SYMPOSIUM: Role of Forage in Tomorrow’s Dairy Cattle Feeding Programs

Minimizing Cost of Forage in Tomorrow’s Dairy Ration

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Abstract

Changing technology and cost-price relationships will have an impact on forage production and feeding in the future. Increasing input costs, accompanied by prospects for moderate to no increases in milk prices in the years ahead, stress the need for minimizing cost of forages and other inputs. Cost-price relationships between areas often vary considerably, resulting in different economic choices of forage crops to grow and in the optimum combination of forage and grain to feed. The economic optimum in forage feeding will range from 40 to 70% of the total dry matter consumed. It is expected that higher prices for feed grain will encourage increased and more economical production of forage crops. The trend will be toward highly mechanized forage systems based on feeding of complete-feed silage.

A most promising method of reducing cost is to increase both the yields and nutritive value of forage crops. Forage costs per cow can be reduced by $6 to $20 by increasing yields to more economical levels. On highly productive land in the Midwest, yields of 32,200 to 42,800 kg/ha (18 to 24 ton/acre) of 32% DM corn silage and 20,600 to 26,800 kg/ha (6.5 to 8.0 ton/acre) of 90% dry matter alfalfa hay are attainable and cost-reducing. Highly mechanized silage and haylage systems tend to improve quality and reduce labor inputs. The break-even point in costs between medium and highly mechanized systems is at 90 cows, with labor at $2 an hour, and 60 cows when labor costs $4 an hour.

Forage is one of the major dairy inputs accounting for 25 to 30% of the cost of producing milk. Forage and concentrates together add up to 45 to 60% of all costs (2, 9, 23, 24). Cost of forage in the dairy ration can be minimized either by reducing unit costs, by increasing quality, which may result in higher production of milk or reduced protein supplement, or by feeding more concentrates and less forage.

Major emphasis in this paper will be given to a discussion of the impact of new technology on the costs of alternative forage crops and systems, some factors affecting the most profitable choice of forage and grain crops to grow and feed, and potentials for reducing costs of growing, harvesting, storing, and feeding forages to dairy cows.

A discussion of the role of forages in tomorrow’s dairy cattle feeding programs must take into account expected changes in the economic climate. Dairymen are faced with increasing costs of most inputs and little prospect for higher milk prices in the years ahead. The cost of owning land (interest and taxes) has increased by an average of 13.3% per year since 1951-1959. Land is selling for 66% more per acre, an increase of 6.6% per year. Suburban developments near metropolitan areas, investments by nonfarmers in land as a hedge against inflation, and the desire of many farmers to add land to their present units are expected to keep cost of land high. We can expect much higher farm-wage rates, a shorter work week, and increased fringe benefits if dairymen are to compete in the labor market. The highly mechanized machines and equipment which dairymen will invest in to utilize labor more efficiently also will cost more.

Filled milk and substitute dairy products will have an impact on demand and price for milk. Higher Class I utilization of milk can be expected as the less efficient dairymen quit farming. This will increase the price paid dairymen in some areas without resulting in higher retail prices. All of these factors stress

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the need for more economical production and feeding of forage crops.

Impact of Technological Innovations

Forage production and feeding practices have changed as a result of new technology, improved varieties and cultural practices, and larger-scale operations. In the United States the past ten years, the quantity of corn silage fed per cow was doubled and the quantity of total harvested forage, on a hay equivalent basis, was increased by 909 kg, or from 2,727 to 3,636 kg. This increase in harvested forage fed was due largely to less dependence on grazing. As herds become larger and more specialized in the future, a major source of summer feed will be silage or haylage. Grazing will be confined largely to areas not suited for mechanical harvesting.

Corn silage has benefited especially from the development of improved technology and practices. Minimum tillage, higher plant population, increased rates of fertilizer, substitution of chemicals for cultivation, improved harvesting and handling machinery and equipment, and lower-cost storage have increased yields and lowered per unit cost of producing corn silage.

The alfalfa crop has also benefited from new technology. Improved seeding practices, including chemical control of weeds in producing economical yields the year of seeding, higher rates of fertilizer, and more frequent harvests have resulted in higher yields and higher quality. Development of the know-how in storing forage as haylage and more satisfactory equipment to fill and unload silos have made alfalfa more competitive. Should preliminary experiments (6) in the use of Simazine in increasing protein content of legumes and grasses prove successful, this would make them still more competitive. In preliminary tests, crude protein content was increased by 10% for alfalfa and 52% for ryegrass forage.

The addition of urea to corn silage has greatly reduced the need for oil meal in the concentrate ration, thereby cutting protein costs. One of the problems in feeding urea is reduced palatability of the ration, resulting in lowered feed intake and milk production or animal gains. Fletcher et al. (7) found that heifers fed urea-treated silage had a 13.7% higher feed efficiency when fed four times rather than two times daily. A Kansas study (12) now in progress indicates the possibility of more efficient use of urea by slowing down release of ammonia. These and other developments will tend to increase the acceptance of urea by more dairymen and will have an impact on the kind of forage crops grown in the future.

The production of high-lysine corn and future prospective developments of higher-protein content of feed grains will also encourage production of lower-protein forage, such as corn and sorghum silage (13). A problem is increasing yields of the higher-protein grains to make them competitive with present high-yielding varieties.

Research results (21, 28, 29, 31, 33) indicate that a complete-feed silage has practical and economic potentials for mechanized group-feeding. To achieve flexibility in feeding, silage and grain may be stored in separate units and combined at time of feeding. Several new dairy housing setups in Michigan have no grain feeding mechanism in the parlor. All concentrates are fed with the silage. This change in feeding method will tend to eliminate hay, and will reduce investments. Limited research (27) indicates that labor requirements for milking cows can be reduced by 10% by eliminating concentrate feeding in the parlor.

Computer science will play an increasingly important role in optimizing net income for forage production and feeding systems. Linear programming has proven useful in formulating least-cost rations (1, 21). West Virginia scientists (25) have developed a model involving use of linear programming to optimize returns from different crop management systems.

Factors Influencing Choice of Feeds

Individual dairy farmers are faced with problems of selecting the combination of feeds which minimize costs and maximize net returns for the whole farm. Alternative choices include: a) growing versus buying forages, b) selection of the forage or combination of forage crops which minimizes feed costs, c) application of fertilizer and other inputs up to a point where marginal returns = marginal costs, resulting in the most economical production, and d) selection of machines and methods of harvesting, storing, and handling which minimize losses and reduce labor and other unit costs. A major problem for both dairy farmers and economists in appraising alternative choices is the lack of adequate and reliable research data (18).

The most profitable combination of forage and grain to grow or feed is determined by many factors, which often vary from area to area, and farm to farm. Relative yields as affected by the productivity of the soil and the skill of the operator in growing different
crops, relative acres of cropland, and availability of forage crops for contract purchase are major factors influencing choice.

Availability of both capital and labor affect the profitability in growing and feeding alternative forage crops. Shandys and Sitterly (39) found that both the optimum number of cows to milk and the forage program were affected by the availability of capital. Farms were operated more intensively when capital was limited. Shapley (38), assuming the best technology in the production of feed crops and milk, found that corn silage was the most economical forage crop to grow on highly productive cropland when no restrictions were put on harvest labor. A combination of 50% DM from alfalfa haylage and 50% DM from alfalfa haylage was most profitable when seasonal labor was assumed to be in limited supply during the September-October corn silage harvest season.

The trend in some areas is towards separation of animal agriculture from the traditional production of feed on farms producing milk and meat. Specialized dairy farmers in Arizona and California have for years purchased forage and grain. Dairy farmers in the Northeast have been buying their grain and part of their forage requirements for many years. Michigan dairymen with 100 or more cows and cooperating in the Telfarm Record Project in 1966 bought one-third of their feed (11). A high per cent of dairymen in the Midwest, Northeast, and Southeast will probably continue to produce at least their silage and haylage needs (19, 43).

Since forages are usually fed ad libitum, the quantity consumed is inversely related to the level of concentrate feeding. The expected concentrate-hay relationship and resulting milk production for a high-producing cow fed over a range of forage-hay ratios of 80:20 to 40:60 are shown in Figure 1.

The most economical level to feed concentrate to individual cows is associated with milk production responses to variable quantities fed and to milk-feed and grain-forage price relationships (16). With milk priced at $11.60/100 kg, grain at $68.20/100 kg, and hay at $35.20/100 kg the most profitable feeding level was at 2,410 kg concentrates. Pricing hay at $44 but making no other change in prices, it would pay to increase concentrate feeding by 455 kg, which would reduce hay consumed by approximately 350 kg. Increasing the cost of grain or assuming a less responsive cow would suggest feeding less grain and more forage. A Virginia study (34) showed an optimum forage-to-grain feeding (DM) ratio of 33:67 when 5,900 kg milk production per cow was assumed, and a 43:57 forage-grain ratio for cows with an assumed potential of 5,000 kg milk. Milk was priced at $12.61/100 kg.

Dairymen do adjust their feeding programs to milk-feed and grain-forage price relationships. A 1960 study (14) showed a range of from 818 to 2,509 kg grain fed per cow for six milk production areas of California. The low rate was associated with a Northern area distant from metropolitan markets. The high level was for the Metropolitan Los Angeles area, for which a high percentage of milk is contracted at Class I prices. The highest rates of grain feeding in the United States are in areas of highest milk prices and highest percentage utilization of milk as fluid (30).

From a physiological standpoint there is an optimum range in feeding concentrates and forage. Kesler and Spahr (26) present data which indicate that the maximum nutrient intake is attained when concentrates make up 50 to 60% of the total dry matter consumed. Thus, the physiological optimum in forage feeding would be 40 to 50%. Extremely high levels of concentrate feeding tend to depress milk fat percentage and production and, thus, are unprofitable. Feeding grain at low levels to high-producing cows tends to limit economical production of milk. From an economic standpoint, the optimum range in forage feeding for most areas would be from 40 to 70% of the total dry matter consumed. The higher levels of forage feeding are usually attained when forage quality is very high, grain price is high, milk price is low, or when production is at relatively low levels. The lowest levels of forage feeding are associated with high levels of milk production, high prices for milk, and low prices for grain.

![Fig. 1. Concentrate-hay feeding relationships for high-producing Holstein cow (milk production scale, 10 kg).](image-url)
The emphasis on forage feeding in the future will depend to a large extent on the cost of grain relative to forage and milk. The extent to which our government becomes committed to feed a hungry world and the magnitude to which our government becomes committed the price levels for grain. Our agricultural plant has much reserve capacity which could be mobilized for greatly expanded grain and food production.

It is not likely in the immediate years ahead that we shall see either a continuation of present low prices or extremely high prices for feed grains. Moderately higher grain prices will encourage the feeding of more forage, but this may be offset by higher levels of milk production which change the economic relationships in feeding. Looking beyond the next five to ten years, it is difficult to predict levels of prices. Increasing population, accompanied by a decreasing farmland acreage in the United States, and increased shipments of food and feed grain to hungry countries could result in greatly increased costs of feed grains.

Another point to consider is that the price for corn silage may be more nearly related to the value of its grain content in the future, while that of alternative forage crops such as alfalfa will be on the forage value alone. Western dairymen and livestock feeders contract with corn growers for delivery of corn silage to their silos. The buyer and seller agree on establishing a value for corn grain at the elevator during a specified period and use an assumed grain content (usually ranging from 5 to 6 bushels/ton) as a basis for pricing corn silage.

Cost Reduction Potential

Farm accounting studies show that many dairymen have high costs in producing forage due to low yields, high losses during harvest and storage, poor choice of crops, and over-investment in equipment on small farms (4, 11, 32, 36, 42). There appear to be many opportunities to reduce cost of forages.

More economical yields. Yields of legumes and grasses are generally low compared to corn silage. A major reason is that the level of improved practices and technology used in producing and harvesting legume-grass crops has lagged far behind those used in growing and harvesting corn and other grain crops. Production of 5,000 to 7,500 kg/ha of corn grain (100 to 150 bushels/acre) is readily attained on the most productive land, yet yields of 10,714 to 17,857 kg/ha (6 to 10 tons/acre) of alfalfa have been reported only in very recent years and quite infrequently.

Duvick (5) reports that only 12% of Michigan's acreage of hay and cropland pasture was fertilized in 1964, compared to 93% of the corn crop. However, the average rate of application has increased substantially for both crops since 1959. Fertilizer is one of the few inputs which costs no more per unit today than ten years ago.

The most profitable level to apply fertilizer depends on the response in yield to additional increments and the value of the extra yield. The principle of diminishing returns applies in the application of fertilizer as well as in the feeding of concentrates to dairy cows. Ibach and Adams (22) suggest the concept of "maximum" versus "minimum" rates of input in allocating expenditures for the farm budget so that the marginal return per dollar cost of each item of expenditure is the same. Maximum yield is quite likely not to be the most profitable (37).

The costs of growing and harvesting alfalfa haylage and corn silage in Southern Michigan were calculated for seven yields representing a range in levels of practices and two soil associations. The range in yields studied was from 21,430 to 42,850 kg/ha (12 to 24 tons/acre) of 32% DM corn silage and 13,700 to 27,400 kg/ha (7.6 to 15.4 tons/acre) of 50% dry matter alfalfa haylage (4.2 to 8.5 tons 90% dry matter hay), Table 1.

These unit costs were used in calculating total annual feed costs for a Holstein cow (including necessary replacement) producing 5,800 kg milk when fed either corn silage or haylage as the major forage. For the corn silage program, it was assumed that 23,182 kg corn silage, 1,364 kg hay, 2,455 kg grain, 273 kg soybean meal, and 11.4 kg urea would satisfy the nutritional requirements. For the alfalfa haylage alternative, it was estimated that 17,273 kg of haylage and 2,909 kg grain, and no protein supplement would be needed.

Each increase of 3,570 kg/ha (2 tons/acre) in the yield of corn silage or its equivalent increase in dry matter yield of alfalfa haylage reduced total feed cost per cow and replacement by $6 to $20, depending on the location on the cost curves (Fig. 2 and 3). Increasing fertilizer and other inputs in an effort to increase yields much beyond these shown would result in leveling off, followed by increasing costs.

For equal dry matter yields per hectare, total feed costs per cow were nearly the same for alfalfa haylage and corn silage.
TABLE 1. Estimated yields and costs of growing, harvesting, and storing 1,000 kg corn silage and alfalfa haylage as affected by two soil productivities and varying management and fertilizer practices.

<table>
<thead>
<tr>
<th>Soil productivity and 1,000 kg DM yield/ha</th>
<th>1,000 kg yield</th>
<th>Cost/1,000 kg</th>
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<tr>
<td></td>
<td>Corn silage</td>
<td>Alfalfa haylage</td>
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<td>Moderately productive</td>
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<td>13.71</td>
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*Actual weight based on 32% dry matter corn silage and 50% dry matter haylage.

The break-even cost of feeding a 5,909-kg producing cow for a year was at a yield of 22,143 kg/ha (12.4 tons/acre) when corn silage yields were 35,710 kg/ha (20 tons/acre) (Fig. 2). This is in agreement with an Ohio study (8) comparing nutrient values of high-quality alfalfa hay and corn silage. This is a ratio of 3:1 of corn silage to hay yields. A more normal ratio is one of 4:1, or 35,710 kg corn silage to 8,928 kg hay (20 tons corn silage to five tons hay or 16 tons corn silage to four tons hay). At the yield relationship of 4:1, and using urea to lower the cost of protein, the corn silage program was the lowest cost. If corn silage yielded 28,570 kg/ha (16 tons/acre) and alfalfa haylage yielded 20,536 kg/ha (6.4 tons hay/acre), a ratio of 2.5:1, then the alfalfa haylage alternative would be the least costly. Under a different set of assumptions relative to inputs and costs, the optimum forage feeding program would change. Many farmers will find it more profitable to feed both alfalfa and corn silage or other combinations of forage crops rather than a single source of forage.

Research results (3, 10) showed equally high milk production when cows were fed varying proportions ranging from all corn silage to all alfalfa hay when properly supplemented with grain and protein. However, from an economic standpoint, it will be necessary to increase yields substantially if alfalfa is to compete favorably with corn silage for a portion of the cropland acreage on level, highly productive cropland (15). The technology and practices are available for much higher yields than normally attained.

Higher-quality forage. Many experiments have shown relationship of date and method of harvest and forage quality. Forage quality
is also related to the number of cuttings. Harvesting the alfalfa crop three times instead of two in southern areas of the Great Lakes States and four times instead of three in eastern Corn Belt states have resulted in higher yields and higher quality of legume-grass crops.

Purdue animal scientists and agronomists (35) conducted a three-year experiment applying the best technology in growing and harvesting alfalfa-grass stands on highly productive soils. Yields averaged 11,071 kg/ha (6.7 tons/acre) for the alfalfa-orchard grass and 11,607 kg/ha (7.0 tons/acre) for the alfalfa-timothy stands when harvesting four cuttings each year. Tesar (41) showed DuPuits alfalfa yield increases of 16% in going from two to three cuttings, but a 46% increase in feeding value.

Improved machines and methods of harvesting and storing. The cost of producing forages on many dairy farms has been reduced in recent years as a result of using improved harvesting equipment and methods, and storage facilities. Equipment such as crimpers and crushers, windrowers, and improved choppers and blowers have reduced labor requirements and have generally resulted in improved quality and reduced losses.

The more highly mechanized forage systems become more economical when dairy herd size is 60 or more cows (20). The economy of investing in highly mechanized forage systems is also determined to a large extent on the cost of labor. The break-even point in costs for medium and highly mechanized systems was at 90 cows with labor at $2 an hour, at 75 cows when labor was charged at $3 an hour, and at 60 cows when labor cost $4 an hour. The highly mechanized systems reduced costs the most for farms with 120 or more cows. The cost of producing a ton of hay was lowered to the point where less than 1,360 metric tons of silage were needed annually. Bunker silos became the most economical storage systems when the forage was largely corn silage and 3,600 or more metric tons were stored annually (17).

Stanton and Loomis (40) report that green-chop operations are labor-intensive, a reason dairymen were generally discontinuing this type of feed in favor of corn silage and haylage. A major incentive to mechanize forage feeding was to add more cows with the same labor force. A high per cent of dairymen in most milk-producing areas need to improve over-all efficiency and size of operation, if they are to stay competitive in the future.

References

(18) Hoglund, C. R. 1967. Selection of forage crops as related to availability and reliability of input-output data. Paper pre-


