TOP SPOILAGE LOSSES IN HORIZONTAL SILOS IN WESTERN KANSAS[1]

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Summary

The top 3 feet from 30 horizontal silos was sampled at three depths to determine top spoilage losses, using ash content as an internal marker. When compared to face samples, corn and forage sorghum silages exhibited similar additional organic matter (OM) losses in the top 18 inches. In the top 18 inches, covering silage reduced spoilage losses of OM from 41 to 27 percentage units compared to uncovered counterparts. Covering corn silage reduced spoilage losses of OM from 49 to 31 and 9 to 1 percentage units in the top and second 18 inches, respectively. Similar reductions in OM losses from covering were observed in the forage sorghum silages. Although spoilage losses observed in covered silages appear high, covering silage stored in horizontal silos greatly reduced the estimated storage losses in the top 3 feet.

(Key Words: Survey, Top Spoilage, Silage, Horizontal Silos.)

Introduction

In the High Plains, horizontal silos are preferred to store large amounts of silage. By design, these structures allow large percentages of the silage mass to be exposed to environmental and climatic effects. Excessive dry matter (DM) and nutrient loss can occur in the top layer and greatly decrease storage efficiency. In a silo with 900 tons storage capacity (100 ft long × 40 ft wide × 10 ft deep), up to 25% of the original silage mass is within the top 3 feet. The conventional method of protecting the top layer is covering with plastic sheeting and tires. However, to our knowledge, the extent of top spoilage losses has not been documented under farm-scale conditions.

The objective of this survey was to determine the extent of the losses associated with the top layer of horizontal silos by using ash content as an internal marker.

Experimental Procedures

In January of 1990, the top 3 ft from 30 horizontal (bunker and trench) silos was sampled, each at three locations across the width of the silo. Sample depths were: 1) 0 to 18 in from the top (depth 1), 2) 19 to 36 in (depth 2), and 3) a representative silage sample from the face, at least 6 ft from the top (face). Depth 1 was sampled using an 8 in diameter × 18 in long PVC pipe with a serrated end. Depth 2 was sampled using a silage corer, powered by an electric drill. Face samples were collected by hand in locations where there was no observable spoilage (12 to 18 in into the silage face). The silage samples were then frozen

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[4]The silos were located in the Dodge City, Scott City, and Colby areas of Western Kansas.

and transported to Manhattan for analyses of pH and DM and ash contents.

Results and Discussion

Illustrated in Figure 1 is the relationship between ash content of a sample and estimated spoilage loss of organic matter (OM). Spoilage loss is defined as the OM loss over and above the loss undergone by the presumably well-preserved "face" sample. The relationship is based on the assumption that, as spoilage occurs, OM disappears but the absolute amount of ash remains constant. The graph assumes that the face silage is 8% ash (DM basis), thus 92% organic matter. The relationship between ash in a silage sample and spoilage loss of OM can be expressed as:

$$1 - [(AF \times OMS)/(AS \times OMF)] \times 100$$

Where:

AF = percent ash at the face.
OMF = percent organic matter at the face.
AS = percent ash in the top sample.
OMS = percent organic matter in the top sample.

Regardless of face ash content, small increases in ash content of deteriorated silage represent large percentage unit increases in OM loss.

Shown in Table 1 are the effects of crop and covering on additional percentage unit spoilage losses of OM. There was no difference between crops at depth 1; corn and forage sorghum silages both exhibited an additional 38 percentage unit spoilage loss of OM. However, corn silages tended to have greater OM losses at depth 2 than forage sorghum silages (7 vs 3 percentage units). Covering silage reduced spoilage losses of OM at depth 1 from 41 to 27 percentage units compared to silage with no cover. Similarly, losses at depth 2 were reduced from an additional 6 percentage units down to 2 when silages were covered. Covering corn silage reduced OM losses from 49 to 31 and 9 to 1 percentage units at depths 1 and 2, respectively, when compared to uncovered silages. Similar trends were observed in covered forage sorghum silages.

Shown in Table 2 are the effects of covering and sample location on pH, DM and ash contents, and estimated spoilage losses of OM for 10 of the 30 corn and forage sorghum silages. For both crops, face silages had low pH values (3.56 to 3.92) and acceptable DM contents (25.0 to 38.9%), indicating satisfactory preservation. The pHs of covered silages were not greatly affected by depth, although depth 1 silages had slightly higher values. The pH values of un-covered silages at depth 1 were very high (4.96 to 7.50), whereas pHs at depth 2 approached those of the face silages. Also, ash content was higher in the uncovered silages at depth 1, ranging from 11.7 to 23.9 percent. Ash content at depth 2, although higher, approached that found in the face samples. Covering reduced increases in ash content compared to uncovered silages at both depths. Face ash content ranged from 5.7 to 10.5 and 6.6 to 11.6% for corn and forage sorghum, respectively. Because of this variability, estimates of spoilage losses of OM were made only within individual silos. In both crops, uncovered silages exhibited higher OM losses (ranging from 37.1 to 73.4 percentage units) compared to their covered counterparts (ranging from 13.3 to 42.4 percentage units). However, uncovered corn silages tended to have higher OM losses than uncovered forage sorghum silages. As expected, estimates of spoilage loss of OM were lower at depth 2, regardless of crop or covering treatment.

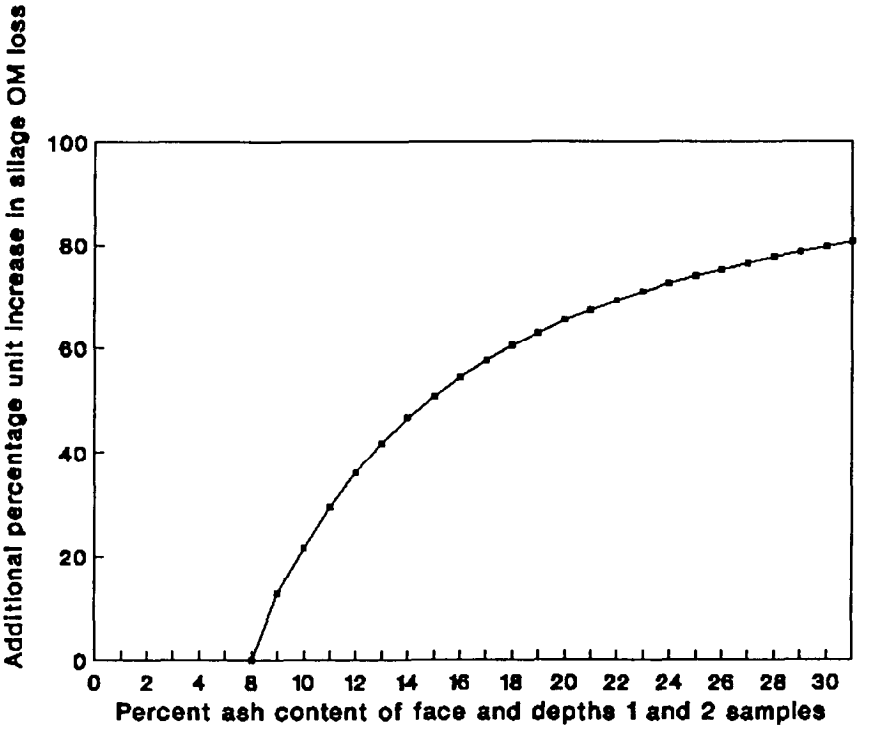

Figure 1. The Relationships between Ash Content of Silages and Organic Matter Loss above that Already Undergone by Well-preserved (Face) Silage

Table 1. Effects of Crop and Covering Treatment on Additional Spoilage Losses of OM at Depths 1 and 2 Compared to the Face Sample

Crop and treatment	Depth 1 vs face	Depth 2 vs face
Crop	---- Percentage unit spoilage OM loss ----	
All crops (30)[2]	39	6
Whole-plant corn (14)	38	7
Forage sorghum (13)	38	3
Treatment		
Covered (5)	27	2
Uncovered (22)	41	6
Corn		
Uncovered (12)	49	9
Covered (2)	31	1
Forage sorghum		
Uncovered (10)	42	3
Covered (3)	23	2

[1]Number of silos per crop or treatment in parentheses.
[2]Includes data from uncovered alfalfa, wheat, and oat silages.

Table 2. Effects of Covering Treatment and Location on pH, DM and Ash Contents, and Estimated Spoilage Losses of OM of 10 Representative Corn and Forage Sorghum Silages

Crop and treatment	Location	Silage pH	Silage DM, %	Silage Ash, %	Estimated OM loss[1]
Corn					
Uncovered	Depth 1	5.95	37.3	23.9	73.4
	Depth 2	3.66	38.7	10.2	26.6
	Face	3.67	34.0	7.7	--
Uncovered	Depth 1	5.33	37.0	11.7	51.8
	Depth 2	3.74	34.0	6.2	3.4
	Face	3.73	37.0	6.0	--
Uncovered	Depth 1	4.96	34.8	17.8	64.6
	Depth 2	3.62	38.6	8.6	18.5
	Face	3.66	38.7	7.2	--
Covered	Depth 1	4.55	33.4	13.4	24.2
	Depth 2	3.65	34.1	10.6	1.0
	Face	3.61	25.0	10.5	--
Covered	Depth 1	4.25	23.0	9.5	42.4
	Depth 2	3.53	33.9	5.8	1.8
	Face	3.56	33.6	5.7	--
Forage sorghum					
Uncovered	Depth 1	7.50	45.5	13.6	37.1
	Depth 2	3.78	35.9	9.1	0
	Face	3.76	33.7	9.1	--
Uncovered	Depth 1	7.47	24.8	20.2	48.2
	Depth 2	4.18	26.1	12.5	8.1
	Face	3.92	22.3	11.6	--
Uncovered	Depth 1	6.93	45.7	15.5	45.4
	Depth 2	3.91	41.8	9.6	5.7
	Face	3.79	38.9	9.1	--
Covered	Depth 1	3.84	26.8	9.7	13.3
	Depth 2	3.71	29.9	8.8	3.7
	Face	3.62	29.1	8.5	--
Covered	Depth 1	3.81	25.3	10.0	36.4
	Depth 2	3.56	34.4	6.7	1.6
	Face	3.64	28.4	6.6	--

[1]See equation on page 71.