Abstract #: W114

Relating Dry Matter Density to Dry Matter Loss within Corn Silage Bunker Silos

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ABSTRACT

The objective was to refine the relationship between dry matter (DM) density and DM loss within corn silage bunker silos. Poly-weave nylon bags (36 per silo) containing chopped brown mid-rib (BMR) corn were buried in three bunker silos during filling on the same farm. Bags were blocked by depth from the end of the bunk, 10.6 m (Front), 27.8 m (Center), and 44.9 m (Back), level from the silo floor, 0.6 m (Bottom), 1.5 m (Middle), and 2.15 m (Top), and within level, location from the east wall, 0.9 m (I), 4.7 m (II), 8.4 m (III), and 12.2 m (IV). Upon feed-out, all bags at a specific depth were retrieved and silage cores for DM density were obtained at each bag position. Cores were collected using a 5.08 cm diameter stainless-steel coring tube driven by a gas-powered drill. Corn and silage DM was determined using a Koster moisture tester. Data were analyzed using PROC MIXED and RSREG within SAS. The model included the fixed effects of depth, level, location, all interactions, and the random effect of bunk. Significance was set at *P*<0.05, and trends at 0.05<*P*<0.10. There were no significant interactions. Density was affected (*P*<0.0001) by depth, level, and location. Density was 201, 253, and 255 kg DM/m3 for the front, center, and back, respectively. Density was 284, 268, and 224 kg DM/m³ for the bottom, middle and top, respectively. Density was 219 and 211 kg DM/m³ for I & IV compared to 260 and 254 kg DM/m³ for II & III, respectively. DM loss % was affected (*P*<0.001) by depth and level but not location. Loss was 9.2, 6.5, and 7.3 % for the front, center, and back, and 6.5, 5.0 and 8.4 % for the bottom, middle and top, respectively. There was a linear inverse relationship (R^2 = 0.18) between loss and density. Response surface regression of DM density and DM% versus DM loss also showed an inverse relationship (R^2 = 0.28). These results suggest a large degree of variation in DM loss is not associated with the DM density and DM% of the corn silage within a bunker silo.

INTRODUCTION

- **Corn silage is the most commonly fed ensiled forage for dairy cattle in the northeastern U.S.**
- **Ensiling results in a loss of dry matter (DM), often termed "shrink", that can range from < 1 to > 3.3% per month of storage (Holmes, 2006) and represents an economic loss to the dairy producer, but there is no simple on-farm method to assess DM loss.**
- **The DM density of silage is inversely related to DM loss, and the work of Ruppel et al. (1995) has been used extensively to describe this relationship. However, this work was performed in hay crop silage bunkers, and the packing characteristics of hay crop silage are quite different from corn silage.**
- **Therefore, the objective of this study was to refine the relationship between DM density and DM loss within corn silage bunker silos and determine if DM density could be used to accurately assess DM loss in corn silage.**

MATERIALS AND METHODS

- **Porous, poly-weave nylon bags (N=36) containing chopped brown midrib (BMR) corn were weighed and buried in each of two 55.5 m x 13.1 m x 2.4 m bunker silos during filling. A third silo had four bags buried in the dome of the silage in addition to the initial 36 bags (N=40). Chopped corn forage subsamples were collected in plastic storage bags, sealed, and place on ice until analyzed for DM content.**
- **Bags were blocked by depth from the end of the bunk, 10.6 m (Front), 27.8 m (Center), and 44.9 m (Back), level from the silo floor, 60 cm (Bottom), 150 cm (Middle), and 215 cm (Top), and within level, location from the east wall, 0.9 m (I), 4.7 m (II), 8.4 m (III), and 12.2 m (IV). Bags in the 3rd silo Dome were placed at the Center and Back depths in locations II and III at 300 cm above the silo floor.**
- **All silos were packed using a tractor and a loader with a combined weight of 60,327 kg. Average delivery rate of chopped corn during filling was 163 tonnes per hr. All bunks were sealed with 1 layer of 6 mil polyethylene plastic on the sidewalls and 2 layers on the top with tires covering the entire surface.**
- **Upon feed-out, bags at a specific depth were retrieved as a group (n = 12), weighed and subsamples were placed in plastic storage bags, sealed and placed on ice until analyzed for DM content.**
- **Silage cores for DM density determination were obtained at each bag position using a Stihl gas-powered drill and a 5.08 cm ID stainless steel probe. Cores were collected into plastic storage bags, sealed, weighed, and placed on ice until analyzed. Core depth was measured to the closest 0.64 cm and recorded.**
- **Dry matter content of chopped corn and corn silage samples was determined using a Koster Moisture Tester (Koster Crop Tester, Inc., Brunswick, OH). All samples were run in duplicate. Core DM density was determined by dividing the total core dry weight by the core volume, and reported as kg DM/m³.**
- **Dry matter loss within each bag was determined as the difference in DM weight of the bagged chopped corn prior to burying and the bag of corn silage upon retrieval.**
- **Data were analyzed using PROC MIXED and RSREG within PC SAS v9.1 (SAS Inst. Inc., Cary, NC).. The model included the fixed effects of depth, level, location, all interactions, and the random effect of bunk. Significance was set at *P*<0.05, and trends at 0.05<*P*<0.10.**

RESULTS

Figure 1. Relative positions of chopped corn filled bags at burial in bunker silos

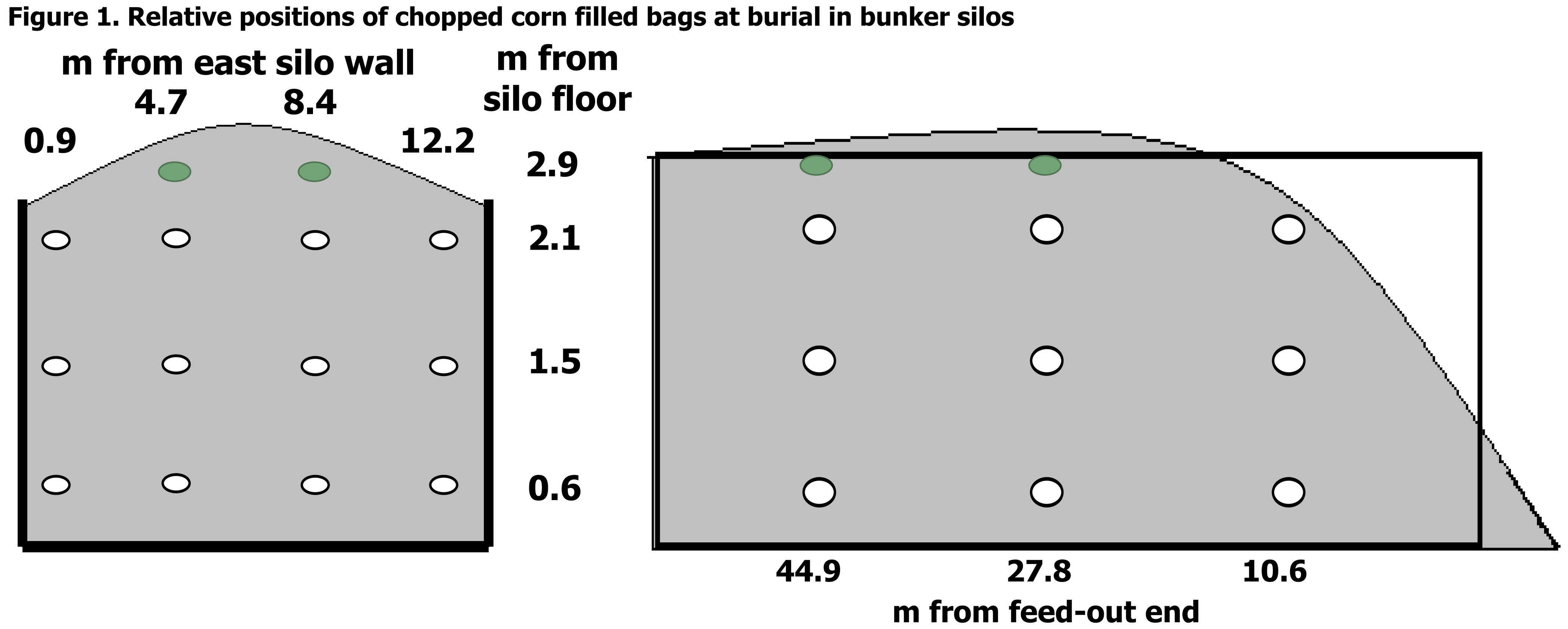


Figure 2. Chopped corn filled bag during placement for burial.

Figure 3. Regression DM loss versus DM density of corn silage within bunker silos.

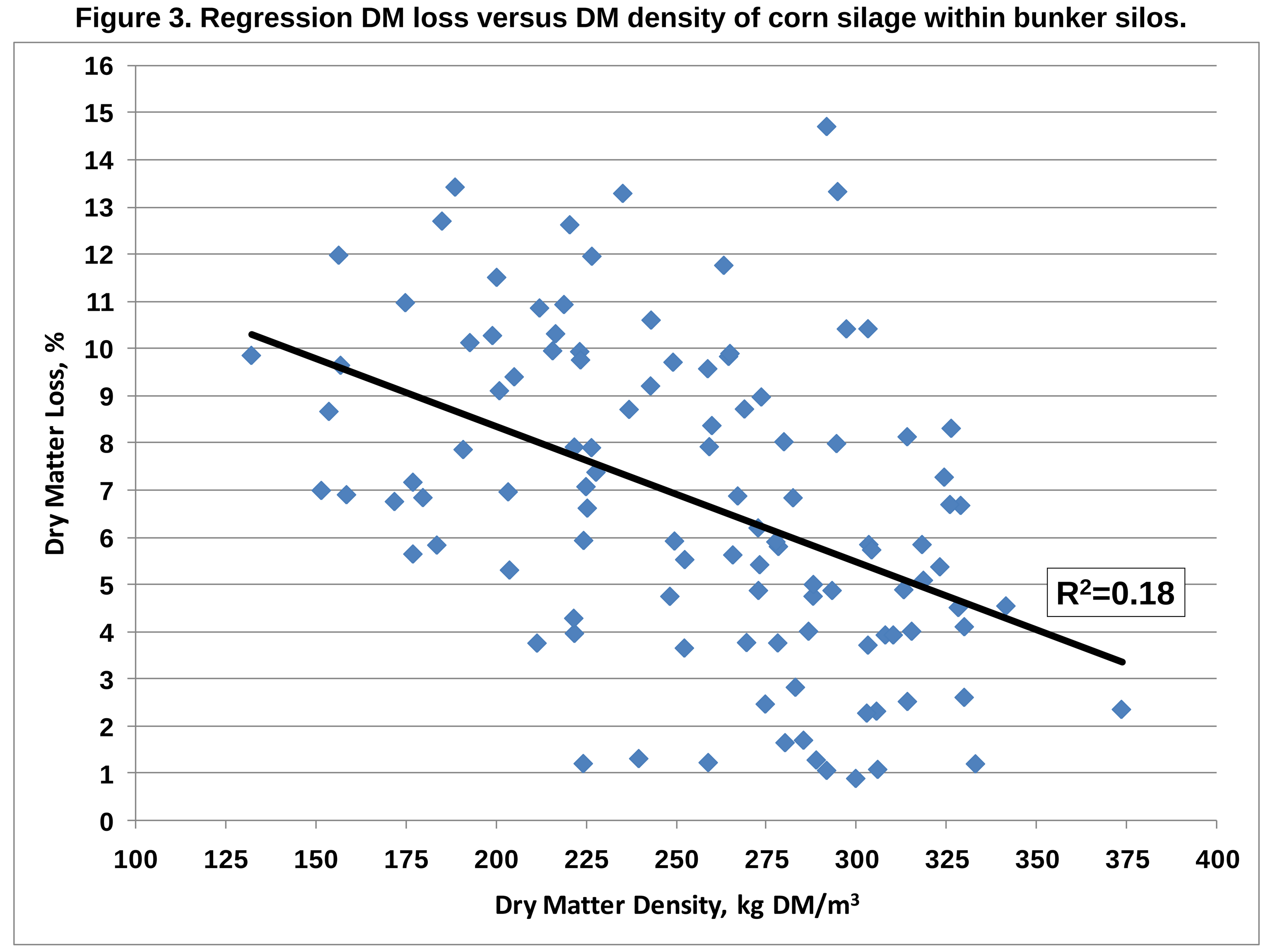
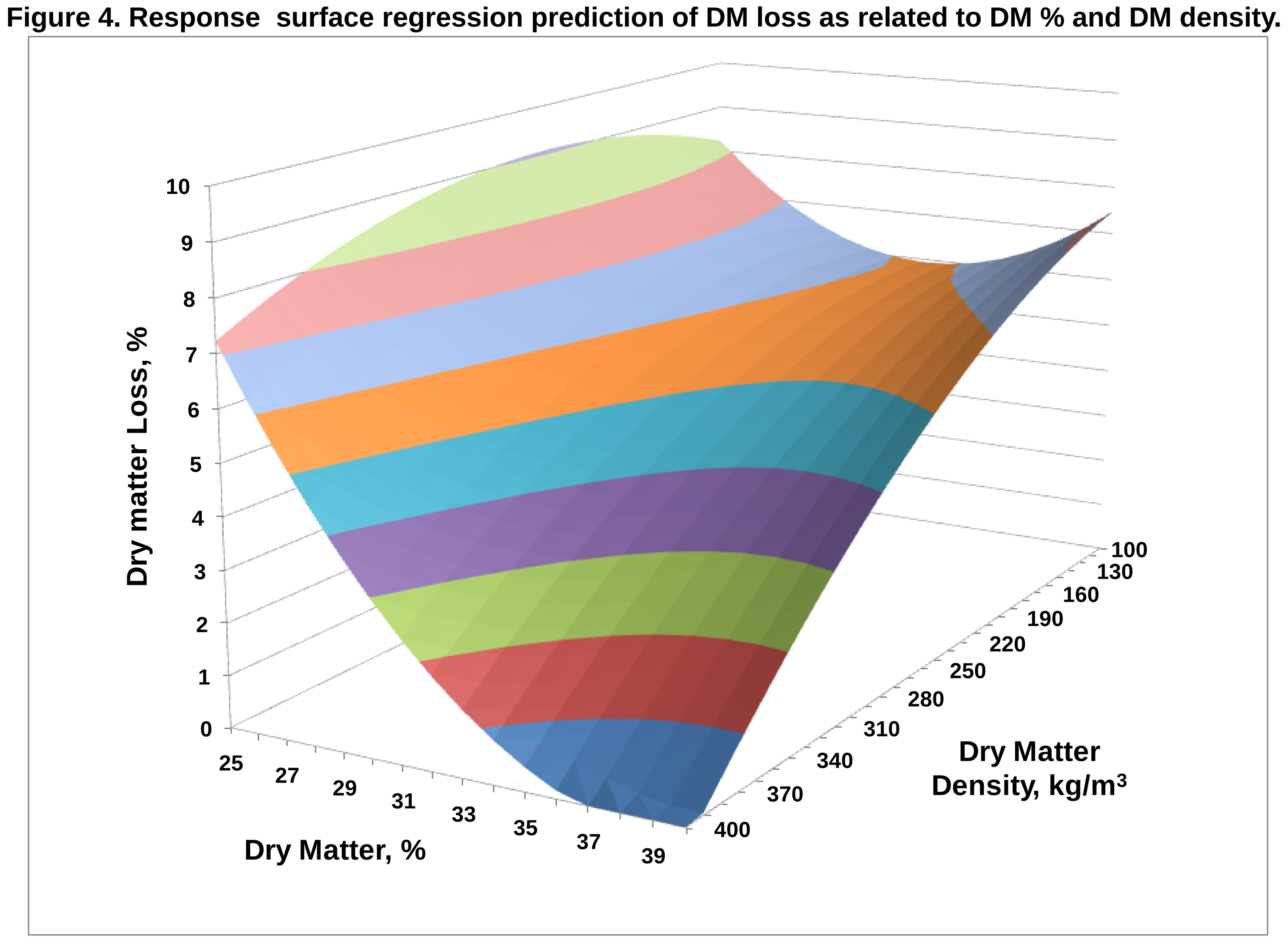


Figure 4. Response surface regression prediction of DM loss as related to DM % and DM density.



Tables 1, 2, & 3. Effects of depth, level and location within bunker silo on DM density, DM %, and DM loss.

	Depth in Bunk				
Parameter	**Front**	**Center**	**Back**	**SE**	**P-value**
Density, kg DM/m³	201^{a}	255^{b}	253^{b}	5.3	< 0.0001
DM, %	30.0^{a}	31.3^{b}	32.3^{c}	0.26	< 0.0001
DM Loss, %	9.2^{b}	6.5^{a}	7.3^{a}	0.55	0.0002

	Level					
Parameter	**Bottom**	**Middle**	**Top**	**Dome**	**SE**	**P-value**
Density, kg DM/m³	284^{d}	268^{c}	224^{b}	169^{a}	6.2	< 0.0001
DM, %	31.4^{b}	31.7^{b}	30.6^{a}	29.4^{a}	0.28	0.007
DM Loss, %	6.5^{d}	5.0^{c}	8.4^{b}	10.9^{a}	0.62	< 0.0001

	Location					
Parameter	**I**	**II**	**III**	**IV**	**SE**	**P-value**
Density, kg DM/m³	219^{a}	260^{b}	254^{b}	211^{a}	5.8	< 0.0001
DM, %	30.3^{a}	31.8^{b}	31.9^{b}	31^{a}	0.30	0.0008
DM Loss, %	8.3	7.6	7.6	7.2	0.61	0.57

[a,b,c] denotes significantly different LS Means within a row (*P*<0.05)

RESULTS & CONCLUSIONS

- **Dry matter density was significantly affected by depth, level and location within the bunk (Tables 1, 2, & 3). Dry matter loss was significantly affected by depth and level, but not location. There were no significant interactions of depth, level, or location on DM density or loss. These results would suggest that sealing the sidewalls with plastic reduced DM losses along the walls where silage is less packed.**
- **There was an inverse relationship between DM density and DM loss (Figure 3), but the relationship was weak (R^2=0.18). The large degree of variation in DM loss within the silos suggests that factors other than density play a role in DM losses.**
- **Response surface regression of DM loss in relation to DM % and DM density (Figure 4) also showed an inverse relationship and the model accounted for a larger proportion of the variation in DM loss (R^2=0.28).**
- **Using the response surface regression prediction, it would appear that silage with higher DM content exhibited a more linear inverse relationship between DM density and DM loss compared to wetter silage.**

REFERENCES

Muck, R. E. and B. J. Holmes. 2000. Factors affecting bunker silo densities. Appl. Engr. In Agric. 16(6):613-619.

Ruppel, K. A., R. E. Pitt, L. E. Chase, and D. M. Galton. 1995. Bunker silo management and its relationship to forage preservation on dairy farms. J. Dairy Sci. 78:141-153.