You Can't Judge a Bunker Silo by Its Cover

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For more than 30 years, recommendations for managing bunker silos at filling have included:

- Filling as quickly as possible;
- Filling in thin layers (6 inches);
- Packing with a heavy tractor to concentrate the load on a small footprint;
- Packing each layer for an extended period of time;
- Covering as soon after filling as possible;
- Covering with plastic which is weighted to maintain close contact with the silage and arranged to shed water.

Throughout this period, producers have sought less time-consuming and less difficult alternatives to these recommendations. The process of covering with plastic and adding weights (boards, tires, soil, etc.) requires much hand labor for covering and uncovering and can be a wet and dirty job. For these reasons, stories abound how producers have used alternative covers with "pretty good" success. Some of these alternatives include: candy, lime, molasses, small grain sod, manure solids, small grain straw, corn fodder, soil, sawdust, no cover, etc.

Visual observation of the silo top frequently reveals a 2- to 8-inch layer of spoiled (black) feed. Producers consider this thin layer as a small loss which can be sacrificed so as to avoid the labor of covering the bunker with plastic. This visible loss is only a part of the loss which is occurring. When the blackened material is removed prior to feeding, it is referred to as visible waste.

Some covers allow precipitation to percolate into and through the silage. That which percolates through the silage is called effluent. This effluent carries soluble organics, including organic acids, from the silage. These removed organics represent a dry matter (DM) loss. The reduction in organic acids causes the pH to rise. The higher pH makes the silage more easily decomposed by microbial activity. Percolating water can also transport oxygen into the silage. This oxygen supports microbes which cause silage deterioration. Microbial deterioration is called gaseous dry matter loss. The effluent and gaseous dry matter losses are not visible to producers, so they are not aware of the magnitude of the loss.

Minson and Lancaster (1965) conducted research in New Zealand in 1963 and 1964 to determine the impact of silo cover on DM loss. They harvested grass at about 80% moisture and placed it into bunker silos to a depth of 3.5 feet. The following cover systems were applied.

None	Exposed to the atmosphere.
Roof	No cover touching the silage. Structural roof shed rain from bunker.
Sawdust	5-inch layer of sawdust on top of silage.
Soil	5-inch layer of soil on top of silage.
Limestone	3-inch layer of ground limestone on top of silage.
Plastic	Plastic on top of silage weighted with 5 inches of soil.

Precipitation onto the bunker silos was about 20 inches during the 167- to 224-day storage period. Effluent was collected from the bottom of all but one of the silos. Spoiled feed was weighed as it was rejected by the herdsman. Gaseous losses were determined by subtracting effluent and visible waste losses from the total DM loss. The results of the study are shown in Table 1. In the case of the plastic covered bunker silo, visible waste was very low. Effluent loss occurred because the forage was harvested at such a high moisture content that some juice was expressed. The effluent DM loss from the roofed silo was quite similar. The other covers did not exclude precipitation as well as the plastic and roof which resulted in an increased effluent loss. The large visible waste loss (4 inches and 10% DM) in the roofed structure was probably facilitated by the diffusion of oxygen deeper into the silage as the top surface dried out. The other cover systems had similar visible waste losses except for the plastic which had very little.

Table 1. Effects of Cover Type on DM Loss from a 3.5-foot Deep Bunker Silo (Minson and Lancaster, 1965)

Cover Type	**None**	**Roof**	**Sawdust**	**Soil**†	**Limestone**	**Plastic**
Visible Waste (inches)	3.0	4.0	3.0	2.0	2.0	0.0
Cause of Loss	**Two-year Average DM Loss** (%)					
Visible Waste	5.6	10.0	4.2	6.3	5.8	0.8
Effluent	7.5	3.0	6.5	5.0	‡	2.5
Gaseous	21.1	19.6	19.3	13.8	- - -	8.6
Total	**34.2**	**32.6**	**30.0**	**25.1**	**23.6**	**11.9**
Moisture Content at Recovery (%)	82.0	78.6	81.6	79.4	80.4	78.6

† Vegetation grew last 60 days.
‡ Leak caused effluent not to be collected.

The gaseous loss for the plastic covered bunkers was lowest of all systems. Movement of oxygen through the remaining surface covers by diffusion and/or percolation contributed to significant losses caused by aerobic activity. The sum of all losses resulted in a 2-2.9 times increase in loss compared to that of the plastic cover which did a good job of excluding oxygen and precipitation.

What does this mean to the producer in the upper Midwest who wilts hay silage valued at \$100/TDM before placing it in an 8.5-foot deep bunker silo? Let's assume that there is adequate wilting and that the 2.5% effluent loss does not occur from juice seepage. Assume the choice is to cover with plastic and tires or not to cover at all. Assume the bottom 5 feet of silage experiences a gaseous loss of 8.6% in both cases. Assume the silage is packed to a density of 40 lbs/ft^3 (14 lbs DM/ft^3) in a bunker silo 25 feet wide by 100 feet long. The silage placed in the bunker is 148.8 TDM valued at \$14,880. The average loss in the plastic covered silo is:

$$\frac{[(0.8 + 8.6) \times 3.5] + (8.6 \times 5)}{8.5} = 8.93\%$$

The average loss in the uncovered bunker is:

$$\frac{[(5.6 + 5 + 21.1) \times 3.5] + (8.6 \times 5)}{8.5} = 18.1\%$$

The DM matter loss in the plastic covered bunker is 13.3 TDM valued at \$1330 while the loss in the uncovered bunker is 26.9 TDM valued at \$2690. The \$1360 difference in lost value can defray the cost of the plastic. If the plastic costs \$100 and the labor to cover and uncover is 20 man hours, the payment for investing this labor is:

$$\frac{\$1360 - \$100}{20\ hr} = \$63/hr$$

which is not a bad wage rate for a good manager!

K. K. Bolsen (1995) studied the effect of cover type and time of application on a 3.5-foot deep bunker silo. This study also considered the effect of exposure time in storage. Table 2 shows that covering immediately with a plastic cover results in DM recovery exceeding 85% (15% DM loss) at all depths for storage periods up to 180 days. The top 13 inches experienced the largest DM loss. Depths greater than 13 inches had losses in the range of 5-8%. The average DM loss of 9% compares very closely with the 9.4% (corrected for seepage) found by Minson and Lancaster (1965) in the plastic covered bunkers.

Table 2. Effects of Covering and Time on DM Recovery from a 3.5-foot Deep Bunker Silo (Bolsen, 1995)

	Time Post	**DM Recovery** (%)		
Depth (inches)	**Filling** (days)	**Cover Immediately**	**No Cover**	**Cover after 7 Days**
0-13	7	91.4	85.9	85.9
	21	91.7	69.4	80.9
	90	87.5	46.9	80.5
	180	86.5	37.7	78.1
13-26	7	95.6	92.6	92.6
	21	96.6	90.8	90.7
	90	93.6	67.9	89.3
	180	92.1	65.8	91.9
26-39	7	96.2	93.1	93.1
	21	96.9	93.2	92.8
	90	95.5	88.3	92.7
	180	94.6	92.6	95.6

When no cover was used, significant dry matter loss occurred to the 26-inch depth. Loss values of 62% in the top 13 inches and 34% in the next 13 inches were experienced after a 180-day storage period. This 34% average loss compares closely to the 32% (corrected for seepage) found by Minson and Lancaster (1965) in their uncovered bunker silos.

By delaying covering for a period of 7 days, Bolsen (1995) was able to demonstrate significant DM losses in the top 13 inches during the delay period. After the cover was added, further DM loss was similar to that of the immediately covered bunker. Thus, covering is effective on a "better late than never" basis but is most effective when applied immediately. These data and analysis strongly support the recommendation of covering the bunker silo with a material which excludes oxygen and rain water.

References

Bolsen, K.K. 1995. Losses from top spoilage in horizontal silos. *Proc. of the Second National Alternative Feeds Symp*., St. Louis, MO.

Minson, D.J. and R.J. Lancaster. 1965. The efficiency of six methods of covering silage. *New Zealand J. of Agric. Res.*

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