Management of Bunker Silos

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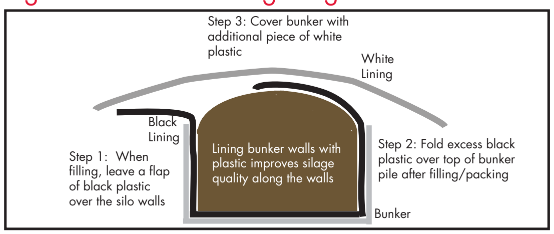
Preparing for Filling

Before starting, silo floors and sides should be repaired if any structural damage has occurred. All old silage should be removed and, ideally, the empty silo left to be further sanitized by rain and sun.

Lining the inside of bunker walls with plastic prior to filling prevents water from seeping in at these edges. The result of this additional effort is that silage quality and dry matter along the wall is the same as that throughout the silo. This procedure can be accomplished by placing a small amount of old silage on the bottom of the plastic at floor level. Stretch the plastic to the top of the wall and then extend it an additional 6 to 8 feet. Sealing is completed after filling by extending the wall plastic back out onto the top of the pile prior to covering with the top plastic (Figure 12). An alternative approach which has been used is to extend the top plastic beyond the edge of the silo and seal at the wall with sand or gravel filled silage bags (or tubes). Tubes should be laid inside, as opposed to on top of, the silo wall to eliminate the risk of damaging the plastic as the silage settles. This approach is not as effective as lining the walls with plastic, since there is still silage deterioration along the wall from oxygen infiltration through and along the edge of the wall. Additionally, water can accumulate in the plastic swale along the wall.

Figure 12: Bunker Lining Diagram



Receiving, Filling and Packing

Forage Dry Matter (DM) should be checked throughout the filling process to ensure feed is being chopped at the appropriate DM. Haylage should be harvested at 35 - 45% DM, while corn silage goals range from 32-38% DM. Collecting samples of silage throughout the day, compositing and then submitting a sub-sample for laboratory analysis removes much of the mystery concerning the contents of the bunker silo.

Dr. Marshall McCullough wrote that silage is a feedstuff resulting from the anaerobic preservation of moist forage by the formation and/or addition of acids. The key words here are anaerobic and acids. Oxygen needs to be forced out from the silage - achieved by correct packing. Silage density is primarily the result of packing intensity, crop DM, and particle length. It is directly related to DM losses from the silo, and to the amount of silage storage space required. The packing density achieved on commercial operations has been shown to vary considerably (Table 7).

Table 7: Summary of Core Samples Collected from 168 Bunker Silos

	HAYLAGE (87 silos)		CORN SILAGE (81 silos)	
	AVE.	RANGE	AVE.	RANGE
DM %	42	24-67	34	25-46
Wet Density (lbs/ft3)	37	13-61	43	23-60
Dry Density (lbs/ft3)	14.8	6.6-27.1	14.5	7.8-23.6
Ave. Particle Size (in)	0.46	0.27-1.23	0.43	0.28-0.68

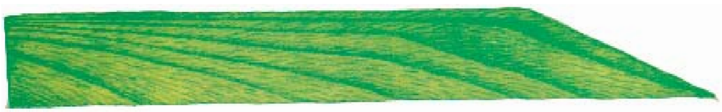
(Holmes & Muck, 1999)

Inadequate packing causes problems both at ensiling and feedout, resulting in increased DM losses and reduced silage quality. At ensiling, plant respiration is extended and increases the growth of undesirable organisms and soluble protein levels while reducing the quantity of sugars available for the desirable acid-producing organisms. Poor packing increases silage porosity, which results in additional spoilage and DM loss at feed-out due to greater oxygen infiltration.

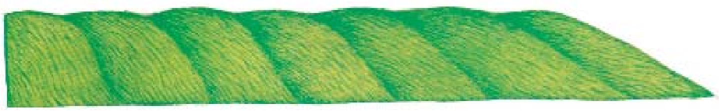
The progressive wedge (Figure 13), with a slope of about 30°, is the recommended approach to filling bunker silos as it minimizes the amount of silage exposed to oxygen if the top surface is covered as filling progresses. Packing vehicle weight and the thickness of the layer of silage being packed are two of the main variables influencing silage density. The estimated amount of packing weight needed can be calculated by multiplying the estimated tons of crop delivered to the silo in an hour by 800 (Table 8).

Better yet, refer to the bunker silo density calculator (www.uwex.edu/ces/crops/uwforage/storage.htm) and estimate what

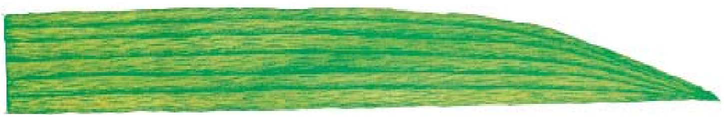
Figure 13: The Progressive Wedge



Progressive Wedge



Height before Length



Length before Height

Source: NCR 574 Corn Silage Production, Management, and Feeding. May 1995.

will need to be done in your silo to achieve your density goals. Remember that average bunker silo densities are around 15 lbs. DM per ft^3, while elite bunker silo managers will have silo densities of around 20 lbs. DM per ft^3. Running these calculations prior to starting the ensiling process allows you to check if you have enough wheel weights, liquid to tires, or front-end or 3-point hitch weights. Will there be room to add more packing tractors? Packing with dual as compared to single-wheeled tractors does not reduce silage densities, provided packing time is sufficient. Keeping the blade width narrower than the axle width allows for proper packing along bunker silo walls.

Table 8: Calculations for Packing Tractor Weight/Filling Rate to Achieve Minimum Target Packing Density (14 lb/cu ft) in Trench and Bunker Silos

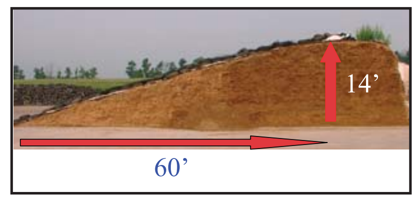
Optimum packing vehicle weight (lbs)	=	filling rate (tons/hr) x 800
Optimum filling rate (tons/hr)	=	vehicle weight (lbs.)/800

MANAGEMENT OF BUNKER SILOS

In many situations, particularly with larger and custom chopping operations, the crop is coming in faster than there physically is room on the silo for the necessary number of tractors. In these situations the "wedge" should be flattened so that it becomes more of a platform increasing the available surface area for packing tractors. The increased surface area also makes it easier to spread thinner layers of silage.

The packing process should be viewed with as much importance as that associated with the chopping process. Packing equipment should be operated continuously throughout the chopping process, with forage distributed in layers ideally no more than 4" and certainly less than 6" thick prior to packing.

Figure 14: The Proper Run/Rise Ratio for a Well-Made Drive-Over Pile



4.25 Run/Rise Fill at ratio >4:1

Figure 15: Drive-Over Piles

Drive-over piles can be used to successfully store silage. Many producers, however, make the sides so steep that they cannot be adequately packed. This results in a tremendous amount of DM loss and silage with reduced quality. Run: rise ratio should not be less than 4:1 (slope < 25% or ~ 22%) along the sides to allow for continued effective and safe packing in all directions throughout silo filling Figures 14 & 15).

All packing tractors should be equipped with operator safety belts and cabs or roll-over protection systems.

Covering

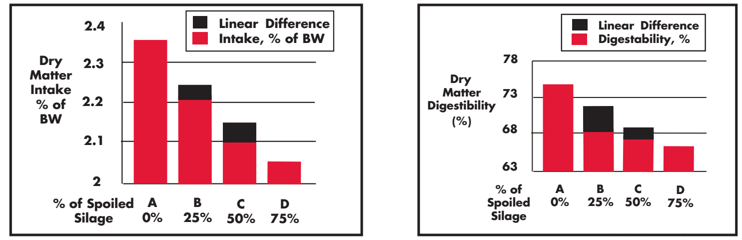
If it starts to rain during silo filling, will you be shut down? How long will it last and how much rain will there be? Since these answers are unknown, the safest and best approach is to perform a quick cover job with plastic and a minimal number of tires (Figure 16) to minimize the spoilage layer that often occurs with these harvest interruptions.

Silo covering is one of the least favorite jobs on the dairy, but also a very profitable one, with improved silage DM recovery and healthier cows likely results of your efforts. Sealing and covering a 40'x100' bunker returns approximately $2,000 and $4,000 in improved silage dry matter recovery when filled with corn or alfalfa silage, respectively. Additionally, feeding spoiled silage from an uncovered silo top has been shown to dramatically affect intake and digestibility (Figure 17). The silage should covered as soon as possible after filling is completed in order to assist the desired anaerobic process, and to reduce spoilage. Don't skimp on plastic thickness or quality - the cost of the plastic is trivial in comparison to the effort to properly put it on and its importance to silage quality and DM recovery. Use plastic that is at least 5 mm thick. Dual layer - black inner and white outer - thick (> 5 mm) plastic resists deterioration well. Cover the entire slope in front of the bunker or around the drive-over pile with plastic when filling is complete to prevent excessive spoilage in these areas. Recently, oxygen barrier films have been used to cover bunkers reducing surface spoilage when compared to traditional plastic, presenting a possible alternative to traditional plastic. Tire to tire placement is the most popular way to keep plastic in place. Concerns about the mosquito harboring West Nile virus, rodents, and the mess and effort associated with complete tires have

Figure 16: Cover the silage surface temporarily if rain halts silage production

> *"Sealing and covering a 40'x100' bunker returns approximately $2,000-$4,000 in improved silage DM recovery..."*

Figure 17: The Effect of Feeding Spoiled Silage on Dry Matter Intake and Total Ration Dry Matter Digestibility



(Whitlock et al.,2000)

led to the use of alternatives, including gravel filled bags, cut tires and truck tire sidewalls. All can work, but be sure that there is sufficient weight along the sides of the plastic to resist the wind and keep plastic in place (Figure 18).

Feed Out Management

The key steps here are to:

- Collect and discard spoiled silage.
- Remove silage with techniques that minimize air infiltration.
- Feed any loose silage left from the previous day to low impact groups (e.g. bred heifers).
- Be an alert, organized silo manager.

Spoiled silage from along the top and sides of the silo, also balls or chunks in the main body of the silo, should be discarded; as we have seen in Figure 17, reductions in intake and digestibility can occur if this feed is included in the diet. Silage with only slightly compromised quality (wetter or underwent a poorer fermentation) can still be fed to groups such as the bred heifers or far-off dry cows.

The best approach for removing silage is to use a bunk defacer

Figure 18: Use of gravel filled bags (left) and tires (right) to weigh down plastic covering

Photo Courtesy of Limin Kung,Jr.

(Figure 19). Defacers have a lot of benefits: they do not cause fracture lines that allow air into the silo; they mix the silage from across the height of the silo, reducing ration variability; they break up haylage clumps, which can reduce mixing time; they leave a very straight face which does not catch water; and they can cause less damage to the silo and the equipment used to remove silage from the bunker. When using loader buckets to remove silage, either shave across the width of the silo, or try to remove a chunk of silage from the bottom of the silo and then chip downward as the bucket is progressively moved.

Figure 19: Bunk Defacer

Silage should be removed at the rate of at least 4" during the summer and 3" during the winter to stay ahead of spoilage. The rate necessary will vary, due primarily to the packed density and resultant porosity: **feed out rate should be managed to avoid silage heating.** As Table 9 indicates, variation in silage density is extreme, thus, the necessary silage removal rate is variable as well. The fermentation acid profile will also influence the necessary face removal rate: silage that has increased levels of acetate, propionate, or butyrate will be more stable than those only high in lactate since these acids are much more potent inhibitors of molds and yeasts than lactic acid. Silage inoculated with *L buchneri 40788* will not have to be fed as quickly since the elevated levels of acetate and propionate in this silage impairs the growth of yeasts and molds and improves feed stability.

The objective when collecting a silage sample for DM or laboratory analysis is to obtain a sample representative of all silage that will be fed. This is important because silage varies considerably across the height of the silo (Table 9).

Dry matter results can be very consistent when samples are properly taken and truly representative of the silage being fed. It is important to take your time and do a careful job. If silage along the top and sides of the silo is fed separately, then it should be sampled separately. It would be entirely inappropriate to collect samples as high as one could reach, and then not bother to sample the upper half of the silo.

Table 9: Variation Between Regions (upper, middle and lower thirds) in DM and NDF in 9 Haylage and 11 Corn Silage Bunker Silos

	Haylage		Corn Silage	
	DM	NDF	DM	NDF
Average deviation, %	21.0	14.7	12.3	8.6
Median deviation, %	19.4	14.4	8.3	8.4
Smallest deviation, %	5.2	5.4	1.3	.5
Largest deviation, %	44.7	24.8	55.0	18.6

(Stone 2003)

In a survey of bunker silos, haylage DM varied between upper, middle, and lower regions of the silo by 20%, and corn silage by 10%, (Table 9). Consider this variability when collecting a silage sample for analysis and when feeding cows.

A representative pile of feed can be obtained with a backhoe or silage face shaver by digging a vertical trench near the midsection of the silo, or by scraping across the entire face with the loader bucket. A loader bucket does not work as well in digging a vertical "trench" in one area of the silo because it is very difficult to remove a uniform depth across the height of the silo. The large pile of collected feed now needs to be mixed. Although this can be done by hand, the mixer wagon is better at breaking up clumps of haylage. Residual feed in the mixer should be diluted by adding a loader bucket of the forage to be tested, briefly mixing, and then discharging. The collected forage can now be added to the mixer wagon, mixed for a few minutes, and then discharged. A single-handed scooping motion is used to collect feed from throughout this pile for DM or laboratory analysis. Care should be taken to grab all silage particles within the area "scooped", otherwise fines can be left behind. The additional care and attention paid to careful sampling will result in accurate, consistent laboratory results.

Be an alert, organized silo manager. Remove plastic and tires in a timely manner, ideally on a daily basis but certainly no more than three days ahead of feeding. Always try to exclude tires from entering the mixer wagon since hardware damage could occur from mixer wagon knifes cutting into steel belted radial tires. Carefully observe and smell layers of silage within the bunker. Watch for layers of silage that went through *clostridial* or abnormal fermentations. Consider the selective removal of these layers and either discard or feed to nonlactating animals.