Optimizing the Net Energy Yield From Your Corn Silage

by Steve Soderlund, Pioneer Livestock Information Mgr.

While corn silage usually is considered a "forage" or "roughage" source, it is a valuable energy feedstuff for both dairy and beef producers. Corn silage provides more net energy yield per acre than other crop commonly raised. However; the net energy yield of corn silage can vary significantly depending on a number of factors, including: hybrid selection, planting density, growing conditions, harvest maturity, cutting height, kernel processing and storage and feedout losses.

Influence of Hybrid Selection

The primary hybrid factors that influence corn silage energy yield are relative maturity (CRM), plant height and grain to stover ratio. In general, fuller season hybrids tend to produce more tons but tend to have less net energy and thereby will produce less milk or beef per ton. The taller hybrids tend to yield more tons but will have lower energy values due primarily to their lower grain to stover ratio. The grain to stover ratio in corn silage can range from 30:70 to 60:40 on a DM basis.

Pioneer collects and analyzes over 18,000 corn silage samples per year from 11 different research stations across North America to provide yield and nutritional information for its hybrids. In addition to hybrid evaluation, Pioneer conducts management studies to provide producers with information on planting rate, harvest timing, kernel processing and cut height.

Influence of Planting Rate

Increasing the number of plants per acre generally increases silage tonnage but usually results in lower quality. This reduction in quality is due primarily to a lower grain to stover ratio due to less ear flex, taller plants and an increased percentage of rind in the stalk. Research conducted by Pioneer in LaSalle, Colorado (data shown in Figure 1) suggests that the **optimal plant density** for maintaining high yields and high TDN values under irrigation is **34,000 to 36,000 plants per acre**.

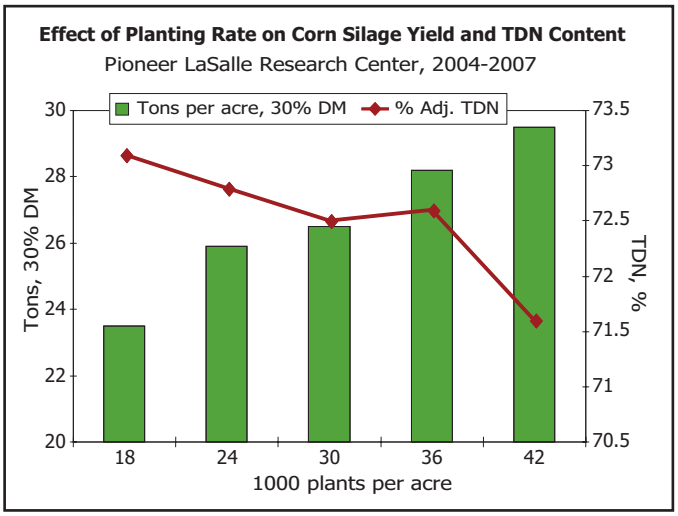

Figure 1. Effect of planting rate on corn silage yield and TDN content. Pioneer LaSalle Research Center, 2004-2007.

Pioneer Hi-Bred silage research plots at LaSalle, Colorado.

Effect of Harvest Maturity on Yield, Nutrient Content and Digestibility

Maturity at harvest has an extremely large influence on corn silage yield and energy content. Pioneer data (Figure 2) show that as the plant matures, moisture content declines but **starch content increases approximately 1% unit per day from 1/3 milk-line to black layer**. The percentage of NDF (neutral detergent fiber) in silage decreases with increasing maturity.

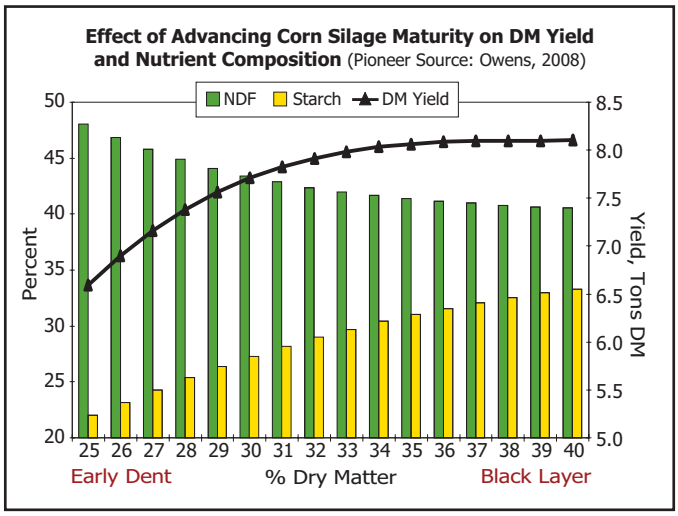

Figure 2. Effect of advancing corn silage maturity on DM yield and nutrient composition. Source: Pioneer Hi-Bred (Owens, 2008).

Once kernels have reached black layer, starch accumulation will cease and the kernels will start to harden. While starch content increases with advancing maturity, **starch digestibility of corn silage that is not processed will decline as whole plant DM increases above 35%.** Research from the University of Wisconsin suggests that starch digestibility can drop as much as 20 percentage units between 30% and 40% dry matter for corn silage that is NOT kernel processed (Figure 3). Fiber (NDF) digestibility also declines with increasing maturity, but the decline is relatively small.

Kernel processing markedly improves starch digestibility from corn silage harvested past 1/2 milk-line and is highly recommended to maximize net energy yield. **Pioneer research suggests that the maximum net energy yield is achieved at**

34% dry matter for unprocessed corn silage and at 37% for processed corn silage.

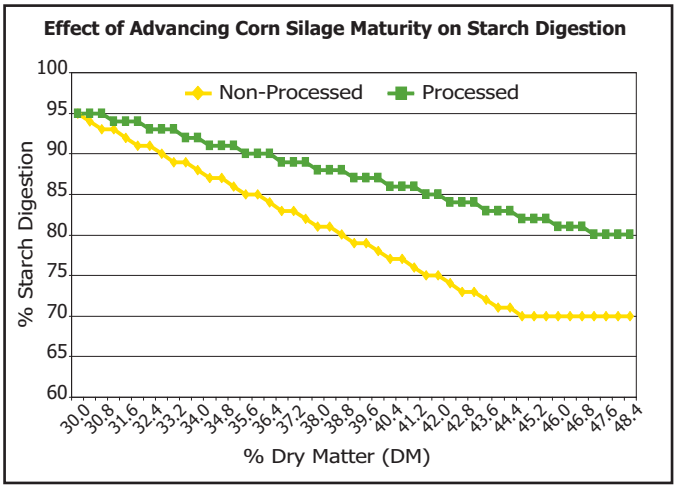

Figure 3. Effect of advancing corn silage maturity on starch digestion. Source: Dr. Randy Shaver, UW-Madison.

Optimizing Kernel Processing

The extent of kernel processing varies dramatically depending on the gap setting between the processing rolls. Kevin Shinners, University of Wisconsin Ag engineer, reported that at a gap setting of 1 mm, 100% of the kernels are crushed. At a setting of 3 mm, 95% of the kernels are crushed, and at a 5 mm setting, only 88% of the kernels are crushed. In addition to increasing the digestibility of the grain, kernel processing breaks cob pieces and prevents sorting of cobs by livestock fed silage. Kernel processing also fractures stalk pieces, perhaps increasing their digestibility. Shinners makes the following recommendation to optimize both kernel processing and harvester efficiency:

- Set the processing roll clearance at 3 mm. If you operate the machine at 3/4-inch length of cut and a 3-mm clearance, the horsepower requirement will be similar and throughput will be similar to cutting at a 3/8-inch length of cut and not kernel processing.
- If you set the rolls at 1 to 3 mm clearance when chopping at early dent, you may not have to change the clearance as the crop matures. Some farmers think they need to reduce the processing roll clearance as the corn ripens, but Wisconsin researchers found that this change was not necessary.

We recommend that producers closely monitor kernel damage throughout harvest. A quick and simple method for evaluating kernel damage is to sort out the number of whole or poorly processed kernels in a 32-ounce container:

- Collect a 32-ounce container worth of corn silage or take a two-handed scoop (do not grab or you will drop kernels).
- Sort out and count all half or whole kernels.

If you find two or more, you likely want to discuss creating more kernel damage with the chopper operator. Finding more than a few whole or half kernels may indicate that some starch will not be utilized to its fullest potential at feedout.

Effect of Cut Height

To increase quality of silage, one can increase the cutting height and leave more stubble in the field. The least digestible portion of the corn plant is the lower stalk, so raising the cut height alters corn silage quality by reducing fiber content, increasing starch content, improving whole plant digestibility and increasing meat or milk production per ton. Recent Pioneer research evaluating the effect of high chopping on nutrient composition found that (Figure 4):

- High chopping is more advantageous for more mature corn plants. When chopped at 30% moisture, little advantage to high chopping was detected.
- Chopping at a 24- rather than a 6-inch height increased the concentrations of dry matter (2 to 3%) and starch (2 to 3%) and decreased NDF (1 to 2.5%) of corn silage.
- Both cellulose and hemicellulose content were reduced by high chopping; however, lignin content remained relatively unchanged by high chopping.
- For each one-inch increase in chop height, yield of dry matter was reduced by 0.6 to 0.9%. That equals 1 to 1.5 tons of wet silage per acre for each 6-inch increase in cutting height.

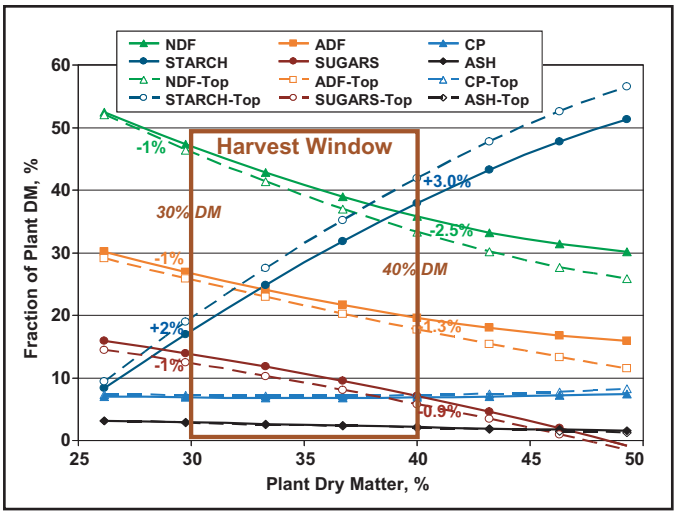

Figure 4. High-chopping effects on plant composition. Source: Pioneer Hi-Bred.

For dairy producers, high chopping improves the nutritive value and milk yield per ton of silage. However, corn growers need to be compensated for the reduced yield and chop-height agreements must be relayed to operators of silage harvest equipment.

Storage Management and Inoculation Effects

Producing high quality silage requires proper handling, storage and feedout management. Losses during fermentation and feedout lower both the amount and the net energy value of the silage. Storage loss can exceed 20% in poorly managed bunker silos. The nutrients lost have a digestibility similar to or greater than corn grain. Proper storage management

recommendations to minimize storage and feedout losses include:

- Proper compaction to exclude air (optimal pack density is >15 lb DM per cubic foot).
- Covering with plastic held securely in place with tires or weights.
- Keeping the face clean and loose material on the silo floor cleaned up.
- Inoculating with a research-proven forage additive.

Pioneer and university research has shown that treatment with a good inoculant can reduce DM loss by 25 to 30% in well-managed silage and improve the feeding value by 5 to 10%. Pioneer® brand 11CFT silage inoculant has taken inoculation to the next level by incorporating a unique Lactobacillus buchneri strain that produces enzymes to increase the digestibility of the fiber in corn silage and reduce losses associated with heating of the silage during feedout. On average, 11CFT inoculant improves NDF digestibility by 4% units; that, in turn, increases the net energy value of the silage substantially. Pioneer is the clear leader in the development of crop-specific forage additives and offers several corn silage inoculant choices to meet various producers' needs. Just like corn growers should choose the "Right Seed Product for the Right Acre" livestock, producers should use the **"Right Inoculant Product for the Right Bunker."**

Bottom Line

Silage plot harvester in LaSalle, Colorado research field.

Optimizing the net energy yield of corn silage starts with selecting corn hybrids that have the potential for high tonnage, high starch yield and good fiber digestion. Pioneer and university data suggest that the optimal harvest maturity for maximizing both yield and the net energy value of whole plant corn silage is between 1/2 to 3/4 kernel milk-line. Moisture content of the silage at harvest typically will be between 63 to 66% at this stage. Kernel processing is highly recommended and becomes much more important as the corn matures. Pioneer research suggests that maximum silage net energy yield is achieved at 37% dry matter, provided the crop is adequately processed during harvest. If the corn is not kernel processed, then the maximum energy yield is obtained at about 34% dry matter. "High chopping" corn silage often improves the net energy value for dairy producers when the crop becomes overly mature, but the reduced crop tonnage makes it most useful when crop yield exceeds the need and when grain price is high or forage price is low. Proper storage management techniques and inoculating with a research-proven forage inoculant will help to minimize energy loss during storage and feeding and optimize the net energy yield of corn silage.