Northern NY Agricultural Development Program
2023 Project Report

The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York

Project Leader:

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Collaborators and Research Locations:

- Happy Haven Farm, 249 Thompson Road, Mooers, NY
- Miner Institute, 586 Ridge Road, Chazy, NY

Background:

Interseeding cover crops into corn has been suggested as a way to reduce the environmental impacts of silage corn production while reducing the labor demand for timely cover crop planting after silage harvest. However, there is the potential that this practice could reduce corn silage yields through companion crop competition if water or crop nutrients were to become limiting during the growing season. This potential for competition poses a significant barrier to the implementation of interseeding on northern New York dairy farms and would need to be outweighed by other direct benefits to the cropping system.

Forage sorghum and other alternative forages have been increasing in popularity in recent years due to certain agronomic and economic benefits over corn silage. Alternative forages also may provide forage quality benefits over corn silage such as improved crude protein content. Forage brassicas, for example, can achieve a protein content similar to alfalfa while remaining lower in overall fiber content. Unfortunately, difficulties harvesting and ensiling wet forages such as these have limited their potential utilization on many conventional dairy farms in New York.

For this project in 2023, we proposed that interseeding alternative forages into corn silage may be a way to improve the economics of cover crop interseeding by adding value to corn silage through additional yield or improved forage quality. If the interseeded crop attains a height suitable for harvest, it is possible that additional yield may be produced by the system as a whole. Furthermore, since corn silage dries down and ensiles consistently well, the harvested mix of corn and alternative forage would be much easier to manage as silage than alternative forages alone. However, research is needed to quantify the agronomic, nutritional, and economic potential of such a system in northern New York.

Our objective was to quantify the potential benefits that interseeding two different alternative forage species might have on the yield and quality of a corn silage crop

Methods:

Research plot establishment: On May 16, 2023, a two-acre block of dwarf corn (Stine 9545G) was planted at Miner Institute (Chazy, NY; Roundabout silt loam soil). The corn was on 30 inch (in.) rows at a plant population of 32,019 plants/acre as measured by the precision planting system on the planter.

A second block of corn was also established by collaborating dairy producer Happy Haven Farm, Mooers, NY, according to grower standard practice. A conventional Pioneer hybrid was used (P9789) and was planted at a similar population on 30 in. rows.

At both locations, previous manure application provided the majority of crop nutrition during the growing season. Glyphosate alone was used for weed control to ensure that there would be no soil residual that might impact the interseeded crops.

Treatments: The two alternative forage crops chosen for this study were forage sorghum (male sterile, SP1727, S&W Seed, Longmont, CO) and forage kale (Cultivar: Bayou; Saddle Butte Ag Inc., Tangent, OR). They were chosen based on their forage quality characteristics and commercial availability.

Interseeding took place at the V5 stage at the Chazy location and the V7 stage at the Mooers location. A 6-row drill interseeder (Hershey Farms LLC, Elizabethtown, PA) was used to make four passes with kale and four passes with sorghum with four 6-row control strips at each location (randomized complete block design). The seeding rate was calculated to be approximately 10.7 lbs./acre for the sorghum and 6.4 lbs./acre for the kale.

Data Collection: Harvest took place on September 22, 2023, at the Mooers location and October 6 at the Chazy location. Entire strips (all approximately 500 ft. long) were harvested at the Chazy location using a Kemper type head on a self-propelled forage harvester (John Deere, Moline, IL). The goal was to harvest as much of the alternative forage along with the corn as possible. All forage material from each strip was collected in a forage dump truck that was then weighed on drive-over scales. A subsample of material from each plot was used to fill a 2 gallon plastic bucket to a weight of 3645 g, which was then sealed and allowed to ferment for 90 days. Upon opening, the ensiled forage was mixed and subsamples were dried and submitted for analysis.

Due to poor growth of the interseeded forage and limited equipment availability, only corn stalks were harvested at the Mooers location (hand harvesting of 8 stalks/strip). After being chopped, the stalk sample material was oven dried (55°C) to a constant weight.

Analysis: Upon opening, subsamples of silage from each bucket were sent to Dairyland Labs (Arcadia, WI) and analyzed for an in-vitro gas production analysis package (Fermentrics), as well as wet chemistry determination of crude protein, soluble protein, and minerals.

Additionally, insoluble protein, acid detergent fiber, neutral detergent fiber, lignin, starch, sugar (WSC), ether extract (fat), and silage pH were predicted via in-house near infrared spectroscopy calibrations. Physically effective fiber (peNDF) was calculated through mechanical sieving in

addition to predicted fiber content. All results from this study were tested for statistical significance ($P \leq 0.05$) using a mixed model analysis of variance (SAS JMP) that included the fixed effect of treatment and rep designated as a random effect. Tukey's highly significant difference was used for means separations when significance was detected.

Results and Discussion:

Yield and Moisture:

The potential for a yield loss is one of the greatest concerns with the interseeding of crops. Our research found that interseeding did not have a significant effect on yield at either location. At the Mooers location, interseeding was done relatively close to canopy closure. Thus, it is not surprising that no statistical yield difference was detected here, since the corn canopy shaded the interseeded crop so heavily. In fact, almost all the kale had completely died out by the end of the season as a result of being smothered by the corn. While the sorghum grew a little, it was unable to attain a height sufficient to be even partially harvested with the corn. For this reason, only corn samples were taken to estimate plot yield. No significant difference in moisture content was detected at the Mooers location.

At the Chazy location, establishment of interseeded crops was more successful. This was likely aided by the earlier interseeding and shorter stature of the corn. By the end of the season, the sorghum plants were about waist high in some areas and some of the biomass was clearly harvested along with the corn. The kale, however, appeared to be stunted and failed to reach a harvestable stature. Since none of the kale appeared to be harvested, it is surprising that its presence did not appear to have even the slight negative impact on the corn yield. Oddly enough, the moisture content of the corn was affected by interseeding at the Chazy location with the kale treatment causing the forage material to be slightly drier than both the sorghum treatment and the control corn. Yield and moisture data for the Mooers and Chazy locations can be found in Tables 1 and 2 respectively.

Table 1. Mooers location results of interseeding forage sorghum and kale into vegetative corn; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023.

	Control	Kale	Sorghum	SE	*P*-Value[1]
Yield, tons/acre (65%moisture)	25.9	25.6	25.2	0.7	0.77
Moisture, % as fed	61.6	61.1	61.3	0.7	0.84

[1] *P*-values generated from analysis of variance were considered significant at $P < 0.05$.

Forage Quality:

Forage quality was only measured at the Chazy location and a significant treatment effect was not detected for most parameters measured. For protein and fat, however, a significant treatment effect was detected. For crude protein, both the interseeded kale treatment and the interseeded sorghum were proportionally lower in protein than the control. This may be a symptom of increased nitrogen demand exerted on the soil as a result of having two crops growing at the same time. In this case, it would make sense that the nitrogen would have to be split beween the crops and a lower total crude protein percentage would be harvested. Crude fat was slightly (but significantly) lower in the kale treatment as compared to the others tested. While it is not clear why this may have been the case, it may be that interseeding reduced the fat content of the corn

in both cases, but additional lipids were captured in the corn treatment through the harvested sorghum tops. Forage quality data for the Chazy location can be found in Table 2.

Table 2. Chazy location results of interseeding forage sorghum and kale into vegetative corn; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023.

	Control	Kale	Sorghum	SE	*P*-Value[1]
Yield, tons/acre (65% moisture)	17.6	18.6	18.3	0.6	0.30
pH	3.75	3.70	3.69	0.05	0.69
Moisture, % as fed	61.8[a2]	60.3[b]	61.6[a]	0.4	0.02
Microbial biomass, mg/g	110	115	111	5	0.79
Fast, Kd/hr	23.4	24.1	23.9	0.8	0.81
Slow, Kd/hr	4.95	5.55	5.24	0.35	0.43
C:B1, Kd/hr	18.3	22.3	21.6	2.0	0.34
C:B3, Kd/hr	4.95	5.55	5.24	0.35	0.43
Fast pool gas, ml	27.4	27.3	27.1	0.5	0.95
Slow pool gas, ml	54.3	48.3	48.5	3.7	0.46
Fast pool time to max rate, hr	2.38	2.25	2.38	0.13	0.77
Slow pool time to max rate, hr	10.4	9.3	10.0	0.7	0.42
Crude protein, %	6.90[a]	6.45[b]	6.49[b]	0.10	0.01
Adjusted crude protein, %	6.77[a]	6.21[b]	6.26[b]	0.13	0.02
Acid insoluble protein, %	0.77	0.79	0.79	0.02	0.67
Soluble protein, % protein	53.9	56.2	53.4	1.5	0.52
Acid detergent fiber, %	19.5	20.6	20.9	0.7	0.38
Neutral detergent fiber, %	33.9	34.1	34.6	0.7	0.84
Lignin, %	2.23	2.46	2.50	0.09	0.19
Water soluble carbohydrates, %	4.91	4.92	4.84	0.11	0.91
Ethanol soluble carbohydrate, %	1.82	1.51	1.40	0.30	0.59
Starch, %	40.3	40.1	38.9	0.9	0.41
Non-fiber carbohydrates, %	53.6	54.3	53.8	0.7	0.81
Fat (either extract), %	3.40[ab]	3.30[b]	3.42[a]	0.08	0.04
Total fatty acids, %	2.65	2.55	2.57	0.05	0.40
Ash, %	4.79	4.50	4.34	0.14	0.17
Ca, %	0.20	0.20	0.20	0.01	0.69
P, %	0.21	0.21	0.21	0.01	0.90
Mg, %	0.15	0.15	0.15	0.00	0.86
K, %	0.87	0.83	0.85	0.03	0.28
S, %	0.09	0.09	0.08	0.00	0.27
Na, %	0.02	0.01	0.01	0.01	0.18

[1] *P*-values generated from analysis of variance were considered significant at $P < 0.05$.
[2] Superscript letters (a,b, etc.) denote similar (same letter) or significant differences (different letters) among entries.

Conclusions:

- Interseeding corn with forage sorghum and kale did not result in a corn yield decline - as is often the concern with interseeding. Across multiple years, the more diverse

interseeding systems may even support higher average yields and better resilience to regional climate extremes.

- The forage sorghum turned out to be more shade tolerant than the kale and produced harvestable biomass that was able to be cut by a multi-directional corn head.

- Minimal quality differences can be expected as a result of interseeding forage, but slightly lower protein may be a concern and interseeding with kale or another brassica species may result in a lower moisture content and lower fat content, making species selection an important consideration.

- To improve interseeding success, interseeding at plant stage V5 or sooner is suggested.

Education and Outreach:

Outcomes of this study are being shared with farmers and agricultural professionals in the 6 counties in the Northern New York region and beyond by summarizing data and reporting results in the Miner Institute Farm Report as well as other publications that may reach the targeted audience. These results have been, and will continue to be, shared with growers and industry professionals through presentations and word of mouth.

Next Steps:

Further research is needed to better document the performance of corn interseeded with alternative forages under different growing conditions. While it was somewhat of an atypical growing season for the region (see **Appendix**), the testing and trial conditions in 2023 resulted in minimal impact on the corn crop. Investigation into pushing the envelope through earlier interseeding, wider row spacing, and other factors may provide more insights into the potential value of alternative forage interseeding or lack thereof.

Acknowledgments:

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For More Information:

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Appendix: Figures

Climatic conditions during the 2023 growing season: The 2023 growing season was not a typical one for the region. Conditions were abnormally dry in the spring, followed by an anomalously wet summer; Figure 1, below.

From a temperature standpoint, the spring and fall were warmer than normal, but the late summer was slightly cooler than average; see Figure 2, page 7.

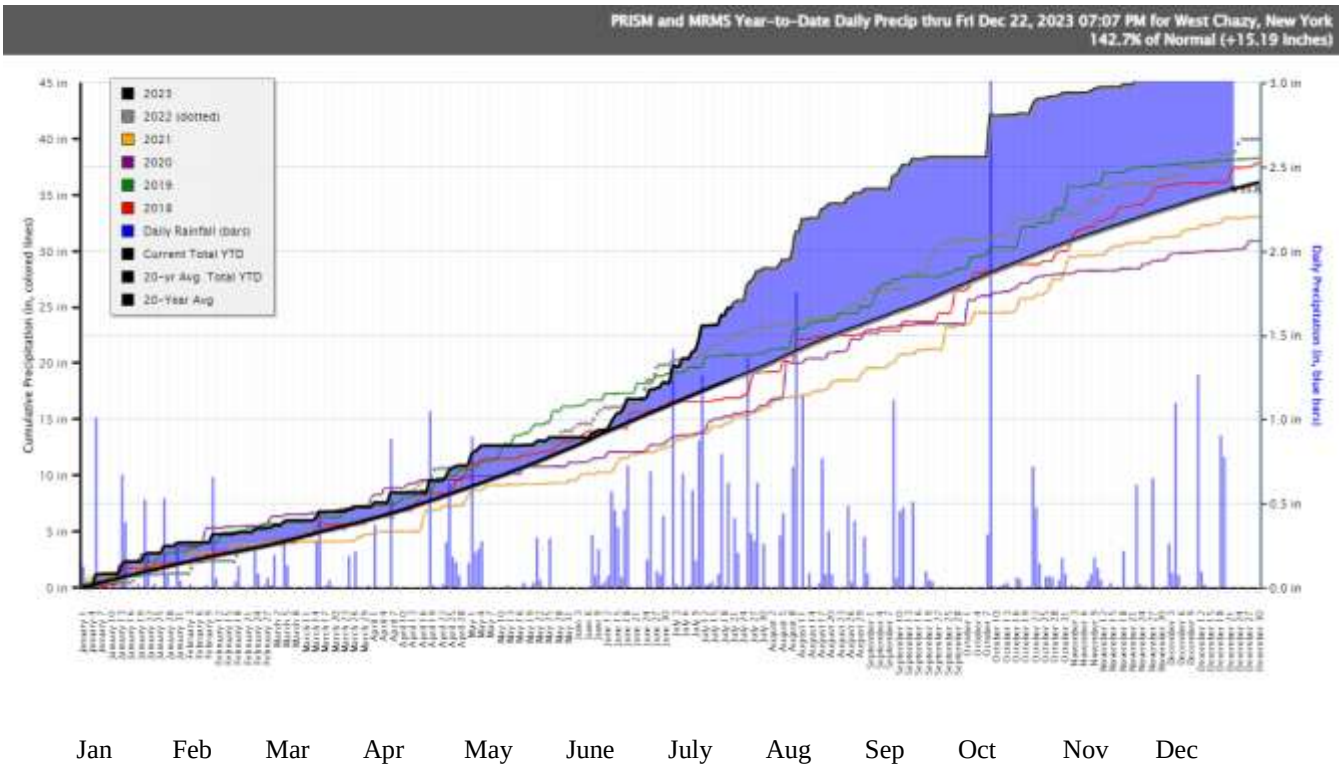

Figure 1. Miner Institute 2023 daily rainfall (blue bars), accumulated precipitation (black line) and departure from normal (shaded area). A notable dry period was experienced during the entire month of May, while most other parts of the season received excessive moisture. Total yearly precipitation was 142.7% of normal. The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023.

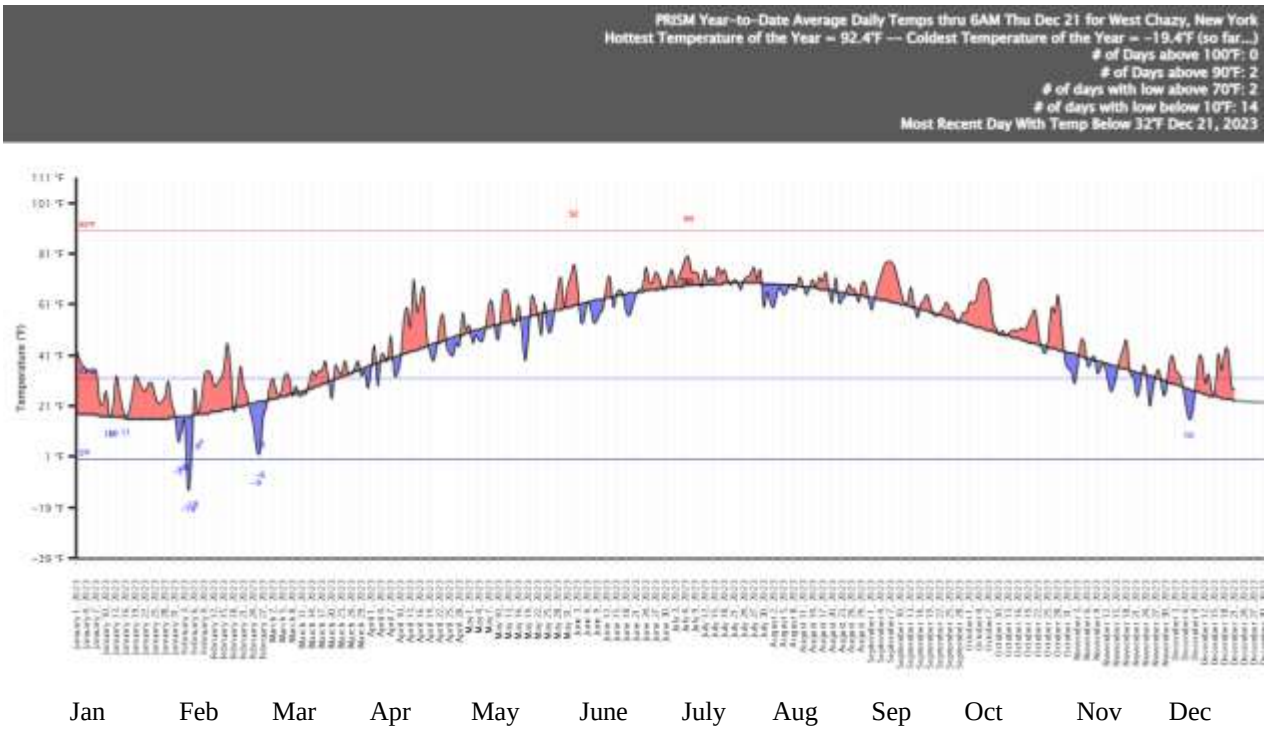

Figure 2. Miner Institute 2023 average daily temperature. While most of the year was warmer than normal, there were some notable cold spells in May that delayed crop development. Heat and drought were not a stress factor during pollination/early kernel development. A warmer than normal fall extended the growing season and also contributed to an extremely rapid dry-down. The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023.

Photos:

Left: Photo 1. Interseeding corn with forage sorghum at the Miner institute Chazy location; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023. Photo credit: Allen Wilder.

Right: Photo 2. Forage sorghum growing between dwarf corn at the Miner Institute Chazy location; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023. Photo credit: Allen Wilder.

Left: Photo 3. Forage kale Interseeded in dwarf corn at the Miner Institute Chazy location; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023. Photo credit: Allen Wilder.

Right: Photo 4. Interseeded forage sorghum prior to harvest at the Miner Institute Chazy location; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023. Photo credit: Allen Wilder.

Left: Photo 5. Interseeded forage sorghum prior to harvest at the Mooers location; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023.Photo credit: Allen Wilder.

Right: Photo 6. Interseeded forage sorghum strip after harvest at the Miner Institute Chazy location; The Effect of Interseeded Alternative Forages on the Yield and Forage Quality of Corn Silage in Northern New York, NNYADP, 2023. Photo credit: Allen Wilder.