Component Pricing of Milk to Farmers: A More Equitable Way

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This paper demonstrates that multiple-component pricing of milk to farmers is more equitable than butterfat differential pricing because butterfat and nonfat components are not produced in fixed proportions. Conditions are derived for directly calculating producers' multiple-component prices, and for determining the expected relationship between butterfat differential and multiple-component prices. Prices for 274 Oregon producers are calculated under these alternative price regimes. Producers with protein tests less than the pool average are overpaid under butterfat differential pricing and, consequently, experience price declines under multiple-component pricing. Concomitantly, high-test producers are underpaid and experience price increases.

In recent years, there has been increased interest in pricing milk on the basis of either its protein or nonfat solids, as well as on the basis of its butterfat. There are several reasons for this increased interest in multiple-component pricing. First, nutrition-conscious consumers are demanding less fat and more protein in both fluid and manufactured milk products as evidenced by substantial increases in per capita consumption of low-fat and skim milk, hard cheeses, and dried nonfat solids with concomitant declines in consumption of whole milk, cream, and butter. This condition has resulted in substantial increases in the value of skim milk relative to its butterfat value and in the price of dried nonfat solids relative to butter [Graf]. Second, the technology for testing for nonfat solids and protein has been refined, and costs have been reduced to the point that testing does not restrain implementation of a multiple-component price system [Johnson and Christensen]. Finally, the single-component, butterfat differential price system, currently in use in most of the United States, results in inequitable payments to producers [Brog; Hillers *et al.*; Jacobson and Walker; Johnson 1975; Luedtke and Stelly; Smith and Snyder; and Snyder and Smith].

This article is concerned with the inequity in farmers' milk prices that is inherent in the butterfat differential price system. The second section contains background information on the butterfat differential price system, and on milk composition and component variability in order to demonstrate why inequities arise. The methodology and data utilized to measure the inequity and demonstrate the conditions which govern its nature are treated in the third section. The basic approach is a comparison of simulated producers' milk prices under the butterfat differential blend price for February, 1977, in the Great Basin Marketing Order, and under an alternative hypothetical multiple-component price system, using production data from Oregon. Results are presented in the fourth section, and implications are found in the concluding section.

The Butterfat Differential Price and Milk Composition

For many years, dairy farmers in most of the United States have been paid under a

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butterfat differential price system for milk in both manufacturing and fluid markets. In this system, each milk producer in any given market is paid for each unit of butterfat per cwt of milk, plus a skim value per cwt, which is the average value of all nonfat components. Prices vary among producers according to variation in butterfat test since all receive the same skim value per cwt.

The principal components of cows' milk are water, fatty solids, and other solids including protein, lactose, and minerals. Fatty solids are usually referred to as butterfat while protein, lactose, and minerals are generally called solids-not-fat (SNF). Lactose and minerals account for approximately 5 percent of milk by weight with relatively little variation in this share between cows or herds both within and among breeds. There is, however, considerable variation in butterfat and protein which are the most important milk components in terms of nutritional and economic value [Johnson 1971; Ontario]. Since protein is highly variable, while lactose and minerals are relatively constant, there are relatively large variations in SNF, which are mainly due to the variations in protein.

The level of butterfat in milk is positively correlated with protein and, therefore, with SNF; cows and herds with high butterfat milk generally tend to have relatively high levels of protein and SNF [Ontario]. Regression of protein on butterfat based on the Oregon production data used in this study indicated that for each unit change in the butterfat test of milk, protein would change by 0.38 units in the same direction.[1] Similar results have been found to hold for several disparate sets of production data relating SNF and butterfat [Jack *et al.*; Jacobsen; and Luedtke and Stelly].[2]

If the relationship between protein and butterfat were perfect, butterfat differential pricing could be equitable. Perfect correlation of these components implies fixed proportions production, or that the precise level of protein (or SNF) in milk could be determined from its butterfat test alone, or vice versa.[3] Under such conditions, the price per unit of butterfat and the skim value in the butterfat differential price system could be adjusted to reflect changes in the value of protein (or SNF). The result would be a changed, more equitable price for every producer, but based on the existing, single-component, butterfat differential price system rather than on some new multiple-component price system.

However, the correlation between protein (or SNF) and butterfat is imperfect [Ontario] and protein (or SNF) and butterfat are not produced in fixed proportions. Cows and herds both within and among breeds with identical butterfat tests are observed to have significantly different levels of protein and SNF (e.g., Oregon data). Under the butterfat differential price system each herd is correctly paid the same amount per cwt of milk based on the price per unit of butterfat since their fat tests are identical. But, they are also paid the same price per cwt of skim milk despite significant variations in its composition and actual value.

Consequently, the only way that milk producers can be equitably compensated is to receive a differential price for protein (or SNF) as well as for butterfat or any other valuable component. This rationale provides the basis for examining the impact of a multiple-component price system on existing butterfat differential prices.

Methodology

This section discusses the methodology and data necessary to analyze the effect on producers' butterfat differential prices of im-

[1]The estimated regression equation is: protein = 1.89 + 0.38 butterfat, with a standard error of estimate of 0.02.

[2]The regression relation estimated by Jack *et al.* is: SNF = 7.07 + 0.44 BF (where BF = butterfat), with a standard error of estimate of 0.36.

[3]If correlation between protein (or SNF) and butterfat tests were perfect, the standard error in a linear regression of protein on butterfat would be zero since all observations would fall on the regression line. If so, there would be an exact linear relationship between the two components with no variance.

plementing a multiple-component pricing system. The general approach is to compare the existing butterfat differential prices of a set of producers with their corresponding prices under a hypothetical multiple-component price system. The standard prices, producer prices, and pool values are defined for each of the alternative price systems and then conditions are derived which: (i) permit producers' multiple-component prices to be directly calculated; and (ii) determine the relationship between the two sets of prices. The model is tested with production data from Oregon and price data from Utah.

The butterfat differential price for standard milk (i.e., milk with some specified level of butterfat) in a given market is:

$$P' = x\,BF + C\,, \tag{1}$$

where x is the price per pound of butterfat; BF is some arbitrarily set standard for butterfat; and C is the average value of all nonfat components per cwt of milk, hereafter referred to as the skim value. Skim value is determined as a residual by subtracting the value of butterfat from the total value of the pool of milk in the market and dividing the remaining value by the total pounds of milk in the pool.

Given the butterfat differential price for standard milk in (1), the price for any producer i of n producers in the market is:

$$p_i' = x\,BF_i + C\,, \tag{2}$$

where BF_i is the butterfat test of the ith producer; and $i = 1, \ldots, n$. Consequently, each producer in the market is paid the same skim value, C, per cwt of milk, and a differential amount based on the fat in his milk, with variations in p_i among the n producers being completely due to variations in the butterfat test, BF_i.

The value of milk produced by the ith producer is the price per cwt (p_i') multiplied by the number of cwt, designated as w_i, for the time period in question. The value of the milk of all n producers is the sum of each producer's value, or:

$$V' = \sum_{i=1}^{n} p_i' \, w_i\,. \tag{3}$$

The hypothetical multiple-component price for standard milk is given by:

$$P = x\,BF + r\,T + K\,, \tag{4}$$

where r is some market-based price per pound of protein, T is some arbitrarily chosen standard for protein, and K is the average value of all components besides fat and protein per cwt of milk, hereafter referred to as the fluid value.[4]

The price to the ith producer is:

$$p_i = x\,BF_i + r\,T_i + K\,, \tag{5}$$

where T_i is the protein test of the ith producer. Each producer is paid the same fluid value (K) but differential amounts for both fat and protein based on each producer's tests for these components.

Under this multiple-component price regime, the value of the pool of milk is given by:

$$V = \sum_{i=1}^{n} p_i \, w_i\,. \tag{6}$$

In the longer run, producers can be expected to respond to a multiple-component price system by modifying feeding, genetic, and management programs in order to increase production of relatively more valuable components [Cropp *et al.;* De Mediros; Johnson 1971; Wankier; Wilcox *et al.*]. Unfortunately, little is known about the elasticity of such production responses.

In order to abstract from the complexities of longer run adjustments to a multiple-component price system, the following restriction is imposed:

$$V' = V\,. \tag{7}$$

This restriction implies that levels of produc-

[4]In the rest of the paper, protein will be treated as the nonfat component to receive a differential price because the Oregon production data on protein are judged more reliable than those on SNF. However, the following arguments apply equally to SNF, or any other valuable milk component.

tion (w_i, BF_i, and T_i), the price of butterfat (x), the value of nonfat components (C), and the butterfat standard (BF) are the same under the multiple-component price system as they were under the butterfat differential system for a set of producers in a given market.

Concomitantly, imposition of the restriction $V' = V$, permits K to be determined, and p_i in (5) to be directly calculated. Note in (4) that K and P are not empirically observable since (4) is a hypothetical price system, and without K, p_i in (5) cannot be calculated. However, the condition under which the restriction, $V' = V$, holds is:

$$(8) \qquad K = C - r\,T^* ,$$

where $T^* = \frac{\sum_{i=1}^{n} T_i w_i}{\sum_{i=1}^{n} w_i}$, the average level of protein in the pooled milk of the n producers. Since C and r are known and T^* can be calculated given T_i and w_i, then K can be determined from (8) and the set of prices, p_i, in (5) can be directly calculated.[5]

Condition (8) simply requires that K be the average value of all components besides butterfat and protein as it was defined in (4). By definition, C is the average value of all nonfat components, and $r\,T^*$ is the average value of protein. Consequently, the difference between C and rT^* must be the average value of all components besides fat and protein.

Thus, the pool value will not change under a multiple-component price system as long as the fluid value, K, is defined as the difference between the skim value and the average value of protein, assuming that the standard (BF) and the price of butterfat (x) do not change.

The multiple-component price of standard milk (P) may vary from the butterfat differential price of standard milk (P′) given $V' = V$, depending on where the standard for protein is set, but this has no effect on the equality of the pool values or the individual producers' multiple-component prices as long as $K = C - r\,T^*$. If the standard for protein is set equal to the average for the pool, then the butterfat differential and multiple-component prices will be equal. If the standard is less than this average, the multiple-component price will be less than the butterfat differential price, and vice versa.

The conditions governing the relationship between a producer's butterfat differential price, p_i', and multiple-component price, p_i, can be determined by setting up the inequality:

$$(9) \qquad p_i' \geqslant p_i .$$

Substituting for p_i' and p_i from (2) and (5), respectively, and for C from (8) and reducing yields:

$$(10) \qquad T_i \leqslant T^* .$$

That is, when the protein test for the ith producer (T_i) is less than the average (T^*), his butterfat differential price (p_i') is greater than his corresponding multiple-component price (p_i). By a similar argument, when $T_i = T^*$, $p_i' = p_i$, and when $T_i > T^*$, $p_i' < p_i$.

Data

Basic production data were obtained from Mayflower Farms of Portland, Oregon for 274 producers. Data include each herd's milk production during February, 1966, and weighted average butterfat and protein tests for the same month based on two bulk tank samples taken at 15-day intervals.[6] Data from Oregon were used because data from other states were not readily available.[7]

[5]Several researchers have approximated K by subtracting the value of standard butterfat (x BF) and of protein (r T) from the butterfat differential price of standard milk (P′ in (1)). This is tantamount to setting the multiple-component price, P, in (4) equal to the butterfat differential price, P′, in (1). In this case, unless the standard for protein is arbitrarily set equal to the average for the pool, K is not equal to $C - r\,T^*$ and pool values will change under the multiple-component price regime. See Whitaker for a detailed discussion of the consequences of approximating (K) in this manner.

[6]The age of the Oregon data does not limit their utility since they demonstrate the expected variation in components among herds.

[7]The Oregon data were available on tape and were

The uniform (blend) price in the Great Basin Marketing Order during February, 1977 was used to calculate the butterfat differential price of milk for each of the 274 producers. The uniform price equation for standard milk in February, 1977 was:

$$(11) \qquad \$9.29 = \$1.06(3.5) + \$5.58 ,$$

where \$9.29 is the butterfat differential price, \$1.06 is the producers' price per pound of butterfat, 3.5 is the percent of butterfat in standard milk, and \$5.58 is the skim value.

The hypothetical multiple-component price for standard milk is directly related to the butterfat differential price for February, 1977, given $V' = V$. This restriction requires that the price of butterfat and the amount of butterfat in standard milk be unchanged in the multiple-component price. This condition is tenable since it is unlikely that economic conditions and existing industry standards will be affected by implementation of a multiple-component price, at least in the short run.

The price (r) per pound of protein used in this study is based on the wholesale market price of dry nonfat milk solids (skim powder), just as the price per pound of butterfat is related to the wholesale price of butter.[8] The price of skim powder is easily justified as an approximation of the value of SNF since skim powder is comprised of all nonfat solids, and the yield of skim powder per pound of SNF is approximately 1. However, variations in protein do account for most of the variations in SNF, so that variations in yields of skim powder are principally due to variations in protein. Consequently, a pound of protein can be assumed to be worth at least the price of skim powder (\$.625/lb. for spray processed skim powder in Chicago for February, 1977).[9]

The standard for protein can be set at any level as long as the fluid value (K) in the multiple-component price is defined as the difference between the average value of all nonfat components (C), and the average value of protein ($r\,T^*$) for the pool of milk according to condition (8). This specification assures that the pool value of milk will not change under the new price regime. The average value of protein for the 274 producers is the product of the differential price per pound of protein ($r = \$.625$) and the average protein test for the pooled milk ($T^* = 3.41$) and is \$2.13. Subtracting this value from the skim value ($C = \$5.58$) yields the fluid value ($K = \$3.45$).

Given a standard for protein of 3 percent, the multiple-component price for standard milk is:[10]

$$(12) \qquad \$9.04 = 1.06(3.5) + \$.625(3.0) + \$3.45 ,$$

where \$9.04 is the uniform or average price for standard milk; \$1.06 is the differential price per pound of butterfat; 3.5 is the percentage of butterfat in standard milk; \$.625 is the differential price per pound of protein; 3.0 is the percentage of protein in standard milk; and \$3.45 is the fluid value.

Results of the Analysis

Butterfat differential and multiple-

ready for immediate use. More recent data for a relatively large number of California producers are available but require additional processing before they can be analyzed. Data from Pennsylvania and Texas herds were not available.

[8]The price of butterfat in most federal marketing orders is determined by multiplying the price of 92 score butter in Chicago by the yield of butter per pound of butterfat which is approximately 1.2 (butter is approximately 20 percent water). For example, in the Great Basin Marketing Order, the Class I butterfat differential for any given month is the price per point of 92 score butter in the previous month multiplied by 1.2, while the differential for Classes II and III is the current months price multiplied by 1.15. The producer differential is the average of the Class I, II, and III differentials weighted by the amount of butterfat in each class.

[9]Other rationale could have been employed to determine a value for protein. The value of additional cheese from higher-test milk is one possibility. Also, all the value of skim powder could have been assigned to protein [Hillers *et al.*]

[10]The standard for protein has been arbitrarily set at 3.0 percent, which is less than the average test (3.41) for the pool of milk. Consequently, the multiple-component price of standard milk (\$9.04) is less than the butterfat differential price of standard milk (\$9.29).

TABLE 1. Simulated Butterfat Differential and Multiple-Component Prices for 20 Selected Producers

Producer	Protein Test	Butterfat Test	Butterfat Price	Hypothetical Component Price	Price Change
	%	%	$	$	$
1	2.94	3.80	9.61	9.31	−.30
17	3.14	3.59	9.38	9.21	−.17
33	3.18	3.78	9.58	9.44	−.14
49	3.23	3.51	9.30	9.19	−.11
65	3.27	3.88	9.69	9.60	−.09
81	3.29	4.05	9.87	9.80	−.07
97	3.33	3.66	9.46	9.41	−.05
113	3.36	3.65	9.44	9.41	−.03
129	3.39	3.91	9.72	9.71	−.01
143	3.41[a]	4.37	10.21	10.21	0
145	3.41	3.68	9.47	9.48	+.01
161	3.46	3.75	9.56	9.59	+.03
177	3.49	4.20	10.03	10.08	+.05
193	3.54	3.83	9.64	9.72	+.08
209	3.62	4.15	9.98	10.11	+.13
225	3.71	4.23	10.06	10.25	+.19
241	3.81	5.10	10.99	11.24	+.25
257	3.93	4.75	10.62	10.94	+.32
273	4.26	3.95	9.77	10.30	+.53
274	4.47	6.00	11.94	12.61	+.67

[a]The protein test of producer 143 is equal to the weighted average for the pooled milk of the 274 producers.

component prices were calculated for each of the 274 producers using their production data for February, 1966, the values of C from (11) and K from (12), and equations (2) and (5), respectively. The results are presented for 20 of the 274 producers in Table 1. Approximately every 16th producer was selected in ascending order of protein test starting with the lowest. The producer with a protein test equal to the average for the pool (3.41) and the producer with the highest test (4.47) were also included.

Each producer's protein test relative to the average determined the direction and magnitude of price change under multiple-component pricing of milk consistent with (9) and (10). Producer 143, who had a protein test equal to the average for the pool of 274 producers, had identical butterfat and multiple-component prices. The multiple-component prices of producers with protein tests less than the average were less than the corresponding butterfat differential prices. The difference ranged from $.01 per cwt less for producer 129 to $.30 less per cwt for producer 1, who had the lowest protein test. In a similar manner, producers with protein tests higher than the average for the pool had higher multiple-component prices than butterfat differential prices. These differences ranged from $.01 to $.67 greater per cwt, as the size of the protein test increased.[11] In essence, producers with low protein tests have been overpaid, while those with high protein tests have been underpaid by the inequitable multiple-component price system.

The results also illustrate the basic reason why component pricing is necessary to correct inequities arising from the imperfect correlation between protein (or SNF) and butterfat. Consider producer 273 with a

[11]Utilizing a different price for protein than $.625 per pound will affect the magnitude of price change for all producers. The effect of a protein differential greater than $.625 per pound is a bigger change in every producers butterfat differential price. Consequently, producers with protein tests less than the average would suffer larger price declines than shown in Table 1, while producers with protein tests greater than average would experience larger price increases. The opposite holds for a protein differential less than $.625.

much higher protein test than average for the level of his butterfat. The butterfat differential price of standard milk could be adjusted by changing the price of butterfat and the skim value in order to account for the value of protein that is on average jointly produced with butterfat. However, if this were done, producer 273 would be greatly underpaid because his actual protein test is much higher than the average level of protein associated with his butterfat test. The point can also be illustrated by considering producers 33 and 161 who have almost identical butterfat tests but very different levels of protein. The only way to fairly compensate for the components in their milk is by a multiple-component pricing system, since they would be paid essentially the same price under any butterfat differential price system.

Thus, this study has three basic findings which are generally applicable. First, changing from a butterfat differential to a multiple-component price system in a market will result in a decline in price for all producers who have protein tests less than the average for the market pool and who have been overpaid. Concomitantly, all producers who have protein tests greater than the average and have been underpaid will experience price increases under a multiple-component price system. The second closely related finding is that the magnitude of the price change experienced by the ith producer is directly related to the difference between the average protein test for the pool and the producer's protein test. Finally, multiple-component pricing is the only way to correct inequities inherent in all butterfat differential price systems, since butterfat and protein are not produced in fixed proportions.

Implications of the Results

The implications of the results of this study are clear: multiple-component pricing of milk will result in more equitable milk prices for individual producers. Furthermore, multiple-component pricing will likely lead to a more efficient utilization of resources and a relative increase in the production of protein (or SNF) as producers and processors adjust resource use and technology on the farm and in the plant in response to the differential price of protein. However, evidence on increased efficiency has not been presented in this study.

There are, however, a number of problems which make implementation of multiple-component pricing difficult. One dilemma is the effect on milk volume of partial implementation in a marketshed by one handler or cooperative. A second concern is the notion that the marginal cost of protein cannot be recovered in milk sold as Class I products in the fluid market. A third and closely related problem is whether component pricing should be implemented at the producer level alone, or at the producer level and in class charges to handlers, in the fluid market. Each of these problems is briefly considered.

Implementing multiple-component pricing by only one or a limited number of processing firms in a given market, either fluid or manufacturing, will likely result in an immediate disruption in their sources of supply. This result may occur because producers with protein (or SNF) tests less than the average will receive lower prices under the multiple-component price system and will seek higher prices offered by firms still buying milk under the butterfat differential price system. This loss of volume will be partially offset as producers with protein tests higher than the average shift from firms buying on the butterfat differential system to the few firms paying the higher multiple-component price.

Firms that implement multiple-component pricing when most buyers continue with a butterfat differential price are likely to attract the high protein test milk in the marketshed. Since higher-test milk is, on average, associated with lower volumes [Ontario; Wilcox *et al.*], the tendency is toward reduced volumes for innovative firms. Consequently, any firm contemplating a change to multiple-component pricing should carefully consider the consequences before action is taken.

Marketwide implementation of component pricing would be less disruptive to milk supplies of individual firms than partial implementation and would likely result in more efficient use of resources. However, under marketwide implementation, producers suffering reduced prices could not offset losses by changing cooperatives or handlers, and some marginal producers could be forced out of dairying.

One argument often advanced against multiple-component pricing in the fluid market is that consumers are not willing to pay for extra protein (or SNF) in Class I (fluid) products. The evidence usually cited is that consumers generally will not pay a premium for protein fortified lowfat milk relative to regular lowfat milk, and that, therefore, consumers do not demand additional protein in fluid milk. On this basis, it is argued that handlers cannot pay differential prices for protein (or SNF) used in fluid products and that component pricing should not be implemented, at least for milk used in fluid products.

This argument is largely untested and appears to be fallacious. Evidence is also available to demonstrate that consumers generally will not pay a premium for highfat milk relative to whole milk, but no one has suggested (to the best of my knowledge) eliminating the butterfat differential charged to handlers for Class I use because of a demonstrated lack of demand for additional fat in fluid milk.

Each fluid product is basically comprised of varying quantities of butterfat, protein, lactose, minerals, and water; and it is the unique combination of these components in each product that permits consumers to distinguish among them. Other things such as pasteurization, homogenization, culturization (e.g., buttermilk), flavoring (chocolate milk, eggnog), and packaging also result in product differentiation, but alteration of the various component levels is the basic process for producing different fluid products. In essence, handlers produce the various fluid products that are demanded by consumers basically by changing the proportion of components in the raw milk that is delivered to the plant. To the extent that a milk component commands a price in some alternative nonfluid use, then handlers must pay that price for such components used in fluid products if efficiency is to prevail in the market.

Under the butterfat differential price system in the fluid market, handlers do pay for each pound of butterfat which they use in fluid or manufactured products. This price is based on the wholesale market price of 92 point butter in Chicago (see footnote 8) and is essentially the value of butterfat in its best alternative use. However, handlers only pay the average price per cwt for skim milk without regard to its content.

Pricing each unit of protein (or SNF), as well as butterfat would encourage handlers to utilize the nonfat components more efficiently. For example, there would be direct incentives to more efficiently utilize excess milk supplies by satisfying the demand for fluid products with lower protein test milk, and diverting high-protein test milk into manufacturing in order to obtain greater yields. The pressure for such diversion would be even greater if the protein (or SNF) handler differential were higher for Class I use, as it is for butterfat.

Such diversion is being done on a limited basis, by at least one handler in the Great Basin Order, suggesting that basic economic forces are exerting their influence on management decisions despite the lack of incentive in the formal price system. Diversion of high protein milk can occur if consumers do not distinguish lower protein levels in fluid products. When they do, then it becomes profitable to put more protein in fluid products through fortification or use of higher-test milk. Of course, the profitability of diverting high-test milk to manufacturing also depends on other factors, especially location of the raw milk relative to fluid processors, and relative to plants for manufacturing excess supply into nonfluid products.

Thus, multiple-component pricing likely can be implemented in fluid markets.

Whether or not consumers will pay for additional quantities of protein in fluid products is not at issue. The basic question is whether handlers should pay the opportunity cost of using the various nonfat components in producing fluid products.

The final issue is whether component pricing should be implemented at the producer cooperative level alone, or also in class charges to handlers [Graf]. This issue is closely related to the above question. If a cooperative were to implement component pricing, the immediate consequence would be more equitable producer prices and, ultimately, more efficient resource use at the farm level, with a tendency for relatively more nonfat solids to be produced. However, until handlers are charged the opportunity cost of every valuable component in milk, there is likely to be inefficient use of milk components and other inputs by milk processors. This condition suggests that multiple-component pricing should be implemented simultaneously at the handler and the producer cooperative level.

In summary, there is revived interest throughout the United States in implementing multiple-component pricing of milk. Perhaps the most compelling reason for multiple-component pricing is the inequity in producer prices under a butterfat differential system which has been illustrated in this article. There are, however, enough practical difficulties to implementing component pricing that it is advisable to proceed with caution.

References

Brog, Roy A. "Economic Incentives for Cheese Processors Using a Protein-Fat Pricing Model." *J. D. Sci.* 54 (1971):1006-1012.

Cropp, Robert A., Hugh L. Cook, and Allan N. Bringe. *Pricing Milk to Farmers on a Component Basis.* University of Wisconsin, Cooperative Extension Programs, ZA7760814, June, 1977.

De Mediros, George. "Experiences with and Suggestions for Multiple Component Pricing Plans." *Proceedings — Western Dairy Conference Symposium.* Seattle, March 11-12, 1971, pp. 22-28.

Graf, Truman F. "Economic Rationale for Using Both Nonfat and Fat Values in Pricing Milk." University of Wisconsin, Cooperative Extension Programs, Staff Paper Series, No. 129, August, 1977. (Mimeograph)

Hillers, J. K., L. J. Manus, M. V. Waananen, M. F. Miller, L. J. Christensen, and F. R. Johnson. "Effect of Seventeen Milk Pricing Systems on Producers Price of Milk," *J. D. Sci.* 54 (1971):187-190.

Jack, E. L., E. B. Roessler, F. H. Abbott, and A. W. Irwin. *Relationships of Solids-Not-Fat to Fat in California Milk.* California Agricultural Experiment Station, Bulletin 726, 1951.

Jacobsen, M. S. "Butterfat and Total Solids in New England Farmers Milk as Delivered to Processing Plants." *J. D. Sci.* 19 (1936):171-76.

Jacobsen, Robert E. and Francis E. Walker. "Efficiency Considerations in Butterfat Differential and Component Pricing of Milk." *Am. J. Agr. Econ.* 55 (1973):214-17.

Johnson, Frank R. and Lawrence J. Christensen. "Multiple Component Pricing Cost and Techniques." *Proceedings — Western Dairy Conference Symposium.* Seattle, March 11-12, 1971, pp. 14-17.

Johnson, Stewart. "Experiences with and Suggestions for Multiple Component Pricing Plans." *Proceedings — Western Dairy Conference Symposium.* Seattle, March 11-12, 1971, pp. 29-37.

______. "Pricing Systems as Related to Milk Composition Variability." *J. D. Sci.* 56 (1975):297-302.

Luedtke, Larry and Randall Stelly. *An Economic and Statistical Analysis of Solids-Not-Fat and Protein Components of Milk.* Texas Agricultural Market Research & Development Center, Research Report MRC 75-2, Texas A&M University, August, 1975.

Ontario, Department of Agriculture and Food. *A Study of Milk Composition in Ontario.* Study conducted in Ontario by the Dairy Branch of the Ontario Department of Agriculture and Food and others during 1961-65. Toronto, 1969.

Smith, Blair J. and Stephen D. Snyder. "Effects of Protein and Fat Pricing on Farm Milk Prices for the Five Major U. S. Dairy Breeds." *Amer. J. Agr. Econ.* 60 (1978):126-131.

Snyder, Stephen D. and Blair J. Smith. *The Potential Effects of Various Fat and Protein Differentials on Returns to Selected Dairy Farmers.* Agricultural Experiment Station AERS 122, The Pennsylvania State University, July, 1976.

Wankier, W. Gordon. "Possible Ways that Milk Producers may Respond to a Multicomponent Milk Pricing System." Unpublished M.S. thesis. Utah State University, 1978.

Whitaker, Morris D. "The Effect of Component Pricing on the Producer Price of Milk." Utah Agricultural Experiment Station Journal Paper No. 2225, August, 1976.

Wilcox, C. J., S. N. Gaunt, and B. R. Farthing. *Genetic Interrelationships of Milk Composition and Yield.* Southern Cooperative Series Bulletin No. 155, March, 1971.