Industry Presentation

Silage Density - Survey Shows More Packing of Bunkers and Piles Is Needed

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Introduction

Minimizing shrink on forages is a key factor to improving profitability and forage quality on our dairies. Getting adequate pack or density on forage piles and bunkers is a key to reducing shrink. Ruppel et al. (1992; Table 1) showed that corn silage dry matter (**DM**) loss in bunker silos after 180 days of storage was reduced from 20.2 to 10 % as density was increased from 10 to 22 lb DM/ft^3. We have seen increases in the delivery rate of corn silage to bunkers and, in particular, to piles in recent years as the sizes of the dairies have increased. What is not certain is if enough packing tractors are being used to get the desired minimum pack density of 15 lb DM/ft^3.

Conducting the Survey

Packing densities of bunkers and piles were collected on 40 dairies in three states (MN, WI, and IA; Table 2) from May to August, 2005. We used a 2 in. diameter by 24 in. long stainless steel core sampler powered by either a gas-powered drill or by an 18 volt ½-inch drill. We sampled across the face of the bunker or pile 3 ft above the floor, 2 ft below the top edge, and in the middle of these two levels. At each level we sampled approximately 4 to 6 ft from the edges of the bunker walls. Samples for the edges of the piles were taken at distances approximating 20 to 25 % of the total width of the piles. A center sample was taken between the two side samples in both bunkers and piles. An example of sample locations for a pile measuring 160 ft wide starting at the left side of the pile would be 40 ft (left side), 80 ft (center) and 120 ft (right side). A total of 334 core samples were taken to determine density (Table 3). We combined the samples from each layer and determined DM content.

Table 1. Corn Silage Dry Matter Loss in Bunker Silos[1]

Silage Density (lbs DM/ft^3)	DM Loss at 180 days, (%)
10	20.2
14	16.8
15	15.9
16	15.1
18	13.4
22	10.0

Source: Ruppel et al., 1992

Table 2. Number of farms.

	IA	MN	WI
Bunkers	10	6	11
Piles	1	7	5

Table 3. Schematic of corn silage density in bunkers and piles.

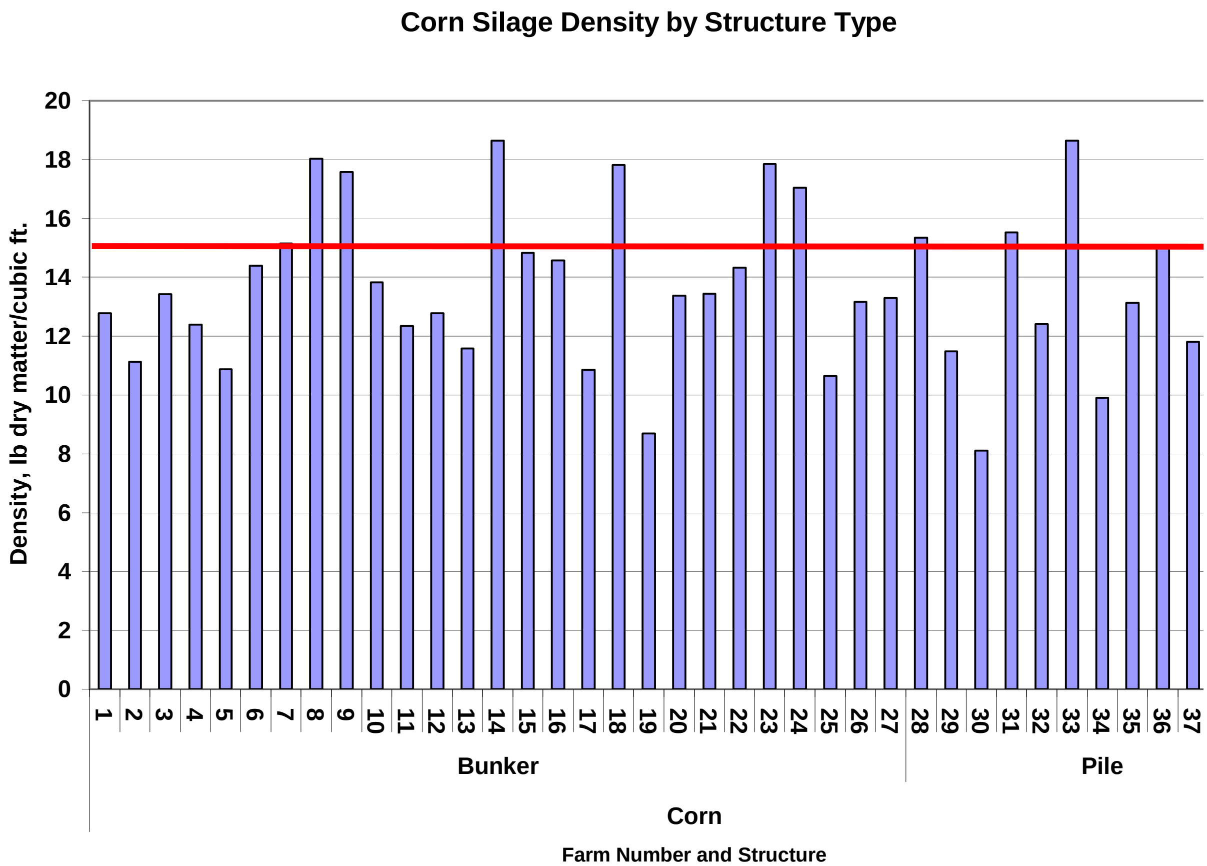
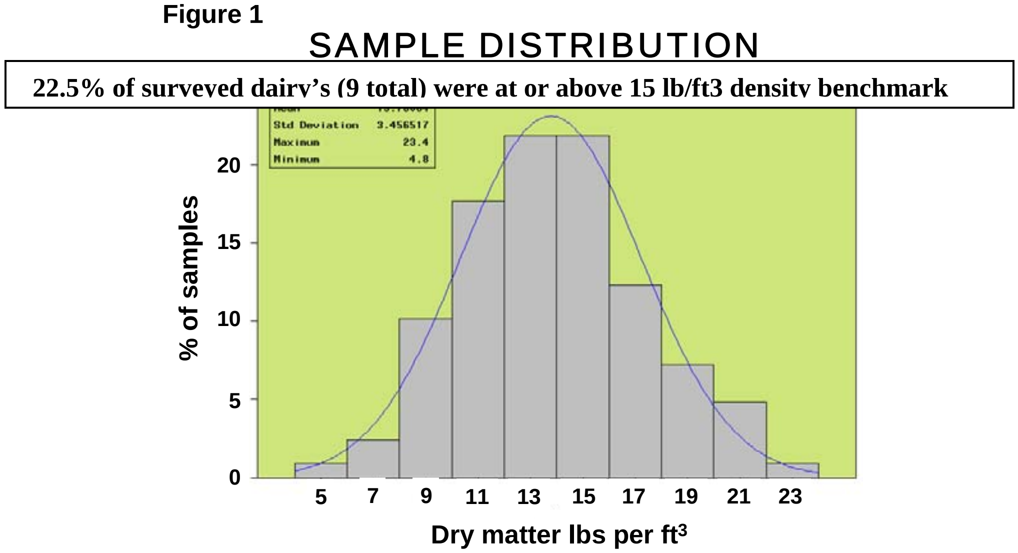


Figure 1



Results of the Survey

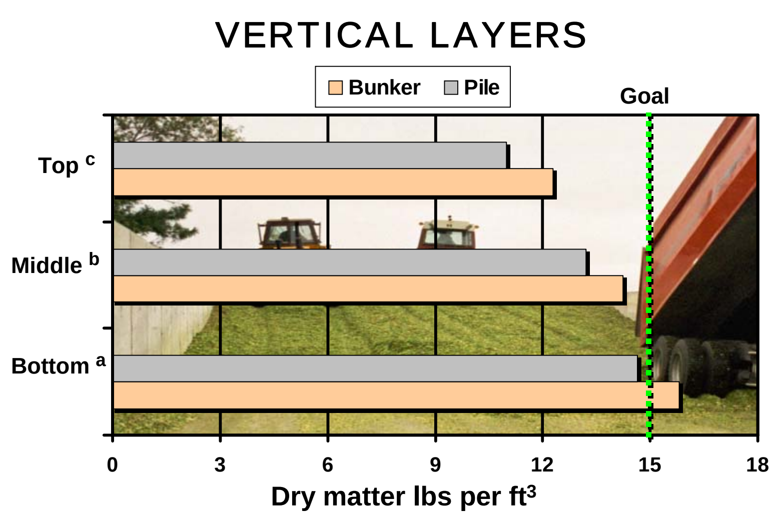
Data were analyzed using PROC MIXED of SAS software. The effects of storage structure (bunker vs. pile), vertical layer (top, middle, and bottom), horizontal layer (left, center, and right), and all interactions on packing density were determined. There were no interactions among storage structure, vertical, and horizontal layers; therefore, only main effects are presented.

Regardless of storage structure, average density achieved was 13.8 lb DM/ft^3. Average packing density for bunkers was numerically ($P = 0.17$) greater than that of piles (14.1 vs. 13.0 lb DM/ft^3, SEM = 0.58). One possible explanation might be that piles often have a higher delivery rate simply due to the ease of dumping trucks from any side of the pile. Significant differences were observed for both vertical (Figure 2) and horizontal (Figure 3) layers. Packing density decreased ($P < 0.05$) from 15.2 lb DM/ft^3 in the bottom layer to 13.7 and 11.7 lb DM/ft^3 (SEM = 0.44) in the middle and top layers, respectively, for both bunkers and piles. This clearly indicates the importance of packing silage into 6-inch layers to maintain optimal density as the pile grows in size. In addition, the reduced density in the top layer promotes surface spoilage. Packing densities observed in the centers were greater ($P < 0.05$) relative to the left and right sides (14.3 vs. 13.3 and 13.0 lb DM/ft^3; SEM = 0.44). Two factors are likely responsible for this effect: 1) safety and 2) operators are preventing damage to the bunker sidewalls or the plastic lining the sidewalls.

Key Points of DM Loss

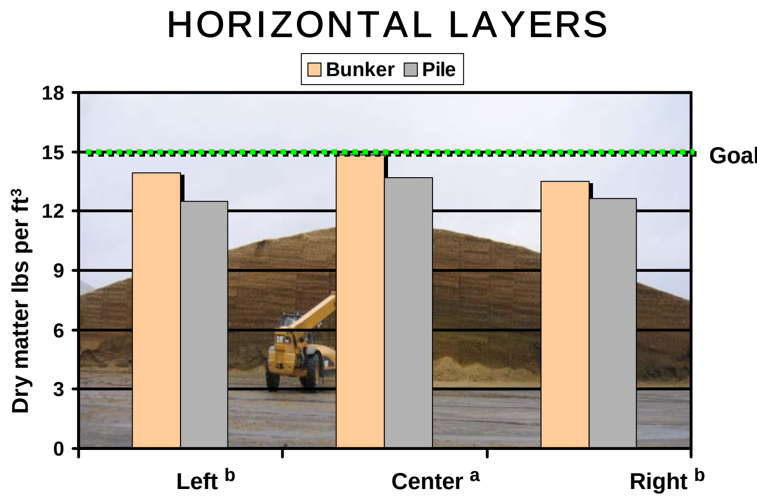
When storing corn for silage; oxygen and the bacteria that utilize it are the mortal enemy. These bacteria are the enemy to silage because in the process of utilizing the trapped oxygen in the bunker or pile, they *burn* energy (DM) to grow and multiply,

Figure 2



abc Layers not bearing common superscripts differ ($P < 0.05$). Structure $P = 0.17$

Figure 3



ab Layers not bearing common superscripts differ ($P < 0.05$). Structure $P = 0.17$

thus reducing overall silage yield. There are two key points where this *shrink* loss occurs, at storage and feedout. With the cost of producing and harvesting corn silage, the loss of DM can have a significant economic impact and should be minimized; if possible, primarily through good storage and feedout management practices. Here's a closer look at the primary points of DM loss.

Dry Matter Loss #1.

Silage shrink at the bunker during storage and ensiling. Dry matter lost through this process can be significantly reduced by forcing as much oxygen out of the pile before the bacteria can utilize it. This is done through good packing practices as the silage is delivered to the storage structure and by increasing the overall compaction density. A good rule of thumb

Table 4. Percent feeding loss by silage storage system.

Storage System	Feeding Loss (DM %)
Bunker/Silage Bag (less than 5"/day)	11
Bunker/Silage Bag (more than 5"/day)	5
Tower Silo (Haylage)	11
Tower Silo (Corn Silage, whole plant)	4

Source: Penn State University[2], 1993.

Table 5. Example analysis of the cost of shrink between average and *best case* from density survey.

Location of DM Loss	Current Practice	Best Case from Survey[1]	Difference	$ Value lost per ton[2] (@$20/ton)
Bunker shrink	18.5% (@12 lb. DM/ft3)	12.3% (@19.25 lb. DM/ft3)	6.2%	$1.24
Feedout Shrink	6.5%	5%	1.5%	$0.30
Total Shrink	25%	17.3%	7.7%	$1.54
Lbs. lost in 25 tons of silage per acre	12,500 lbs. (6.25 tons)	8,650 lbs. (4.33 tons)	3,850 lbs. (1.93 tons)	
Value of DM lost per acre @ $20/ton	$125.00	$86.60	**$38.60**	

Source: Oelberg, Harms, Ohman, Hinen, and Defrain, 2005.
[1] Survey packing densities on 40 dairies in Iowa, Minnesota, and Wisconsin during May to August, 2005.
[2] DM loss would be significantly higher than $20 per ton because the loss comes primarily from soluble starch and protein rather than from fiber.

is to pack to a density of 15 lb DM/ft^3 or greater to minimize DM loss. Table 1 shows various silage packing densities and the typical DM loss associated with them.

Dry Matter Loss #2.

Silage shrink at the bunker during feedout. Dry matter losses also occur during feedout with any silage storage system. Maintaining anaerobic conditions within the storage structure are critical for long-term stable silage storage. Once the structure is opened and silage re-exposed to oxygen, DM losses will begin to occur more rapidly. A smooth, firm silage face and feedout at an appropriate rate is key to reducing this form of DM loss. Table 4 indicates the average percent feeding loss for silages stored in specific structures.

Economic Impact Analysis

It is important to note that just 22.5 % of the surveyed dairy's (9 total) averaged at or above 15 lb DM/ft^3 benchmark for adequate density. Utilizing the density data from the 334 individual samples collected through this survey, it is possible to construct an example of an average producer and the predicted DM loss associated with his/her current storage and feedout practices, compared to the *best case* producer, as sampled during this project, with an average bunker density of 19.25 lb DM/ft^3. Here is an example of the economics associated with this comparison.

Example: An average producer harvests and stores corn silage in a bunker silo and is able to get it packed to a density of 12 lb of DM/ft^3. His feedout practices are good; however some excess silage that does

Table 6. The "Big 4" Factors for Quality Silage	
1. Harvest at proper moisture content • Bunker – 65-70 % moisture • Bag – 60-70 % moisture **2. Harvest crop with proper length of cut** • Processed TLC – 1/2-3/4 inches • Unprocessed TLC – 3/8-3/4 inches **3. Calculate the proper size silage pile for your operation** • Need to feed at least 6-12" off the whole face every day. • Make the sides no more than 15 to 30 degrees in slope to maintain safety and obtain proper pack.	**4. Rapid filling and air-tight storage as quickly as possible** • Remove oxygen quickly to prevent nutrient loss. • Proper packing with enough weight (t of corn silage/hour x 800 = total lb. of tractors) • Maintain no more than a 4" to 6"/layer of silage at packing. • Maintain a wedge shaped packing face as the bunker or pile is being filled • Pack, pack, pack, then pack some more. • Bunker density minimum of 15 lb./ft^3 DM. • Cover with plastic as soon as the last load of silage is packed and weigh plastic down with wall-to-wall tires or half tires.

not get fed each day is apparent and the face management at the bunker could be improved. His average yield for corn silage is about 25 t/acre and the current price for corn silage out of the field in his area is $20/t. Table 5 is a comparison of this producer's predicted DM loss to the real life *best case* and the associated economic impact. At an assumed yield of 25 t of silage/acre at a cost of $20/t harvested, the difference in corn silage value lost through this producer's current silage management practices compared to that of a *best case* producer from the survey is $38.60/acre. In more telling terms, if this producer harvests 500 acres of corn silage/year, this would equate to a loss of $19,300/year, or the cost of 772 t of silage.

The quickest and easiest way to reduce this producer's lost value is to improve his packing and storage practices. As a point for thought, by using the $19,300 in lost DM value in the example above and a tractor rental rate of $0.22/horsepower hour (ie. 100 hp tractor costs $22/hour), this producer could afford to rent two, 200 hp tractors for additional packing and afford to operate them for 219 h to improve packing density and reduce lost value.

The value loss in this example is only that realized by direct reduction in loss of silage DM. What is not captured here is any additional dollar's lost through feed spoilage organisms and their subsequent effect on reduced DM intake by the animal and the related loss in milk production, which can be significant. Additional points of potential DM loss such as covering practices and feed refusal/discard have also not been considered here.

Conclusions

Minimizing shrink on forages is a key factor to improving profitability and forage quality on dairies. Getting adequate packing density on forage piles and bunkers is imperative to reducing shrink and increasing economic return on overall feed cost. The results of the silage density data obtained during this survey clearly shows that more care needs to be paid to proper packing and feedout practices at many dairies today. To minimize shrink and maximize forage quality, follow the **Big 4** recommendations of silage storage management (Table 6).

Literature Cited

Penn State University. 1993. "Harvesting and Utilizing Forage", Circular 396. State College, PA.

Ruppel, K.A. 1992. Effect of bunker silo management on hay crop nutrient management. M.S. Thesis, Cornell University, Ithaca, NY.