Silage Inoculants: It's All About Microbiology

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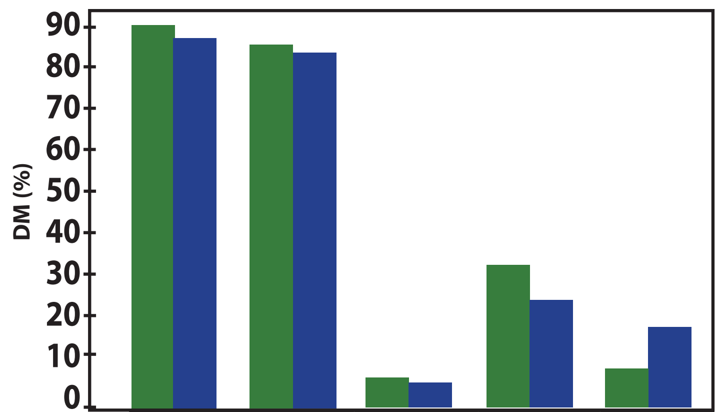
Bacterial inoculants have been around for many years, but only recently have microbiologists been enlisted to improve on the original strains used in the industry. Today there are advanced bacterial inoculants that are capable of delivering higher levels of performance in protecting, preserving, and enhancing the quality of silage during all phases of fermentation and feedout.

"In the world of bacterial inoculants, two key families of bacteria are used for silage crops, namely *Lactobacillus plantarum* and *Lactobacillus buchneri*," says Scott Dennis, Ph.D., DuPont Pioneer technical services and training manager, global forages. Extreme differences between each family of bacteria influence fermentation success and the ability to perform well under various environments.

Since 1978, Pioneer microbiologists have been working to understand how these differences can convert into improved and more cost-effective silage. To help measure these variations, microbiologists have developed scientific capabilities to screen and evaluate bacterial strain combinations and then test their performance in the field. This ongoing research and evaluation process has resulted in a continuous progression of new bacterial inoculants designed to be compatible with each major silage crop.

By studying bacterial strains that improve front-end fermentation, microbiologists discovered that some strains of bacteria were better for corn, others were more beneficial for alfalfa, and still others paired well with grasses. Matching strains to crops helps drop the pH level more quickly and allows more efficient preservation of dry matter compared to previous inoculant formulations, allowing you to make the most out of your silage.

Figure 1. DM recovery of Pioneer® brand inoculated and control silage in university studies, 1981-1995.



	Treated	Control	Difference	% Difference	Cents/ Cow/Day Savings
Alfalfa	90.0	85.1	4.9	32.2	7
Corn Silage	86.7	83.4	3.3	23.2	17

Advanced Fermentation

The basic function of an inoculant is to provide a fast, more efficient fermentation of silage. Quick fermentation preserves silage, maintains a high level of silage quality, and results in decreased fermentation losses.

"The fermentation process is both biological and chemical in nature," Dennis states. "One of the most fundamental chemical activities is the production of organic acids that reduce silage pH, with lactic acid being the most important of these acids."

Lowering pH, while eliminating oxygen through good management practices prevents spoilage organisms from growing and stabilizes the silage. Only naturally occurring epiphytes produce organic acids that lower pH, that is, if a bacterial inoculant designed to enhance this process is not added. Although the end result may be an ensiled crop, increased shrink and energy loss are the high risks of allowing only natural bacteria to ferment the crop.

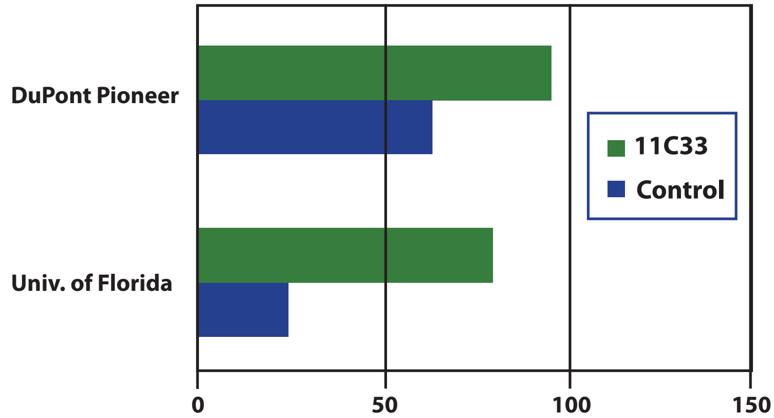
The initial fermentation process is best accomplished when homofermentative bacteria (*L. plantarum*) convert sugars (the energy source) to lactic acid. Unfortunately, naturally occurring lactic acid bacteria are typically inefficient and unable to drop the pH as low or as rapidly as specialized *L. plantarum* strains. Pioneer® brand inoculants have been developed to contain highly efficient strains of bacteria that help reduce the energy costs of preservation. These energy savings directly translate to reduced shrink and allow for greater dry matter recovery of 3-5% during the initial phase of fermentation (Figure 1).

Easy Access Fiber

Enhanced fiber digestibility and nutrient availability of the ensiled crop are the most recent innovations in bacterial inoculants. Researchers have also discovered a unique strain of *L. buchneri* that produces two key enzymes (ferulate and acetyl esterase) that improve silage quality, especially the digestibility of fiber.

Lignin, found in forage plants used to make silage and feed for ruminants, bonds with cellulose and hemicelluloses and hinders the digestion of the fiber by the rumen bacteria. As a result, animals cannot take full advantage of the energy in these components. The enzymes produced by the unique *L. buchneri* strain found in fiber technology inoculants can separate the lignin from the cellulose and hemicelluloses. This then allows rumen microbes to use these two fiber sources as a more efficient energy source.

Figure 2. Time required to increase silage temperature by 5°F after exposure to air.



Improved Aerobic Stability

It is critical to deliver fresh feed to livestock from the silo. At feedout, when the face of the silage bunker is re-exposed to oxygen, the fermentation process restarts. This is due to the aerobic organisms – typically yeasts, molds and bacillus – which are present in the silage, that again begin to grow in the presence of oxygen. When these organisms grow, they consume energy, often resulting in heating that is costly in quantity and quality of silage.

"In fact, one of the primary energy sources for the growth of silage spoilage yeasts is lactic acid," Dennis reports. "As these organisms consume lactic acid, the pH rises, which allows other spoilage organisms to grow and even more damage can occur to the silage, resulting in moldy, lower-energy feed."

In the 1990s researchers isolated and identified strains of *L. buchneri* that could be combined with crop-specific, fermentation-controlling bacteria to dramatically improve aerobic stability, or bunklife (time before heating occurs). These inoculants provide, on average, 40-plus additional hours of stability (Figure 2).

L. buchneri is a hetero-fermentative species and will typically produce 50% lactic acid and 50% acetic acid when grown in pure culture. However, in the silo, the slower growing *L. buchneri* will convert a portion of the lactic acid to acetic acid after the initial fermentation has stabilized. Acetic acid is weaker than lactic acid, so the final pH will be slightly higher. However, acetic acid is a good yeast inhibitor, helping to reduce heating during feedout. When yeast growth is present, the resulting feed is more consistent and stable while still maintaining high forage quality. Keeping silage stable in the bunk and maintaining aerobic stability on the back end add up to improved palatability and feed consumption.

Current Pioneer brand inoculants offer a combination of *L. plantarum* strains that produce lactic acid during the front-end fermentation along with *L. buchneri* strains that produce acetic acid to reduce heating during feedout. This formulation preserves silage quality from initial storage through feedout and helps you get more out of your silage and means less reliance on supplemental feed for a measurable cost savings.

Microbiologists and forage experts have determined great silage quality depends on several key factors: proper silage moisture, elimination of oxygen, efficient reduction of silage pH, aerobic stability, and enhanced forage digestibility. The best way to manage these factors involves checking the moisture levels prior to harvest, good silage packing, covering the silage pile, and the use of a bacterial inoculant.

"With high feed costs for animal operations," Dennis says, "preserving, protecting, and enhancing silage quality is now more important than ever."