Kansas Agricultural Experiment Station Research Reports

Volume 0
Issue 2 *Dairy Research (1984-2014)*

Article 259

2000

Silage Management: important practices often overlooked

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Keywords
Dairy Day, 2000; Kansas Agricultural Experiment Station contribution; no. 01-166-S; Report of progress (Kansas State University. Agricultural Experiment Station and Cooperative Extension Service); 861; Dairy; Silage; Silage storage

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SILAGE MANAGEMENT: IMPORTANT PRACTICES OFTEN OVERLOOKED

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Summary

Four important silage management practices that are in the control of livestock producers and that are sometimes poorly implemented or overlooked entirely include: inoculating, packing, sealing, and managing the feedout face.

(Key Words: Silage, Silage Storage.)

Inoculating Silage Crops

Effective bacterial inoculants promote a faster and more efficient fermentation of the ensiled crop, which increases both the quantity and quality of the silage. Inoculants have inherent advantages over other addi-tives, including low cost, safety in handling, a low application rate per ton of chopped forage, and no residues or environmental problems. The bacteria in commercial products include one or more of the following species: *Lactobacillus plantarum* or other *Lactobacillus* species, various *Pediococcus* species, and *Enterococcus faecium*. These strains of lactic acid bacteria (LAB) have been isolated from silage crops or silages and were selected because: 1) they are homofermentative (i.e., ferment sugars predominantly to lactic acid), and 2) they grow rapidly under a wide range of temperature and moisture conditions. Recently, several products also have contained *Lactobacillus buchneri* (a heterofermentative LAB) or strains of *Propionibacterium* (which are capable of producing propionic acid during the ensiling process).

Inoculant research at Kansas State University. Evaluation of silage additives began in 1975 in the Department of Animal Sciences and Industry. A summary of results from over 200 laboratory-scale studies, which involved nearly 1,000 silages and 25,000 silos, indicated that bacterial inoculants were beneficial in over 90% of the comparisons. Inoculated silages have faster and more efficient fermentations — pH is lower, particularly during the first 2 to 4 days of the ensiling process for hay crop forages, and lactic acid content and the lactic to acetic acid ratio are higher than in untreated silages. Inoculated silages also have lower ethanol and ammonia-nitrogen values compared to untreated silages.

Economics of bacterial inoculants. What is the "bottom line" calculation of the value of inoculating corn silage and alfalfa haylage for a dairy herd with an average milk production of 87 lbs per cow per day and a daily dry matter (DM) intake of 54.2 lbs? The increase in net income, calculated on a per ton of crop ensiled or per cow per day or per cow per year basis, is realized from increases in both preservation and feed utilization. The additional "cow days" per ton of crop ensiled, because of the increased DM recovery, and the increased milk per cow per day from the inoculated silage or haylage (0.25 lbs) result in a $6 to $7 increase in net return per ton of corn ensiled and about a $14 to $15 increase in net return per ton of alfalfa ensiled.

Recommendations. Why leave the critical fermentation phase to chance by assuming that the epiphytic microorganisms (those occurring naturally on the forage) are going to be effective in preserving the silage crop? Even if a dairy or beef cattle producer's silage has been acceptable in the past -- because silage-making conditions in most regions of North America are generally good -- there are always opportunities for improvement.

Although whole-plant corn and sorghum ensile easily, research data clearly show that the quality of the fermentation and subsequent preservation and utilization efficiencies are improved with bacterial inoculants. Alfalfa (and other legumes) are usually difficult to ensile because of a low sugar content and high buffering capacity. However, adding an inoculant helps ensure that as much of the available substrate as possible is converted to lactic acid, which removes some of the risk of having a poorly preserved, low-quality silage. Finally, if producers already are doing a good job but using a bacterial inoculant for the first time, they probably will not see a dramatic difference in their silage. But the benefit will be there — additional silage DM recovery and significantly more beef or milk production per ton of crop ensiled.

Selecting a bacterial inoculant. The inoculant should provide at least 100,000 and preferably 200,000 colony-forming units of viable LAB per gram of forage. These LAB should dominate the fermentation; produce lactic acid as the sole end product; be able to grow over a wide range of pH, temperature, and moisture conditions; and ferment a wide range of plant sugars. Purchase an inoculant from a reputable company that can provide quality control assurances along with independent research supporting the product's effectiveness.

Achieving a Higher Silage Density

Achieving a high density of the ensiled forage in a silo is an important goal for dairy producers. First, density and crop DM content determine the porosity of the silage, which affects the rate at which air can enter the silage mass at the feedout face. Second, the higher the density, the greater the capacity of the silo. Thus, higher densities typically reduce the annual storage cost per ton of crop by both increasing the amount of crop entering the silo and reducing crop losses during storage. Recommendations usually have been to spread the chopped forage in thin layers and pack continuously with heavy, single-wheeled tractors. But the factors that affect silage density in a bunker, trench, or drive-over pile silo are not completely understood. Kurt Ruppel (Pioneer Hi-Bred) measured the DM losses in alfalfa silage in bunker silos and developed an equation to relate these losses to the density of the ensiled forage (Table 1). He found that tractor weight and packing time per ton were important factors; however, the variability in density suggested other important factors that were not considered.

In a recent study, Brian Holmes, extension specialist at the University of Wisconsin-Madison, and Rich Muck, agricultural engineer at the U.S. Dairy Forage Research Center in Madison, measured silage densities over a wide range of bunker silos in Wisconsin, and the densities were correlated with crop/forage characteristics and harvesting and filling practices. Samples were collected from 168 bunker silos, and a questionnaire was completed about how each bunker was filled. Four core samples were taken from each bunker feedout face, and core depth, height of the core hole above the floor, and height of silage above the core hole were recorded. Density and particle size also were measured.

The ranges of DM contents, densities, and average particle size observed in the hay crop and corn silages are shown in Table 2. As expected, the range in DM content was narrower for the corn silages compared to the hay crop silages. The average DM content of the corn silages was in the recommended range of 30-35%. But several of the haylages were too wet (less than 30% DM), which can lead to effluent loss and a clostridial fermentation, or too dry (more than 45% DM), which can lead to extensive heat damage, mold, and the risk of a fire. The average DM densities for the hay crop and corn silages were similar and slightly higher than a commonly recommended minimum DM density of 14.0 lb/cu ft. Some producers were achieving very high DM densities, whereas others were severely underpacking. One very practical issue was packing time relative to the chopped forage delivery rate to the bunker. Packing time per ton was highest (1 to 4 min/ton on a fresh basis) under low delivery rates (less than 30 tons/hr on a fresh basis). Packing times were consistently less than 1 min/ton (on a fresh basis) at delivery rates above 60 tons/hour.

Dairy producers can control several key factors to achieve higher densities, which will minimize DM and nutrient losses during ensiling, storage, and feedout.

Forage delivery rate. Reducing the delivery rate is somewhat difficult to accomplish, because very few dairy producers or silage contractors are inclined to slow the harvest rate so that additional packing can be accomplished.

Packing tractor weight. This can be increased by adding weight to the front of the tractor or 3-point hitch and filling the tires with water.

Number of tractors. Adding a second or third packing tractor as delivery rate increases can help keep packing time in the optimum range of 1 to 3 minutes per ton of fresh forage.

Forage layer thickness. Chopped forage should be spread in thin layers (6 to 12 inches). In a properly packed bunker silo, the tires of the packing tractor should pass over the entire surface before the next forage layer is distributed.

Filling the silo to a greater depth. Greater silage depth increases density. But there are practical limits to the final forage depth in a bunker, trench, or drive-over pile. Safety of employees who operate packing tractors and who unload silage at the feedout face becomes a concern. Packing in bunkers that are filled beyond their capacity and the chance of an "avalanche" of silage from the feedout face pose serious risks.

Table 1. Dry Matter Loss as Influenced by Silage Density

Density (lb of DM/ft^3)	DM Loss at 180 Days (% of the DM ensiled)
10	20.2
14	16.8
16	15.1
18	13.4
22	10.0

Table 2. Summary of Core Sample Analysis from the Bunker Silos

Silage Characteristic	Hay Crop Silage (87		Corn Silage (81 silos)	
	Avg	Range	Avg	Range
Dry matter, %	42	24-67	34	25-46
Density on a fresh basis, lb/cu ft	37	13-61	43	23-60
Density on a DM basis, lb/cu ft	14.8	6.6-27.1	14.5	7.8-23.6

Protecting Silage from Air and Water

Until recently, most large bunker, trench, or drive-over pile silos in Kansas were left unsealed. Why? Because producers viewed covering silos with plastic and tires to be awkward, cumbersome, and labor-intensive. Many believed the silage saved was not worth the time and effort required. But if silos are left unprotected, DM losses in the top 1 to 3 ft can exceed 60 to 70%. This is particularly disturbing when one considers that in the typical "horizontal" silo, 15 to 25% of the silage might be within the top 3 feet. When the silo is opened, the spoilage is apparent only in the top 6 to 12 inches of silage, obscuring the fact that this area of spoiled silage represents substantially more silage than originally stored.

The most common sealing method is to place polyethylene sheet (6 mil) over the ensiled forage and weight it down with discarded tires (approximately 20 to 25 tires per 100 sq ft of surface area). Producers who do not seal need to take a second look at the economics of this highly troublesome "technology", before they reject it as unnecessary and uneconomical. The loss from a 40 × 100 foot silo filled with corn silage can exceed $2,000. Loss from a 100 × 250 foot silo can exceed $10,000.

Managing the Feedout Face

The silage feedout "face" should be maintained as a smooth surface that is perpendicular to the floor and sides in bunker, trench, and drive-over pile silos. This will minimize the square feet of surface that are exposed to air. The rate of feedout through the silage mass must be sufficient to prevent the exposed silage from heating and spoiling. An average removal rate of 6 to 12 inches from the "face" per day is a common recommendation. However, during periods of warm, humid weather, a removal rate of 18 inches or more might be required to prevent aerobic spoilage, particularly for corn, sorghum, and whole-plant wheat silages.

For more information about these and other silage management practices visit the Kansas State University Silage Team's website at:

http://www.oznet.ksu.edu/pr_silage.