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Corn silage forage quality: Hybrid genetics versus growing conditions

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Over the past four years a number of groups in the Northeast have initiated efforts to increase collaboration and enhance our understanding of corn silage hybrid forage quality through existing Corn Silage Hybrid Evaluation programs. This collaboration includes Cornell University, Penn State University, Professional Dairy Managers of Pennsylvania, University of Vermont, Western New York Crop Management Association, and the University of Maine.

The group has focused their efforts in three main areas: 1) aligning trial methods and report formatting to allow better cross-referencing of trial data from the various programs, 2) focusing on emerging forage quality parameters to improve the metrics utilized for hybrid comparisons, and 3) utilizing data from across the region to better understand the influence of growing conditions on hybrid performance.

This collaboration allowed us to identify a small subset of hybrids entered into multiple programs over the last two years. Differences in performance between the same genetics in different growing environments and different genetics in the same growing environment of this subset were compared.

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FIGURE 1
Shift in starch content between growing seasons

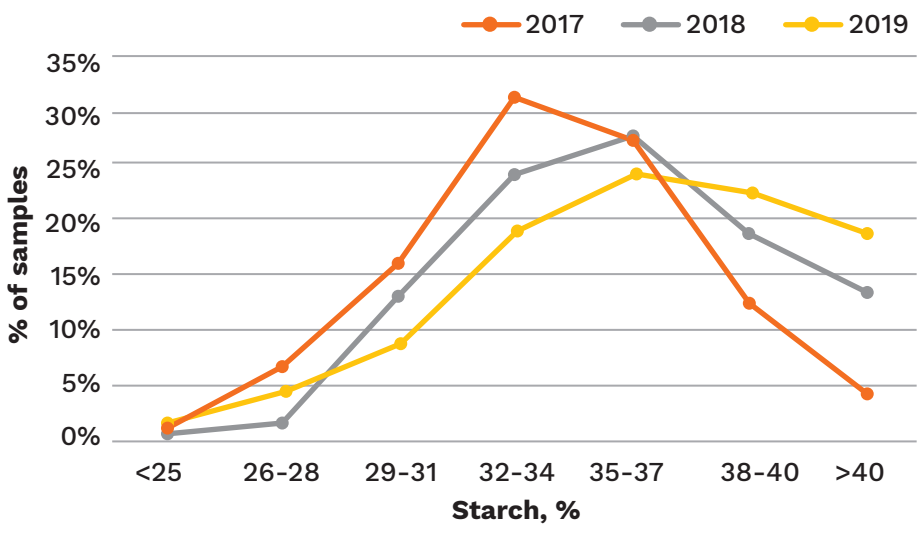
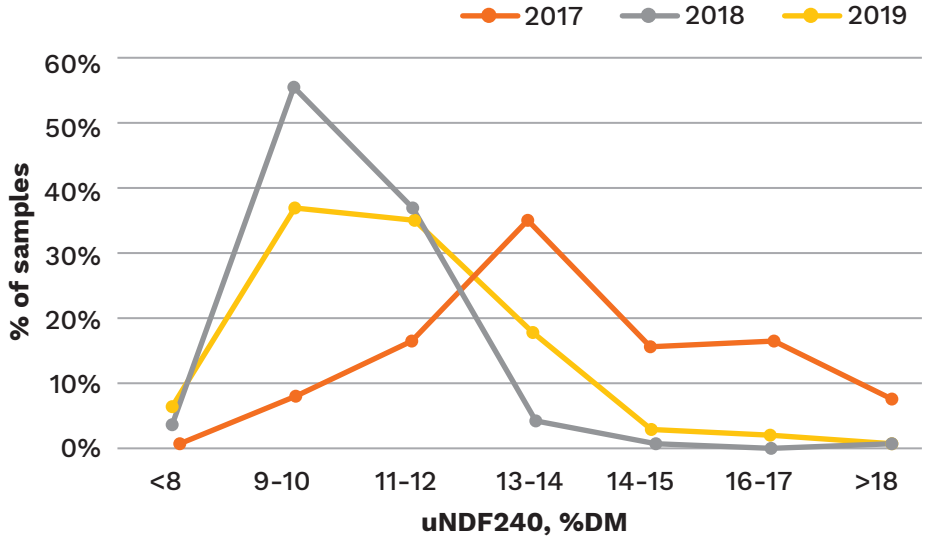


FIGURE 2
Shift in undigested fiber content between growing seasons



GROWING CONDITIONS IMPACT CORN FORAGE QUALITY

It has long been understood that weather conditions have an influence on key corn silage forage quality parameters. Generally, dry to moderate moisture conditions, and moderate heat prior to tasseling, is considered best to balance overall crop performance and fiber digestibility (Van Soest, 1996; Van Soest and Hall 1998; and Mertens, 2002).

In general, fiber digestibility can be quite high in drought-stressed corn, but obviously in this situation overall crop performance is likely to suffer. Excess moisture can also be detrimental to crop performance, however, even if overall performance is not hindered by the excess moisture we expect fiber digestibility to be lower.

As with any grass, we know that fiber digestibility is best prior to heading, or the switch from vegetative to reproductive growth stages. Fiber digestibility will decline further at the time of heading but does not change significantly after that. The difference with corn is that following heading (tasseling) the development of the ear contributes another important factor to overall forage quality – starch. Lauer (2019) shows the "double peak of corn silage quality" with the first peak in fiber digestibility at the late vegetative stages and second peak at traditional corn silage harvest timing when you optimize the content of starch with the fiber digestibility.

In regard to growing conditions post-tasseling, the biggest impact is clearly on ear development, or as it relates to forage quality – starch content. As we turn our attention more towards the total digestible nutrients that the crop contributes to the cow's diet, it is also of interest to consider the impact of ear-to-stover ratio. The ear acts to dilute out the fiber portion of the composite sample (ear plus stover) and thereby increases the proportion of digestible material in the whole plant.

As a farm looks for the best ways to select corn hybrids that meet the forage needs of their herd, it is important to recognize the role of genetics and environment. Genetic selection is important for a number of reasons including crop yield, forage quality, and pest tolerance, but if the influence of growing environment is not recognized in decision-making, looking at genetics alone may result in selecting hybrids that do not achieve the goals of the herd.

TABLE 1

Environment has a much greater influence on performance than hybrid genetics

	Year	30-hr NDFD, % NDFom	240-hr uNDFom, % DM	Starch, % DM	Tons/acre, 35% DM
R^2 Environment	2019	0.52	0.42	0.64	0.52
	2018	0.60	0.47	0.49	0.75
R^2 Hybrid	2019	0.13	0.12	0.02	0.05
	2018	0.04	0.03	0.03	0.03

TABLE 2

Range for key crop performance indicators for 2018 and 2019 across locations and hybrids

	Year	30-hr NDFD, % NDFom	240-hr uNDFom, % DM	Starch, % DM	Tons/acre, 35% DM
Range across locations (parameter mean of all hybrids by location)	2019	7.1	4.1	12.1	11.7
	2018	8.6	3.9	11.2	15.1
Range across hybrids (parameter mean across locations by hybrid)	2019	2.0	1.1	1.5	2.3
	2018	2.0	0.9	2.4	2.2

SEASON-TO-SEASON DIFFERENCE

Figures 1 and **2** show the shift in key forage quality parameters, starch content, and undigested fiber (uNDF at 240 hr), between growing seasons in our trials in New York and Vermont. This data is strongly correlated to the growing environment of these seasons. The 2017 growing season can be summarized by above-average rainfall and below-average heat accumulation corresponding to a greater proportion of samples having a higher uNDF240 value and lower starch content. This was followed by below-average, but generally adequate rainfall

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in 2018, and moderate heat, resulting in a much higher percentage of samples being more digestibile (lower uNDF) and having a higher starch content. While the 2019 results fall in between 2017 and 2018 in both growing conditions and these forage quality indicators.

WITHIN-SEASON VARIATION

Data gathered through the collaborative efforts in the Northeast over the last two years provide good insight and follow the pattern of previous studies. In 2018, we were able to compare four hybrids grown at seven different locations in Vermont, New York, and Pennsylvania. In 2019, three hybrids were grown at eight different locations. This allows for the comparison of the same genetics across multiple growing environments. In **Table 2** , the range (maximum – minimum) in mean values observed between 1) hybrids across all locations and 2) locations across all hybrids is presented for key crop performance indicators. In both years, it is evident that the range between locations is much greater than the range between hybrids, indicating that environment has a much greater influence on performance than the hybrid genetics. This is reflected in the observed R^2 values presented in **Table 1**. For interpretation purposes, when assessing starch in 2019, the environment explains 64 percent of the variation observed while the hybrid only explains 2 percent of the observed variation in starch.

Understanding hybrid performance in the context of growing conditions is critical when evaluating data from both private and public sources. In addition to the hybrid-specific data presented in public trial reports, the use of location averages and corresponding weather data from these reports is incredibly valuable for decision making. In fact, it can be as useful, or even more useful, than data from individual hybrids.

2019 TRIAL RESULTS

New York and Vermont Corn Silage Trials: Cornell:
blogs.cornell.edu/varietytrials/corn-silage/

University of Vermont:
uvm.edu/extension/nwcrops/research

Penn State/PDMP Corn Silage Hybrid Performance Trial:
extension.psu.edu/2019-results-pa-commercial-grain-and-silage-hybrid-corn-tests-report

Western New York Crop Management Association:
testplot.azurewebsites.net/

University of Maine Extension:
extension.umaine.edu/waldo/programs/ag/

References available upon request.

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