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EFFECT OF CORN SILAGE HYBRID CHARACTERISTICS & FERMENTATION ON KEY FORAGE QUALITY METRICS

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Corn Silage Processing Score (CSPS)

Starch

1. Content
2. Digestibility
3. **Availability (CSPS)**

Corn Silage Processing Score	Starch, % of total on or below the 4.75 mm screen
Optimally Processed	**> 70%**
Adequately Processed	**50-69%**
Inadequately Processed	**< 50%**

Influence of Fermentation

Table 1. Effect of ensiling on ruminal in vitro starch digestibility in whole-plant corn silage.

	Days Ensiled										
Experiment	0d	30d	45d	60d	90d	120d	150d	180d	240d	270d	*P*<
	% of Starch										
Der Bedrosian et al., 2012[1]	69	---	75	---	77	---	---	79	---	82	0.01
Ferraretto et al., 2014a[2]	62	72	---	---	---	79	---	---	84	---	0.001
Windle et al., 2014[1]	54	---	59	---	63	---	68	---	---	---	0.01
Young et al. 2012[1]	---	---	76	---	---	---	79	---	---	---	0.01

[1]Ruminal in vitro starch digestibility at 7 h on samples ground through a 3-mm Wiley Mill screen.
[2]Ruminal in vitro starch digestibility at 7 h on samples ground through a 4-mm Wiley Mill screen.

Table 2. Effect of ensiling on ruminal in vitro neutral detergent fiber (NDF) digestibility in whole-plant corn silage.

	Days Ensiled										
Experiment	0d	30d	45d	60d	90d	120d	150d	180d	240d	270d	*P*<
	% of NDF										
Cherney et al., 2007[1]	56	50	---	---	---	---	---	---	---	---	0.001
Der Bedrosian et al., 2012[2]	62	---	60	---	60	---	---	59	---	59	0.01
Ferraretto et al., 2014[3]	57	56	---	---	---	55	---	---	56	---	NS[5]
Hunt et al., 1993[4]	73	---	---	71	---	---	---	---	---	---	NS
Young et al. 2012[2]	---	---	61	---	---	---	60	---	---	---	0.02

[1]Ruminal in vitro NDF digestibility at 48 h on samples ground through a 1-mm Udy Mill screen.
[2]Ruminal in vitro NDF digestibility at 30 h on samples ground through a 2-mm Wiley Mill screen.
[3]Ruminal in vitro NDF digestibility at 30 h on samples ground through a 1-mm Wiley Mill screen.
[4]Ruminal in vitro NDF digestibility at 48 h on samples ground through a 2-mm Wiley Mill screen.
[5]Non-significant.

Time in the silo effect on corn silage processing score[1]

Storage length, days	0	30	120	240	*P*-value
Ferraretto et al., 2015 – trial 1	50.2	61.1	-	-	0.01
Ferraretto et al., 2015 – trial 2	60.3	63.6	67.2	68.4	0.08
Agarussi et al., 2020	28.8	-	28.8	-	0.97
Saylor et al., 2020	62.4	59.7	64.8	67.7	0.01

[1]Corn silage processing score - % of starch passing through the 4.75 mm sieve.

Table Courtesy: Luiz Ferraretto

Influence of Ensiling on the Digestibility of Whole-Plant Corn Silage, Wisconsin Focus on Forage

https://fyi.extension.wisc.edu/forage/influence-of-ensiling-on-the-digestibility-of-whole-plant-corn-silage/

Study Objectives

Evaluate the effects of hybrid characteristics on CSPS at harvest

- Understand risk of changes to CSPS during harvest

Evaluate if duration of fermentation alters nutrient metrics

- CSPS
- in-vitro starch digestibility (IVSD; 7 hr, 4 mm),
- neutral detergent fiber after 30 h of fermentation (NDFd30, % of NDFom)
  - CSPS x Fermentation time

Materials and Methods

- Crop years: 2018 and 2019
- 4 hybrids planted at 5 test sites in NYS
  - Plot Size: 0.63 acres (0.25 hectares) per hybrid
  - Row Spacing: 30-inch (0.76 m)
- Farms followed best agronomic practices
  - Plant Nutrition
  - Pest Management

Pre-Harvest Data Collection

- Randomly collect 15 stalks of each hybrid
- Separate Ear from Stover
- Dry Matter analysis

Field Layout			
Hybrid 1	Hybrid 2	Hybrid 3	Hybrid 4
12 rows	12 rows	12 rows	12 rows

Hybrid Code	Relative Maturity	Hybrid Descriptor	Ear Flex	Plant Height Index
1	97	Dual Purpose	5 out of 9	5 out of 9
2	98	Leafy	Flex	9 out of 9
3	91	Dual Purpose	5 out of 9	4 out of 9
4	100	Leafy, Floury	Flex	9 out of 9

** Seed Company Descriptors of Hybrids*

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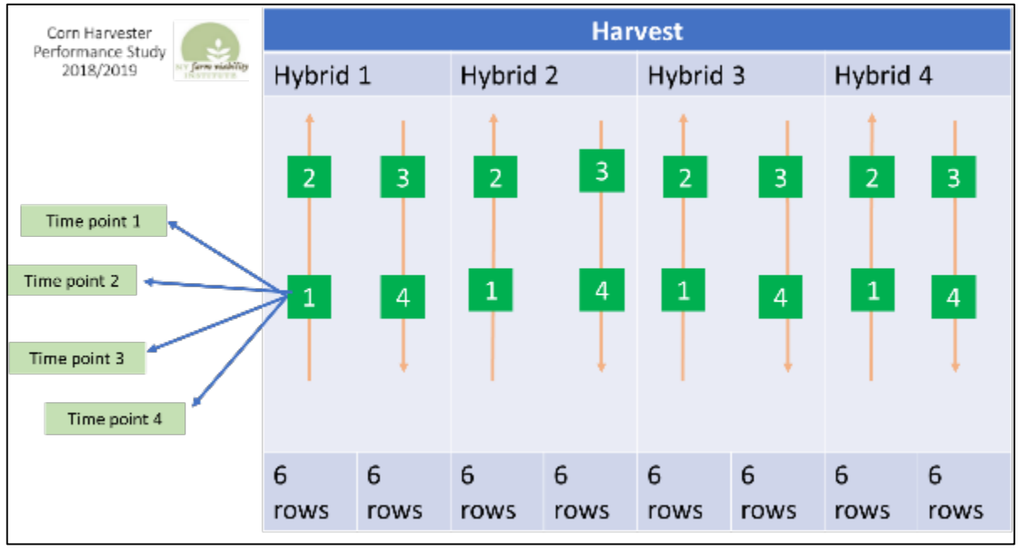
Materials and Methods

- **Harvest**
  - Collected 4 random samples per hybrid
  - Subdivided samples into 4 and randomly assign to 0-, 45-, 90-, or 135-day groups
    - Total of 64 samples per hybrid for 3 locations
    - *Only fresh samples were collected at 2 of 5 farms*
- **Post Harvest**
  - Samples were vacuum sealed and stored in dark room at consistent (room) temperature
  - At each timepoint, samples were submitted to Cumberland Valley Analytical Services for analysis



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Statistical Analysis

Objective 1: Evaluate the effects of fermentation time on nutrient metrics

- Repeated-measures ANCOVA with fixed effect of fermentation time (PROC MIXED; SAS v. 9.4)
- Covariates included hybrid and year
- Random effect of site-year
- *P*-values were corrected for multiple comparisons with a Tukey's honestly significant difference test

Objective 2: Effect of ear to stover ratio on CSPS for green samples

- ANCOVA with fixed effect of ear to stover ratio (PROC MIXED; SAS v. 9.4)
- Covariates included hybrid, DM (whole plant or ear), and year
- Random effect of site-year

Least squares means and SE for the effect of fermentation time on IVSD, NDFd30, and CSPS

	Fermentation Timepoint, d					
Forage Metric	0	45	90	135	SE	*P*-value
IVSD, % starch	**58.2^{d}**	**63.2^{c}**	**67.2^{b}**	**69.4^{a}**	**1.7**	**< 0.001**
NDFd30, % NDFom	**57.4**	**57.1**	**57.0**	**56.8**	**0.8**	**0.23**
CSPS, % starch	**60.3^{A}**	**60.0^{BA}**	**59.3^{BA}**	**58.4^{BC}**	**5.9**	**0.07**

^{a,b,c,d}Means with different superscripts differ ($P < 0.05$).
^{A,B,C}Means with different superscripts differ ($P < 0.10$).

Corn Harvester Performance Study 2018/2019

NY farm viability INSTITUTE

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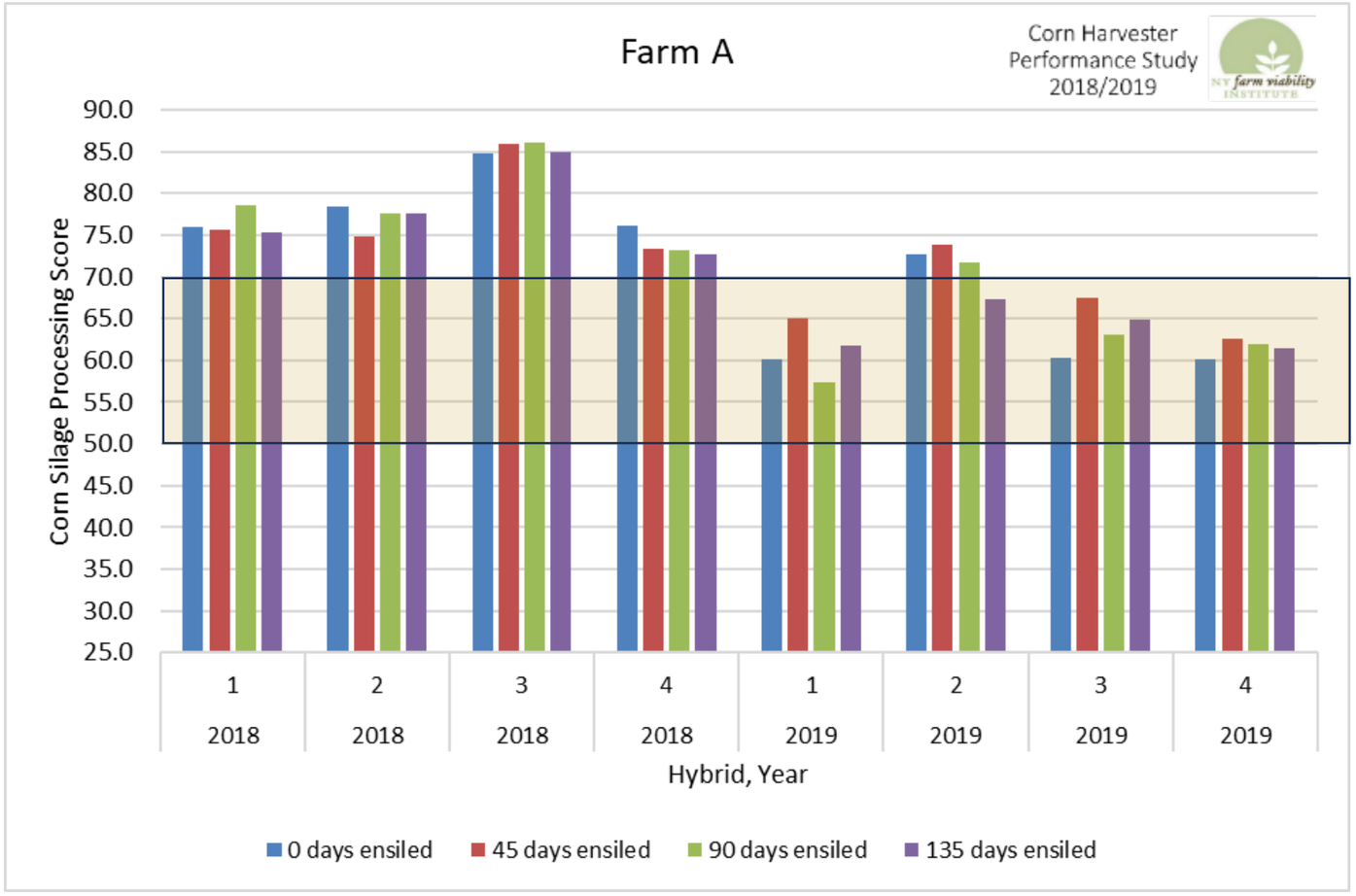
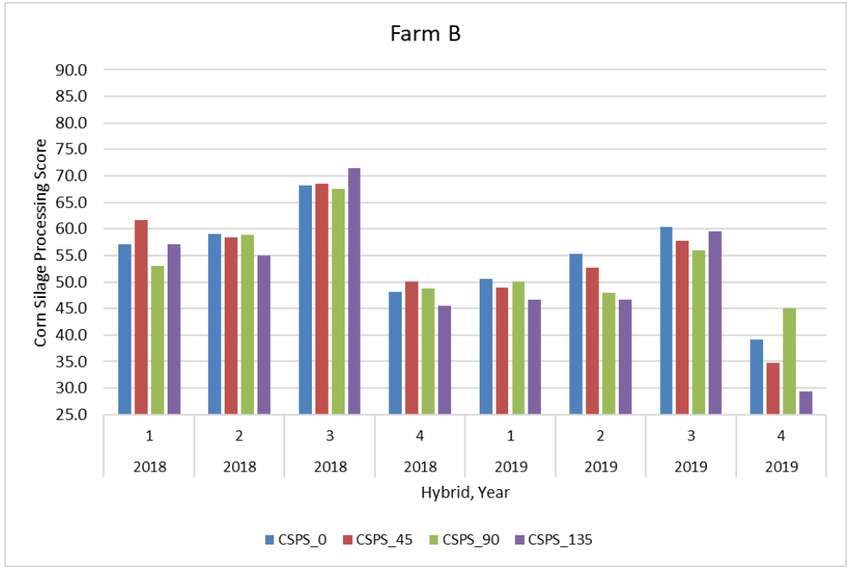
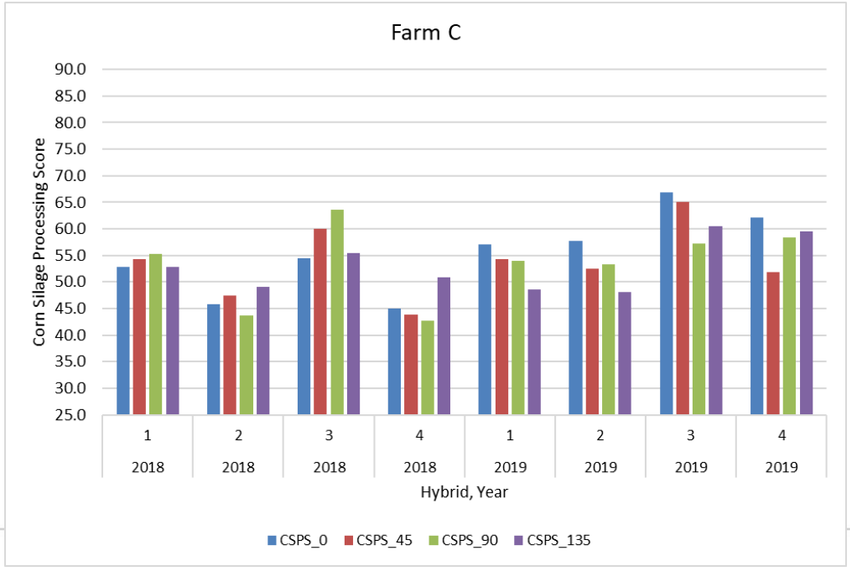
Hybrid x Season Results







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Hybrid Characteristics & CSPS

Corn Harvester Performance Study 2018/2019

	Unit Change	Resulting Change in CSPS, %*	*P*-value
Ear to Stover Ratio, 100% DM	+0.10	+1.70 (± 0.41)	<0.001
Ear DM, %	+1.0	- 0.78 (± 0.30)	0.01
**controlling for ear dry matter*			

Corn Silage Processing Score	Starch - % of total on or below the 4.75 mm screen
Optimally Processed	> 70%
Adequately Processed	50 – 69%
Inadequately Processed	< 50%

Ear to Stover Ratio		Range in Ear to Stover Ratio	Resulting Impact on CSPS, %
Within location		0.5 to 0.9	8 to 15
Between Locations	2018	0.2 to 0.9	3 to 15
	2019	0.6 to 0.9	10 to 15

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Kernel Processing Information Series
https://cals.cornell.edu/pro-dairy/our-expertise/forage-systems

Outcomes

Messages to farms

- Continue to strive for **Optimal Processing Score** in **Green Samples**
- Changes during harvest (hybrid type, plant maturity) necessitate continual monitoring and adjustments to processing equipment

Extension Materials

- ***Kernel Processing Information Sheet Series***
  - Corn silage kernel processing
  - Effect of corn plant characteristics on corn silage processing scores
  - Impacts of fermentation
  - Industry snapshot
  - Corn plant dry down

https://cals.cornell.edu/pro-dairy/our-expertise/forage-systems

Opportunities for further Research

- Does CSPS at harvest affect how starch changes during fermentation
- Observations from data
  - High CSPS samples (>70)
    - Less change in IVSD across fermentation time
    - Greater reduction in starch content across fermentation time
    - Higher sugar content at each fermentation timepoint
- Follow-up study (Wilder et al., Miner Institute, *Northern NY Agricultural Development Program Funding*)
  - degree of processing did not significantly affect the content of starch or sugar
  - The hypothesis that this change in starch content was due to degradation into other pools (soluble starch, sugar) was not observed
  - **Limitation: narrow range is CSPS (**Heavily processed mean: **63.9**, Moderately processed mean: **62.3)**

https://nnyagdev.org/wp-content/uploads/2022/03/NNYADPCornP2021ReportFINAL.pdf

Thank You!

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