Beyond the Raw Metrics for Corn Silage Quality

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On many dairies, procuring corn silage is the single largest feed investment made each year. While multiple business entities may be involved in seed selection, planting, fertilizing, irrigating, and harvesting the crop, once it's in storage at the farm it is an enormous investment whose fortune is almost entirely cast. In other words, once it's in storage the options for improving its performance are severely limited. This makes handling all the pre-storage management decisions crucial. None of the metrics we have available for making these decisions are perfect, but they can be useful if we understand their purpose and the aspects of our decisions that the metrics do not directly inform.

Kernel size metrics

Metrics for measuring and managing particle size generally fall into two categories, primarily qualitative and useful for in-field decision making or primarily quantitative and useful for diet formulation and quality grading. For example, corn silage processing score (CSPS) is a lab-based measurement that quantifies the percent of starch in large particles. These scores use a robust, if imperfect, method that requires oven drying the sample and mechanically separating it using a specific set of sieves, shaking instrument, and time. Under absolute best-case conditions, the time between taking a sample, getting it to a lab and getting analysis results would be 8 hours, but more often it's 2-3 days. How many tons of silage can be harvested in 8 hours? This is a useful metric for grading the harvest quality after the fact or for equipment manufacturers to use in evaluating new designs. It's not practical for making in-field adjustments of harvesting equipment.

Figure 1 - Starch that is retained on the 4.75mm screen of CSPS cause lower scores. Kernels may be shattered and still retained on this screen.

A practical approach in the field would be to sample a liter size cup of silage multiple times throughout the day and count the number of whole kernels. Separation and counting of the kernels can be made easier by shaking the sample through a Penn State shaker box or floating the sample in a 5-gallon bucket of water and then slowly pouring off the liquid and forage portion, leaving only the kernels in the bottom. It's generally recommended that no more than 2 whole kernels should be found in a liter sample and that kernels should be "fractured" instead of "nicked". In any case, this is a qualitative assessment that's useful for real-time decisions in the field but is not robust enough to guide diet formulation or scientific evaluation of equipment engineering.

For the forage portion of corn silage, the Penn State Particle Separator is a nice tool for on-farm assessment of particle length. While traditionally we've mostly been concerned with forage particles being too short, recent research from Miner Institute has illustrated that particles that are too long take a longer time to chew and ultimately result in lower intake levels. (Last year Miner Institute released updated PSPS recommendations for TMR, suggesting that the traditional recommendations for corn silage may warrant modification to lower targets for the top screen.

(Table 1) Penn State Particle Separator recommendations for corn silage

	Sieve (mm)	% retained
Top	19	3-8
Mid 1	8	45-65
Mid 2	4	20-30
Pan	-	<10

Table 1- Adapted from https://extension.psu.edu/penn-state-particle-separator

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Lab grade methods for forage particle size also exist but are generally utilized only for engineering research and occasional diet formulation cases. Forage Particle Size analysis using the ASAE S424 method was originally developed at the University of Wisconsin. This laboratory analysis features mechanical operation, use of as-fed samples, and very large surface area, all of which enhance the repeatability and accuracy of measured values (Maulfair et al., 2010).

Nutrient quality metrics

The nutritional value of corn silage is more difficult to assess than most feeds because it provides energy through the digestion of both starch and fiber, whose digestibilities vary widely. Most energy-based quality metrics (TDN, NEL, milk/ton) will rank samples similarly. In nearly any hybrid evaluation program, silages need to be high in starch and high in fiber digestibility to be ranked near the top.

However, making practical decisions about hybrid selection requires considering information that doesn't appear on most forage reports and information that doesn't fit nicely into a quality index. First, consider that feed testing laboratories don't measure yield, so understanding hybrid performance requires looking at sources beyond a feed test report. Second, energy-based metrics don't tell the entire story of feed quality that is relevant to milk production. Consider two facts about the common energy-based metrics available:

1. Pure corn grain will rank higher in energy than any combination of grain and forage, but we don't grow silage solely for its grain characteristics.
2. They don't directly give higher NDFD feeds credit for the fact they will drive higher dry matter intakes. When the units on a metric are expressed as %DM or per ton, they can't illustrate the fact that cows will consume silages at different rates.

Consider the implications of Figure 2 which compares dry matter yield, energy concentration, and NDFD across multiple hybrids. Focusing only on samples with milk/ton above 3900lbs, we can find dramatically different feeds with similar energy values. Should we prefer 10 tons of yield with 30% uNDF/NDF or 9 tons of yield with 15% uNDF/NDF? While it's easy to purchase more corn grain when needed, finding alternative sources for fiber that is both digestible and physically effective can be challenging.

In conclusion, there are many decisions that can be made before the corn silage crop is in storage and the figurative die is cast for milk production in the following year. The available metrics inform decision making by telling us specific things about silage quality. Ultimately optimizing decisions requires understanding both what the metrics do and do not tell us**.**

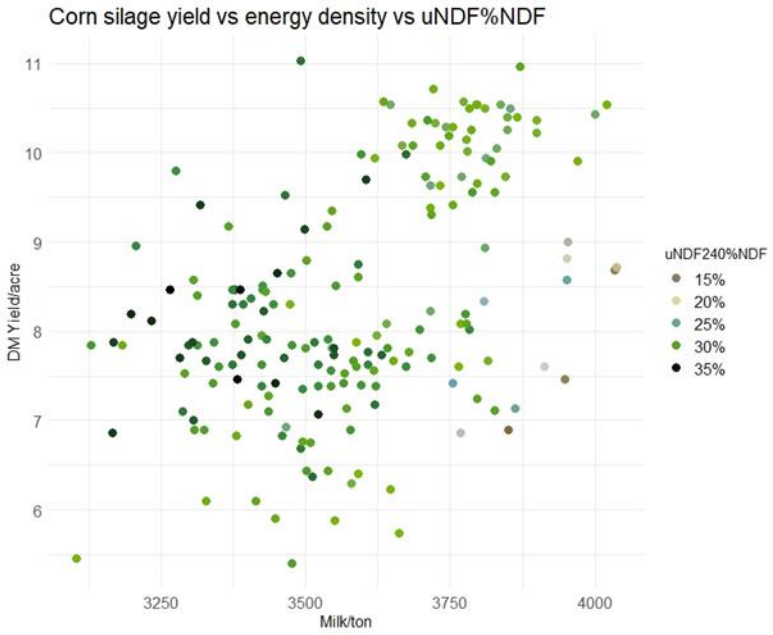

Figure 2 - Adapted from New York and Vermont Corn Silage Hybrid Evaluation Program 2018