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Ash Concentrations in Silages can be used to Assess Avoidable Top Layer Losses Due to Aerobic Spoilage in Silos on Commercial Farms

CHAMBERLAIN, A. T.[1], WILKINSON, J. M.[2], BOLSEN, K. K. [3]
[1]*Chalcombe, Little Tapnage, Titchfield Lane, Wickham, Hants, PO17 5PQ, UK*
drtomchamberlain@chalcombe.co.uk
[2] *School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough, Leics, LE12 5RD, UK*
[3]*Kansas State University, 6106 Tasajillo Trail, Austin, TX 78739 USA*

Introduction

Dry matter (DM) losses in stored silage can be considerable and one of the biggest components is loss in the top layer, which can account for 30 to 150 g/kg of original crop DM ensiled in covered silos (McGechan, 1990). Theoretically, loss due to aerobic spoilage may be eliminated if oxygen is excluded from the top layer by covering the top surface of the silo with an oxygen barrier film (Wilkinson and Fenlon, 2014). Thus, aerobic top layer loss may be considered to be avoidable by best-practice silo management.

Few farmers weigh forage as it is ensiled and most do not weigh all that is removed, making it difficult to quantify storage losses in commercial silos. Previous research has used differences in silage ash concentration at different depths below the top surface of the silo to assess organic matter (OM) losses during the storage period (Bolsen et al., 1993; Bolsen, 1997). Covering silos with plastic film has a large influence on upper layer losses and Bolsen (1997) recorded average OM losses in the top 500 mm on 127 commercial farm horizontal silos of 203 g/kg in covered and 470 g/kg in uncovered silos. The aim of the research reported here was to assess avoidable dry matter losses in the top layer of silos on commercial dairy farms and to present the results in financial terms for use by farmers and advisors.

Material and Methods

Silage was sampled from 12 walled bunker silos in England in the winter of 2015/16. All crops had been ensiled for at least six months at the time of sampling. Three different types of forage (grass, maize and whole crop wheat silage) were stored in the silos and a wide range of covering and sealing protocols were used. Pairs of samples, each of approximately 500 g, were taken across the exposed feed-out face as a column from the top 200 mm and also from the central core, defined as being 1.5 m below the top layer sample and at least 1.5 m from the edges of the silo. 31 pairs of samples were collected. Each entire sample was dried in a forced air oven for 48 hours as it was not possible to reliably sub-sample silages with variable amounts of visible spoilage. The dried material was ground to pass through a 1.0 mm screen and divided into three parts (each 40 to 60 g), which were ashed at a maximum temperature of 600^{o}C for 14 hours (Sluiter, et al., 2005). The difference in ash concentration between core and top layer within a pair of samples was tested for significance using a two-sample t-test (n=3). For 18 out of 31 pairs the difference was significant ($p<0.05$). The ratio of ash in the top layer sample to the ash concentration of the core was used to calculate the avoidable loss (g/kg DM) in the top layer. Muck and Holmes (2000) recorded an average core FW density of 637 kg/m^3 for 168 commercial bunker silos filled with forage maize and lucerne and FW density in the top layer was assumed to be 490 kg FW/m^3, or 0.77 of core density (D'Amours and Savoie, 2005), to calculate avoidable loss of fresh weight (FW) and DM per square meter of top surface. The financial value of avoidable loss per square metre of silo top surface was calculated assuming a value of €120/tonne silage DM.

Results and Discussion

In 13 pairs of samples (42% of all samples) there was no significant difference in ash content and there was minimal visible spoilage in these silos. Summary statistics for the 18 pairs of samples (58%) with significant differences in ash between the core and top 200 mm of the silos are in Table 1. Median avoidable losses from the top 200 mm per square metre of top surface were 56 kg FW (range 8 to 276 kg) and 19 kg DM (range 2 to 77 kg, Table 1). Ashbell and Weinberg (1992) compared different silo coverings and took 'top-surface' samples varying in depth from 150 to 500 mm; using the above methodology losses ranging from 5 to 360 kg FW were derived from their results.

Avoidable top layer losses translate into financial losses ranging from €0.26 to €9.26/m^2 of top surface (median = €2.22). Actual losses are often greater than this as much of the visible silage remaining in top 200 mm maybe judged to be unfit for feeding to livestock and discarded. The technique described here is sufficiently powerful to detect top layer losses as small as 8 kg FW/m^2.

Table 1 Summary statistics for core DM, ash concentrations in the core and the in the top 200 mm, estimated avoidable losses due to aerobic spoilage (FW and DM) and calculated financial losses for 18 paired samples from commercial bunker silos.

	DM of core sample (g/kg)	**Ash in core** (g/kg DM)	**Ash in top 200 mm** (g/kg DM)	**Avoidable loss in top 200 mm per m^2 of top surface**		**Financial loss /m^2 of top surface** (€)
				kg FW	kg DM	
Median	290.0	32.3	60.7	56.3	18.5	€ 2.22
IQR[a]	27.5	51.6	88.0	68.6	21.7	€ 2.60
Minimum	270	25	34	8	2	€ 0.26
Maximum	520	93	200	276	77	€ 9.26

[a]Inter-quartile range

Conclusions

The results presented in this paper indicate that measuring the ash content of paired silage samples can be used to quantify avoidable losses in the top layer of a bunker silo due to aerobic spoilage. More than half (58%) of samples showed significant losses in the top 200 mm of the silo. Whilst avoidable losses can be considerable (up to 276 kg FW in top 200 mm per square metre of top surface) the technique described here is sufficiently powerful to detect losses down to 8 kg FW/m^2. Expressing the losses per square metre of silo surface allows comparisons between silos and between different covering protocols. Converting losses into financial terms allows farmers and their advisors to assess losses relative to the costs of possible preventive measures.

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