is probably low for large scale modern cheese factories. In my opinion, the most appropriate value to use as a default value currently is between 90% and 93%.** As technology of cheese making continues to advance, these values may change and they may need to be re-evaluated periodically.

Nonfat, Noncasein, Solids Recovery in the Cheese. The 1.09 factor in the VanSlyke equation assumes that there will be 1.7% salt in the cheese and that some nonfat, noncasein, milk solids (i.e., other milk solids) will be retained in the cheese. The current pricing system uses a 1.09 factor and that value has been used traditionally for Cheddar cheese that contains about 36 to 37% moisture. This value is used in the current Class III price calculation. As can be seen from Table 2, the calculated Class III milk price is sensitive to this coefficient in the equation. A change of 0.01 in this coefficient causes the milk price to change by $0.0966. In my opinion the value of 1.09 is a good value for a Cheddar cheese that contains about 36 to37% moisture and 1.7% salt. Given a constant salt content of 1.7%, the true value of the 1.09 factor will increase with increasing moisture content of the cheese. This happens because there are other milk solids dissolved in the free moisture portion of the cheese and as moisture content of the cheese increases so does the nonfat, noncasein milk solids content of the cheese. The actual moisture content of the barrel cheese reported in the survey is usually between 35 and 36%. The moisture content of the block cheese reported in the NASS survey must be greater than 36.5% moisture. **Thus, in my opinion the 1.09 factor is probably close enough, given the importance of some other factors that will be discussed.**

Moisture Content of the Cheese. A value for the target moisture content of the cheese is used in the cheese yield calculation. Cheese yield is very sensitive to moisture content, with cheese yield increasing with increasing moisture. Therefore, one would expect a change in the assumption for cheese moisture content in the Class III price calculation to have a large influence on the milk price. As seen in Table 2, an increase in moisture content of 1% causes a $0.1608 increase in the milk price. The Cheddar cheese moisture assumption in the current Class III pricing system is 38% and I have used that value as an assumed value in my proposed price calculation. **However, the most important point is that the value assumed in this calculation and the moisture value for the cheese and price for the cheese included in the NASS survey must match.** Unfortunately, only the moisture content of the barrel cheese included in the NASS survey is known currently. I think the dairy industry would be better served if the moisture content of all cheese in the survey was reported and a cheese price calculated at moisture content that is the same for both NASS moisture adjustment and the Class III yield formula calculation. The sensitivity analysis in Table 2 uses a constant cheese price for all moisture contents and therefore shows a significant variation in milk price. The magnitude of the milk price changes shown in Table 2 actually demonstrate what happens to milk price when the moisture content of the cheese included in the NASS survey does not match the assumed value used in the cheese yield formula. However, as I explained earlier in this report the true average of the 39% moisture adjusted barrel cheese and the block cheese of unknown moisture content is probably near 38% and, therefore, under the current price calculation the moisture adjusted cheese price, the mean moisture adjusted basis for the cheese in the NASS survey, and the cheese moisture assumption in the current Class III price calculation seem to be comparable at about 38%.

Casein as a Percentage of True Protein. The current Class III pricing system used 75% of protein as casein to arrive at the protein factor (equivalent to a factor of 79.76% of true protein). Second, this value (75% of crude protein) is, in my opinion, too low. In the past several years, I have been approached by cheese makers that have been concerned that the casein as a percentage of either crude or true protein is lower than normal. In every case that I have been involved with, the low values have been traced to improper methodology for measuring casein or poor handling of milk samples during collection and the time immediately prior to analysis. A paper on the proper handling of milk samples for casein analysis and the a description of the chemical methods for casein determination in raw milk has been published (reference).

Typically a value such as 0.78 times percent crude protein in the milk has been used in the cheese yield equation as a substitute for a casein percentage. In Table 2, I have shown values for 75 to 79% of crude protein and the corresponding values for casein as a percentage of true protein. The value of 0.78 on a crude protein basis is almost equivalent to 0.83 on a true protein basis (Table 2). As the default value for casein as a percentage true protein is increased, the Class III milk price increases. The milk value increases by $0.0616 for every one percent increase in casein as a percentage of crude protein. The value would be slightly larger on a true protein basis. **In my opinion, a value of 82.2 to 82.4% for casein as a percentage of true protein is probably a correct value for this parameter. This is quite different than the assumption in the current price calculation that was used to derive the protein factor.**

Cheese and Dry Whey Make Allowances.

Cheese. The calculated Class III milk price in the current milk pricing system and the Class III price calculation proposed in this document are both sensitive to the make allowances selected as default values. The sensitivity of the Class III price in the system that I have described is shown in Table 3. As make allowance for cheese changes by $0.01, the milk price at 3.5% fat will change by $0.0956 per hundred weight. While cheese manufacturing cost is a very important parameter, it changes with changing economic conditions, scale of production, and advances in technology. Therefore, surveys and collection of actual data are probably the best approaches to keep this assumed value current and realistic with conditions in the industry.

Whey. The make allowance for dry whey is also an important component of the Class III milk price in the current Class III pricing system and the one that I have proposed. As the make allowance for whey increases, the milk price paid to the farmer decreases. As make allowance changes by $0.01, the Class III milk price changes by $0.0627 in the Class III price calculation system that I have proposed when all other assumptions are the same as the current system.

NASS Cheese and Whey Prices.

Cheese Prices. The Class III milk price is extremely sensitive to change in Cheddar cheese price, as it should be. As can be seen from Table 4, an increase in the cheese price of $0.10 per pound will increase the Class III milk price by $0.9907. Since the value for fat in Class III is determined directly by the cheese price in the approach that I have presented, it eliminates the decrease in Class III milk price to producers with a fat to protein ratio less than 1.28 when the fat value in Class III decreases. Thus, changes in cheese price will clearly drive changes in Class III milk price. **The accuracy and representativeness of the NASS cheese price is critical. Also, the harmonization of the cheese price and the moisture basis is extremely important.**

The pay price to a farmer at constant milk composition will increase when cheese price increases and decrease when cheese price decreases. The calculated Class III milk price using the calculations that a I propose and in the current calculation is the most sensitive to change in cheese prices. Therefore, big changes in cheese prices in the market place will drive big changes in the milk price, as it has in the past. However, changes in fat value in other milk utilization classes will not cause the skim value to change in the Class III price calculation that I have proposed.

Whey Prices. While not as important as cheese price, the whey price does influence milk price in this system. In the calculation that I proposed, the whey price directly influences the value of the true protein from the milk that goes into the whey. As can be seen in Table 4, an increase of $0.01 per pound in the whey price will increase milk price by $0.0627.

Calculation of Milk Prices in the Proposed System and the Current System - Questioning Some of the Defaults.

As mentioned earlier, the two methods of price calculation (current and the one I have presented) return similar total Class III milk prices when they start with the same assumptions. However, the two systems arrive at different fat and protein values. The system I have proposed eliminates the decrease in milk protein and skim price when milk fat price goes up and visa versa.

In my opinion, some of the default assumptions need to be evaluated from a technical basis for their correctness. Changes in these default values will cause the same direction of Class III price change in both the current system of milk pricing and the system that I have proposed. To illustrate these changes in default values that I think need to be evaluated, I will present 5 columns of data in the form of a spreadsheet (pages 15 and 16) and calculations on the spreadsheet that illustrate the impact of the default value selected for each parameter.

The **first column** of data reflects the current default values as used in the current Class III milk price calculation. Some of the default values were used as the basis for the derivation of the protein and fat factors in the current system so they are part of the assumptions, even though they may not be visible in the routine calculation each month in the current pricing system. The calculation of milk price using the March 1999 data using my price calculation produce a milk price of $11.66 for a milk of 3.5% fat. This is $0.15 higher than the price calculated using the current system for the March 1999 data. As mentioned earlier, this difference between the two calculations will vary from month to month and other people are calculating those relationships.

The **second column** of assumptions and data represents the outcome of a change in the assumption for cheese moisture and cheese price that corresponds to that moisture content. In the same fashion as NASS does when they calculate a moisture adjustment of barrel cheese composition and price from the level of 34 to 35% (its actual moisture at production) to the value of 39%, I have adjusted the yield and price per pound of cheese back down to 36% moisture. In reality the cheese was never made at 39% moisture and never had as high a cheese yield as indicated in the first column. By raising the moisture content to 39% and lowering the price per pound of cheese, the fixed cheese make allowance ($0.1702/lb) is subtracted from a lower cheese price. In my opinion, this results in too much make allowance being subtracted off the cheese price. I have lowered the assumption for the moisture content of the cheese from 38% to 36% moisture and adjusted the price per pound of cheese upward from $1.3064/lb to $1.3485/lb to reflect the higher value per pound of cheese at lower moisture and then recalculated the Class III milk price. This price per pound of cheese ($1.3485) is closer to the price that was reported in the NASS survey before moisture adjustment. To what may be the surprise of some individuals, this change in assumption at the point of calculation of the per pound values of protein and other solids produces a higher Class III milk price not a lower price. The calculated Class III price increases from $11.6591 to $11.7240 or about $0.0649/cwt. If one goes back to the current pricing system and makes the same changes to moisture for use in the calculation of the fat and protein factors and then makes the same moisture adjustment to the cheese price, the Class III milk price also increases. Since the barrel cheese was never made at 39% moisture, I see no basis for adjusting the moisture up to 39% and the price per pound of cheese down. This inflates the cheese yield to a value that never existed and then allows for a make allowance based on a higher yield of cheese.

The **third column** demonstrates the impact of changing the casein as a percentage of true protein to a value that is more representative of the true value in the milk supply. The original value of 75% of crude protein (i.e., 79.76% of true protein) is not consistent with the normal values found in the milk supply when fresh milk is analyzed by the official reference methods for true protein and casein analysis (7). The data referenced earlier in this presentation has demonstrated that a more appropriate assumption for this value is about 82.2% of the true protein is casein. If this assumption is used in the proposed new calculation system (third column) it produces a milk price of $11.8664 when coupled with the previous change in moisture basis from 38 to 36% moisture. The price increase due to this change in assumption would be about $0.1424/cwt. If this same change in assumption for casein as a percent of true protein is used to recalculate the protein and fat factors in the current system, the milk price will also increase in the current milk pricing system.

The **fourth column** demonstrates the impact of changing the assumption for fat recovery in the cheese from 90% to 91.5%. This change produces a higher Class III calculated price in both the current system of price calculation and will produce a price increase in the new system. The price change is about $0.0344/cwt due to this change. A value of 91.5% fat recovery in the cheese may be more representative of fat recovery performance in modern well managed cheese plants. Some factories will perform better than this and some will perform worse.

The **fifth column** deals with the issue of the selection of a milk composition at which to calculate the per pound values of fat, true protein, and other solids. In my opinion, the milk composition used for this calculation should represent the average of the raw milk supply as it would be received at cheese factories. An estimate of this average is 3.67% fat, 2.9862% true protein and 5.6835% other solids (protein and other solids are based on a 3.1% true protein and a 5.9% other solids content in the skim portion). This estimate is taken only for the purpose of example. A determination of the average milk composition should be used as the base. When the previous changes in assumptions are used with this milk composition, the calculated Class III milk price is $12.2221/cwt versus $11.9008 at 3.5% fat. The key point is that the calculated price per pound of fat and other solids are unchanged by this difference in the selection of the default milk composition, however the price per pound of protein increases by $0.0356/lb of protein.

What is important about the selection of a milk composition for calculation of this price? The milk composition selected becomes the "pivot point" for net revenues for the cheese maker. A milk with a composition lower than average will produce a negative net return for the cheese maker (relative to the pivot point composition) and a milk with a composition higher than average will produce a positive net return, if the processor's cheese making performance meets the assumptions. Placing the pivot point of net return at the average milk composition for the milk supply still gives the cheese maker the incentive to buy higher solids milk to improve profitability, as is the case in the current system. With respect to the ratio of fat to true protein, the cheese maker will have a positive net revenue when the fat to true protein ratio is higher than the average of the milk supply. If the fat is too low for the amount of protein in the milk, then the cheese maker will have the incentive to add cream to maintain the level of fat on a dry basis in the cheese that is as high as is realistic with respect to quality of full fat Cheddar. This is not different than the signal in the current system.

This demonstrates changes in net revenue behaviors resulting from milk pricing that happen **both** in the current Federal Order system and in the new system of calculation that I propose. If the composition for a producer's milk is higher than those assumed for the milk in the Class III protein value calculation, then the cheese maker will get a higher net return on that milk. On the other hand, if the milk from a producer has a milk composition lower than the assumptions in the Class III calculation, then this producer's milk will cause a lower net return for the cheese maker than predicted in the calculation. Again, this is not different than what is happening in the current pricing system. The slope of these relationships are fairly steep and the slope will be influenced by the absolute level of the cheese price. Also, if a cheese factory happens to have a milk supply that is lower in composition than their competitor, then they have a built in disadvantage in net return even though their milk price was lower. This would indicate that these pricing approaches over pay producers with milk composition below the Class III milk composition assumptions used to calculate protein and other solids values and under pay producers that have milk compositions that are higher than the Class III milk composition assumptions. Both the current Class III system and the new Class III price calculation I have proposed (that calculate a fixed price for a pound of protein) do not address this issue. Thus, end product pricing would correct this problem and would deliver payments to each producer that would be linked respond directly to the value of cheese and whey that could be produced from each producer's milk.

Milk Price Calculator:

I have included a milk price calculator in the spread sheet. It uses the fat, true protein, and other solids prices per pound that are determined in the calculation done in column five. I have shown the calculated milk price for five different milk compositions. In addition, I have shown the total returns from cheese plus dry whey plus whey cream. I have not deducted the make allowance from these total returns. The make allowances are used in the calculation of the milk price and should represent the make costs and some return to the cheese maker at the milk composition used to calculate the values of a pound of fat, true protein, and other solids. As discussed earlier, since most of the costs in the make allowance are in reality fixed with respect to the volume of milk processed and do not vary with yield of cheese and whey product, it is not meaningful to calculate a different cheese and whey powder make cost for each different milk composition. The total revenues per hundred weight of milk processed for the cheese maker increase or decrease, respectively, as the milk component concentrations increase or decrease. To maximize the total return on the milk used to make cheese, the Cheddar cheese maker must control casein to fat ratio in the vat. This is no different than under the current pricing system.

IDEAS FOR THE FUTURE AS THE DAIRY INDUSTRY CONTINUES TO ADOPT NEW TECHNOLOGIES.

It is possible mathematically to keep the net returns to a cheese maker constant across all milk compositions, without producing the decreasing protein (skim) value when fat values increase as it occurs now in the current milk pricing system. However, the approach that would be used to achieve this would calculate a protein "value" for "each" milk instead of calculating a fixed protein price per pound that is applied uniformly to milk from all producers. The disadvantage of this approach is that it would be harder for producers to understand, *unless* the price calculation was converted to a cheese yield and whey powder yield basis to communicate to the farmer. If this was done, it would be very easy for a farmer and the cheese industry to understand the milk price. An approach that would keep net returns to the processor constant (given a constant make allowance in $/lb of product for cheese and whey) on each producer's milk would increase the difference in milk price between milks that have low versus high protein and fat concentration. This approach would also more correctly return to each farmer the true value of that milk in Class III.

An approach to pricing that holds net revenues for the cheese maker constant on all milk compositions would also put cheese companies that happen to have different average composition in their milk supplies on a more equal playing field. The cheese factory receiving a milk with higher concentration of fat and protein would still have some competitive advantages with respect to manufacturing efficiency, but the competitive advantages for that cheese manufacturer that are created by the pricing system would be eliminated. Cheese factories that have lower manufacturing costs per pound of product would still have competitive advantages over those with higher manufacturing costs. The interface of this approach for Class III pricing with other classes could be problematic unless the value of components is more completely reflected in other products. A discussion of this topic is outside the scope of this hearing. The dairy product manufacturing industry is not at this level yet, but may be someday. At that time, many of the limitations in the current system of milk pricing calculations will be more easily resolved.

CONCLUSIONS:

1. The current milk pricing system produces a decrease in protein and skim value as the milk fat value used in the current class III calculation increases. This results in abnormally high protein prices (and skim milk price) to cheese makers when fat value is low and the reverse

when milk fat prices are high. This produces decreasing milk price to producers with a fat to true protein ratio of less than 1.28 when fat value goes up. This causes higher volatility in milk protein price than there should be and it sends a confusing price signal to most producers. **In my opinion the automatic decrease in protein value with increasing fat value for a producer with a fat to protein ration of less than 1.28 that happens in the current Class III price calculation needs to be eliminated and one way to do this is by changing the method of Class III price calculation.**

2. The method that I have proposed to calculate Class III relies on the same foundation of the VanSlyke cheese yield formula as the current system and when using the same assumptions as the current system, the proposed method returns a milk price that is about $0.15/cwt higher at 3.5% fat for the March 1999 data than the current system. This difference will vary from month to month. **In my opinion, the system of Class III price calculation that I have proposed would reduce volatility of protein prices, it would establish a fat value in Class III that is tied directly to the NASS cheese price, and it would eliminate the Class III milk price behavior of decreasing protein values caused directly by increased fat values that sends a confusing price signal to producers in the current system.**

3. The parameters used as default values for the NASS cheese price and moisture adjustment should be reevaluated. The values for NASS cheese price and moisture that are used in the cheese yield calculation to determine true protein price should reflect the average composition of the cheese as it is made, not a 39% moisture. This will allow a more correct make allowance adjustment. **In my opinion, the cheese price used in the Class III price should be a price per pound of cheese at a moisture test that more closely represents the actual moisture at which the cheese was produced and that same moisture assumption should be used in the cheese yield formula for the price calculation.**

4. The default assumption used in the current price formula for casein as a percentage of crude protein of 75%, which equates to a value of 79.76% on a true protein basis is too low. **In my opinion, the best analytical data at the present time would indicate that a more correct value for the assumption of casein as a percentage of true protein is approximately 82.2%.**

5. The default assumption for fat recovery in the cheese of 90% is low in relation to average cheese industry performance using average modern cheese making technology. **In my opinion, a more representative average value for large modern Cheddar cheese factories would be 91.5%. Some factories have higher fat recovery in cheese than this, others have lower.**

6. **In my opinion, the default milk composition (at which the protein and other solids prices per pound are calculated in the Class III price calculation method that I have propose) should represent a milk composition that is the average milk composition with respect to fat, true protein and other solids content present in the milk supply used by**

cheese makers.

This information was provided by David Barbano after the Hearing (May 16, 2000)
Comments by David Barbano
This is the material that I presented at the end of my testimony with suggestions on how to modify the current method of
calculation of the protein price per pound to make it more technically correct
This makes the protein price calculation more technically correct but does not address the bigger issues that I mentioned
in my testimony Since it also does not address the issue of the full accounting for components and yields, it results in a final milk
price that is NOT balanced with expected revenues for the cheese maker The point I made about balancing the system at the
point where the prices per pound of component are calculated is critical to achievement of a fair pricing system Thus, this change made in
isolation will not produce a proper change in the total system of milk price calculation A careful examination of the system that
I presented at the hearing will illustrate the need for a comprehensive approach to balancing (milk price versus product values minus make allowance)
the method of price calcultion for the minimum Class III price

The information below is the exact material displayed at the Hearing

True Protein Price **March 1999 - Current System**

1 3064 Nass Cheese Price
0.1702 Make Allowance
1 405 Current Protein Factor
1 582 Current Fat Factor

Step 1	1 3064 minus	0 1702 times	1 405 equals	1 797468	1 5964
Step 2	1 3064 minus	0 1702 times	1 582 equals		0 4464
((1 797468 minus (	1 4487 times	1))	times	1 28)	
				total	2 0428

True Protein Price **March 1999 - Technical Correction of the Protein Factor**

1 3064 Nass Cheese Price
0.1702 Make Allowance
1 405 Current Protein Factor
1 582 Current Fat Factor

1.456 Corrected Protein Factor

Step 1	1.3064 minus	0 1702 times	1 456 equals	1 797468	1 6543
Step 2	1 3064 minus	0 1702 times	1 582 equals		0.4464
((1 797468 minus (	1.4487 times	1))	times	1 28)	
				total	2 1007

True Protein Price **March 1999 - Technical Correction of Fat Retained in Cheese**

1 3064 Nass Cheese Price
0 1702 Make Allowance
1 405 Current Protein Factor
1.582 Current Fat Factor

1 456 Corrected Protein Factor

Step 1	1 3064 minus	0 1702 times	1 456 equals	1 797468	1 6543
Step 2	1 3064 minus	0 1702 times	1.582 equals		0 6319
((1 797468 minus (	1 4487 times	0.9))	times	1 28)	
				total	2 2862

Table 2. Sensitivity Analysis - VanSlyke Yield Equation Parameters
Using March 1999 Price Data and Current Default Assumptions

% Fat Recovery in Cheese	Class III Price ($/cwt) at 3 5% fat
88.0	11 6110
89.0	11.6350
90.0	11.6590
91.0	11 6830
92.0	11.7070
93.0	11.7310
94.0	11 7550

Solids Recovery Factor	
1 07	11.4659
1.08	11.5625
1 09	11 6591
1.10	11.7557
1.11	11 8523

Moisture Content. %	
35 0	11 1575
35.5	11 2379
36 0	11 3183
36.5	11.3987
37.0	11 4791
37.5	11 5595
38 0	11 6399
38.5	11 7203
39 0	11 8007

Casein as a percent of Crude Protein	Casein as a percent of True Protein	
75.00	79.76	11 6591
75.50	80.3	11.6899
76.00	80 83	11.7207
76.50	81 36	11.7515
77.00	81.89	11.7823
77.50	82 42	11 8131
78.00	82 95	11.8439
78.50	83 49	11.8747
79.00	84.02	11.9055

Table 3 Sensitivity Analysis - Make Allowance
Using March 1999 Price Data and Current Default Assumptions

Make Allowance Cheese, $/lb	Class III Price ($/cwt) at 3.5% fat
0.10	12.3300
0 11	12.2344
0.12	12.1388
0.13	12.0432
0.14	11.9476
0.15	11.8520
0.16	11.7564
0.17	11.6608
0.18	11.5652
0.19	11.4696
0.20	11 3740

Make Allowance Whey, $/lb	
0.10	11.8912
0.11	11.8285
0.12	11.7658
0.13	11.7031
0.14	11.6404
0.15	11.5777
0.16	11.5150
0.17	11.4523
0.18	11.3896

Table 4 Sensitivity Analysis - NASS Cheese and Whey Prices
Using March 1999 Price Data and Current Default Assumptions

Cheese Price, $/lb	Class III Price ($/cwt) at 3.5% fat
1.00	8.7929
1.10	9.7836
1.20	10.7743
1.30	11.7650
1.40	12.7557
1.50	13.7464
1.60	14.7371
1.70	15.7278
1.80	16.7185
1.90	17.7092
2.00	18.6999

Whey Price, $/lb	
0.15	11.5669
0.16	11.6296
0.17	11.6923
0.18	11.7550
0.19	11.8177
0.20	11.8804
0.21	11.9431
0.22	12.0058
0.23	12.0685
0.24	12.1312
0.25	12.1939

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