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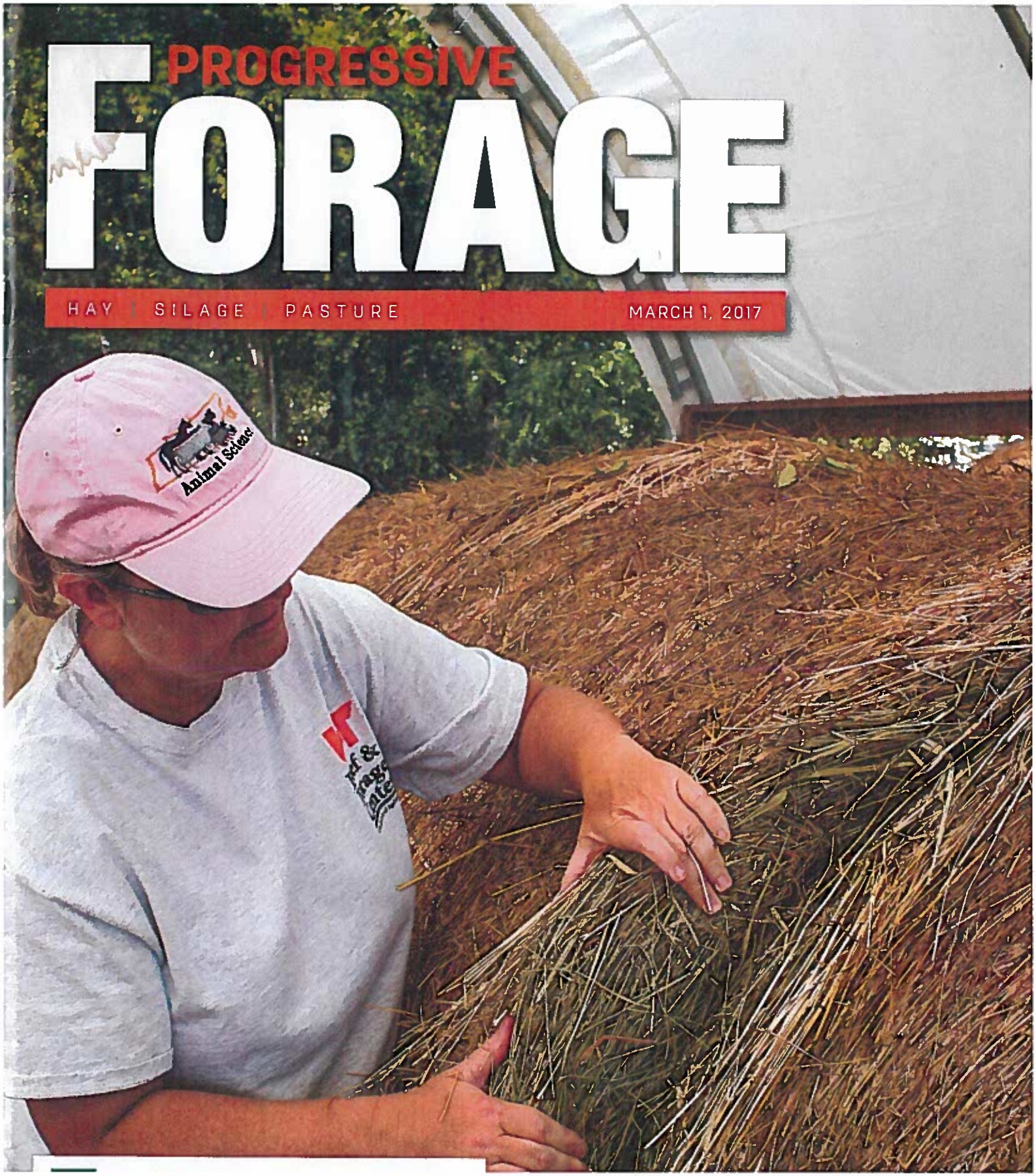

Silage inoculants: Are they worth the money?

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Forages represent a significant proportion of the feed costs of dairy production. The generation of high-quality silage is therefore important in determining the profitability of dairying. Addition of silage inoculants to freshly harvested forage can increase the likelihood of obtaining good-quality silage and should be viewed as an insurance policy for forage.

First-generation silage inoculants

First-generation silage inoculants contain homolactic bacteria such as *Lactobacillus plantarum*, which accelerate the decline in silage pH as a result of an increase in the production of lactic acid.

This rapid decline in pH prevents the growth of spoilage bacteria, yeasts and molds as well as stops respiration by forage plant cells, conserving the sugars in silage. This rapid decline in pH also reduces silage shrink during ensiling.

However, upon aerobic exposure of cereal silages, yeast can utilize lactic acid for growth, resulting in an increase in silage pH. At this point, both yeast and molds can rapidly utilize the sugars for growth, reducing the quality of the silage.

Bunk life of the silage can also rapidly decline, especially when ambient temperatures are high, so that feed value is lost before cows have a chance to consume the silage.

Second-generation silage inoculants

This problem led to the development of second-generation silage inoculants, which include bacteria such as *Propionibacteria spp.* and *Lactobacillus buchneri*. Generally, studies have shown inoculants that contain *L. buchneri* are more effective at improving the aerobic stability of silage than those that contain Propionibacteria.

Lactobacillus buchneri are heterolactic, degrading some of the lactic acid into acetic acid, which inhibits the growth of yeasts and molds, improving silage stability at feedout. Under these conditions, the bunk life of the silage can be extended, reducing the likelihood that it will deteriorate before consumption.

The rapid decline in silage pH characteristic of first-generation silage inoculants and the increased production of acetic or propionic acid associated with second-generation inoculants does not address one of the main constraints to forage utilization in ruminants: barriers to the digestibility of forage fiber.

Studies with second-generation inoculants show they have little impact on fiber digestibility across a range of silages. This is because these inoculants lack the enzymes to digest plant cell walls and, thus, there is no improvement in ruminal fiber digestibility during ensiling.

Third-generation silage inoculants

Third-generation silage inoculants have only recently been introduced to the market. These inoculants are targeted against ferulic acid, a compound that limits the digestion of forage fiber in ruminants, possibly by inhibiting the attachment and growth of the bacteria that are responsible for fiber digestion in the rumen.

Ferulic acid forms linkages between lignin and components of the plant cell wall that can lower the overall digestibility of the silage. Hydrolysis of these linkages increases the digestibility of fiber in the rumen and, as a result, may improve milk production.

Third-generation inoculants have been shown to improve the fiber digestibility of corn silage, but the variables that may influence this response have not been completely characterized. Ensuring that the enzymes responsible for breaking down ferulic acid remain active during ensiling may also pose a challenge.

Economics of silage inoculants

There are few published reports on the effect of inoculants on milk production in dairy cattle. In a series of 19 studies with corn silage, inoculants improved dry matter recovery by 1.3 percent and feed efficiency by 1.8 percent, and in 36 studies measuring milk production, positive responses were observed 47 percent of the time with an average increase of 0.37 gallon per day in studies that exhibited a statistical difference.

Of course, comparisons such as these must be taken in the context that rate of inoculant application, species of bacteria, moisture levels and diet composition differed markedly across studies.

In a series of 14 lactation studies, the inoculant *L. plantarum* MTD1 improved dry matter intake by 4.8 percent and milk production by 4.6 percent when it was applied to grass, corn or alfalfa. A single inoculant from a U.S. manufacturer was used in five lactation studies and in four studies with beef cattle; milk production increased by an average of 0.2 gallon per day and average daily gain by 11.9 percent.

Assuming that inoculants improved dry matter recovery by 1.25 to 2.5 percent and milk production by 0.02 gallon per cow per day, net returns were estimated at $5.76 and $14.40 per ton of corn and alfalfa silage, respectively.

Positive animal responses appear to occur more frequently with some inoculants than with others. Unfortunately, the majority of inoculants marketed have never been evaluated in animal studies. Further, the practice of extrapolating results from one product to another is scientifically invalid and likely no better than a random guess of the response that may be achieved.

For example, we found that average daily gain and feed efficiency of feedlot cattle were entirely different when alfalfa silage was inoculated with *L. plantarum* alone as compared with the same strain of *L. plantarum* in combination with *E. faecium*. In general, a product for which research exists to support growth or milk production claims is likely more reliable than one without such research.

Cost of forage is one of the most important factors dictating the profitability of dairy and background feedlot operations. Consequently, improvements in aerobic stability, digestibility of fiber and feed efficiency with third-generation inoculants could offer greater economic return than inoculants that simply improve the ensiling process. We are not aware of published lactation studies with these inoculants, but we have run experiments using third-generation inoculants applied to barley silage that was fed to backgrounding steers.

At a cost of $2 per ton of treated silage, inoculation of barley silage with a third-generation inoculant reduced the cost of gain by 6 percent, resulting in a net return of $10.70 per head. This increase in return on investment could greatly impact the profit margins of feedlot operations during backgrounding.

Fourth-generation inoculants – on the horizon

Fourth-generation inoculants are presently under development with the focus on delivering silage with the properties of third-generation inoculants along with probiotic properties that could deliver performance or health benefits to the animal. Some of these may target improvements in the intestinal microbiome within cattle.

A recent Canadian study found inoculation with strains of Saccharomyces did not affect the nutritional quality or aerobic stability of corn silage. Inoculation had no negative or positive impact on the microbial populations quantified or silage quality. Although yeast populations did not increase during the ensiling process, the inoculants survived the ensiling period to multiply during aerobic exposure so that the number of colony-forming units present were markedly greater than that in terminal silage.

Inoculating ensiled forage with yeast may be an effective strategy for on-farm production of selected direct-fed microbials as a component of a silage production system. Although strains of Saccharomyces alone would not constitute a fourth-generation inoculant, combining them with *Lactobacillus spp.* that enhance ensiling, improve aerobic stability and increase fiber digestion could generate a true fourth-generation inoculant.

Probiotic strains would have to grow to sufficient numbers within the silage to reach levels that were beneficial on the health or growth of cattle.

Conclusion

To make good-quality silage, one must have an appreciation of the plant and microbial and environmental factors that influence silage fermentation, all of which ultimately dictate the nutrient value and quality of silage.

Effectiveness of an inoculant depends on the type and viability of bacteria in the inoculant, the number and types of natural microbes on the forage, method of application, the characteristics of forage ensiled and the type of ensiling practice employed. These factors must be considered as an integrated package, as neglect of any one component can lead to a breakdown in the forage preservation process.

Silage inoculants can facilitate the ensiling process, but they are not a replacement for paying attention to the fundamental factors that are the keys to making good-quality silage. Advancements in inoculant science have produced inoculants that can improve the aerobic stability of silage and, in the case of third-generation inoculants, even the digestibility of fiber.

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