ECONOMIC ANALYSIS OF HIGH-LEVEL GRAIN FEEDING FOR DAIRY COWS

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SUMMARY

The economic consequences of feeding variable quantities of grain and forage to lactating cows with an assumed producing ability of 10,500 lb 4% FCM milk were budgeted for five combinations of milk and feed prices. The four feeding levels included 3,000, 4,500, 6,000, and 7,500 lb grain mixture per cow. Quality of forage was assumed to be average.

With low grain ($50 per ton) and low hay ($22 per ton) prices and milk at $4.15 hundredweight net at the farm, the most profitable level of grain feeding was at 6,000 lb, at a milk output of 11,000 lb. When milk in excess of 10,500 lb per cow was sold at $3.00 per hundredweight, the optimum feeding rate was reduced to 5,000 lb grain. When all milk was sold at $3.00 per hundredweight, the optimum rate was only 4,000 lb grain.

With high grain ($65 per ton) and low hay prices, and low grain and high hay ($35 per ton) prices, the most profitable feeding rates were at 4,500 and 6,000 lb, respectively. From an economic standpoint, it is not necessary to exactly pinpoint the most profitable level of grain feeding. Over a grain feeding range of 500 lb + or − from the economic optimum, there were relatively small variations in returns above costs of feed. Missing the economic optimum by over- or under-feeding grain by 1,000 lb, or 20%, resulted in $6 lower returns over cost of feed per cow.

Interest in high-level grain feeding has resulted from relatively low prices for feed grain and increased productivity of dairy cows. Improved technology and increased use of fertilizer have resulted in higher yields of corn for grain and silage. Yields and quality of hay are also being improved as a result of increased use of hay conditioning and drying equipment, better know-how in harvesting and storage of low-moisture, legume grass silage, and improved cultural practices. These developments are resulting in lower cost of forage nutrients. Thus, forage crops as well as grain are low in cost.

Low cost of forages, as well as the trend toward loose housing and the problems of controlling forage intake, are expected to encourage free-choice feeding of forages.

Artificial insemination, reduction in the number of small dairy herds, and increased technical skill and know-how on the part of the remaining dairy farmers have resulted in increased milk production per cow and increased technical efficiency.

Recent high-level grain feeding experiments indicate that the inherent capability of dairy cows to produce large quantities of milk is greater than many dairy farmers anticipate. Charron (3), of G.L.F., during 1960 conducted a study to determine the effects, if any, on the health of the animal and the response of dairy cows when fed increased quantities of a grain mixture. Of 442 cows in 48 herds, 90% of the cows responded with an increase of 1,000 lb or more milk and 57% of the cows with an increase of 2,000 lb or more milk. At the time the project was initiated, 84% of the cows were fed at daily rates ranging from 11 to 20 lb. Of the high TDN-fed cows during the test period, 60% received 21 to 25 lb grain daily, 22% over 25 lb, and 16% received 16 to 20 lb. With the price of milk assumed at $4.75 hundredweight and grain at $3.50 hundredweight (New York prices), 40% of the cows showed a profitable response to the increased grain feeding. A similar study (4) conducted in 1961, but with grain fed to the appetite limit of all cows, resulted in only 23% of the cows showing a profitable response.

For alternative grain-feeding levels there is need for an economic analysis within which the concept of diminishing returns is taken into account. Jawetz (10), in a review of input-
output relationships in milk production, suggested the need for revision of conventional recommendations of production requirements per unit of milk, because of the proportionally higher requirements at high levels of yield than at low levels. This conclusion is in agreement with statements by Putnam and Loosli (14), Bloom et al. (1), and Dickson and Kopland (5). Reid (15) has pointed out "that the principle of diminishing returns is an important economic factor in the production of milk is indisputable."

That this principle applies to high-producing cows was demonstrated by Dickson and Kopland (5). A three-level grain feeding study resulted in decreased efficiency in use of feed as the quantity of grain was increased. Pounds of milk produced for the all-roughage, the limited-grain (1:6), and the full-grain (1:3) rations were 13,656, 16,848, and 17,851, respectively. The calculated pounds of TDN required to produce 100 lb of milk were 53.4, 55.5, and 68.9, respectively, for the three feeding levels.

For any given cow, as more grain is fed one can expect higher TDN feed requirements per unit of milk output and increased total cost of feed (5, 7, 11). Dairy farmers need to be more concerned about maximizing returns over cost per cow or per farm than attaining the lowest cost per unit of milk output. The highest net return per cow is usually achieved at a point short of the maximum attainable production but above the lowest unit cost of milk output. Production responses of individual cows to increased grain feeding and price relationships determine this economic optimum in feeding grain.

A major problem in making an economic evaluation of different levels of grain feeding is finding data suitable for economic analysis. Many experiments involve only two levels of grain feeding. These are often at low levels and may completely miss the most profitable range in feeding. Results are often erratic or not suitable for application to farm conditions, because of the small number of cows included or the limited period of the study.

Results of research work involving studies of fixed forage-concentrate ratios (1) have not been very useful in making application to dairy farms on which forages are generally fed free choice. Economists (13) and dairy nutrition researchers (6, 9, 17, 18) often use DHIA data in evaluating the effects of increased grain feeding on the economics of milk production. When records for individual cows or herds from widely scattered dairy farms differing in markets, managerial skill of operator, and farm resources are sorted into groups by level of milk production, the results are confounded by the effects of inheritance, management, quality of forage, and other variables. DHIA records are inappropriate for economic analysis of levels of grain feeding, because of the lack of accuracy of records of feed, particularly of forages (19), and because of the confounding of the results. When Michigan DHIA (12) herds are grouped by different production levels, a straight-line relationship is shown between milk production and pounds of grain fed.

DATA AND METHODS

Empirical data used in making an economic analysis of alternative grain-feeding levels were based on a three-level grain feeding study by Brown et al. (2). The criticism of small number of observations applies, since only 18 cows were involved, but the experiment was designed to cover a wide range in levels of grain feeding. The 18 cows were divided into three comparable groups for a 260-day experimental period. The producing ability of the cows was estimated as 10,500 lb FCM for the 260-day period. For a 305-day lactation period, the producing ability would have been nearly 11,500 lb. The shape of the production curve would...
Our changes have been little, if any, if milk production had been adjusted to a 305-day period.

The data were adjusted to meet the needs of studying four levels of grain feeding at 1,500-lb intervals from 3,000 to 7,500 lb. To adjust for restrictions placed on both grain and forage at the 4,500-lb experimental level, milk production was increased by 300 lb (Figure 1). The shape of production curves for this study, a Montana study (5), Series I experiments from Jensen et al. (11), and synthesized production functions for excellent and average forage are shown in Figure 1. The shape of the synthesized milk production curves and feed data for the excellent and average forage alternatives were based largely on research results adjusted to commercial dairy farm conditions. Because of the lack of precise experimental data for the whole range in grain feeding it was necessary to estimate some of the input coefficients.

The quantities of grain and hay equivalents fed or consumed by lactating cows when fed grain and forage at different combinations are shown in Figure 2. The forage-grain relationships based on the Brown et al. adjusted (2), Putnam and Loosli (14), and Ronning (16) data follow a remarkably similar pattern. The feed input and milk production response coefficients are shown in Table 1. As more grain is fed, each additional 1,000 lb replaces a larger quantity of hay, but the total pounds of feed and TDN increase. These relationships are based on average-quality forage and good management practices.

Five combinations of milk and feed prices were applied to the input-output data for the four levels of grain feeding (Table 2). Three milk price situations were selected to represent 1) a fluid market in which all milk is paid for at a blend price, 2) a base-surplus market in which individual dairymen establish a base and receive manufacturing prices for all milk produced above this base quantity for each month of the next marketing year, and 3) a market based on utilization of milk for manufacturing purposes. These prices are net at the farm after deducting cost of hauling. The low-grain and low-hay situation represents midwestern prices which are expected to continue under current government price support programs and normal climatic conditions. The high-grain and high-hay prices represent deviations in price which might result from drought, change in government feed programs, or other changes. It is recognized, however, that milk-feed price relationships and levels of prices vary considerably between producing
TABLE 2
Selected milk and feed prices used

<table>
<thead>
<tr>
<th>Alternative price relationships</th>
<th>Price per hundredweight 4% FCM</th>
<th>Price per ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base or blend</td>
<td>Surplus or manufacturing</td>
</tr>
<tr>
<td>A. Low-grain and low-hay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. All milk at base price</td>
<td>$4.15</td>
<td>$4.15</td>
</tr>
<tr>
<td>2. Limited base</td>
<td>$3.00</td>
<td>$3.00</td>
</tr>
<tr>
<td>3. All milk at manufacturing price</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B. High-grain and low-hay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. All milk at base price</td>
<td>$4.15</td>
<td>$65</td>
</tr>
<tr>
<td>C. Low-grain and high-hay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. All milk at base price</td>
<td>$4.15</td>
<td>50</td>
</tr>
</tbody>
</table>

* Assumed that under a base-surplus plan in operation in Michigan that base price would apply to first 10,500 lb milk sold per cow, with balance of milk selling at the surplus price.

areas. It is believed that these examples illustrate the effect of changing price ratios on the economic optima in grain feeding. Returns above cost of feed was the measure used in determining the most profitable level of grain feeding. This method of evaluation disregards changes in labor use and investments in feed storage and handling equipment associated with varying levels of grain feeding. However, if appropriate prices are used, this method of analysis can provide reasonable estimates of the economic consequences of feeding lactating dairy cows different combinations of grain and forage (8).

RESULTS AND DISCUSSION

Returns above cost of feed were calculated for the four grain-feeding levels and the five milk-feed price relationships and are shown graphically in Figure 3.

Low-grain and low-hay prices. With a price assumption of $50 per ton for grain mixture and $22 per ton for hay, and all milk at $4.15 per hundredweight, the most profitable feeding was at the 6,000-lb grain level (Figure 3). Milk production at this level was 11,400 lb. Returns above cost of feed would be reduced if more or less grain was fed. Under a base-surplus plan and an individual farm base of 10,500 lb per cow, the economic optimum would be reduced to about 5,000 lb grain.

Dairymen selling all milk at a manufacturing price of $3.00 per hundredweight would maximize returns above feed cost at the 4,000-lb grain level. Under the price relations assumed for feed and the lower price for milk, returns above cost of feed per cow would be only 45% as high as when milk sold for $4.15 per hundredweight.

High-grain and low-hay prices. Except in the event of a national emergency, it is not likely that the price of grain will become high relative to hay, at least in the near future. Previous to the present surplus grain situations and lower support prices, the cost of a ton of grain was normally about two and one-half to three times as high as for a ton of hay. In more recent years this ratio has been about 2:1. With a price assumption of $65 per ton for grain mixture and $22 per ton for hay, and all milk selling at $4.15 per hundredweight, it would be profitable to feed only about 4,500 lb of grain.

![Figure 3](image-url)
Low-grain and high-hay prices. Prices paid for hay often vary greatly between areas, due to local drought conditions. A combination of low-grain and high-hay prices would be characteristic in these areas. On the basis of $50 per ton for grain mixture, $35 per ton for hay, and $4.15 per hundredweight for milk, it would pay to feed 6,000 to 6,500 lb of grain mixture on the basis of the assumed input-output relationships.

Range of economic indifference. Uncertainties on the part of dairymen relative to expected production response of individual cows fed various quantities of grain and variable qualities of forage make it difficult to pinpoint the most profitable level of grain feeding. From an economic viewpoint, it is possible to deviate as much as 10% from the economic optimum without greatly affecting net returns. An examination of the returns over cost of feed for the alternative of a limited base (10,500 lb per cow) and a milk price of $3 per hundredweight for all milk sold above this base suggests an economic optimum of 5,000 lb grain to feed (Figure 4). Net returns are reduced by only $2 to $3 per cow when 500 lb more or 500 lb less grain is fed. This is the range of economic indifference, the feeding zone within which a dairyman should operate. Missing the economic optimum by more than 10% reduces returns. Feeding grain at a rate of 1,000 lb or 20% above or below the optimum would reduce returns by $6 per cow. For a 50-cow dairy herd, feeding 6,000 lb rather than 5,000 lb grain would lower returns over cost of feed by $300 and would add 16,000 lb milk to markets already in surplus supply.

Individual dairymen will need to adjust levels of grain feeding, not only to changes in costs of feeds but also to differences in inherent capabilities of cows to convert grain to milk and to differences in quality of forage.

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REFERENCES


