Survey of Current Management Practices and Evaluation of their Impact on Nutrient Content of Small Cereal Silage in Nebraska

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Summary with Implications

The nutrient content of small cereal silage from 16 producers in Nebraska was measured at harvest and post-fermentation. At packing, 42% of the samples were below the target dry matter of 30–35%. Samples with dry matter percentages below 30% had a significant increase in the loss of energy (total digestible nutrient) content of the silage. The wetter silage appeared to have increased rates of clostridial fermentation as indicated by production of butyric acid. These data suggest that moisture management is a challenge and increased attention to ensuring the target dry matter content is achieved before packing could improve the quality of small cereal silage.

Introduction

Double cropping a small cereal with another annual forage, corn silage, or a cash crop can be a way to get more productivity off the same acres. Making silage from small cereals can shorten the harvest window and potentially preserve more feed value than harvesting hay. The goal of making silage is to produce a stable feed in which most of the dry matter (DM) and energy of the fresh crop is captured. However, management can have a large impact on the effectiveness of preserving the feed value of the forage. The objectives of this project were to understand current small cereal silage management practices of producers in Nebraska and identify opportunities for improved silage management.

Table 1. Dry matter (DM), energy (TDN), crude protein (CP) and fermentation profile of the small cereal silage samples (n = 18) from 16 producers in Nebraska.

	Boot	Heading	Anthesis	Milk	Soft Dough	Average[1]
Samples, %	5.6	33.3	11.1	16.7	33.3	—
Packing (pre-fermentation)						
Dry Matter, %	35.4	28.8	28.6	31.4	33.1	31.5 ± 6.7
TDN, % of DM	63.2	57.7	56.0	57.6	54.1	56.5 ± 4.0
CP, % of DM	9.38	10.7	10.3	10.5	9.87	10.2 ± 2.1
Feed out (post-fermentation)						
Dry Matter %	33.8	27.7	24.1	34.6	30.8	30.2 ± 5.5
TDN, % of DM	61.4	53.1	45.8	48.5	53.0	51.9 ± 5.4
CP, % of DM	12.8	10.9	8.7	12.1	11.5	11.2 ± 2.1
pH	4.09	4.57	4.94	4.00	4.20	4.4 ± 0.48
Lactic Acid, % DM	5.24	2.83	5.94	6.52	2.91	3.6 ± 2.6
Acetic Acid, %DM	5.48	2.49	4.42	3.57	1.60	3.1 ± 1.9
Butyric Acid, % DM	<0.01	4.41	3.02	<0.01	0.07	2.8 ± 1.8
Ammonia-N, % of CP	11.4	21.7	28.2	6.8	11.3	15.9 ± 18.7

[1]Mean ± standard deviation

Procedure

Samples of small cereal silage were obtained from 19 different harvests from 16 producers in Nebraska during 2021. Producers answered survey questions at the time of harvest and again during feed out to allow for evaluation of the management impacts and the resulting fermentation on the silage nutritive value. Survey responses were obtained for 18 samples at the time of harvest and all 19 samples for feed out.

At harvest, a grab sample of the chopped forage was obtained as it was being placed into the silo. A post-fermentation sample was obtained during feed-out approximately 2 weeks after the pile was opened from the freshly exposed silage face. These samples were frozen for a minimum of 48 hours after collection before being shipped on ice packs to Dairyland Laboratories and were analyzed using near-infrared spectroscopy (NIR) analysis to determine DM, crude protein (CP), and total digestible nutrients (TDN). The TDN was estimated using the OARDC summative equation. Fermentation analysis evaluating the acid profile was conducted using high performance liquid chromatography (HLPC).

Silage density in the piles, bunkers, and bags was determined by obtaining 3 cores at approximately 4 feet from the ground from across the freshly opened face using a Dairy One Master Forage Probe. The depth of the core was measured to determine the volume sampled and the wet weight of the sample obtained was measured. These samples were then analyzed for DM. The amount of DM in the cores was calculated and divided by the volume of the cores to determine the density of the silage.

Results

Of the samples (n = 19) obtained 53% were cereal rye, 26% triticale, 5% wheatlage, 5% oatlage, and 11% mixed small cereal/annual legume. Based on the survey data, at harvest (n = 18), 6% were boot stage, 33% heading, 11% anthesis, 17% milk, and 33%

Table 2. Silo type and ensiling management of small cereal silage used by 16 producers in Nebraska.

	Bag	Bunker	Pile	Average
Samples[1], %	18%	35%	47%	-
Density[2], lb DM/ft^3	3.7 ± 2.2	6.1 ± 1.9	4.9 ± 2.0	5.2 ± 2.0
Covered silage, %	—	33%	75%	57%
Inoculated, %	33%	50%	87%	57%

[1] Represents 19 different harvests as three producers had two crops

[2]Mean ± standard deviation

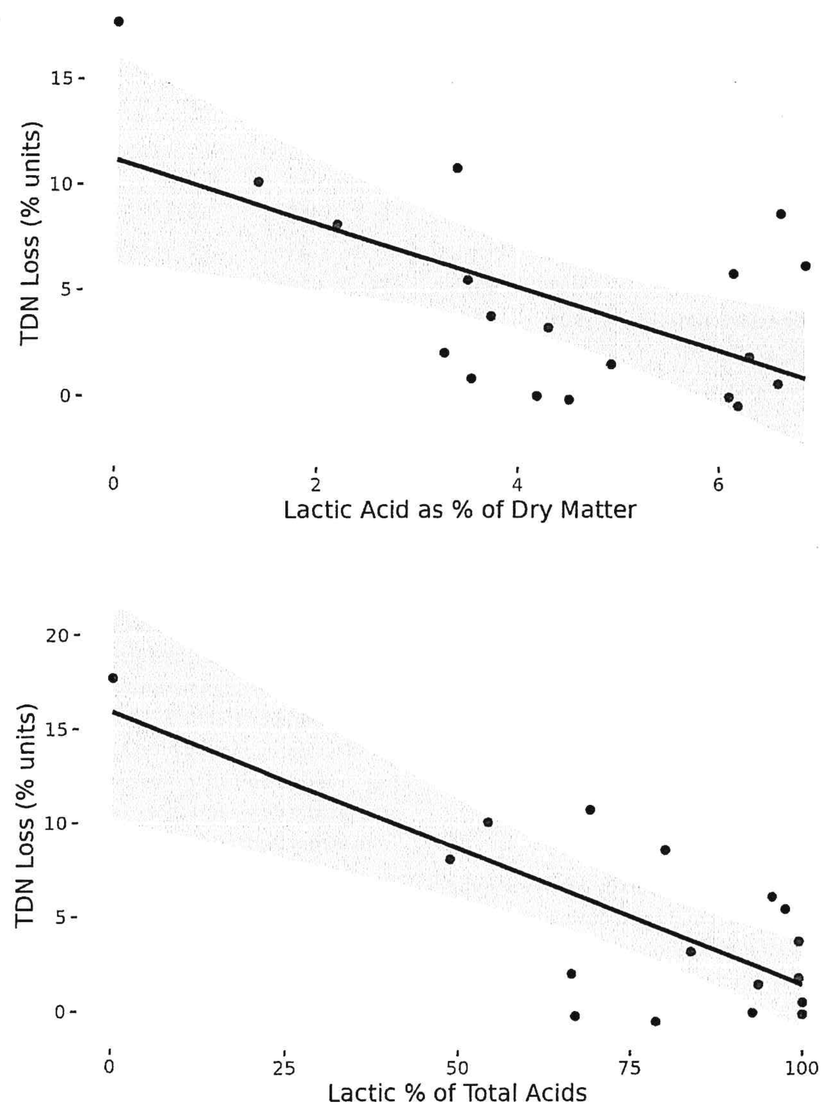

Fig. 1. The correlation of lactic acid as a percentage of the dry matter (top panel) and as a percentage of the total acids (bottom panel) and the loss of total digestible nutrients from packing to feed-out of small cereal silage. Lactic acid (% DM) Y= -1.5x + 11.2 ± 2.3 (R^2 = 0.32; P < 0.01). Lactic acid (% total acid) Y = -0.144 x +15.9 ± 2.7 (R^2 = 0.53; P < 0.01).

were soft dough at harvest (Table 1). The majority (80%) of the producers reported determining the harvest date based on growth stage of the forage. The other 20% reported harvesting based on a calendar date.

Producers also reported why they choose the date they harvested: options to choose from included, balancing yield and quality, wanting high yield and okay lower quality, wanting high quality and okay with lower yields, timing of planting for the next crop, and chopper availability. Producers were able to choose more than one option but 50% targeted high yield with lower quality, 25% wanted to balance yield and quality, and the other 25% chose chopper availability, with one of the other options.

Generally, the small grain forage going into the silo (pre-fermentation) was similar to medium- to high-quality hay with an average of 56.5% TDN and 10% CP (Table 1). However, following fermentation, energy (TDN) averaged 51.9% TDN, a 4.6% energy loss. This suggests there are opportunities to improve management and capture more feeding value.

At harvest, 47% (n = 9 / 19) of the samples were within the target DM range (30 to 35%), 42% (n = 8 / 19) were too wet, and the other 11 % (n = 2 / 19) were too dry. The majority (84%; n = 16 / 19) of the survey responses stated that the producers wilted the crop. Of those who wilted, 44% of the samples (n = 7/ 16) were still too wet suggesting a wilting period that was too short. It has been shown that earlier maturity stages have more moisture standing in the field than later maturity stages (*2023 Nebraska Beef Report*, pp. 34–36). Of those that wilted boot, heading or pollination, wilting for 16 to 24 hours appeared to achieve targeted DM content. For milk or soft dough, 0 to 2 hours seemed to commonly result in achieving the target DM.

Of those that responded to the surveys, the majority, 61% (n = 11 / 18), did not measure DM to determine when to pack the silage. The methods used by those that did measure dry matter (39%; n = 7 / 18), included sending a sample to a lab (43%; n = 3 / 7), using the Koster tester (29%; n = 2 / 7), the squeeze test (14 %; n =1 / 7), or a microwave test (14%; n =1 / 7). However, of those who measured their small cereal dry matter, 57% (n = 3 / 7) were within target

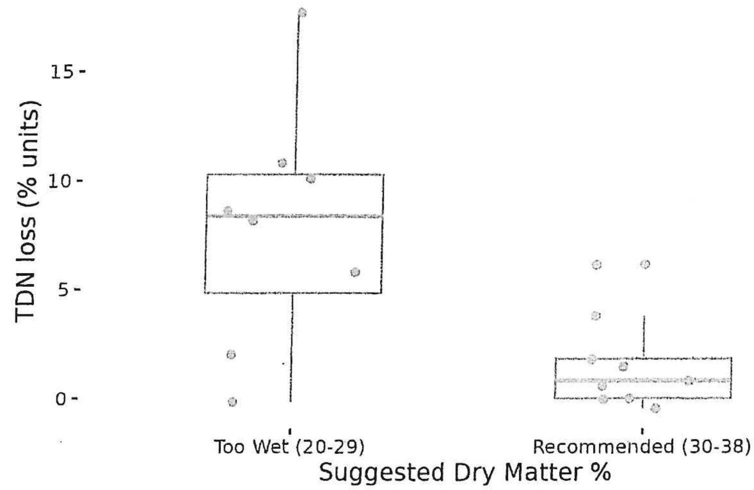

Fig. 2. The effect of dry matter content of small cereal grains at packing on energy loss during fermentation. Producers within the recommended dry matter content (right side) had significantly ($P = 0.02$) less total digestible nutrient loss (3 % units) than those which packed the silage when it was too wet (8 % units). The middle perpendicular line in the box is the median value with 50% of the samples falling above and 50% falling below this line. The box contains 50% of the samples. Single dots outside of the box would be considered an outliner (unusually large or small value) for the sample type.

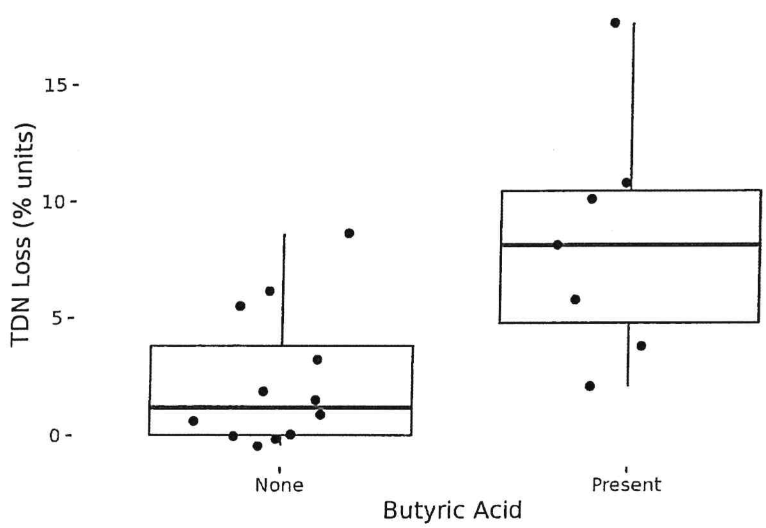

Fig. 3. The presence of butyric acid and its effect on energy loss. The average TDN loss for the small cereal silage with no butyric acid present was less ($P = 0.02$) than silage with the presence of butyric acid (2.3 vs. 8.3 % units of TDN)

DM range compared to 45% (n = 5 / 11) for those who did not.

Producers used three different silo types: bag, bunker, or ground pile (Table 2). The most common silo type used was a ground pile (45%) and 75% of these piles were covered with plastic. Bunker was the second most common (35%) silo type used and only 33% of these silos were covered.

The goal of silage production is to get rid of oxygen as quickly as possible to allow fermentation (acid production) to begin as soon as possible. Packing the silage can reduce the amount of oxygen present. The recommended packing density to best preserve the feeding value of the forage is 15 lb DM/ft^3. Overall, packing density appeared to be a major challenge as the average density achieved was one-third of the recommended at only 5 lb DM/ft^3. Small cereal silage can be harder to pack due to the hollow stems; therefore more pack tractor weight relative to the rate of incoming forage is likely needed and/or thinner layers should be packed.

The goal of fermentation is to drop the pH of the silage as quickly as possible to preserve as much of the nutritive value as possible. Post-fermentation samples with a greater percent of the lactic acid present had less ($P < 0.01$) TDN loss during fermentation (Figure 1). Due to the strong acidity of lactic acid, it would be expected that samples with more lactic acid present had a more rapid decline in pH, resulting in the forage being preserved more quickly.

Those who packed their silage too wet lost more ($P = 0.02$) energy (8 TDN units) than those who were within the target dry matter (2 TDN units; Figure 1). However, there was a wide range in loss (0 to 18% units of TDN) for those who packed their silage too wet. The low loss in this situation was created by the producers starting to feed right after packing and feeding the forage out very quickly (less than a month from packing to full utilization). The range in TDN loss for samples within target DM was much lower at 0 to 6 units of TDN.

Typically, when moisture content of silage is too high there is a risk of clostridial fermentation and production of butyric acid. The TDN loss for the samples that did not have butyric acid production (2 % units) was less ($P = 0.02$) than those that had butyric acid present (8 % units). Out of those samples that were too wet, 63% (n = 5 / 8) had butyric acid present compared to 11% (n = 1 / 9) of samples in the target DM. Overall, these data suggest the consequence of packing small grain silages when they are too wet is a tripling of the loss of estimated TDN during fermentation.

On average, 57% of the silage samples had an inoculant added, with almost all (87%) those that stored silage in a pile inoculating the silage and the minority of those that bagged the silage inoculating (Table 2). When all the silage samples were separated based on DM content at packing and then separated based on whether samples were inoculated, there were too few samples to conduct a statistical analysis. However, it is interesting to note that for silage packed too wet, the energy loss during fermentation when an inoculant was used was 5.9 TDN units (n = 5) and when an inoculant was not used the energy loss was 11.2 TDN units (n = 3). However, for samples within target DM range, samples in which an inoculate was used had an energy loss of 2.3 TDN units (n = 5) vs. 1.1 TDN units (n = 3) when an inoculant was not used. An accurate conclusion with the inoculants cannot be made due to the small sample size, further research in this area will need to take place.

Conclusion

Packing density and moisture management appear to be a challenge for producers making small cereal silages. When comparing the total digestible nutrient (TDN) content of the small cereal forage at harvest to the post-fermentation sample there appeared to be an increase in the amount of TDN lost during fermentation for the samples that were too wet when packed. Many producers did not appear to wilt the small cereals long enough to reach the target dry matter of 30 to 35%, resulting in increased incidences of clostridial fermentation and large losses in the energy content of the silage.

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