SILAGE FOR BEEF CATTLE
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BEEF UP YOUR SILAGE MANAGEMENT FOR MINIMAL SHRINK

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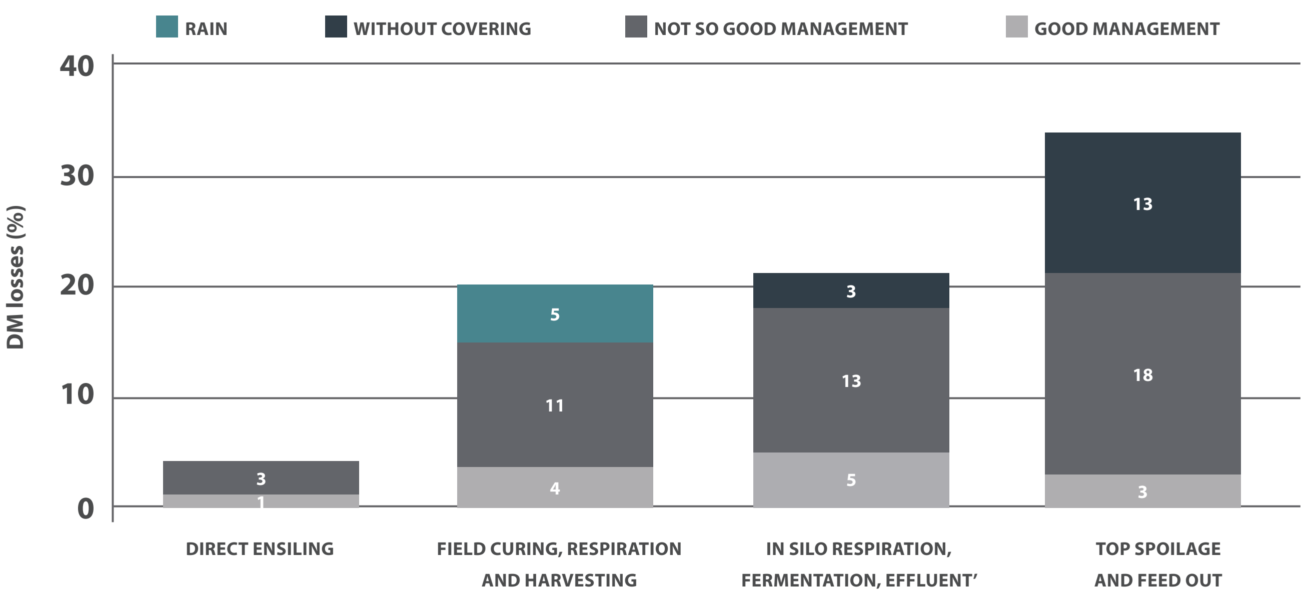
Dr. Renato Schmidt has a dairy/beef cattle farm background and is originally from Brazil, where he obtained a B.Sc. degree in Agronomy and a M.Sc. degree in Animal Sciences. He moved to the US to earn his Ph.D. in Animal Sciences from the University of Delaware with Dr. Limin Kung Jr. He worked on numerous experiments evaluating the effects of different additives on the fermentation of forage crops, and specifically developed molecular techniques to study microorganisms during ensiling. He's authored and co-authored 14 peer-review journal publications and 27 scientific abstracts. He joined Lallemand Animal Nutrition, North America as Forage Products Specialist in February 2008 and has presented technical/ scientific talks in Brazil, Canada, Mexico, Costa Rica, Nicaragua, Czech Republic, England, Scotland and throughout the USA.

INTRODUCTION

Silage can be defined as a product formed when forage with adequate moisture content is stored anaerobically, being at the risk of spoilage by aerobic microorganisms (Woolford, 1984). The inclusion of higher amounts of ensiled feeds (high-moisture corn, corn silage, haylages) in feedlot rations has recently been gaining popularity in the U.S.

There are two ultimate goals of the ensiling process - (1) to retain as much as possible of the original nutrients and dry-matter (DM) through an efficient lactic acid fermentation; and (2) to have a stable product throughout the phases of storage and feed-out. Unfortunately, losses inevitably occur during the ensiling process, field harvest, through plant respiration and microbial fermentation, effluent production and exposure to air during storage and feed-out. Furthermore, the level of management has a major impact on the magnitude of these potential losses, since some are avoidable (Figure 1).

FIGURE 1. Potential losses during the phases of ensiling (Borreani et al., 2018)



LOSSES OCCURRING BEFORE ENSILING

Some forage crops require a period of wilting in order to be ensiled at the correct moisture content. Ensiling wet forages results in seepage losses and the fermentation is more extensive; i.e. the extra moisture allows the microorganisms to remain active for a longer period of time during ensiling which uses nutrients, therefore, the lactic acid bacteria needs to produce more acid to stabilize the forage mass, as it is more "diluted".

A fast wilting in the field is vital for minimizing nutrients and DM losses. Conditioning the forage and spreading the crop are important management tools. Depending on the weather, wide swathing can reduce the field drying time and result in a more homogeneous moisture content of the forage; however, there is a good chance of driving over the swath, leading to leaf losses, reduced regrowth and lowered yield. The length of wilting impacts the final contents of soluble sugars, which will be the substrate for an effective fermentation, with minimal losses. This point is of particular concern when ensiling legumes that normally have high buffering capacity. Recent research showed that mowing in the morning can maximize dry down and avoid sudden weather changes. In contrast, when cutting in the afternoon, the sugar content of the plant is increased due to photosynthetic activity.

OXYGEN – THE WORST ENEMY OF ENSILING

Before the active fermentative phase takes place, oxygen must be excluded from the forage mass. Packing the forage tight is one of the most important (and most overlooked) factors when making good silage.

General guidelines for silages packing densities are at least 15 lb DM/ ft3 or 44 lb fresh matter (FM)/ft3. Silage porosity, which is defined as the volume of gas-filled voids as a fraction of total silage volume, should be less than 0.4 (Holmes and Bolsen, 2009). There are spreadsheets available from the University of Wisconsin Extension website to help calculate the packing weight needed for specific situations (http://www.uwex.edu/ces/crops/uwforage/storage.htm).

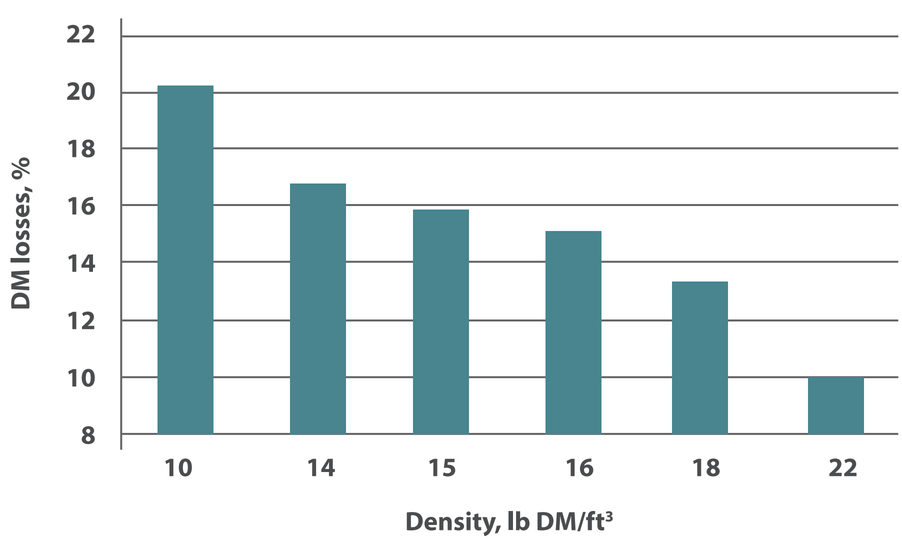
Packing density is affected by DM content, particle size and degree of packing. The degree of packing in turn is affected by the weight of the packing tractor(s), silage height, layer thickness of the forage spread and the packing time.

Ruppel (1992) showed that DM loss is directly related to the DM density of the silage. As we increase DM density of silage, we decrease DM loss in that silage (Figure 2). Noteworthy, densely packed silage also requires less storage space. Going from 13 to 15 lb DM/ft3 in a silo allows to ensile about 15% more forage in the same space.

Forages with high moisture content pack well but, as previously discussed, there is a chance of high losses due to seepage, in addition to an inefficient and/or undesirable fermentation.

FIGURE 2.

The effects of packing density on the DM losses in 25 bunker silos (Ruppel, 1992).



In contrast, dry forages will contain more air trapped and thus will need to be chopped more finely in order to facilitate a more dense packing and improve this situation. However, the short particle size may have negative effects on rumination time and rumen health because of decrease effective fiber in the feed.

To maximize the packing density, it is recommended to spread thin layers (6 inches thick) of fresh forage from each truck load. Slow delivery rate of forage to the silo normally results in thinner layers across the top of the silo, allowing more packing weight per amount of forage.

In field conditions, the "800" rule is a practical and easy tool on the basis that 800 lbs of packing weight is needed for every ton of crop delivered per hour (Ruppel, 1997); for example, for a delivery rate of 150 tons/h, 120,000 lbs of packing weight (tractors) would be required for the packing job.

FERMENTATION PATTERNS

Excess oxygen in the forage mass delays the fermentation. Trapped air allows plant respiration and microbial activity, which results in nutrient and DM losses, and heat production. Specifically, simple sugars are utilized in this process and converted to water and carbon dioxide; this lost carbon, which represents 2 to 4% of DM losses, is one of the main causes of shrink.

When anaerobic conditions are achieved, the actual fermentation starts and the dominant microbial population will dictate the fermentative pathway and subsequently the magnitude of the potential DM losses. In theory, homolactic bacteria produce only lactic acid from glucose and fructose, so no DM losses occur, while heterolactic bacteria produce 1 mol of CO_2 per mol of glucose, resulting in 24% DM loss (McDonald et al., 1991). However, if microorganisms other than lactic acid bacteria dominate the ensiling process, such as yeasts or clostridia, the DM losses increase to approximately 50%.

Relying solely on the natural population of microorganisms for the fermentation process is a dicey decision. At the very best, the result is normally an inefficient fermentation with a slow rate of pH drop. Therefore, adding an efficient strain of homolactic bacterium (or more than one) is advisable to guarantee an efficient fermentation and save most of DM and nutrients.

STORAGE PHASE

After long hours, often days of packing the forage in the silo, it is imperative to properly cover and seal as soon as possible. If not properly covered, storage losses can be extensive due to air exposure and the effects of the elements. Bolsen et al. (1993) reported extensive DM losses when comparing the effects of covering bunker silos with a polyethylene film to uncovered silos. At the top 10-inch layer, corn silage that was covered only had 22.5% of DM losses whereas the uncovered silage had 80.4% of DM losses.

Horizontal silos have been usually covered with a polyethylene sheeting and weighted down with tires – ideally split tires or tires cut in half, to reduce the weight, the number of tires needed and to limit breeding grounds for mosquitos. A more recent technology is to cover the silo using "oxygen barrier" films, composed of two layers of polyethylene, and a middle layer of polyamide, totaling 0.45 µm in thickness. These type of films are less permeable to oxygen transfusion but require an additional sheet of regular polyethylene film or a tarpaulin to protect against mechanical damage. Another benefit is that oxygen barrier films clings to the surface of the forage, filling in the gaps and reduce the presence of air pockets.

FEED-OUT RATES FROM THE SILO

The feed-out removal rate of silage from the silo is comparable to a race against time, so air cannot penetrate as quick into the silage mass. Fast removal rates lead to reduced aerobic spoilage and low losses. It is recommended to remove 4-6 inches per day of silage from the entire silo face, however, this rate could be lower for stable silages during the winter (Borreani et al., 2018). In contrast, the removal rate should be faster when feeding out dry, unstable silages or that are fed during the hot summer months. As previously discussed, the degree of porosity or density plays a significant role in the rate and extent of air infiltrating the silage mass.

The recent emphasis on using mechanical defacers or rakes has helped to reduce aerobic face losses. Using a bucket to knock down the silage create fractures in the silo face, which allows for a deeper penetration of oxygen, leading to increased yeast activity, heating and greater DM and feed value losses. A defacer or rake minimizes the air penetration, and the face is straight to reduce the chance of creating overhangs that can fall and cause accidents.

The main cause of aerobic deterioration and losses during feed-out are the lactate utilizing yeasts. In the presence of air, they can grow at low pH using lactic acid and the remaining sugars. Once the pH increases due to decreasing content of lactic acid, other opportunistic microbes also become active. Shot-chain acids like propionic, sorbic and acetic have strong anti-fungal properties and have been used to inhibit yeast activity.

Chemical additives based on buffered propionic acids have been utilized although they should be applied at 0.2-0.3% FM for consistent improvements in aerobic stability of corn silage (Kung et al., 2003). A biological alternative is to use a Lactobacillus buchneri based inoculant; this bacterium produces moderate amounts of acetic acid during the storage phase. Applying the recommended dose of 400,000 colony-forming units per gram of forage instead of the standard 100,000 CFU/g for homolactic products results in consistent improvements in aerobic stability. Under farm-scale conditions, Queiroz et al. (2012) reported that the spoilage losses of bagged corn silage during feed-out that were inoculated with L. buchneri 40788 were 43% less than non-inoculated corn silage.

FINAL COMMENTS

Silage losses can easily happen between 15-20% in field conditions. If shrink can be reduce by a 5-point percentile, there would be savings of $2,000.00 USD per 1,000 tons of silage, assuming that the silage is valued at $40.00 USD per ton FM. Replacing 5% DM loss in 1,000 tons of corn silage (DM basis) would require 39.77 tons or 1,657 bu of 86% DM shelled corn, based on the assumed TDN (total digestible nutrient) values of 70 and 88%, respectively. Moreover, silage with high shrink or degree of deterioration not only has less overall tonnage to be fed, but the feed is also of lower nutritional quality.

With the time and money invested in seed genetics, growing and harvesting the plants also need to be considered before ensiling the crop; thus, it is unacceptable if the ensilage is done improperly. Paying attention to details and following the recommended management practices for all four phases of ensiling – aerobic, fermentation, storage and feed-out – are vital to retain most of the nutrients and DM, resulting in minimal shrink.

REFERENCES

Bolsen, K. K., J. T. Dickerson, B. E. Brent, R. N. Sonon, B. S. Dalke, and J. E. Boyer Jr. 1993. Rate and extent of top spoilage losses in horizontal silos. J. Dairy Sci. 76:2940-2962.

Borreani, B., E. Tabacco, R. J. Schmidt, B. J. Holmes, and R. E. Muck. 2018. Silage review: Factors affecting dry matter and quality losses in silages. J. Dairy Sci. 101(5):3952-3980.

Holmes, B. J., and K. K. Bolsen. 2009. What's new in silage management? Pages 61-76 in Proc. 15th Int. Silage Conf., Broderick, G. A., A. C. Adesogan, L. W. Bocher, K. K. Bolsen, F. E. Contreras-Govea, J. H. Harrison, and R. E. Muck, ed. Madison, Wisconsin.

Kung, L., Jr., M. R. Stokes, and C. J. Lin. 2003. Silage additives. Pages 305-360 in Silage Science and Technology (Agronomy Series No. 42). Buxton, D. R., R. E. Muck, and H. J. Harrison, ed. American Society of Agronomy, Madison, WI.

McDonald, P., N. Henderson, and S. J. E. Heron. 1991. The Biochemistry of Silage. Second Edition. Chalcombe Publications, Bucks, England.

Queiroz, O. C. M., A. T. Adesogan, K. G. Arriola, and M. F. S. Queiroz. 2012. Effect of a dual-purpose inoculant on the quality and nutrient losses from corn silage produced in farm-scale silos. J. Dairy Sci. 95:3354-336.

Ruppel, K.A. 1992. Effect of bunker silo management on hay crop nutrient management. M.S. Thesis, Cornell University, Ithaca, NY.

Ruppel, K. A. 1997. Economics of silage management practices: What can I do to improve the bottom line of my ensiling business? Pages 125-136 in Silage: Field to Feedbunk, NRAES-99, Northeast Regional Agricultural Engineering Service, Ithaca, NY.

Woolford, M. K. 1990. The detrimental effects of air on silage. J. Appl. Bacteriol. 68:101-116.

Woolford, M. K. 1984. The silage fermentation. Microbiological Series, 14. Marcel Dekker Inc., New York, NY. 350 p.

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Figure 2. The effects of packing density on the DM losses in 25 bunker silos (Ruppel, 1992).