Producing High Quality Corn Silage for Dairy Cows

by Joe Lauer, University of Wisconsin

Dairy expansion, commercialization of new corn hybrids specifically selected for forage yield and quality, and new ideas for production and management have changed the view of farmers regarding the importance of corn silage to livestock production. Many producers are reevaluating their cropping systems and increasing their use of corn silage as a forage source in today's dairy ration.

Corn can produce high DM yields with one harvest. It is a good crop to recycle nutrients from manure and maintain water quality. Corn is easily ensiled and results in palatable forage with relatively consistent quality and higher energy content than other forages. Silage production requires less labor and machinery time, thus, the cost/ton of DM produced tends to be lower for corn silage than for other forages.

Farmers' perceptions about corn silage have changed dramatically in the last decade. Farmers are now recognizing the added value that high yielding, high quality corn silage can bring to a dairy operation. The most dramatic changes have occurred in hybrid selection and harvest management, both influencing silage yield and quality. But, even selecting the "best" hybrid might not be enough if some aspect in agronomic management is lacking, for example, delayed harvest.

Different management decisions must be made when growing corn for silage use rather than for grain use (Table 1). Some decisions depend upon the amount of flexibility a producer wants to have at the time of harvest. Some decisions must be made in the spring, which thereby locks a field into silage harvest in the fall.

For example, high plant populations will require that the field be harvested for silage. Leaving the silage for grain harvest would be more risky due to lodging potential. Relatively few cornfields planted in the spring are managed for silage harvest in the fall. In most years, the decision to harvest a field for grain or silage is made in the fall.

Table 1. *Corn management considerations and adjustments for grain or silage use.*

Decision	Grain	Silage
Hybrid Selection	**High grain yield**	**High grain and silage yield**
Yield Potential	Base on multi-environment average performance and consistency	
Full-Season	--	5-10 RM days longer
Maturity	8-10 day range	8-14 day range
Standability	High	High (Allows flexibility)
Pest Resistance	High	High (Allows flexibility)
Ear and Kernel	Hard	Soft
Traits		
Stover Quality	--	Low NDF, high digestibility
Management		
Planting Date	May 1-7	May 1-15
Row Spacing	15-30 inches	15 inches
Plant Population	28,000-32,000 plants/ac	28,000-42,000 plants/ac
Pest Management	Higher economic threshold	Lower economic threshold
Fertilizer Inputs	High	Greater nutrient removal
Harvesting and Storage	Expensive	More expensive
Use and Market	On-farm, local and export market	On-farm or local market

Hybrid selection decisions can be challenging and confusing due to the numerous hybrid choices available to farmers. The basic principle of hybrid selection is that any good forage crop should have high DM yield, high protein content, high energy content (high digestibility), high intake (low fiber), and optimum DM content at harvest for acceptable fermentation and storage. With the exception of high protein level, corn silage exhibits these characteristics better than other forages.

Selecting hybrids for silage production depends on whether a field is planted specifically for silage or whether the field may be harvested for grain (dual purpose). Many U.S. farmers and livestock producers grow corn for both grain and silage and decide at harvest which fields are to be used for each purpose. This flexibility is appreciated because at planting it is difficult to predict overall forage needs later in the year or know the condition of the corn crop at harvest. But, an increasing number of producers either contract fields or make selection decisions to plant fields with corn hybrids developed specifically for silage use. These fields must be harvested for silage and options for other uses become limited.

Silage-Specific Hybrid Selection. Selection for silage fields should be based on both high grain and yield, while hybrids planted in fields harvested for grain should be selected for grain yield. The decision to plant a field to a silage hybrid, such as a 'leafy' or brown midrib hybrid, should only be made if a producer plans to harvest that field for silage. Usually silage only hybrids have grain yield potentials 10-20% below that of grain hybrids. Selecting silage hybrids with both high grain and silage yield potential allows the producer flexibility in the fall when silage harvest decisions are made.

Regardless of end use, the hybrid selection decision should be made on multi-environment average data that performs well consistently. When considering transgenic hybrids, buy only the traits necessary and remember that "every hybrid must stand on its own" for performance – do not purchase a hybrid based upon base genetics or family performance.

In a silage field, full-season hybrids can result in a five to ten day longer season than what would normally be grown for grain. Concerns for getting the field to black layer is not as important as it is with grain. The greater expected yield potential with longer season hybrids often makes it worth the risk. This means that the maturity range of hybrids planted on a farm can be greater if both corn grain and silage is being produced helping to minimize the risk of weather problems during a particular growth stage (particularly pollination/silking) and spread the workload during harvest. It is recommended that growers plant 50% of their corn acreage in the full-season maturity range and 25% in the mid- and shorter-season range.

Good standability and pest resistance should be present in the hybrid selected. This allows flexibility for harvesting the field as either corn for grain or silage in the fall. Corn hybrids with poor standability must be harvested as silage, because if lodged, they will be difficult to pick up with a corn head.

Evidence suggests that softer kernel texture provides greater digestibility and energy in the silage. This may be managed by using kernel processors through correct timing of harvest. Kernel processors can also extend the harvest season by breaking kernels that might be too hard in typical grain hybrids.

Certain hybrids with specialty traits may be appropriate for fields grown specifically for silage. The decision to grow specialty silage corn decreases flexibility in the fall at harvest due to lower yield potential. Brown midrib corn has greater digestibility of the stover portion of corn silage and can be an advantage in dairy systems where digestible fiber is limiting. Leafy type hybrids produce very high tonnages. Specialty hybrids where flexibility may not be sacrificed are Bt hybrids. Evidence from Iowa suggests that the incidence of mycotoxin development is lower in Bt hybrids, which are high grain producers.

Stover quality in hybrids should include low NDF and high digestibility traits which maximize feed intake and energy potential of forages. These traits are not important in grain hybrids.

Silage Hybrids Affect Animal Performance. Predicting animal performance and relating it to improvements in corn silage quality is complex, but evidence continues to build that milk/beef production can be affected by corn hybrid selection. In numerous studies, relatively small differences in corn silage fiber and digestibility translate into large differences in predicted animal performance. For example, researchers in Michigan have documented milk yield increases of up to five lbs of milk/cow/day using hybrids with high NDF digestibility. Likewise, researchers in Idaho have found that high quality corn silage (low fiber and high digestibility) produced $315 more beef/ac than low quality silage.

These quality differences among corn hybrids are predictable and repeatable for whole plant fiber and digestibility. Previously identified “high” quality check hybrids continue to be above average for milk/ac and milk/ton in numerous testing environments, at the same time previously identified “low” quality check hybrids were average to below average. Consistent performance regardless of environment is important for making hybrid selection decisions for silage quality. A dairyman who buys feed off-farm needs to be interested in feeding the best quality silage he can purchase and would be most interested in how much milk can be produced/ton of silage. A dairyman who grows his own feed should be interested in both producing quality silage as well as high yields from the farm land base.

Silage Planting. The optimum planting date for corn grown for grain is May 1 in southern- and May 7 in northern-Wisconsin. Since grain maturity is not as important in the fall with corn silage, a slightly later planting date can be used without detrimental effects. However, significantly later planting dates will affect silage yield and quality potential as it does grain yield potential. June planting dates yield only about ⅓ to ½ of early May planting dates.

Significant responses to row spacing are more often seen with corn grown for silage than with grain. Silage yield increases have averaged 9% with no changes in quality, while grain yield increases have averaged 4%. With the new chopper heads currently available, narrow row corn production is not difficult for corn silage.

Optimum plant populations for grain production range between 28,000-32,000 plants/ac. Corn silage optimum plant populations are similar, but yield has been observed to continue increasing through the range of 42,000 plants/ac. Significant quality changes occur at higher plant populations.

Corn silage is a more valuable crop when marketed as beef or milk and thus economic thresholds for pest control are lower than corn grown for grain. Greater nutrient removal occurs with corn silage because both grain and stover are removed from the field.

Silage Harvest. A challenge farmers have when producing corn silage is timing harvest to achieve the proper moisture and to ensure adequate fermentation for preservation and storage. The interactions between forage yield and quality, genetics, and environment make it difficult to properly time harvest.

Harvest timing is compounded by synchrony of plant development. Roughly, half of the plants DM is in the stover and half is in the ear. Synchrony of plant drydown means that both the ear and stover dry at similar rates as the field matures. Asynchronous drydown is when either the stover or ear dries at a faster rate than the other.

In the 1980s, corn breeders recognized that stalk integrity would last longer into the harvest season if the stover could stay green longer. Corn hybrids were commercialized with the “stay-green” trait where grain matures and dries while the stover remains green and succulent. This helped prevent late-season lodging and contributed to increased grain yields, but it can cause problems with kernel hardness in silage and the ability of rumen bacteria to degrade starch. In the 1990s, farmers dealt with the “stay-green” trait and kernel hardness by installing forage processors to crack grain either on the chopper or at the silo blower.

A better method might be to pick hybrids that mature more synchronously where the stover and ear dry similarly for harvest at the correct moisture for the storage structure. Forage moisture of standing corn cannot be visibly determined and must be measured by taking time to dry the forage (microwave or oven) or the use of an NIR spectrophotometer.

Prior to the 1970s, estimates of whole plant moisture content in corn were frequently based on grain maturity. Grain moisture content varied with whole plant moisture content in a predictable manner, therefore, grain moisture content was suggested as an indicator of the proper stages of ensiling. A common recommendation during the early 1970s was to harvest corn for silage when the black layer appears at the tip of the kernel. However, grain moisture content varies from 30-42% at black layer appearance, and premature appearance of the black layer may occur due to cool weather when grain moistures range from 15-75%. This large variation of whole plant moisture content often means harvesting silage with moisture content not optimal for proper ensiling. Another issue associated with using black layer is the difficulty to tell when the black layer has formed.

During the late 1980s, yield and quality of corn silage was found to be optimal between ½-¼ kernel milk, and kernel milk-line was suggested as a method for timing corn silage harvest. The milk-line is a transitional layer, or boundary, between the solid and liquid matrices of the maturing endosperm. Kernel milk-line position was demonstrated as a more reliable and useful visual indicator of grain maturity and proper moisture content for ensiling. By the late 1990s, the relationship between forage moisture and kernel milk-line was highly variable among hybrids in different environments due to the ‘stay-green’ trait.

Timing Harvest in the Future. Currently, techniques are being developed to correlate whole-plant moisture with both kernel milk-line and canopy traits (greenness and leaf inclination). There are several reasons for optimism using this method including:

(1) Disappearance of kernel milk and canopy greenness in general correlates with maturity and drydown in corn.
(2) Kernel milk-line and canopy traits are visibly detectable, require no special instruments, and no previous record keeping since the plant is integrating both genetic and environmental characteristics into its dry-down pattern.
(3) Unlike black layer development, which is an end-point, the movement of the milk-line and the change in canopy green color and leaf inclination can be followed over time.

Once the corn silage is ready for harvest, it usually requires more equipment to chop, transport and pack the silos for safe storage. Markets are usually more local than the corn grain markets. Due to high water content, it is usually not economical to transport corn silage more than 100 miles from where it is grown and eventually stored and fed to livestock.

Corn is a versatile crop with many options for use as either forage or grain. Exciting new hybrid traits, fiber digestibility developments, and a better understanding of how genetics interact with management will continue to make corn silage an important forage for the dairy and livestock industries.