Getting the Most Out of Your Silage

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Take Home Message

The keys to making silage are to

- harvest the crop from the field at optimum maturity for good nutritive value,
- if needed, wilt the crop as quickly as possible to an acceptable dry matter content to preserve nutrients and promote a good fermentation,
- chop forage particles to an optimal size to allow for good effective fiber and silo packing,
- use a proven silage additive to promote a more efficient fermentation,
- rapidly exclude air from the forage mass in the silo structure by packing silage tightly,
- seal the silo as rapidly as possible after filling and 7) prevent the penetration of air into the silage mass during storage and subsequent feed out.

Introduction

Harvest and storage management can have marked effects on silage quality. The objective of this paper will be to briefly discuss some recommended management practices to make high quality silages.

Forage Maturity and DM

Forage quality is generally negatively correlated with advancing stage of maturity at harvest but there are comprises that must be made between yield and quality. Harvesting forages at optimum maturity is important because it sets the stage for the rest of the year on the farm. High forage quality drives intake and in turn, this drives milk production. Not even the best nutritionists in the world can make cows maximize their milk production if they are working with extremely poor quality forages. Grasses are often harvested in the boot stage of maturity for good quality. Small cereal grains like barley and wheat may be harvested in the soft dough stage of maturity in cooler climates. Corn silage should be harvested when the whole plant is at 32 to 35% DM and the kernels are at ½ milk line. However, milk line and whole plant DM do not always match up. In all cases, whole plant DM should be the overriding factor for corn silage harvest.

One of the biggest challenges for making good silage is managing the period of wilting to result in maximum conservation of fermentable sugars and obtaining an adequate dry matter level to prevent the growth of clostridia. During prolonged wilts, sugars are metabolized by the plant in the windrow thus a quick dry down is beneficial. Wet silages (especially grasses and alfalfa) are more prone to undergo clostridial fermentations (high concentrations of butyric acid and/or ammonia-N) when the dry matter is less than 30-35%. Ensiling forages too wet also increases the challenges of dealing with silage run off and very high levels of "wild acetic acid" (> 4-5% of the DM) and high total fermentation acids (>10% of the DM). When conditions permit it, wilting above 30-35% DM makes it harder for clostridia to dominate the ensiling process and restricts the total amount of fermentation acids. Extremely dry forages (> 45-50% DM) should be avoided because these silages are more difficult to pack which traps air in the silage mass that may lead to excessive heating and loss of nutrients. To monitor whole plant DM, cut representative samples plants from the field and chop them in order to obtain representative samples. Dry the chopped material down with a microwave or Koster moisture tester.

■ Some Specifics for Corn Silage

For those utilizing whole plant corn, much emphasis has been placed on selection of corn hybrids for dairy cattle. There has been a significant resurgence in using brown mid rib (BMR) corn as newer hybrids now come with many stacked traits and yield drags have been significantly reduced. The MILK2006 spreadsheet from the University of Wisconsin can be found at http://www.uwex.edu/ces/crops/uwforage/dec_soft.htm. The MILK2006 program calculates milk/ton and milk/acre for silage hybrids. This latest version allows for input data related to kernel processing score, degree of starch access and in vitro/in situ starch digestibility. This version also allows one to enter data using either 24, 30 or 48 h in vitro NDF digestibility estimates. Depending on your specific situation, most would try to choose hybrids that give high milk/ton and milk/acre. CornPicker is another program for evaluating corn silage hybrids and is available from Michigan State University (http://www.msu.edu/~mdr/cornpicker.html). This program calculates partial budgets and compares net farm income between two corn silage hybrids. The program is more complicated than MILK2006 but unlike that program, CornPicker provides a monetary bottom line between hybrids. Some of the inputs that users can manipulate include the cost of SBM and corn, cost of the seed; planting densities, amount of the hybrid fed to various groups of cows and of course NDF-digestibility.

Mechanical processing of whole plant corn has been an accepted method to improve the quality of corn silage (Johnson et al., 1999). Whole plant processing crushes the entire plant through rollers and can be accomplished in the field during harvesting, at the silo but prior to storage, or after ensiling and just prior to feeding. Processing corn silage improves starch and allows for good packing in silos even with a longer length of particle chop. Rollers should be set to obtain adequate kernel damage. In drier and more mature corn silage, clearances between rollers will usually need to be tighter. However, care should be taken to monitor the effectiveness of the processing. When large amounts of acreage require harvesting, there may be a tendency to open the rollers more than what is recommended in order to speed up the harvest, reduce energy use and to reduce wear on equipment. As a rule of thumb, adequate processing is occurring if more than 90-95% of the kernels are crushed or cracked and cobs are more than quartered. Many labs currently provide a Corn Silage Processing Score, which is coupled to NIR analyses of corn silage. A dried corn silage sample is sifted through several screens and particles of corn that are greater than ¼ to ½ of a kernel are retained on a screen and considered difficult to digest. The score provides feedback on processing as “optimum”, “average”, or “inadequately processed”. (One draw back is that the test takes several days for completion). An improvement in starch digestion is greater when more mature corn silage (e.g., black layer) is processed. However, always target harvest for 32-35% DM (whole plant DM). Corn should probably not be processed if harvesting forage that is less than 30% DM and especially if the corn has not dented. Improvements in fiber digestion due to mechanical processing are inconsistent. When there are reasons out of your control (inclement weather, equipment problems, and scheduling problems with a contractor) that result in corn being harvested at later stages of maturity, processing should be considered. A common observation by producers switching to processed corn silage is the reduction in cobs in the feed bunk and a reduction in kernels in the manure.

■ Preharvest Preparation

The condition of equipment to be used during harvest and silo filling should be optimized. Knives should be sharpened on the chopper. Silos and forage wagons should be cleaned before filling and moldy and spoiled silages should be removed so that they do not contaminate fresh forage. Bag, bunk and drive over pile silos should be placed in an area with good drainage and a slight pitch away from the feeding end of the bag to prevent accumulation of runoff and rain water. We preferably like to put bags and drive over piles on a poured concrete or asphalt pad. Although this can be costly, it speeds up silage removal and results in less waste, especially during rainy/muddy weather. The ground around bag silos should be kept clean and free of weed growth to deter damage to the bags by animals. When filling multiple bag silos keep them at least 1 meter apart. This will minimize damage to adjacent bags when feeding. When using big bale silage, wrap with a minimum of 4-6 layers of plastic and plan to feed these bales quickly.

■ Particle Size

Chopping silages too fine and too coarse should be avoided. Finely chopped silage reduces the effective fiber and coarsely chopped silage does not pack well and often leads to sorting of the TMR. Forage particle size should be tailored to fit each farm's particular situation and conditions. In general, if faced with drier forages, one can cut shorter to achieve a tighter pack. If feeding long hay, silages may also be cut a bit shorter. General recommendations can be found at: http://www.das.psu.edu/TeamDairy/.

■ Keys to Making Good Silage

The keys to making quality silage are to 1) rapidly exclude air from the forage mass, which will result in 2) a rapid production of lactic acid and reduction in silage pH, and 3) prevent the penetration of air into the silage mass during storage. Excessive air, due to slow silo filling or poor packing (overly dry forage or forage chopped too coarsely) allows the plant to respire for prolonged periods of time. This results in utilization of sugars and excessive degradation of plant protein. Air also encourages the growth of undesirable microbes such as yeasts and molds.

Air can be eliminated by fast filling (but not too fast), even distribution of forage in the storage structure, chopping to a correct length and ensiling at recommended dry matters (DM) for specific storage structures. Bunk and pile silos should be filled as a progressive wedge to minimize exposure to air and packed in 15-20 cm layers. The recommended optimal packing density for bunk silos is about 225 kg of dry matter per cubic meter (Ruppel et al., 1995). Silage corers can be obtained from several commercial sources. An Excel spreadsheet can be downloaded from the University of Wisconsin Extension web site that helps with bunker silo filling (www.uwex.edu/ces/crops/uwforage/storage.htm). Users can input silo dimensions, tractor weight, forage delivery rate, forage dry matter, and packing time to estimate packing density. In several recent surveys of bag silos, packing densities are more commonly between 145 to 200 kg of DM/cu meter. Silage in bags should be packed tightly by monitoring the stretch marks on the bags. Tunnel extensions on older units can be added to increase pack density. Silo bags should be vented for about 3 days to rid the bags of excess gas.

Under anaerobic conditions (lack of air) silage fermentation is dominated by microbial activity. Fermentation is controlled primarily by a) type of microorganisms that dominate the fermentation, b) available substrate (water soluble carbohydrates) for microbial growth, and c) moisture content of the crop. Lactic acid-producing bacteria utilize water-soluble carbohydrates to produce lactic acid; the primary acid responsible for decreasing the pH in silage. Unlike alfalfa and other grass silages, corn silage rarely undergoes clostridial fermentation. However, because of its high starch content, preventing the proliferation of yeasts that produce alcohol and cause lower DM recovery is a challenge in corn silage. Yeasts are also responsible for aerobic spoilage of silages during storage and feed out.

▪ Microbial Inoculation

Because forage often naturally contains many detrimental types of bacteria, the concept of adding a microbial inoculant to silage was to add fast growing homofermentative lactic acid bacteria in order to dominate the fermentation resulting in higher quality silage. Some of the more common homolactic acid bacteria used in silage inoculants include *Lactobacillus plantarum, L. acidophilus, Pediococcus acidilactici, P. pentocaceus, and Enterococcus faecium.* Microbial inoculants contain one or more of these bacteria which have been selected for their ability to dominate the fermentation. The rationale for multiple organisms comes from potential synergistic actions. For example, growth rate is faster in *Enterococcus* > *Pediococcus* > *Lactobacillus*. Some *Pediococcus* strains are more tolerant of high DM conditions than are *Lactobacilli* and have a wider range of optimal temperature and pH for growth (they grow better in cool conditions found in late Fall and early Spring). When compared to untreated silages, silages treated with homolactic acid bacteria are often lower in pH, acetic acid, butyric acid and ammonia-N but higher in lactic acid content and have better DM recovery (Muck and Kung, 1997).

Lactobacillus buchneri has been proven to improve the aerobic stability of silages. In the silo, *L. buchneri* results in a “controlled” fermentation that produces moderate amounts of acetic acid which limits the growth of spoilage yeasts. Production of moderate amounts of acetic acid by this organism is not detrimental to intake nor does it lead to excessive amounts of DM loss during ensiling (Kleinschmit and Kung, 2006). *Lactobacillus buchneri* has been combined with traditional homolactic acid bacteria to form “combination” inoculants that are specifically designed to speed up the fermentation process and to improve the aerobic stability (shelf life) of silages. Recently, strains of bacteria were identified that produce ferulic acid esterase which may help in improving fiber digestion. Nsereko et al. (2008) reported improvements in NDF digestion when rye grass and corn silage was inoculated with these organisms. A commercial inoculant containing a strain of *Lactobacillus buchneri* with this ability has recently been released.

The location of applying a microbial inoculant is important. If silage is to be stored in a bunk, pile or pit silo I would recommend that the inoculant be applied at the chopper for a more even distribution. Remember that these bugs don't have legs, nor do they swim! If all the inoculant gets put on in one spot, it will probably stay there. (Some distribution will occur during tractor movement and packing, but this is not efficient.) For silage that will be stored in a bag silo, application at the chopper or bagger will probably not make a difference. (In some instances, forage is chopped and harvested far away from where it is ensiled. Under these circumstances, it would be preferable to apply the inoculant at the chopper so that the microorganisms can begin their work right away.) Don't forget to properly calibrate your applicators to match forage delivery. Inoculants in water are stable for about 2 to 3 days but maybe less so under very hot temperatures. If for some reason, unused liquid inoculants must be stored, do so in shade and place a few ice packs into the liquid to lower the temperature of the liquid. Do not allow the temperature of water in the applicator tanks to rise above about 37°C as this may decrease the viability of the bacteria (Mulrooney and Kung, 2008). Seal any unused portion of powders tightly to protect from moisture and stored in a cool area.

▪ Sealing Silos and Fermentation

After filling, silage should be covered with plastic as soon as possible and weighted down with tires (tires should be touching) or gravel bags to exclude air. Split tires are a good alternative because they are easier to handle, do not accumulate water (thus less breeding grounds for mosquitoes that could carry the West Nile Virus), and are undesirable for animals to nest in. The return on investment (labor and plastic) is extremely high for covering bunk and pile silos (Bolsen et al., 1993). Oxygen barrier plastics allow less oxygen to penetrate through the plastic and have resulted in improved silage quality when compared to normal plastic in bunker silos (Borreani et al., 2007) and bale silage (Borrreani and Tabacco, 2008).

When conditions allow for it, silage should ferment for a minimum of 6 to 8 weeks before feeding. A gradual transition over a 10 to 14 day period from old silage to new silage is also recommended. Unfermented feed is the equivalent of feeding green-chop that is high in fermentable sugars and can cause cows to go off feed and have loose manure. There is also mounting evidence that starch and fiber digestibility improve with prolonged storage in the silo. This has been shown specifically in high moisture corn (increased starch digestion, Stock et al., 1991) and corn silage (improved starch and fiber digestion, Hallada et al., 2008).

■ Silage Feedout

Proper management for removal of silage from silos and management at the feed bunk can help producers to maximize profits and production. Air has been shown to be able to penetrate 1 meter into the face of even a well packed silo. Enough silage should be removed between facing to minimize aerobic spoilage. Lesser amounts may be removed in areas of the country where ambient temperatures remain cool during the winter months. Removal of silage should be such to minimize loose silage on the ground between feedings. Hot, moldy feeds should not be fed because they are low in nutritive value and digestibility and depress intake. Feed bunks should be kept full but clean of decaying feed. Face shavers are becoming popular but research is needed on their benefit. Extreme care should be taken to prevent air from penetrating between the plastic and reaching the silage mass. An example of putting more weight on the plastic at the leading face is shown in Figure 1.

Figure 1. An example of using gravel-filled bags on the leading edge of the silo face to prevent air from penetrating under the plastic.

■ Conclusions

Great care should be taken to preserve and maintain the nutritive value of forage crops. Management starts in the field with harvesting crops at the optimum maturity and then following this with a quick wilt (for grasses and alfalfa), by chopping to an adequate particle size, treating with a good microbial inoculant, processing the plant (for corn silage), filling silos quickly and packing them tightly and finally managing the silage in the silo with plastic and weights to minimize exposure to air.

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ABSTRACTS