RATE AND EXTENT OF LOSSES FROM TOP SPOILAGE IN PILOT-SCALE, HORIZONTAL SILOS[1]

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Summary

Corn and forage sorghum silages were stored in pilot-scale silos for 180 days, and dry matter (DM) and organic matter (OM) recoveries and estimated OM recovery were measured at three depths within the top 3 ft. of silage. The unsealed silages deteriorated badly in the top 12 in. Actual DM and OM losses in the top 24 in. were higher in unsealed than sealed silages at each successive storage period (7 to 180 days).

The unsealed silages began to deteriorate immediately in the top 12 in. in both crops, and deterioration progressed to the second 12 in. by 90 days post-filling. Sealing immediately after filling preserved more DM and OM after 180 days in the top 12 in. than delayed sealing. Silages from both crops, when sealed immediately and treated with a mold inhibitor, Top Savor®, had the highest DM and OM recoveries in the 0- to 12-in. depth at 7 days post-filling.

Organic matter recoveries estimated by an equation using silage ash content were highly correlated ($r > .93$) to actual OM recoveries in all unsealed silages. Estimated and actual OM recoveries were not highly correlated in sealed silages, particularly below the top 12 in., where OM losses were quite low in both crops.

(Key Words: Silage, Top Spoilage, Pilot-scale, Ash.)

Introduction

Large horizontal silos (i.e., bunkers, trenches, and stacks) are economical for storing large volumes of ensiled feeds, but much of the silage is exposed to the environment. In shallow structures, 20 to 25% of the original ensiled volume can be within the top 3 ft. Past research with alfalfa and corn has shown DM losses of 30 to 60% in the top 2 ft. of silage. Controlled experiments have not adequately characterized the losses occurring in this top layer.

Therefore, our objectives were to determine the rate and extent of losses in the top 3 ft. in pilot-scale, horizontal silos and to verify a method designed to estimate these losses using silage ash content.

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Experimental Procedures

Experiment 1: whole-plant corn. On August 28 and 29, 1990, 45 polyethylene-lined, 55-gallon capacity drums were packed to equal densities with whole-plant corn similar to that used to fill the farm-scale, bunker silos described on page 132 of this report. Each drum was divided horizontally with plastic netting into thirds to partition the fresh material at 12 and 24 in. below the original surface. A perforated 1.0 in. PVC pipe at the bottom of each drum drained off percolated water. Treatments were 1) left unsealed; 2) sealed with .4 mm polyethylene sheeting; 3) sealed with .4 mm polyethylene sheeting after a topical application of a commercial mold inhibitor, Top Savor®, at 1.0 lb/10 sq. ft. (provided by Kemin Industries, Inc., Des Moines, Iowa); and 4) left unsealed for 7 days post-filling, then sealed as described for treatment 3. Drums were stored outside and opened at 7, 21, 90, and 180 days post-filling (3 drums/treatment/opening time). The silage was weighed, mixed, and sampled at each location and processed as described for the farm-scale silages.

Experiment 2: forage sorghum. On September 27 and 28, 1990, 45 drums were packed to equal densities with whole-plant forage sorghum similar to that used to fill the farm-scale, bunker silos described on page 132 of this report. Procedures were the same as in Experiment 1.

Chemical analysis of the samples and statistical analysis of the data. All samples were analyzed as described on page 132 of this report. Data were treated by analysis of variance. Correlation coefficients and estimates of linear regression parameters were determined from actual and estimated OM recovery values from the pilot-scale silos.

Results and Discussion

The effects of sealing treatment, depth from the original surface, and day post-filling on the DM content and DM and OM recoveries of the corn and forage sorghum silages are presented in Table 1.

Experiment 1: whole-plant corn. Unsealed corn silage in the top 12 in. continued to loose DM and OM as storage time advanced ($P < .05$). Estimated OM recoveries were lower ($P < .05$) at both 90 and 180 days post-filling than at 7 and 21 days. The estimated corn silage OM recoveries tended to be higher than the actual OM recoveries in unsealed silage less than 24 in. deep. After 180 days, DM and OM recoveries of the unsealed corn silage at 12- to 24-in. depth were lower ($P < .05$) than the three previous storage times. However, at the 24-to 36-in. depth, DM and OM recoveries remained constant as storage time advanced.

Both corn silages sealed immediately (TRT 2 and 3) had similar DM and OM recoveries as storage time advanced. Delayed-seal silage (TRT 4) had similar ($P > .05$) DM and OM recoveries above 12 in. after 90 and 180 days. In addition, the DM and OM recoveries of the delayed-seal corn silage below 12 in. were not affected by storage time and had values that were similar to those of the two corn silages that were sealed immediately.

Experiment 2: forage sorghum. As was observed for the corn silages, unsealed forage sorghum silage in the top 12 in. continued to loose DM and OM as storage time increased ($P < .05$). In the second 12 in., DM and OM recoveries were lower at 90 and 180 days post-filling than at 7 and 21 days ($P < .05$), but the loss was much less pronounced. The DM recoveries for the silages sealed immediately (TRT 2 and 3) were higher ($P < .05$) in the top 12 in. at 7 and 21 days post-filling than at 90 and 180 days. The DM and estimated OM recoveries were similar ($P > .05$) for the delayed-seal silage stored above 12 in. by 21 days post-filling, and storage time did not affect DM or OM recoveries below 12 in.

Estimating OM recovery from silage ash content. When OM losses were large (top 24 in. in unsealed silage), OM recoveries esti-

mated from ash were highly correlated (r > .93) to actual OM recoveries. As expected, the relationship was much poorer when losses were low (sealed silage and silage deeper than 24 in.). We conclude that in situations where serious silage OM loss is occurring, those losses can be estimated from changes in silage ash content.

Table 1. Effects of Sealing Treatment, Depth from the Original Surface (Depth) and Day Post-filling on the DM Content and DM and OM Recoveries (Rec.) of the Corn and Forage Sorghum Silages in Experiments 1 and 2

Sealing treatment[1]	Depth, inches	Day post-filling	DM, %	Actual DM rec.[2]	Actual OM rec.[2]	Est. OM rec.[3]	DM, %	Actual DM rec.[2]	Actual OM rec.[2]	Est. OM rec.[3]
				------ Corn silages------				--- Forage sorghum silages ---		
TRT 1	0 to 12	7	33.6	86.1^{a}	78.6^{a}	83.0^{a}	30.2	85.9^{a}	85.2^{a}	90.0^{a}
		90	28.7	45.6^{c}	40.8^{c}	41.4^{b}	25.3	46.9^{c}	44.1^{c}	50.4^{c}
		180	36.0	35.7^{d}	31.5^{d}	36.9^{b}	22.1	37.7^{d}	36.6^{d}	42.3^{c}
	12 to 24	7	31.4	87.0^{a}	82.6^{a}	91.2^{a}	29.4	92.6^{a}	92.3^{a}	95.9^{a}
		90	26.9	81.5^{a}	76.8^{a}	81.1^{a}	21.6	67.9^{b}	62.3^{b}	69.7^{b}
		180	23.3	62.1^{b}	57.7^{b}	64.5^{b}	23.0	65.8^{b}	64.0^{b}	69.5^{b}
	24 to 36	7	32.2	88.8^{a,b}	84.2^{a,b}	89.7^{a}	29.1	93.1^{a}	92.6^{a}	92.6
		90	29.0	91.1^{a}	86.1^{a}	85.4^{a}	25.3	88.3^{b}	85.9^{b}	90.9
		180	27.7	83.4^{b}	78.9^{b}	84.2^{a}	25.5	92.6^{a,b}	91.8^{a,b}	87.5
TRT 2	0 to 12	7	32.8	92.7^{a}	88.1^{a}	94.0^{a}	29.4	91.4^{a}	88.7^{a,b}	88.7
		90	31.9	86.4^{b}	81.6^{b}	85.1^{b}	28.1	87.5^{a,b}	86.6^{a,b}	88.5
		180	33.2	85.2^{b}	80.6^{b}	86.2^{b}	29.4	86.5^{b}	85.8^{b}	89.5
	12 to 24	7	33.8	94.1^{a}	89.6^{a}	97.7^{a}	29.9	95.6^{a,b}	92.9	89.1
		90	31.9	87.2^{b}	82.6^{b}	88.5^{b}	29.0	93.6^{a,b}	93.0	91.8
		180	32.3	87.0^{b}	82.5^{b}	90.5^{b}	28.9	92.1^{b}	91.5	90.7
	24 to 36	7	33.6	93.9^{a}	89.3^{a}	96.4^{a}	29.9	96.2	93.7	93.7
		90	32.5	92.2^{a,b}	86.3^{a,b}	84.9^{b}	28.7	95.5	95.3	93.1
		180	31.0	86.1^{b}	81.3^{b}	83.7^{b}	29.3	94.6	94.0	90.9
TRT 3	0 to 12	7	31.8	96.9^{a}	92.3^{a}	97.0^{a}	29.6	93.4^{a}	92.9^{a}	93.4^{a}
		90	32.7	88.0^{b}	83.1^{b}	83.7^{b}	28.6	89.3^{b}	85.4^{b}	86.5^{b}
		180	32.9	87.7^{b}	83.0^{b}	87.4^{b}	29.4	90.0^{b}	89.6^{a,b}	94.5^{a}
	12 to 24	7	34.4	95.5^{a}	90.9^{a}	96.6^{a}	29.3	96.4	95.8^{a}	92.6^{a,b}
		90	32.3	89.6^{b}	84.7^{b}	84.7^{b}	28.7	91.4	88.7^{b}	89.1^{b}
		180	32.1	87.5^{b}	82.7^{b}	85.2^{b}	29.1	90.8	90.4^{a,b}	93.2^{a,b}
	24 to 36	7	33.5	93.8	89.0	91.8	29.8	96.9^{a}	96.4^{a}	92.7^{a,b}
		90	31.2	88.1	83.3	85.9	28.0	92.7^{b}	90.1^{b}	90.5^{b}
		180	30.9	86.3	81.5	83.9	29.3	96.4^{a}	95.8^{a}	92.0^{a,b}
TRT 4	0 to 12	7	33.6	86.1^{a}	78.6^{a,b}	83.0^{a}	30.2	85.9^{a}	85.2^{a}	90.0^{a}
		90	32.8	77.0^{b}	72.4^{b}	75.9^{b}	26.3	80.5^{b}	82.7^{a}	85.6^{b}
		180	33.9	77.1^{b}	72.6^{b}	76.3^{b}	30.5	78.1^{b}	73.0^{b}	79.9^{b}
	12 to 24	7	31.4	87.0^{a,b}	82.6^{a,b}	91.2^{a}	29.4	92.6	92.3	95.9
		90	31.1	85.1^{b}	80.1^{b}	78.4^{b}	27.9	89.3	88.5	87.8
		180	32.4	87.8^{a,b}	83.2^{a,b}	87.1^{a}	29.9	91.9	91.2	89.6
	24 to 36	7	32.2	88.8	84.2	89.7^{a}	29.1	93.1	92.6	92.6
		90	30.7	86.6	81.6	80.2^{b}	28.9	92.7	90.2	91.9
		180	30.2	88.1	83.1	81.6^{b}	28.5	95.6	95.0	91.4

[1]Treatment (TRT) 1 = unsealed; TRT 2 = sealed immediately; TRT 3 = sealed immediately plus Top Savor®; and TRT 4 = sealed 7 days post-filling plus Top Savor®.
[2]Expressed as a % of the DM or OM ensiled.
[3]Estimated (est.) OM recovery calculated from the equation on page 128 of this report.
[a,b,c,d]Means within day post-filling at each depth and sealing treatment in the same column with different superscripts differ (P < .05).