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FORAGE FACTS

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# ECONOMICS OF SEALING HORIZONTAL SILOS

## INTRODUCTION

An economically attractive method in Kansas for storing large amounts of ensiled forage is the horizontal silo (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 feet can exceed 50 percent. This is particularly disturbing when one considers that in the typical horizontal silo, over 20 percent 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 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 feet of the ensiled crop. However, these losses cannot be seen until the silo is opened. Even then, the spoilage might appear to be only the top 6 to 12 inches of silage, obscuring the fact that this area of spoiled silage represents substantially more silage as originally stored.

A few simple calculations allow producers to estimate the value of silage saved by sealing, based on their crop value, silo dimensions, and 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 percent.

The first of the two silo / silage inputs determines the amount of silage within the original top 3 feet of the silo after filling is complete. It is determined by multiplying the silo width(ft) × length(ft) × depth of interest (3 ft) × 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 feet of the silo that is lost as spoilage.

The following example estimates the net return from sealing a horizontal silo with a 40 feet width × 12 feet depth × 100 feet length and an exposed surface of 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 feet
(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 process. 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 × 100-foot silo could save approximately $1,600 worth of silage. Using the same concept, covering a 100 × 400-foot 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 square feet).

Research-based calculations confirm that the financial loss incurred by not sealing silage is substantial and reinforces the 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** | | | | Spreadsheet | |
|---|---|---|---|---|---|
| Silage crop | Corn | Corn | Corn | 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 x 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)** |

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