Selection of corn hybrids for silage production is confusing at best. It used to be so much easier. We simply chose the hybrid with the highest grain-yield for both grain and silage. However, we now know that other important factors affect farm profitability. Simply selecting corn silage hybrids with high grain yield will not necessarily maximize profit for your farm. For instance, yield of forage (composed of the grain plus non-grain parts of the corn plant) is more appropriate than grain yield alone for selection of silage hybrids because there is considerable variation in yield of the non-grain fraction among hybrids. Hybrids with the highest grain yield do not always have the highest forage yield. Forage quality factors such as neutral detergent fiber (NDF), protein, and energy concentrations and NDF digestibility, also vary considerably among hybrids and most important quality factors are not related to grain yield. Consideration of forage yield as well as multiple quality factors makes corn silage hybrid selection a very important economic decision.

Milk per Acre

Milk per Acre is a selection index developed at the University of Wisconsin, which combines yield and quality into a single term, allowing easier ranking of forages and hybrid selection. It is a measure of efficiency in which the amount of cropland on farms is assumed to be limiting. The amount of milk likely to be produced per ton of forage (Milk per Ton) is estimated with an Excel spreadsheet, and this is multiplied by forage yield to calculate the likely amount of milk produced per acre of corn silage (Milk per Acre).

Background. Milk per Ton is an estimate of the milk produced from the energy available from a ton of corn silage dry matter (DM). The energy available for milk production is calculated as the net energy per unit of corn silage, adjusted for energy required for maintenance of the cow. The net energy of corn silage is estimated from forage analysis using a modification of the summative approach of NRC (2001). Adjustment for the energy required for maintenance of the cow is proportional to the percent forage in the diet, which decreases as forage NDF concentration increases. It is important to note that Milk per Ton does not consider milk yield per cow. In computing Milk per Acre, forage quality
factors have no influence on milk yield per cow. We know this is not really true.

Milk per Acre is used by several seed companies and universities to rank corn silage hybrids (including the MSU “Corn Hybrids Compared” Bulletin). However, all selection indexes have underlying assumptions, and the usefulness of an index depends upon how broadly the assumptions apply to its potential users (e.g., dairy farmers). Unfortunately, there are two major underlying assumptions in the Milk per Acre calculation that are not valid for many dairy farms. While hybrid selection is relatively simple using Milk per Acre, the selection is very likely wrong for many farmers and I discourage its use. The purpose of this article is to identify these assumptions and to discuss why they likely are not appropriate for your corn silage hybrid selection.

Assumption #1:

“High-grain corn hybrids are always better for corn silage than low-grain hybrids”. This assumption is often not true because corn grain, as a separate ration ingredient, is often less expensive per pound of DM than corn silage. Farmers then would be better off minimizing the amount of corn silage they feed. To do that they should feed corn silage from a low-grain hybrid with a high NDF concentration to meet the cow’s forage NDF requirement. While corn silage is often assumed to cost less than corn grain because approximately twice as much DM is harvested per acre, the reverse is true on many farms because there is much greater DM loss as shrinkage, spoilage, and refusals for corn silage compared with corn grain. These DM losses are highly variable for corn silage and routinely can exceed 20% for some farms. In addition, the local market price for corn grain usually is less than the cost of corn grain production for Michigan dairy producers.

The grain concentration of corn silage is highly variable across hybrids, from less than 20% to over 50%. Because energy concentration of the grain portion is greater than the non-grain portion, and because Milk per Ton is calculated from the energy available for milk production, corn hybrids with more grain rank higher for Milk per Ton. However, supplemental corn grain is added to lactating cow diets so differences in grain concentration are compensated for when formulating diets. Therefore, differences in grain concentration of corn hybrids affect diet cost, but not the amount of milk produced per cow. The relative prices of corn silage and corn grain are not considered in the calculation of Milk per Ton. While it seems logical that corn silage with more grain and higher energy has greater value, this is not always the case.

The following example will help show the relationship between the prices of corn grain and corn silage. The amount of DM fed from 1 ton of corn silage harvested is 510 pounds, assuming 30% DM and 15% loss from shrinkage and spoilage. This amount of DM from corn grain with a cost of $0.04 per pound ($2.00 per bushel containing 50 pounds of DM) would total $20.40. Assuming that this is the current price for corn grain, if corn silage costs more than $20.40 per ton, then Milk per Ton will rank hybrids opposite to their effect on diet cost and profitability.

An informal survey of participants taken throughout our MSU Dairy Forages 2005 winter program showed a wide range in the relative cost of corn silage and corn grain across regions within Michigan and among farms within regions. In the Thumb area in early 2005, purchased corn silage cost $25 per ton before ensiling or $0.049 per pound of DM after ensiling (with 30% DM and 15% losses), while purchased dry corn grain cost $1.70 per bushel or $0.034 per pound of DM. In this instance, corn silage with low grain concentration is worth more than corn silage with high grain concentration because the cost of the corn silage plus corn grain portion of the diet is less. For example, the cost for 20 pounds of DM from a high grain corn silage (36% NDF, 37% starch, 0.75 Mcal NEL/lb, 8.8% crude protein) included in a ration would be $0.98/cow per day, whereas the cost of 20 pounds of a combination of 13.9 pounds of a low grain corn silage (52% NDF, 21% starch, 0.68 Mcal NEL/lb, 8.8% crude protein) and 6.1 pounds of corn grain (10% NDF, 72% starch, 0.91 Mcal NEL/lb, 9.4% crude protein) would be $0.89/cow per day ($0.09 less/cow per day) while providing the same amount of forage NDF (7.2 lb/day) and the same energy and protein concentrations. However, the high-grain corn silage would rank higher for Milk per Ton (3606 vs. 3161 pounds/ton) and Milk per Acre (25,244 vs. 22,130 pounds/acre, assuming the same yield of 7 tons DM/acre) compared to the low-grain corn silage despite costing more to feed and requiring much more land to grow (see Assumption #2 below). Corn grain is not always less expensive than corn silage. It is important to know the true costs of both corn silage and corn grain, whether they are produced on the farm or purchased, before the value of the grain concentration of corn silage can be determined.

Corn hybrids with high grain and low NDF concentrations require much more corn silage to be included in diets to meet the cow’s forage NDF requirement. This increases the amount of land and silo capacity required per cow, and decreases the amount of space in rations for other feeds. Forages are included in diets of dairy cows to provide digestible and effective NDF, but corn silage with high grain concentration has much less NDF than corn silage with low grain concentration. Over 44% more corn silage must be fed to provide the same amount of NDF in the diet for a high-grain corn hybrid with 36% NDF compared with a low-grain corn hybrid with 52% NDF. Cropland base and silo storage capacity required are affected directly by the concentration of NDF in the corn silage. Also, Milk per Acre ignores the effect of forage quality on the number of acres required for forage production per cow, which is contradictory to the premise that cropland is limiting (see Assumption #2 below). The greater forage concentrations required in diets containing high-grain corn silages decrease the ability to utilize other, less expensive feed ingredients, which can further increase total feed costs and reduce real...
profitability.

Assumption #2:

“The cropland base (acreage) is the most important basis for calculation of efficiency”. Growing feeds and application of manure on the farm demands an adequate amount of cropland per cow, so initially this seems like a reasonable assumption in the Milk per Acre index. However, the amount of land required per cow varies greatly depending upon how much feed is produced on the farm and the extent to which excess nutrients are exported from the farm. When dairy farms expand, more corn silage is often grown on the farm because of its greater yield compared with alternative forages, and grain is often purchased rather than grown on the farm, which allows for more forage production. Unlike forages, grains (primarily corn) are readily available and purchased in Michigan, easily transported, and are often less expensive to purchase than to grow. Although some nutrients are exported in the milk sold, additional nutrients might be exported by selling cash crops or compost, or through agreements with local cash crop farmers for application of manure to their cropland. The amount of forage required per cow varies greatly depending upon forage composition (as discussed previously) and use of other fiber sources in rations. Therefore, the number of cows supported by a given acreage can be extremely variable.

The number of cows on a farm is limited by the number of stalls available, milking facility throughput, and other factors that represent a large portion of the fixed costs of producing milk. Increasing milk yield per cow dilutes these fixed costs as well as the maintenance costs of the cow, increasing the efficiency of production. While forage quality certainly affects milk yield of cows, this is not considered when corn silage hybrids are ranked using Milk per Acre. Very important forage quality factors are not adequately considered and incorporated into the calculation and concept of Milk per Acre.

Corn silage hybrids vary in NDF digestibility. Our research demonstrates that greater NDF digestibility increases feed intake and milk yield of high producing cows. While Milk per Ton includes NDF digestibility in its calculation of energy concentration, it does not adequately account for its effect on feed intake and milk yield on a per cow basis. Variation in NDF digestibility among corn hybrids of up to 10 percentage units and its average effect on milk yield of about 5 pounds/cow per day can have a greater effect on profitability than a 20% variation in forage yield among corn hybrids. And, based on our MSU research, the importance of NDF digestibility increases even more for higher-yielding cows compared with lower-yielding cows.

There is no “best” combination of corn silage yield and quality factors for all dairy farms. Many different factors related to corn silage hybrids affect farm profitability, and these factors vary greatly among farms. High forage yield and high forage NDF concentration have greater and greater importance as cropland becomes more limited. Enhanced NDF digestibility has greater importance for herds with high milk yield compared to herds with low milk yield across farms, and for groups of cows with higher milk yield compared with groups with lower milk yield within farms. Effects of forage NDF concentration on diet cost depend on the cost of corn grain relative to corn silage. Because the importance of each of these factors varies among farms and over time, no selection index can adequately rank corn silage hybrids for all farms.

The best way to rank corn silage hybrids is to calculate a partial budget of corn silage production and utilization for your farm using actual prices. A partial budget considers only those factors in the system affected by the change. For selection of corn silage hybrids, differences in forage yield, grain concentration, price of corn silage relative to corn grain, and effects of differences in NDF digestibility on milk yield can be considered for your specific farm. A future article in Michigan Dairy Review will address how to calculate a partial budget to select corn hybrids for silage. While it requires more work to

Consider These Key Points

- Milk per Acre assumes that: corn silage costs less than corn grain and that cropland is limiting.
- These assumptions often are not correct and bias selection of corn silage hybrids towards those with high grain content and high yields.
- However, corn grain is often less expensive than corn silage, especially after shrinkage and spoilage of silage are considered.
- The number of cows supported by a given acreage is extremely variable, greatly diminishing the value of using Milk per Acre as a broadly applied management tool.
- Milk per Acre does not consider effects of forage quality on milk yield per cow which often has a much greater impact on farm profitability than corn silage energy yield per acre.
- No selection index, such as Milk per Acre can adequately rank corn silage hybrids for all farms or even necessarily for the majority of farms.
- The use of Milk per Acre to select corn hybrids for silage is discouraged.
- A much better approach is to use partial budgeting to compute the value of corn silage production and utilization on your specific farm. This approach will be presented in a future issue of Michigan Dairy Review.
set up initially, subsequent evaluations are easier and the results potentially are very valuable because corn hybrid yield and forage quality have substantial effects on farm economics.

Reference