Economics of sealing maize and alfalfa silages in bunker silos and drive-over piles: an Excel spreadsheet

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Introduction Between 2006 and 2010, the USA produced an average of 97.65 million tonnes of whole-crop maize silage (United States Department of Agriculture, 2011). Approximately 82 to 84 % of this silage was made in bunker silos and drive-over piles. However, the failure to implement proper silage management practices, especially proper sealing technique, resulted in the unnecessary loss of approximately 18 to 20 million tonnes. Standard polyethylene, weighted with discarded full-casing tires or tire sidewalls, has been the most common method used to seal bunkers and piles, but organic matter (OM) losses in the original 0.91 metres can exceed 30.0 % (Berger and Bolsen, 2006).

The use of an oxygen barrier (OB) film (www.silostop.com) as an alternative to standard polyethylene for sealing bunker silos and piles was introduced at the XII International Silage Conference held in Uppsala,Sweden (Degano, 1999). The author stated that the permeability of OB film was 0.025 that of standard polyethylene film of the same thickness. Oxygen transmission rate (OTR) through standard polyethylene film using 100 % oxygen is 1812 $cm^3/m^2/24$ h (American Society for Testing Materials, ASTM D3985), while OTR through Silostop film using 100% oxygen is 65.5 $cm^3/m^2/24$ h (ASTM D3985). Thus, the permeability of OB film was 0.036 that of the std. polyethylene.

This paper presents an Excel spreadsheet, which estimates the economic benefit of sealing ensiled forage or high moisture grain in bunker silos and drive-over piles, and compares two sealing methods, std. polyethlene and OB film.

Materials and Methods The spreadsheet was developed from research conducted at Kansas State University from 1989 to 1995, and equations published by Huck et al. (1997). In the first section of the spreadsheet, the user enters values for the following: depth from the original surface to be evaluated; silage price; as-fed silage densities; bunker or pile deminsions; percent of the silage in the original depth lost during the storage and feedout phases; and cost of the sealing materials. The results are calculated and reported in the second section. Two examples from the spreadsheet, which compare bunker silos and drive-over piles sealed with either standard (std.) plastic or OB film, are presented in Table 1.

In a large, 18.3 m wide x 76.2 m long, bunker silo of whole-crop maize silage, which has an average depth of 3.66 m, sealing would prevent the loss of 7.33 and 9.94 % of the original 3,637 tonnes of crop ensiled for the std. plastic-sealed and OB film-sealed bunkers, respectively. The OB film (bunker silo 2) would save an additional $3,765 of maize silage in the original top 0.91 m compared to std. plastic (bunker silo 1).

In a 27.7 m wide x 62.0 m long drive-over pile of alfalfa silage, which has an average depth of 1.98 m, sealing would prevent the loss of 11.5 and 15.7 % of the original 2,054 tonnes of crop ensiled for the std. plastic-sealed and OB film-sealed piles, respectively. The OB film (pile 2) would save an additional $4,050 of alfalfa silage in the original top 0.91 m compared to std. plastic (pile 1).

Conclusions The economics of properly sealing bunker silos and drive-over piles makes it clear that farmers should pay close attention to the details of this troublesome task. Sealing with OB film has a greater economic benefit than sealing with std. polyethylene.

References

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Table 1 Profitability of sealing maize silage in bunker silos and alfalfa silage in piles with either std. plastic or OB film (maize and alfalfa silages: $60 and $75 per tonne, respectively)[1]

Inputs and calculations	Bunker 1 maize std. plastic	Bunker 2 maize OB film	Pile 1 alfalfa std plastic	Pile 2 alfalfa OB film
Density in top 0.91 m, kg fresh wt. per m^3	**600**	**600**	**550**	**550**
Density below top 0.91 m, kg fresh wt per m^3	**750**	**750**	**650**	**650**
Silo depth, m	**3.66**	**3.66**	**1.98**	**1.98**
Silo width, m	**18.3**	**18.3**	**27.7**	**27.7**
Silo length, m	**76.2**	**76.2**	**62.0**	**62.0**
Silage lost in original top 0.91 m if sealed, % of the crop ensiled[2]	**25**	**12.5**	**22.5**	**12.5**
Cost of covering sheet, ¢ per sq m	**50**	**140**	**50**	**140**
Total silage in the silo, tonnes	3,637	3,637	2,054	2,054
Total value of silage in the silo, $	218,247	218,247	154,051	154,051
Silage in the orig. top 0.91 m, tonnes	761	761	860	860
Silage below the orig. top 0.91 m, tonnes	2,876	2,876	1,194	1,194
Total silage lost in the silo, % of crop ensiled	13.14	10.52	14.07	9.89
Silage lost if sealed, $	11,421	5,710	14,505	8,058
Silage saved by sealing, $	15,989	21,699	17,728	24,174
Sealing cost, $	2,379	4,325	2,930	5,326
Net value of silage saved by sealing, $	13,610	17,374	14,798	18,849
Net benefit from OB film, $	---	3,765	---	4,050

[1]Numbers in **bold** are user inputs.

[2]Values from data by Bolsen et al. (1993) and Kuber et al (2008).