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Silage review: Factors affecting dry matter and quality losses in silages[1]

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ABSTRACT

An overview was made of dry matter (DM) and quality losses that occur during the ensiling process from the field through the feeding phase. The aim was to review the relevant published literature of the last 15 yr focusing on developments achieved after the publication of the book *Silage Science and Technology*. This review discusses the factors affecting DM and quality losses in terms of field and pre-ensiling conditions, respiration and temperature at ensiling, fermentation patterns, methods of covering and weighting the silage cover, and management of aerobic deterioration. The possibility of reducing DM and quality losses during the ensiling process requires knowledge of how to measure losses on farm and establish the status of the silage during the feed-out phase, implementing the most effective management practices to avoid air exposure during conservation and reduce silage aerobic deterioration during feeding. The paper concludes with future perspectives and recommended management practices to reduce losses and increase efficiency over the whole ensiling process in view of increasing sustainability of the livestock production chain.
Key words: dry matter loss, silage management, respiration, fermentation, aerobic deterioration

INTRODUCTION

Producing high-quality forage as silage, while avoiding DM losses as much as possible, is a challenge. The silage-making process is commonly divided in 4 phases: (1) the initial aerobic phase in the silo immediately after harvest, (2) the fermentation phase, (3) the stable storage phase in the silo, and (4) the feed-out phase when the silo feed face is open and the material is exposed to air immediately before, during, and after its removal from the silo (Wilkinson and Davies, 2013). Dry matter losses and quality changes occur during each of these stages of the ensiling process, reducing the quality of the as fed product. The main stages where losses occur are field harvesting, silo respiration and fermentation, effluent production, and oxygen exposure during storage and feed-out phases. Figure 1 reports the minimum value of the DM losses that occur in each stage when good management practices are used and high values of loss when less than good management is performed or no coverings are used (Borreani et al., 1999; Bichert et al., 2000; Rankin and Undersander, 2000; Jones, 2001; Muck et al., 2003; Rotz, 2005). Although some losses are unavoidable, good management practices can reduce or compensate for these losses to provide the quality forage needed for each animal group (Rotz, 2003). Best management practices are described later.

FACTORS AFFECTING DM LOSSES

Field and Pre-Ensiling Conditions

All forages not directly harvested and conserved need a field wilting period to reduce their moisture concentration, to enhance their ensilability characteristics (i.e., increase as-fed concentration of water-soluble carbohydrates and reduce water activity) and avoid seepage losses from the silo. The major field processes involved in crops that are wilted are mowing, dry down (wilting), and baling or chopping, with DM losses and quality changes occurring during each of these processes, reducing the quality of the final product (Rotz, 2003).

Achieving a rapid wilting in the field is essential for reducing DM and nutritive value losses. Conditioning the forage and spreading the crop immediately after cutting has a major effect on the drying rate of forage (Wilkinson et al., 2003). Dry matter losses, especially leaves, were directly related to the forage DM content at the time of treatment and the severity of the conditioning.

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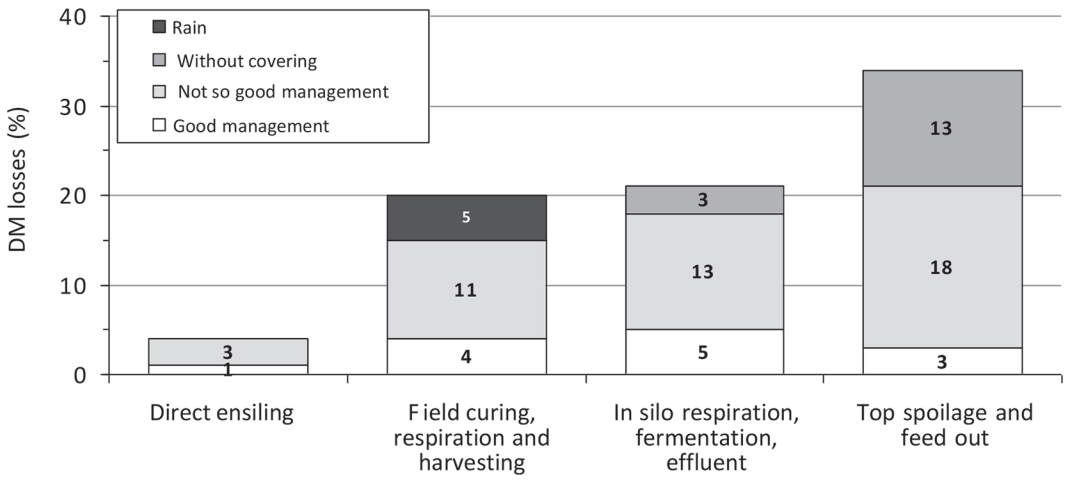

Figure 1. Potential DM losses during silage-making stages. The white portion of bar graph indicates when good management practices are used; the light gray portion is the range of additional losses associated with nonoptimal management practices; and the dark gray portion is the additional losses when no covering is applied (based on Borreani et al., 1999; Bichert et al., 2000; Rankin and Undersander, 2000; Jones, 2001; Muck et al., 2003; Rotz, 2005).

Borreani et al. (1999), evaluating the conditioning effect on drying rate of Italian ryegrass and alfalfa forages in the field, found that DM losses at cutting were always lower than 2.0% for Italian ryegrass even in the more severe conditioning treatments. Whereas in alfalfa, DM losses due to mowing ranged from 0.3 to 1.4% for conventional mowers and from 3.4 to 11.7% for mower-conditioners. This led to a loss of more than 20% of the CP at mowing in alfalfa conditioned with more severe conditioning using steel flails. They concluded that the most severe conditioning (steel flails) followed by tedding is appropriate for grass, as it significantly reduces the wilting time without significantly affecting DM losses. However, a less severe conditioning (rubber rolls) without tedding is more appropriate for wilting alfalfa to avoid excessive leaf and protein loss.

Borreani et al. (1999) evaluated field DM losses from cutting to baling of alfalfa harvested at approximately 40 or 65% DM (Figure 2). Data showed that DM losses under good drying conditions without tedding were mainly due to conditioning treatment, with mechanical losses being highest for flail conditioning. However, field respiration losses during drying followed the opposite trend with losses of 2.0, 1.5, and 1.2% for no, roll, and flail conditioning, respectively.

Kung et al. (2010) compared wide (1.52 m) to narrow (1.20 m) swathing of alfalfa, finding wide swathing saved approximately 22 h of wilting time to reach 45%

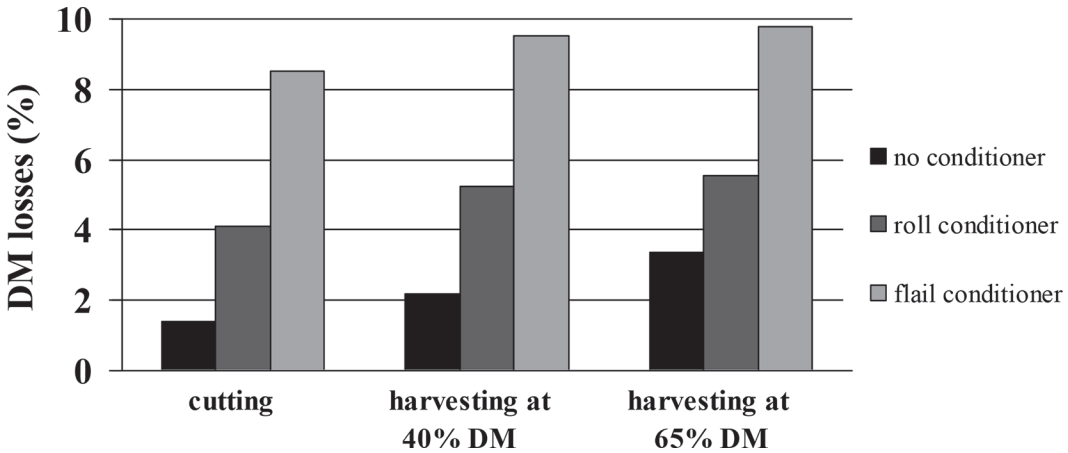

Figure 2. Dry matter losses (%) due to mechanical treatments of an untedded alfalfa forage at 3 different times during drying (data adapted from Borreani et al., 1999).