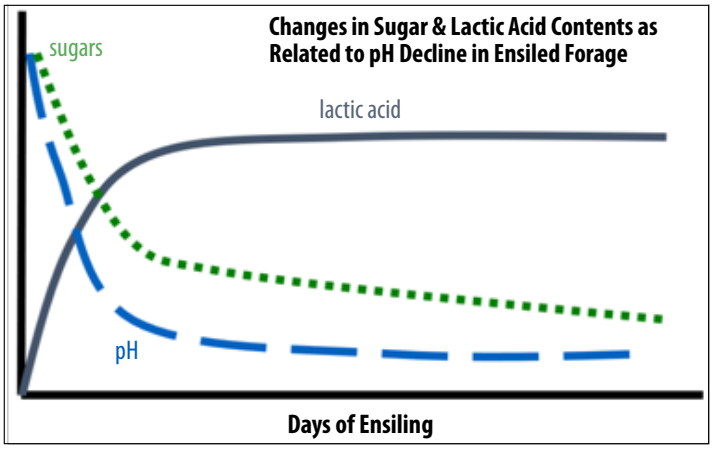
GUEST COLUMN

Whether or Not to Inoculate Forages?

Larry Roth, Cargill Animal Nutrition

Current economic conditions are causing all segments of agriculture to re-evaluate their practices. Forage inoculants are among the expenditures facing scrutiny by dairy and beef farmers, so understanding forage inoculant principles and benefits is essential for determining whether or not to inoculate ensiled forages.



The Ensiling Process. Certain bacteria naturally present on living forage plants are capable, under anaerobic conditions, of producing lactic acid after plants are chopped and packed into silage storage structures. Unfortunately, agronomic conditions and stressors may lessen the impact of these beneficial bacteria, creating an environment amenable for increased growth of harmful bacteria, wild yeasts, and molds capable of producing mycotoxins, which can impair animal health and performance. Inoculating forage with beneficial bacteria can favorably tip the microbial balance for rapid utilization of sugars for lactic acid production to quickly decrease forage pH for nutrient preservation and enhanced forage quality (Figure).

Inoculant Use to Improve Dry Matter (DM) & Nutrient Recovery. Microbiologists have been able to select lactic acid-producing bacteria (LAB) capable of out-growing the harmful microbes residing on forage at harvest. *Lactobacillus*, *Pediococcus*, and *Enterococcus* bacteria, known as homofermenters, efficiently metabolize plant sugar to lactic acid to quickly depress forage pH, inhibiting undesirable bacterial growth and stopping self-metabolism by the forage plants, thereby resulting in greater DM and nutrient recovery, as well as dollar preservation of the harvested crops. Interestingly, the more rapid and efficient the sugar to lactic acid conversion, the greater the opportunity for total sugar preservation.

The pH decline with legume crops is more difficult to accomplish than with grasses (i.e., corn, sorghum). Legumes have lower water-soluble carbohydrate levels, challenging fermentation, and greater protein/mineral levels, which can buffer lactic acid, lessening its effect. It may be advisable to inoculate legumes with greater numbers of LAB (i.e., >100,000 colony-forming units (CFU) per gram of forage). The greater the moisture in harvested forage, the greater the amount of lactic acid needed to depress pH below 5.0 for haylages and 4.0 for corn and sorghum silages for nutrient preservation.

Use of Inoculants to Improve Aerobic Stability. Forage plants stressed by drought, excessive moisture, hail, insects, and other factors often have wild yeast and mold levels >100,000 CFU/g forage, each, at harvest. Inadequate packing to remove oxygen, dry forages, and slow filling of silage structures can lead to yeast and mold growth during initial storage. Failure to cover silage with high-quality plastic and poor feed-out techniques can result in further spoilage and nutrient depletion. Yeast growth that causes heating additionally denatures forage protein, lessening ruminal protein availability.

Research supports use of bacterial inoculants featuring *Lactobacillus buchneri* or *Propionibacterium* for their ability to reduce harmful yeast and mold growth, but use of these does not replace the need for best management practices. *L. buchneri* and *Propionibacterium* are known as heterofermenters due to their metabolism of sugar to lactic acid, acetic acid, and carbon dioxide; consequently, DM and nutrient recovery is lower with heterofermenters than with homofermentative bacteria. Combinations of the two can provide benefits from both types of microbials.

Use of Inoculants to Support Animal Health. Undesirable bacteria, such as *Enterobacteria* and *Listeria,* are introduced by soil and livestock manure into forages at ensiling, and may rapidly increase unless anaerobic conditions and a rapidly falling pH are created.

High levels of *Enterobacteria* (*E. coli*, *Bacillus*, *Clostrida*) may cause digestive disorders when ingested by cattle, and increase loss of DM and nutrients from poorly fermented forages. They infect forages following manure application to fields and then soil incorporation into forages by disc mowing, raking, and chopping. Rapid production of lactic acid by high numbers of LAB can restrict *enterobacteria* growth. Rapid pH decline is complicated when forages have high moisture content and with legumes, which have inherently higher crude protein and minerals and lower soluble sugar levels.

Clostridia resist the desirable forage pH decline by metabolizing sugar to produce butyric acid, which is ineffective for reducing pH, and by excessively degrading protein to ammonia. Failure to rapidly produce lactic acid to depress forage pH not only allows plant metabolism to continue for a prolonged period, but also allows harmful *clostridia* bacteria and other organisms to proliferate, stealing nutrients intended for livestock feeding. It is also possible for spores to contaminate milk, compromising cheese making.

Listeria are present in soil, manure, and decomposing plant material. These harmful organisms grow in a variety of conditions, including aerobic and low temperature situations. Oxygen presence during initial ensiling or later during storage due to holes in the covering plastic can aid *Listeria* growth. Once again, rapid lactic acid production restricts *Listeria* growth in ensiled forages

Conditions Meriting Inoculation of Forages. Inoculation with LAB benefits dairy and beef producers by rapidly producing lactic acid to depress forage pH for DM and nutrient preservation, especially for crops with low native levels of LAB, low soluble sugars, high moisture levels, and soil contamination, and with legumes resisting pH due to buffering protein and minerals. Quickly depressing forage pH may also favor animal health by hindering the growth of *Enterobacteria*, *Clostridia*, and *Listeria*. Forage farmers should consider inoculation with *L. buchneri* and *Propionibacterium* when crops are contaminated with high levels of wild yeasts and mold and when packing and/or feed out conditions are less than desirable. Proper inoculation complements forage best management practices.