Kernel Processing Information Series PD-2021-07-04

FACT SHEET 5: Corn Plant Dry Down

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This series has addressed the influence of dry matter (DM), both whole plant and plant fraction, on corn silage processing score as well as key quality metrics, namely starch content (**FACT SHEET 2: Effect of corn plant characteristics on corn silage processing scores**) from the recent Corn Silage Processing Score (CSPS project). There is also an opportunity in the data to explore the way in which the corn plant dries down, how that impacts harvest timing decisions, and the influence on forage quality.

Whole plant DM has long been considered the best option for timing silage harvest. A whole plant DM of 35 percent is most often cited as an optimum target while a range of 32 percent to 38 percentwhole plant DM is often considered an acceptable range (**Table 1**). The benefits of harvesting in this range are related to both optimizing crop performance and achieving proper fermentation.

TABLE 1: Common Range for Whole Plant DM by Storage Type

Storage Type	Dry Matter, %
Bunk silos and piles	32-36
Bags	32-36
Concrete Uprights	35-38
Sealed Uprights	40-50

Recent growing seasons have shown how differences in ear and stover dry down impact whole plant DM and harvest decisions. In 2018, these plots generally experienced below average but timely rainfall and above average heat accumulation [as measured by Growing Degree Days (GDD) 86/50]. In contrast, 2019 experienced above average rainfall and below area GDD's.

Prior to the dry down process, a corn plant typically has a whole plant DM between 20 and 25 percent. During a normal dry down process (not affected by factors such as drought or frost) the stover DM remains low relative to the ear DM. Ear DM really drives the dry down process to the target stage for corn silage (**Figure 1**).

During the 2018 and 2019 growing seasons the New York Farm Viability Institute funded a project led by Cornell PRO-DAIRY to better understand a number of field factors related to CSPS. Project collaborators include: Cornell Cooperative Extension, Miner Institute, SUNY Morrisville, Cornell University Ruminant Center, Corteva Agri-Science, Seedway, Dairy Support Services, Pominville Dairy, Hilltop Divine Dairy and Kingston Farm.

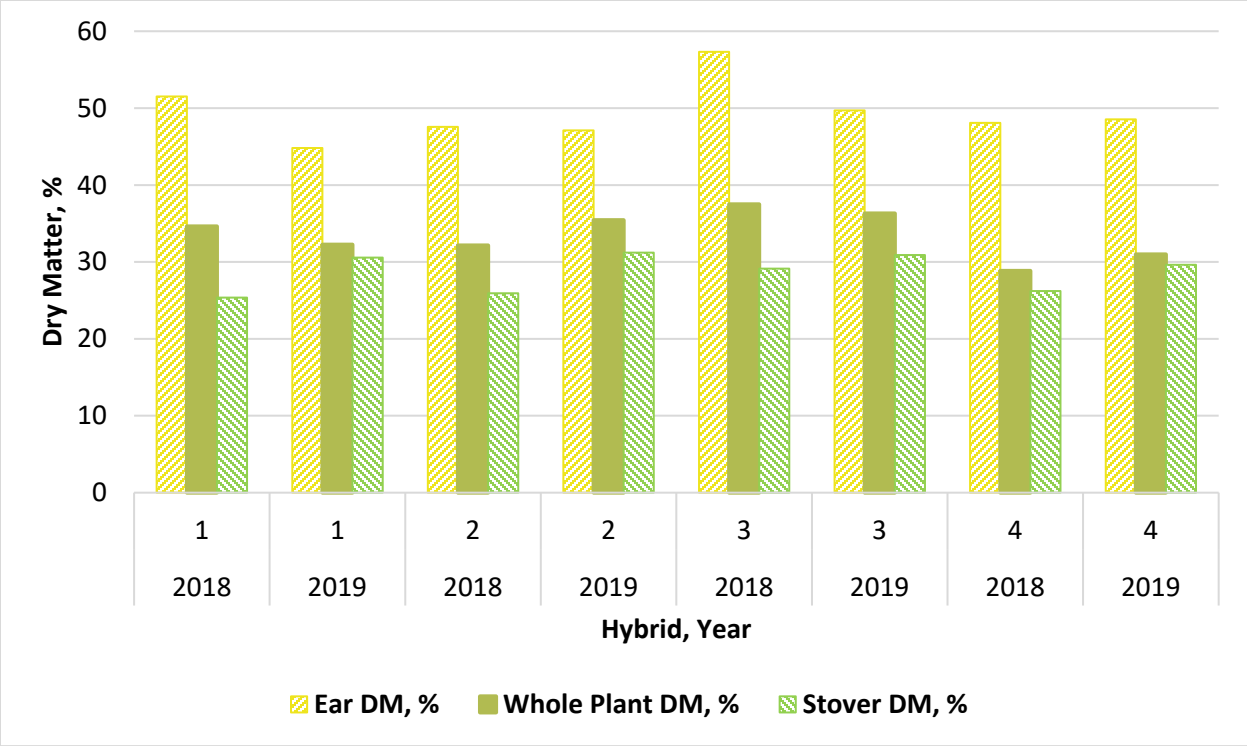


FIGURE 1: Contribution of ear DM and Stover DM to whole plant DM

Looking at the two years represented in this study, it is also worth noting the changing contribution of ear and stover as whole plant DM increased as evident by the slope of the lines shown in figure 2. In 2018, there was an abundance of heat and relatively healthy plants resulting in a shallower slope in the stover DM line and a steeper slope in the ear DM line as whole plant DM increased. The equations derived from **Figure 2** tell us that ear DM increased by 1.076 units for each unit increase in whole plant DM while stover DM only increased by 0.555 units (**Table 2**).

In contrast, in 2019 when the overall plant maturation process was slowed by cool, wet conditions the relationship was reversed leading to the stover making a greater contribution to whole plant DM. The equations derived from **Figure 2** tell us that ear DM increased by 0.784 units for each unit increase in whole plant DM while stover DM increased by a larger amount (0.923 units) for each unit increase in whole plant DM (**Table 2**).

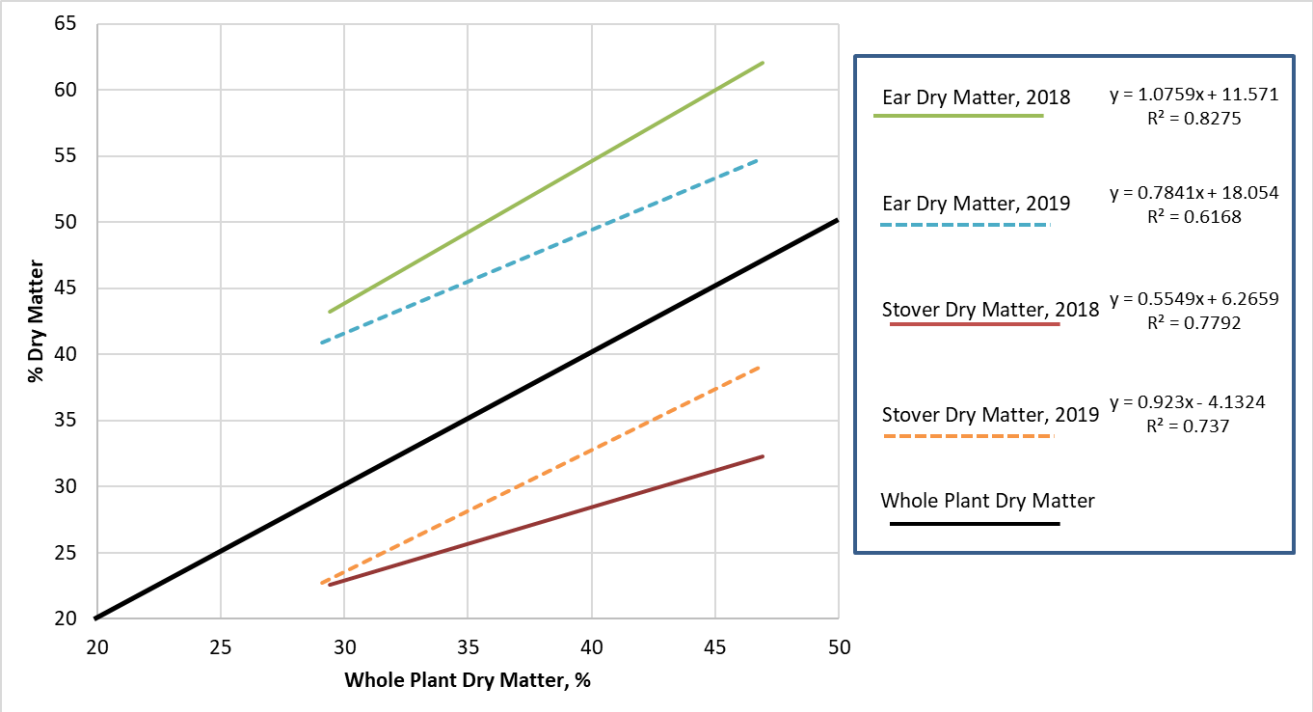


FIGURE 2: Change in ear and stover DM relative to the change in whole plant DM for four hybrids across two growing seasons.

TABLE 2: Average change in ear or stover dry matter (DM) for each one unit change in whole plant DM by year.

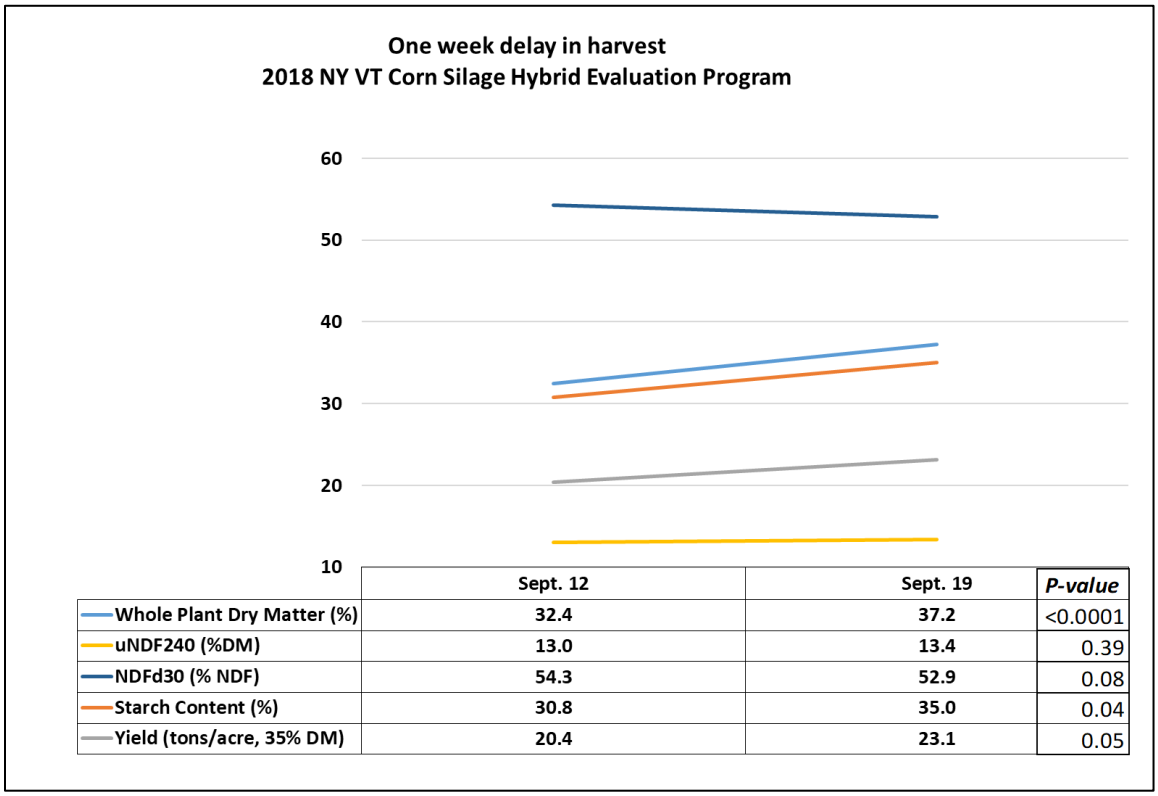
	Ear DM		Stover DM	
	2018	2019	2018	2019
Change for every 1 unit increase in Whole Plant DM	1.076	0.784	0.555	0.923

These differences did have implications in harvest decision making between the two years and the importance of taking actual measurements of whole plant DM for harvest decision making was highlighted. In 2018, many growers were caught off guard by drier than expected corn due to very healthy looking plants and drier than expected ears (a phenomenon that repeated itself in many areas in 2020). In contrast, it was often difficult to achieve target whole plant DM in 2019 and poorer plant health coupled with drier stover often resulted in silage that was wetter than it appeared due to the comparatively lower ear DM.

Forage quality

Within the range of acceptable whole plant DM, there is also debate regarding the pros and cons for specific quality metrics.

A separate study, conducted as part of the NY & VT Corn Silage Hybrid Evaluation program, demonstrates changes in key characteristics as plants mature (**Figure 3**). In this study, the same four hybrids (planted in replicate on the same date) were harvested one week apart. In this seven day period, whole plant DM went from 32.4 percent to 37.2 percent nearly bookending the range of 32 to 38 percent. The overall yield trended higher going from 20.4 tons/acre to 23.1 tons/acre, when adjusted to 35 percent DM. A significant amount of this yield increase is a result of the maturation of the kernels with more of the kernel milk converting into starch as reflected in the 4.2 percent increase in starch content. As anticipated, the changes to fiber digestibility where not significant with this one week delay in harvest. Starch digestibility was not measured in this study and while it is understood starch digestibility can decline as the corn kernel nears black layer (physiological maturity), any level of decline is expected to remain minimal in the target DM range.



	Sept. 12	Sept. 19	*P-value*
Whole Plant Dry Matter (%)	32.4	37.2	<0.0001
uNDF240 (%DM)	13.0	13.4	0.39
NDFd30 (% NDF)	54.3	52.9	0.08
Starch Content (%)	30.8	35.0	0.04
Yield (tons/acre, 35% DM)	20.4	23.1	0.05

FIGURE 3: Change in Crop Yield and Key Forage Quality metrics with one week difference in harvest

While the rate of change in DM, yield, and starch content observed in this specific project may not be realized in every situation, it demonstrates the achievable gains by allowing the crop to reach a greater DM at harvest.

Starch Digestibility

The CSPS project included measures of in vitro starch digestibility (IVSD) and aligns with previous research; including demonstrating how critical fermentation time is in minimizing the impact. The model derived from this analysis suggests for samples taken at harvest (no fermentation) there is a 0.5 percent drop in starch digestibility for each 1 unit increase in whole plant DM, with a similar impact through 90 days of fermentation. The level of impact then drops noticeably between 90 and 135 days, at which point starch showed an expected drop of 0.06 percent for each one unit increase in whole plant DM.

It is important to clarify that 90 or 135 days are not magic numbers. This is a trend over time and this study happened to measure at these time points; however, this does align with and reinforces the significance of current industry guidelines to allow corn silage to ferment for a minimum of three to four months prior to feeding.

Total Digestible Nutrients

Furthermore, a relatively new way to look at total nutritional quality is to calculate the yield of potentially digestible nutrients. This incorporates crop yield, neutral detergent fiber (NDF) and starch content as well as the digestibility of both NDF and starch. The Miner Institute has created a helpful calculator to provide this data which can be found at https://www.whminer.org/dairy/.

When comparing total digestible nutrients to whole plant DM there is no relationship between whole plant dry matter and the yield of potentially digestible nutrients, particularly within the target whole plant DM range (**Figure 4**).

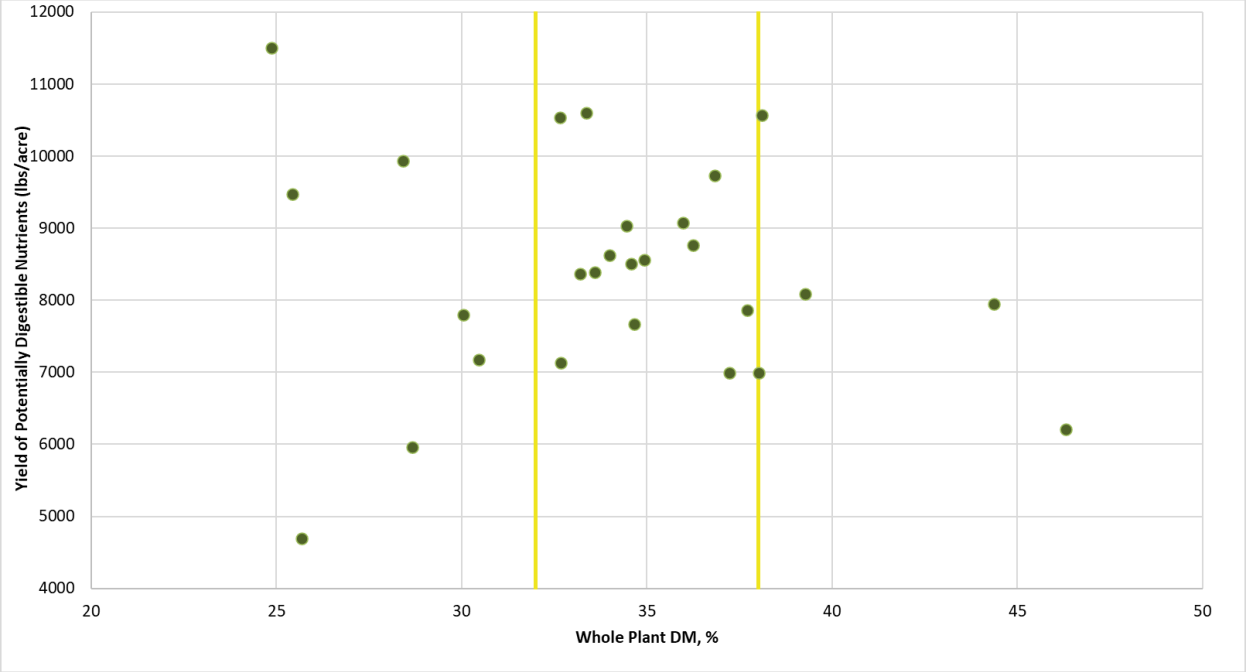


FIGURE 4: Lack of relationship between whole plant dry matter and the yield of potentially digestible nutrients

Conclusions

Focusing management efforts to target whole plant DM is critical to optimizing crop performance and successful fermentation. Within the target range, yield gains can be made by achieving higher whole plant DM (**Figure 3**) without compromising forage quality (**Figures 3 and 4**).

As the plant progresses towards silage maturity, the DM content of the ear and stover contribute differently to whole plant DM and their relative contribution can vary by growing environment. When making harvest timing decisions whole plant DM is the best method for accurate decision making.