LOSSES FROM TOP SPOILAGE IN HORIZONTAL SILOS [1]

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Summary

The top 3 ft of silage from 127 horizontal silos was sampled at three locations across the width of the silo during a 4-year period (1990 through 1993). Ninety-six percent of the silages were either corn or forage sorghum, and only 18 percent of the silos were sealed with polyethylene sheeting. Losses of organic matter (OM) from spoilage were estimated by using ash content as an internal marker. Sealing silos dramatically reduced the estimated spoilage losses in the top 3 ft.

All silages had greater estimated spoilage losses in the top 18 inches in 1991 and 1993 than 1990 and 1992. Sealing reduced spoilage losses of OM in the top 18 inches by 16, 37, 19, and 36 percentage units in 1990 through 1993, respectively, and in the second 18 inches by 4, 13, 3, and 7 percentage units.

Dry matter (DM) contents were lower for forage sorghum silages in the top 18 inches than for corn silages in the first 3 years, and in all 4 years, DM contents for sealed silages were lower than those for unsealed silages. Silage had higher pH values in the top 18 inches than in the second 18 inches.

(Key Words: Survey, Top Spoilage, Silage, Bunker, Trench.)

Introduction

Kansas produces about 3.0 million tons of silage annually from corn and sorghum. During the past three decades, large horizontal silos (i.e., bunkers, trenches, and stacks) have become the most common means of storage. However, because of large surface areas, a high percentage of the silage is exposed to weathering. The conventional method of protecting these silages has been polyethylene sheeting weighted with tires. However, efficacy depends on sealing techniques and the physical properties of the sheeting, and labor is extensive.

Because only limited information is available regarding the DM or OM losses in horizontal silos under field conditions, our objectives were to estimate the amount of those losses from the top layer in farm-scale, horizontal silos and to compare losses in unsealed and sealed, corn and forage sorghum silages. Preliminary results from 1990 and 1991 were presented in KAES Reports of Progress 623 and 651.

Experimental Procedures

In January of 1990, March of 1991, November of 1992, and March of 1993, the top 3 ft of silage from 127 horizontal silos (bunkers, trenches and stacks) in the Colby, Dodge City, Leoti, Scott City, and Manhattan areas of Kansas was sampled at three locations across the width of the silos. Sampling depths were: 0 to 18 inches from the surface (depth 1) and 18

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to 36 inches from the surface (depth 2). Reference samples were taken at least 6 or 7 ft from the top at the feedout surface (depth 3 or face). All samples were taken with a coring device, then frozen and transported to Manhattan for analyses. Sealed silos were covered with a single sheet of .4 or .6 mm, black polyethylene, held in place with either tires or soil.

Additional DM and OM losses (losses in addition to the losses from well-preserved silage) were estimated by comparing ash in the samples to that from a well-preserved reference sample. The relationship between ash changes and DM or OM changes was described in KAES Reports of Progress 623 and 651.

Results and Discussion

The effects of crop and sealing treatment on ash contents and estimated additional spoilage losses of OM at the top two depths in horizontal silos are shown in Tables 1 and 2. In the top 18 inches (depth 1), additional OM loss ranged from 7 to 61%, and as expected, losses were higher in silages that were left unsealed. Applying a seal reduced OM loss in the top 18 inches by a range of 16 to 37 percentage units. Similarly, sealing reduced additional spoilage losses in the second 18 inches by 3 to 13 percentage units.

The effects of crop and sealing treatment on silage DM and pH at the three sampling depths are shown in Tables 3 and 4. The DM contents were lower for forage sorghum silages in the top 18 inches than for corn silages in the first 3 years, and DM contents for sealed silages were lower than those for unsealed silages in all 4 years. The high silage pH values near the exposed surface of the unsealed silages were typical of severely deteriorated silages. In the second 18 inches and at the face, sealing treatment did not appear to affect either DM content or pH. The relatively low pH values at these depths ranged from 3.78 to 4.04 for the 4 years, indicating satisfactory preservation.

Several of the sealed silages had OM losses and pH values in the top depth that were higher than expected, suggesting that some sealing methods were not effective, or that sealing material had been damaged.

Table 1. Effects of Crop and Sealing Treatment on Ash Contents and Estimated Additional Spoilage Losses of OM at the Top Two Depths in Horizontal Silos in 1990 and 1991

	Depth 1[2]		Depth 2		Depth 1		Depth 2	
Crop and Treatment [1]	1990	1991	1990	1991	1990	1991	1990	1991
	% Ash				Estimated OM loss [3]			
All crops (30, 30) [4]	13.6	15.5	8.1	8.7	39	51	6	13
Corn (14, 11)	11.8	12.3	7.0	7.1	38	49	7	17
Sorghum (13, 19)	13.6	17.4	8.9	9.6	38	52	3	12
unsealed (25, 22)	14.1	17.3	8.1	8.8	43	61	6	17
sealed (5, 8)	10.2	10.7	8.3	8.4	27	24	2	4
unsealed (12, 8)	12.0	13.8	6.8	7.3	49	60	9	19
sealed (2, 3)	11.2	8.3	8.2	6.8	31	22	1	5
unsealed (10, 4)	14.5	19.2	9.0	9.7	42	61	3	16
sealed (3, 5)	9.5	12.2	8.4	9.4	23	26	2	4

[1]Number of silos per crop or treatment in parentheses for 1990 and 1991, respectively.
[2]Depth 1 = 0 to 18 inches and depth 2 = 18 to 36 inches from the surface on the day of sampling.
[3]Expressed as percentage unit increase in spoilage loss of OM.
[4]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

Table 2. Effects of Crop and Sealing Treatment on the Ash Content and Estimated Additional Spoilage Loss of OM at the Top Two Depths in Horizontal Silos in 1992 and 1993

	Depth 1[2]		Depth 2		Depth 1		Depth 2	
Crop and Treatment [1]	1992	1993	1992	1993	1992	1993	1992	1993
	——% Ash——				——Estimated OM [3]loss ——			
All crops (46, 21) [4]	13.6	16.6	8.1	10.1	38	41	11	10
Corn (25, 13)	14.4	17.7	7.9	9.7	40	46	11	11
Sorghum (19, 8)	12.1	14.9	8.0	10.8	33	32	9	9
Unsealed (37, 20)	16.9	17.0	7.7	10.1	41	43	12	10
Sealed (9, 1)	11.0	11.0	7.6	8.9	23	7	9	3
Unsealed (21, 13)	17.7	17.9	8.3	9.7	44	46	12	11
Sealed (4, 0)	15.2	—	6.5	—	17	—	6	—
Sorghum								
Unsealed (14, 7)	12.5	15.5	7.8	11.1	36	36	18	10
Sealed (5, 1)	11.1	11.0	8.5	8.9	27	7	12	3

[1]Number of silos per crop or treatment in parentheses for 1992 and 1993, respectively.
[2]Depth 1 = 0 to 18 inches and depth 2 = 18 to 36 inches from the surface on the day of sampling.
[3]Expressed as percentage unit increase in spoilage loss of OM.
[4]Includes data from two unsealed soybean silages in 1992.

Table 3. Effects of Crop and Sealing Treatment on Silage DM and pH at the Three Sampling Depths in Horizontal Silos in 1990 and 1991

	Depth 1[2]		Depth 2		Face		Depth 1		Depth 2		Face	
Crop and Treatment	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
	——%DM——						——pH——					
All crops (30, 30) [1,3]	39.8	42.1	36.4	37.4	33.9	35.4	6.58	7.01	4.04	3.78	3.78	3.83
Corn (14, 11)	43.1	43.2	37.9	37.9	36.4	38.9	6.27	5.91	4.12	3.71	3.71	3.76
Sorghum (13, 19)	34.5	41.4	33.9	37.1	31.0	33.3	6.92	7.69	3.94	3.75	3.75	3.81
Treatment												
unsealed (25, 22)	41.8	45.7	36.5	38.7	34.7	35.7	7.07	7.52	4.08	3.75	3.75	3.78
sealed (5, 8)	26.5	31.9	33.2	33.2	29.7	34.2	4.43	5.79	3.84	3.63	3.64	3.82
Corn												
unsealed (12, 8)	45.6	46.0	38.5	38.3	37.6	39.1	6.59	6.46	4.15	3.73	3.73	3.72
sealed (2, 3)	28.2	35.7	34.0	36.7	29.3	38.3	4.35	5.22	3.92	3.59	3.59	3.86
Sorghum												
unsealed (10, 14)	37.3	45.6	34.2	38.9	31.3	33.8	7.65	8.12	3.99	3.77	3.77	3.82
sealed (3, 5)	25.3	29.6	32.7	32.0	29.9	31.8	4.49	6.14	3.79	3.67	3.67	3.80

[1]Number of silos per crop or treatment in parentheses for 1990 and 1991, respectively.
[2]Depth 1 = 0 to 18 inches; depth 2 = 18 to 36 inches; and face = at least 6 to 7 ft from the surface on the day of sampling.
[3]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

Table 4. Effects of Crop and Sealing Treatment on Silage DM and pH at the Three Sampling Depths in Horizontal Silos in 1992 and 1993

	Depth 1		Depth 2		Face		Depth 1		Depth 2		Face	
Crop and Treatment[1]	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993	1992	1993
	% DM						pH					
All crops (46, 21)[3]	30.2	30.9	32.2	33.4	33.9	33.6	6.25	5.94	4.03	4.03	3.84	4.03
Corn (25, 13)	31.6	32.8	32.8	31.6	33.8	34.9	6.21	5.94	4.04	4.01	3.82	4.03
Sorghum (19, 8)	27.9	36.2	31.4	34.3	34.2	35.2	6.13	5.95	4.03	4.06	3.87	4.02
Treatment												
Unsealed (37, 20)	30.6	30.3	32.9	32.8	33.8	31.9	6.42	5.99	4.05	4.03	3.63	4.00
Sealed (9, 1)	28.5	28.6	33.8	35.4	34.2	34.3	5.59	5.05	3.96	3.93	3.87	4.49
Corn												
Unsealed (21, 13)	32.7	33.6	33.0	30.3	34.2	31.7	6.43	5.94	4.09	4.01	3.82	4.03
Sealed (4, 0)	25.6	-	31.9	-	31.5	-	5.06	-	3.79	-	3.83	-
Sorghum												
Unsealed (14, 7)	26.9	34.9	30.1	31.9	33.5	32.6	6.17	6.08	4.01	4.07	3.86	3.95
Sealed (5, 1)	30.8	28.6	35.3	35.4	36.3	34.3	6.01	5.05	4.10	3.93	3.91	4.49

[1]Number of silos per crop or treatment in parentheses for 1992 and 1993, respectively.
[2]Depth 1 = 0 to 18 inches; depth 2 = 18 to 36 inches; and face = at least 6 to 7 ft from the surface on the day of sampling.
[3]Includes data from two unsealed soybean silages in 1992.

Ash and Organic Matter Loss

During spoilage of silage, microbes use up organic nutrients such as proteins and carbohydrates. However, the absolute amount of minerals (ash) remains the same. Assume 100 g of well-preserved silage contains (dry matter basis) 5% ash and 95% organic matter. Assume that after spoilage, the silage contains 10% ash. Because the absolute amount of ash stays the same, the dry weight of the silage has been reduced to 50 g. The original silage sample contained 95 g organic matter (100-5). The spoiled sample contains only 45 g organic matter (50-5). Therefore, 45/95=47.4% of the organic matter remains and 52.6% has been lost to spoilage.