



The Rumen Microbiome

Dairy Cow Health, Productivity, and the Importance to Our Food Supply

BY JANE SIMONE

The word “sustainable” has become part of the daily lexicon – we hear it routinely as it applies to numerous aspects of our lives. Probably one of the most important areas of sustainability is the global food supply. As the global population continues to grow, and is predicted to reach anywhere between 8.3 and 10.9 billion people by 2050, the availability of nourishing food for everyone is increasingly worrisome. Among the many scientists bringing their considerable intellects to bear on the problem are veterinarians, and Penn Vet is doing groundbreaking research designed to find ways not only to make animals healthier and more productive, but also to impact the related issues of animal nutrition, compromised feed supplies, and environmental degradation.

Research being conducted through the Center for Research on Microbes in Health and Disease by Dr. Dipti Pitta, Assistant Professor of Ruminant Nutrition at Penn Vet's New Bolton Center, focuses on improving food animal productivity through the study of ruminant nutrition and microbiology. She has worked extensively with farmers in such diverse countries as India, New Zealand, and the US on matters related to nutrition. That background and the research findings that emerged from her work are directly applicable to improving agricultural land use and animal production.

Why is this necessary? In developing countries, populations are growing, the demand for protein continues to rise, and communities will need to ensure improved health of

their livestock as well as the protection of ever-diminishing land, crop, and water resources. Dr. Pitta sees a direct connection between a ruminant animal's ability to process food – as a result of the very complex microbiome present in their digestive tracts – and the potential to have the animals thrive on food sources unsuitable for humans, thus protecting crops for human consumption while growing healthy food animals as a protein source. In simple terms, perhaps the microbes normally present in a ruminant's belly could break down plants traditionally thought of as indigestible, thus reducing the need to feed grains, which could then be reserved for human consumption.

Dr. Pitta is also looking at both the good and bad aspects of the microbial populations, or microbiomes, in animals because it is increasingly important to understand how they change with the animal's diet, production phase, and environment. Her goal is to identify the role players that are important for production and eliminate invaders that could be of least value, such as pathogens that can contaminate food products. Clearly, a sick animal without any clinical symptoms will be much less productive than a healthy one, and where groups of animals are herded together, the problem is exacerbated if infections spread. All of these considerations are critical to herd health, to the quality of the meat and milk produced, and thus to the human populations dependent on these animals for nourishment.

As a ruminant, the cow's digestive tract offers a rich source of information pertinent to the study of microbial



Top: Agricultural System and Microbial Genomics Laboratory at New Bolton Center; Bonnie Vecchiarelli extracts DNA.

Bottom: Bonnie Vecchiarelli performs PCR prepwork; a thermal cycler.

environments. Dairy cows are more prone to metabolic problems immediately after calving, as the animal has to adapt quickly from a non-lactating to lactating phase. The “dry” cow’s nutritional needs are much less than those producing milk, so lactating cows are generally fed a much higher energy diet than dry cows. Dr. Pitta is studying the effect of changes in diet and metabolism that occur during the transition from dry to lactation period on the microbial populations, as these are the mechanisms that drive the fermentation processes to release substrates required for producing milk.

Simply stated, this research is important on a number of levels. First, can the understanding of the ruminant’s inherent gut microbiome tell us what and how to feed them to improve milk production? Secondly, will that understanding make it possible to come up with new genes or enzymes that can target locally available, less expensive, and alternative food sources for the animal’s maintenance and production? Thirdly, will it allow us to understand how diseases erupt in an animal that are related to diet or metabolic shifts, thus leading to the ability to either prevent disease or treat it more rapidly and effectively? If so, we have the chance to raise more animals – and *healthier* animals – on less than in years past.

As a by-product, we may then be able to reduce greenhouse (methane) gas emissions, since ruminants are the primary source of such gases, as well as environmental

degradation through nutrient waste, and the exponential diminishing of forests and grasslands as a result of poor husbandry practices.

Veterinarians are critical to maintaining a safe and adequate food supply for everyone. Dr. Pitta’s work through the Center for Research on Microbes in Health and Disease and the Center for Animal Health and Productivity at New Bolton Center is one manifestation of veterinary medicine’s contribution to that effort. Her research findings have the potential to significantly change the way dairy cattle are fed and handled in developing countries, leading to healthier animals and better productivity. At a time when the sustainability of the world’s food supply is in question, her unique approach to helping solve the problems of food animal productivity is not only important – it is vital. An ancient Indian Upanishad (a philosophical text forming the theoretical basis for the Hindu religion) says, “All that is born is born of *anna* (food). Whatever exists on earth is born of *anna*, lives on *anna*, and in the end merges into *anna*. *Anna* is indeed the first born amongst all beings.”

Dr. Pitta is applying 21st century knowledge and expertise to the fundamental element of all life’s survival – food. Her work, and that of many colleagues at Penn Vet and around the world, will bring optimism and solutions to the problems surrounding the future of the planet and its inhabitants – both animal and human. 🍷