The bacterium and the butterfly

Based on an interview with Keith A. Bryan, PhD, Americas Technical Services Manager.

Improving microbial diversity on dairies with a lesson from chaos theory.

A butterfly flaps its wings in the Philippines just after lunchtime on a sunny Wednesday afternoon. As a result, a hurricane strikes the shores of North Carolina five weeks later, shortly before 6 a.m.

Known as the "butterfly effect," this popular metaphor illustrates a central premise of chaos theory, a field of mathematical study that focuses on the behavior of complex systems. The idea is that the initial conditions of these systems are highly sensitive, so small and seemingly insignificant changes can make a big difference. In other words, if the butterfly hadn't flapped its wings at exactly that time and place, the hurricane — if it happened at all — could have had an entirely different trajectory.

In reality, a butterfly flapping its wings is unlikely to influence the weather. But according to technical services manager Keith A. Bryan, Ph.D., nature — particularly microbiology — is full of examples of the butterfly effect in action. And to see its effects, he says, dairy producers need look no further than their own farms.

"Let's suppose you're making alfalfa haylage," Bryan explains. "First of all, there are all kinds of naturally existing organisms in the field. But then you have to mow, wilt, merge and chop the alfalfa, and then you have to ensile and feed it. Every step in the process changes the microbial population on the crop in a somewhat unpredictable way. This, in turn, affects the quality of the silage, and as a result, the health and performance of your cows."

Microbial challenges require microbial solutions

This idea — that tiny changes on the microbial level can have a major impact on animal health and production parameters — is supported by substantial scientific evidence, including lab and field studies conducted by Chr. Hansen. Based on this evidence, Chr. Hansen has developed a new concept of microbial diversity in dairy production, which Dr. Bryan presented to an audience of around 70 invited nutritionists, veterinarians, consultants and researchers at this year's World Dairy Expo in Madison, Wisconsin, USA.

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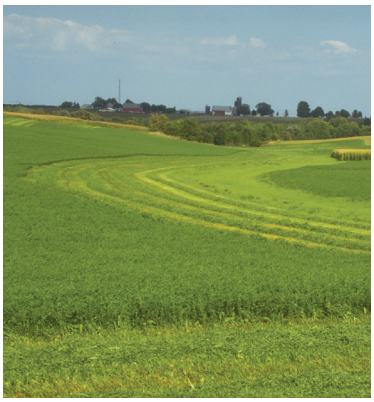
"Recent research has characterized and quantified the microbiomes of numerous genera, species, organs and tissues," Dr. Bryan says. "The next logical step is to describe the changes in microbial diversity that occur to the core and supporting microbiomes as various perturbations are imposed, including disease onset and mitigation and changes to nutrition and the environment.

"Furthermore, with the anticipated reduction in chemical anti-microbials in the near future, we will be confronted with more microbial challenges, not fewer. Microbial challenges require microbial solutions, and this message is at the heart of our new effort to provide nutritionists, veterinarians and producers with the knowledge and tools they need to promote healthy and productive microbial diversity on dairy farms."

Microbial diversity

According to Dr. Bryan, the concept of microbial diversity applies as much to dairy cows as it does to the food they eat.

Going back to the alfalfa silage example, Dr. Bryan says fermentation depends on microbial processes that produce lactic acid, lowering silage pH and preserving it for future feeding. However, these processes can easily be derailed by, say, exposure to oxygen or overgrowth of yeast, leading to spoilage and reduced palatability. By enhancing lactic acid production while limiting oxygen and yeasts, microbial silage inoculants have been shown to improve fermentation — resulting in less waste, better feed quality and higher milk yields.



Growing, harvesting and storing crops affects their microbial diversity, which in turn affects feed quality and animal performance.

The diversity of the cow's own microbiome is also critical to maintain, Dr. Bryan adds, particularly in the rumen and lower gut.

"A healthy microbial balance is essential to the health and production performance of dairy cows, but it can easily be upset by disease challenges, treatment interventions, and environmental and nutritional factors," Dr. Bryan explains.

"Microbial feed additives can help restore this balance by increasing the number of specific strains of beneficial bacteria, while limiting the growth of pathogens through competitive exclusion. The result is improved integrity and function of the rumen and gut, enhanced feed efficiency and increased milk production and components."

Strains matter

The carefully screened and selected bacteria used in silage inoculants and microbial feed additives are natural, but that doesn't mean that all bacteria of the same species are identical, Dr. Bryan emphasizes.

"In the microbial world, strains matter, just like breeds and families within those breeds matter in the dairy cattle world," he states.

Considering that bacterial species can have hundreds of different strains, the challenge of selecting the most effective ones for use in dairy production is a significant one. But with more than 140 years of experience in the microbial business — combined with the industry's largest collection of bacterial strains — Chr. Hansen is in a unique position to advance the microbial diversity paradigm.

"Our mission is to apply our expertise in microbial science to enhance our understanding and applications of microbial diversity in dairy production," Dr. Bryan says. "With this knowledge, our goal is to help the dairy industry gain greater control over the literally microscopic things that end up making a big difference."