LOSSES FROM TOP SPOILAGE IN HORIZONTAL SILOS IN WESTERN KANSAS[1,2]

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Summary

The top 3 ft. of silage from each of 30 horizontal silos in western Kansas was sampled at three locations across the width of the silo for 2 consecutive years (1990 and 1991). Ninety-five percent of the silages were either corn or forage sorghum, and only 22 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 in. in 1991 than 1990; sealing reduced spoilage losses of OM at that depth by 16 and 37 percentage units in 1990 and 1991, respectively. Sealing reduced losses in the second 18 in. by 4 percentage units in 1990 and 13 units in 1991.

The dry matter (DM) contents were lower in forage sorghum silages than in corn silages, and DM contents of sealed silages were lower than those of unsealed silages in both years. Silage in the top 18 in. had higher pH values than that in the second 18 in.; however, corn silages in the top 18 in. had the highest pH values in 1990, whereas forage sorghum silages had the highest values in 1991.

(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, in these structures, a high percentage of the silage is exposed to the environment and weather.

The conventional method of protecting the top layer of silage in horizontal silos has been polyethylene sheeting weighted with tires. However, that protection is variable, depending on sealing techniques and the physical properties of the sheeting. Also the labor required to apply and remove the sealing materials has discouraged most producers from sealing silos.

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horizontal silos and to compare the losses in unsealed and sealed, corn and forage sorghum silages. Preliminary results from 1990 were presented last year (KAES Report of Progress 623).

Experimental Procedures

In mid-January of 1990 and mid-March of 1991, the top 3 ft. of silage from each of 30 horizontal silos (bunkers, trenches and stacks) in the Colby, Dodge City, Leoti, and Scott City areas of western Kansas were sampled at three locations across the width of the silo. Sampling depths were: 0 to 18 in. from the top (depth 1) and 18 to 36 in. from the top (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 of pH, DM, and ash.

The relationship between ash content in a silage sample and estimated additional spoilage loss of OM (in excess of that lost in the presumably well preserved face sample) can be expressed as:

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

Where:

AF	=	percent ash in the face sample.
OMF	=	percent OM in the face sample.
AS	=	percent ash in the top sample.
OMS	=	percent OM in the top sample.

The relationship, illustrated in Figure 1, is based on the assumption that as spoilage occurs, OM disappears but the absolute amount of ash remains constant. In theory, regardless of the percent ash in the face sample, a small increase in ash content in the deteriorated silage sample would represent a large percentage unit increase in loss of organic matter. For example, assume that 100 g of well preserved, face silage contains 5% ash and 95% organic matter. The same silage after spoilage contains 10% ash; however, because the absolute amount of ash is still 5 g, the silage weight has been reduced by one-half to 50 grams. The original sample contained 95 g of OM, and the spoiled sample now contains only 45 g of organic matter. Therefore, 45/95 = 47.4% of the OM remains and 52.6% was lost.

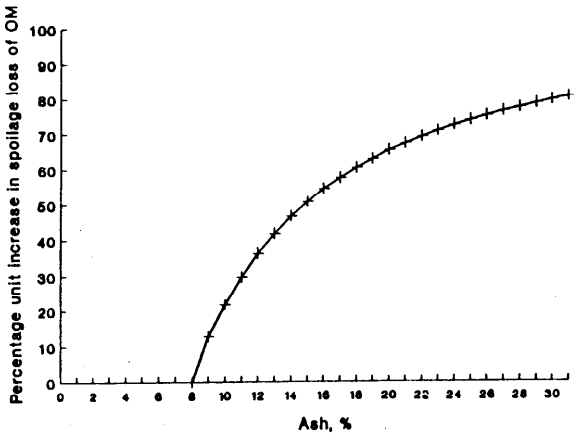

Figure 1. The Relationship Between Ash Content of a Silage and the Estimated Additional Spoilage Loss of Organic Matter.

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 Table 1. In the top 18 in., OM loss averaged 39% in 1990 and 51% in 1991. As expected, losses were higher in both corn and sorghum silages that were left unsealed. Applying a seal reduced OM loss by 16 percentage units in 1990 and 37 units in 1991, respectively, compared to silages that had no seal. Similarly, sealing reduced spoilage losses at depth 2 by 4 percentage units in 1990 and 13 percentage units in 1991.

All silages had greater spoilage losses of OM in 1991 than 1990, regardless of depth. The OM losses were 11 and 14 percentage units (depth 1) and 10 and 9 percentage units

centage units in 1990 and 13 percentage units in 1991.

All silages had greater spoilage losses of OM in 1991 than 1990, regardless of depth. The OM losses were 11 and 14 percentage units (depth 1) and 10 and 9 percentage units (depth 2) higher in 1991 than in 1990 for the corn and forage sorghum silages, respectively. Sealing corn silage reduced spoilage losses of OM by an additional 18 and 38 percentage units at depth 1 and 8 and 15 percentage units at depth 2 in 1990 and 1991, respectively. Similar trends were observed in sealed and unsealed forage sorghum silages.

The effects of crop and sealing treatment on DM and pH at the three sampling locations are shown in Table 2. The DM contents were lower in forage sorghum silages than in corn silages at all depths. The two crops were affected similarly by sealing treatment; the DM contents of the sealed silages were lower than those of the unsealed silages.

As expected, pH was higher near the surface than in the second 18 inches. A year × crop interaction occurred for pH near the surface; the corn silages had the highest values in 1990, whereas the forage sorghum silages had the highest values in 1991. In the second 18 in., silage pH was lower in 1991 than 1990. Near the surface, pH values of the unsealed silages were very high compared to deeper silage. Sealing forage sorghums reduced silage pH more (3.16 and 1.98 units) than sealing corn silages (2.24 and 1.24 units) for 1990 and 1991, respectively.

The DM contents of the face silage samples in the 60 silos surveyed ranged from 22 to 48 percent. As crop DM content increases, higher silage densities are required to prevent the damaging effects of air during the storing and feeding phases. However, the relatively low pH values of the face silages (3.5 to 4.5) indicate that satisfactory preservation had occurred. The high pH values near the surface of the unsealed silages were typical of severely deteriorated silage. Of the 30 silages having a pH value above 7.0, 28 were from unsealed silos.

The sampling date was approximately 60 days later in 1991 than in 1990, and the longer storage time undoubtedly contributed to the higher estimated additional spoilage losses in the unsealed silages in the second year.

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
Treatment								
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
Corn								
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
Sorghum								
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. Sealed silos were covered with a single sheet of .4 or .6 mm, black polyethylene and weighted with either tires or soil.
[2]Depth 1 = 0 to 18 inches and depth 2 = 18 to 36 inches from the surface.
[3]Expressed as percentage unit increase in spoilage loss of OM and calculated from the equation on page 128.
[4]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.

Table 2. Effects of Crop and Sealing Treatment on Silage DM and pH at the Three Sampling Locations in Horizontal Silos in 1990 and 1991

Crop and Treatment	Depth 1[2]		Depth 2		Face		Depth 1		Depth 2		Face	
	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. Sealed silos were covered with a single sheet of .4 or .6 mm, black polyethylene and weighted with either tires or soil.
[2]Depth 1 = 0 to 18 inches; depth 2 = 18 to 36 inches; and face = at least 6 to 7 ft. from the surface.
[3]Includes data from unsealed alfalfa, wheat, and oat silages in 1990.