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Tech Topic

Better silage packing density

By Kevin T. Leahy, Ph.D., PAS
Dairy Technical Service Specialist
Diamond V

In the August 2014 *DairyAdvisor* my colleague, Dr. Bill Stone, discussed *Silage: Keys to reducing surface spoilage*. I'd like to follow up and focus on silage packing density. Like controlling surface spoilage, improving packing density can help preserve silage quality.

Each forage harvest season, during harvest and delivery to the bunker or drive-over pile, I'm asked to evaluate how well the forage is being packed. The question is an important one, whether it refers to corn silage, wheatlage, alfalfa haylage, or sorghum silage. Good packing density helps achieve and maintain an anaerobic (oxygen-free) environment in the silage bunker or pile, which is critical in order to properly preserve the silage and minimize fermentation loss of dry matter and other nutrients. Research and experience suggests many producers can improve.

One of the earlier, often-cited studies by Ruppel (1992), showed that alfalfa silage dry matter loss decreased as silage density increased (Table 1).

Table 1

Relationship of density to alfalfa silage dry matter loss	
Density (DM lb/ft^3)	**DM Loss, 180 days (%)**
10	20.2
14	16.8
15	15.9
16	15.1
18	13.4
22	10.0

Muck and Holmes (2000) suggested that dry matter density should be 15 lb/ft^3 (pounds per cubic foot) or greater in order to minimize dry matter losses. Yet several surveys have revealed lower average densities on most farms, including Muck and Holmes (2000), Craig and Roth (2005), Visser (2005), and Oelberg et al. (2006), as shown in a compilation of survey results (Table 2).

Table 2

Silage density survey data – 2000 to 2006 (lb/ft^3)					
Type of Storage	**Forage Type**	**Samples**	**Average**	**Range**	**Reference**
Bunker	Haylage	87	14.8	6.6 - 27.1	Muck and Holmes (2000)
Bunker	Corn Silage	81	14.5	7.8 - 23.6	Muck and Holmes (2000)
Bunker	Haylage	31	15.9	9.9 - 27.2	Visser (2005)
Pile	Haylage	14	13.7	8.2 - 22. 9	Visser (2005)
Bunker	Corn Silage (2004)	22	12.7 (est.)	8.3 - 16.4	Craig and Roth (2005)
Bunker	Corn Silage (2005)	21	13. 6 (est.)	11.1 - 16.8	Craig and Roth (2005)
Bunker	Corn Silage	27	14.1	8.3 - 18.8	Oelberg et al. (2006)
Pile	Corn Silage	13	13.0	8.1 - 18.9	Oelberg et al. (2006)

Only one time, for a bunker haylage, was the surveyed average density greater than 15 lb/ft^3. In addition, two of the surveys noted that silage densities tended to decrease, measured moving from the bottom to the top of either the bunker or the pile (Craig and Roth, 2005; Oelberg et al., 2006).

The results of these surveys suggest that many dairies still have the opportunity to mitigate silage fermentation losses by improving the density at which silages are packed during ensiling.

Why is it so difficult to improve silage dry matter densities? There are several factors that can affect packing density, including:

- Forage dry matter at harvest;
- Length of cut of the forage;
- Delivery rate of the forage to the bunker or pile;
- Tractor packing time and/or number of tractors;
- Packing layer thickness; and
- Height at which the silage is packed.

Attempting to measure dry matter "on the fly" with all of these factors in play can be difficult, if not impossible.

Rather than trying to measure dry matter density while packing silage at the bunker or the pile, Muck (2010) suggested that it is more practical to measure bulk density – the wet or "as-delivered" density – by measuring the weight of the forage put into the silage structure divided by the volume filled. Muck (2010) also suggested that the minimum bulk density target should be 44 lb/ft^3.

Silva-del-Rio and Heiman (2011) conducted a survey of wheat and corn silage structures in California, measuring bulk (or wet, as-delivered) densities at 2 locations (left and right) 6 ft. from the top of the silage structure and 3 locations (left, center, right) 6 ft. from the bottom of the silage structure. Their results showed the percentage of bulk density samples below 44 lb/ft^3 for each of the sample locations in 25 corn silage structures (Figure 1).

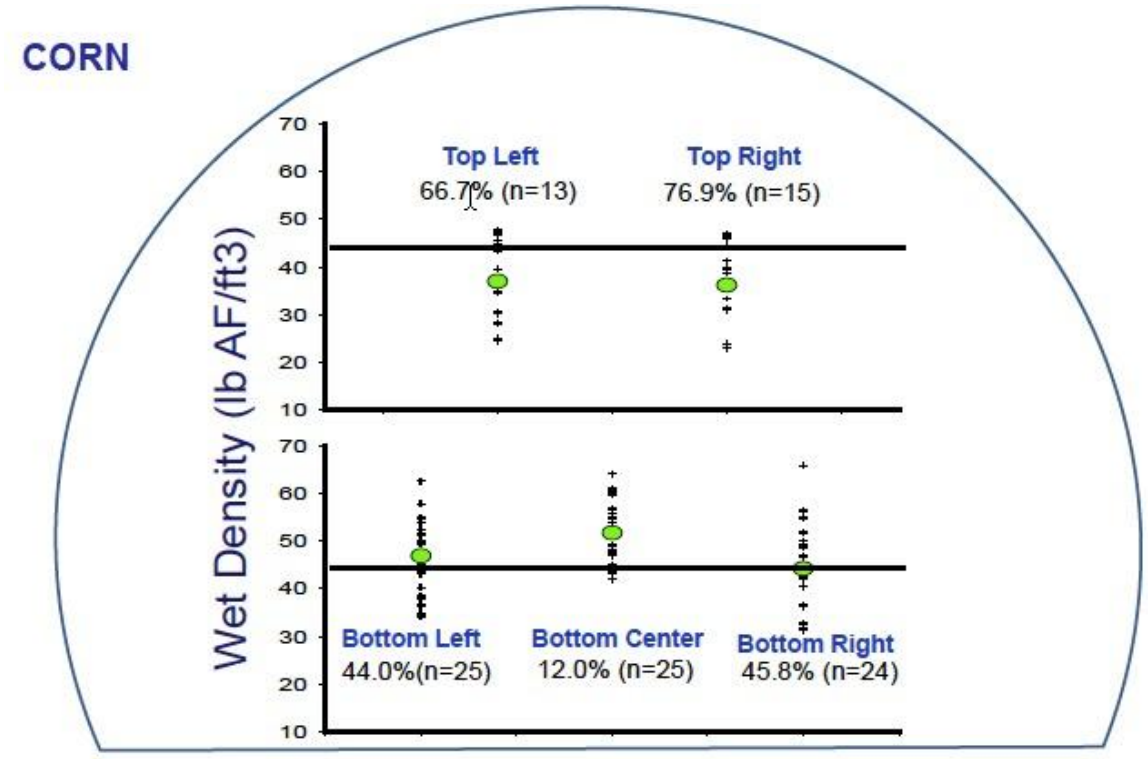

Figure 1. Percentage of wet density samples below 44 lb/ft^3 for each sample location in 25 corn silage structures in California (Silva-del-Rio and Heiman, 2011)

Most of the surveyed corn silage structures (88.0%) had at least one sample below 44 lb/ft^3 and a majority (60.0%) were below 35 lb/ft^3. Not surprisingly, the authors of this study concluded that there were "opportunities to improve silage packing density in California dairies."

This information indicates the importance of measuring silage densities at similar locations if you are going to be making comparisons across bunkers or piles. Here, it is important to stress again safety around silage faces. Any of us who have been in the

dairy industry for any length of time know of serious accidents that have occurred at silage bunkers and piles.

Fortunately, it is possible to get close estimates of existing silage bulk density without using a probe on the silage structure. The dairy's feed management software can provide the amount of as-fed feed fed over a given period of time. With accurate dry matter values for each of the forages, the amount of dry matter fed can be determined. Taking this value and dividing it by the volume (ft^3) of that forage fed during the same time period gives a reasonable calculation of the density for that entire section of the bunker or pile.

Going forward, what can we do to improve silage bulk density? The University of Wisconsin – Team Forage website (http://fyi.uwex.edu/forage/h-s/) offers several Excel calculators that are helpful. There are two separate calculators for calculating both bulk and dry matter densities, the Silage Pile Density Calculator and the Bunker Silo Density Calculator.

In addition, Team Forage offers a spreadsheet that estimates the length of floor needed to achieve a desired forage filling layer thickness (6 inches or less) prior to packing the forage in a bunker or pile. I find this last spreadsheet to be particularly helpful, in that it allows us to make some practical calculations and adjustments in order to get the targeted packing density.

Silva-del-Rio and Heguy (2013) also suggest the following to improve silage bulk density:

1. Adjust the forage delivery rate by having the appropriate number and size of choppers to match the machines doing the packing. Also, ensure that the trucks deliver forage at a constant rate to avoid amounts of forage arriving that overwhelm the packing tractor(s);
2. Consider adding another tractor if there is enough space at the packing area; and
3. Improve packing tractor efficiency by checking that the packing tractors are constantly driving on the pile rather than merely pushing feed and waiting for the next load to arrive. Also, ensure that drivers compact the entire surface, paying special attention to the upper half of the pile where densities tend to be less than optimal.

Take the time prior to forage harvest this year to check out some of the tools mentioned above. Also, do some planning with your dairy team or custom harvester to prepare for harvesting and packing forage to maximize silage density.

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