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ECONOMICS OF SEALING HORIZONTAL SILOS

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Summary

Determining the value of silage saved by effectively sealing a horizontal silo requires only a few simple calculations, but it is still a concept that is often overlooked by many livestock producers who store large amounts of silage in that manner. Kansas produces about 3.0 million tons of silage annually, primarily from corn and sorghum. A majority of this silage is made and stored in either bunker, trench, or "drive-over" pile silos. Only 20 to 30% of these silos are sealed after filling. Producers who do not seal need to take a second look at the economics of this highly troublesome "technology" before they reject it as unnecessary and uneconomical. The loss from a 100 × 250 ft silo filled with corn silage can exceed $10,000.

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

Introduction

Three economically attractive methods in Kansas for storing large amounts of ensiled forage are the horizontal silos (i.e., bunker, trench, or pile), but because so much of the surface of the ensiled material is exposed, dry matter (DM) and nutrient losses can be extensive. If left unprotected, losses in the top 2 to 4 ft can exceed 50%. This is particularly disturbing when one considers that in the typical horizontal silo, over 20% of the silage might be within the top 4 feet.

These losses can be minimized by sealing (covering) the ensiled mass with polyethylene sheets, which usually are weighted with tires or soil. Although this method minimizes losses, it is so awkward, cumbersome, and labor intensive that many producers feel the silage saved is not worth their time and effort.

Top-spoilage research has been conducted at Kansas State University since 1989, and the results document the magnitude of the DM and nutrient losses in the original top 3 ft of the ensiled crop. However, these losses can not be seen until the silo is opened. Even then, the spoilage might be apparent only in the top 6 to 12 inches of silage, obscuring the fact that this area of spoiled silage represents substantially more silage as originally stored.

We provide here a few simple equations, that can be hand-calculated or incorporated into a computer spreadsheet. They allow producers to estimate the value of silage saved by sealing, based on their crop value, silo dimensions, cost of the sealing material, and labor to cover their silage.

Calculations and Examples

Calculating the value of silage saved by sealing is based on four economic inputs and two silo/silage inputs. The four economic inputs are:

1) Value of the silage ($/ton)
2) Cost of the polyethylene sheet (cents/ft^2 × number of ft^2)
3) Cost of the weighting material (zero was used in the examples)
4) labor cost ($/hr × number of hrs).

Ten hours per 4,000 ft^2 of polyethylene sheet were used to calculate the labor cost.

In order to account for overlapping from sheet to sheet and along the side walls or base, we assumed a covering efficiency of 80%.

The first of the two silo/silage inputs determines the amount of silage within the original top 3 ft of the silo after filling is complete. It is determined by multiplying the silo width(ft) by length(ft) by depth of interest (3 ft) by the silage density (lb/ft^3) and dividing the product by 2,000 (lb/ton).

The second silo/silage input estimates the amount of silage within the original top 3 ft of the silo that is lost as spoilage. These values (50% of sealed, 20% if unsealed) are based on research conducted at Kansas State University and published in KAES Reports of Progress 623, p. 70; 651, p. 127; and 727, p. 59 and 63.

The following example estimates the net return from sealing a horizontal silo 40 ft wide by 100 ft long (4,000 ft^2).

Economic assumptions:

1) Corn silage price: $25/ton
2) Polyethylene film: $.055 per ft^2 of surface covered. $.055 × 4,000 ft^2 = $220
3) Weighting material: zero cost assumed
4) Labor cost: 10 hr/4,000 ft^2 sheet × $20/hr = $200
   Sealing cost = $220 + $200 = $420

Silo/silage assumptions:

1) Assuming a silage density of 45 lb/ft^3 (4000 ft^2 surface × 3 ft deep × 45 lb/ft^3)/2000
   = 270 tons of silage within the original top 3 ft

(total capacity of the silo is about 1,080 tons)

2) Assume 20% loss in the top 3 feet if sealed, 50% loss if unsealed.

Loss, unsealed:
270 tons × $25/ton × 50% = $3,375

Loss, sealed:
270 tons × $25/ton × 20% = $1,350
Cost of sealing = $ 420
Net, sealed = $1,770

Net return to sealing:
$3,375 – $1,770 = $1,605

The concepts shown above are presented in a user-friendly spreadsheet format in Table 1. The first nine lines are economic inputs determined by the producer, and the next six lines are results that are based on formulas utilizing the producer's inputs. They can be programmed easily into the spreadsheet using the row letters as guides.

The most important single factor influencing preservation efficiency of ensiled forages is the degree of anaerobic fermentation achieved during ensiling. When silage is not sealed or when the seal is inadequate, air and moisture enter the mass and affect both the ensiling process and silage quality during the storage and feedout phases. Based on the examples in Table 1, sealing a 40 ft × 100 ft silo could save approximately $1,600 worth of silage. Using the same concept, covering a 100 ft × 400 ft silo could save the producer over $16,000.

Although future technology might introduce a more environmentally and user-friendly product, polyethylene (6 mm) is the most effective sealing material available today. The most common sealing method is to place the polyethylene sheet over the ensiled forage and weight it down with rubber tires (20 to 25 tires per 100 sq ft).

Research-based calculations confirm that the financial loss incurred by not sealing silage is substantial and reinforces our recommendation that sealing the exposed surface of a horizontal silo is one of the most important management decisions in any silage program.

Table 1. Value of Silage Saved by Sealing Three Horizontal Silos Differing in Size

Economic inputs					
Silage crop	Corn	Corn	Corn		Spreadsheet Formulas
Silage value, $/ton	25	25	25	A	
Silage density, lb/ft^3	45	45	45	B	
Silo width, ft	40	100	100	C	
Silo length, ft	100	250	400	D	
Cost of 40 ft × 100 ft poly sheet, $	175	175	175	E	
Efficiency of sheet, %	80	80	80	F	
Silage lost if unsealed, %	50	50	50	G	
Silage lost if sealed, %	20	20	20	H	
Labor cost, $/hr	20	20	20	I	
Results					
Silage in the top 3 ft, tons	270	1,688	2,700	J	(C×D×3×B)/2000
Silage value lost if unsealed, $	3,375	21,094	33,750	K	J×(G/100)×A
Silage value lost if sealed, $	1,350	8,438	13,500	L	J×(H/100)×A
Cost per ft^2 of poly sheet, ¢	5.5	5.5	5.5	M	([E/(F/100)]/4000)×100
Sealing cost, $	419	2,617	4,188	N	[(C×D×M)/100)]+ [(I×C×D×10)/4000]
Value of silage saved, $	1,606	10,039	16,063	P	K–(L+N)