Update on UVM research:
Ecology of bedded pack systems on organic dairy farms

"Integrated bedded pack management and fly control reduce mastitis risk by promoting a beneficial teat skin microbiome"

The University of Vermont

Project investigators: **Tucker Andrews, Plant and Soil Science – tucker.andrews@uvm.edu**
Deborah Neher, Plant and Soil Science – deborah.neher@uvm.edu
John Barlow, Animal and Veterinary Sciences - john.barlow@uvm.edu

Project summary:
We surveyed the microbial community of bedded packs on four Vermont farms for four months, additionally measuring the bedded pack of a fifth farm for one year as well as cow quarter milk and teat skin over three summer seasons. Our goals were to 1) identify and compare fungi and bacteria between mastitic and healthy udders, 2) compare bacteria and fungi between multiple different styles of bedded pack, and 3) Identify potential micro-arthropod predators of fly pests in bedded pack.

Our observations included:

- Bedded pack provides habitat for multiple genera of mite that prey on fly larva.
- Bedding material (sawdust vs straw/hay) and management technique (mechanical aeration, temperature) effect the microbiome of the bedding.
- Teat skin microbiome of mastitic and healthy quarters are similar.
- Intramammary gland (milk) microbiome differs between mastitic and healthy quarters.
- Taxa driving the difference between the healthy and mastitic intramammary community are also observed in bedded pack.
- Fungal and bacterial taxa potentially related to mechanisms of resistance are found in both bedding and the mammary gland.

Macrochelidae *Glyptholaspis spp.* – A predatory mite for possible fly bio-control found on bedded packs

Your bedding may promote beneficial microbiota and micro-arthropods.

Acknowledgments:

- **This project was funded by the UVM Dairy Center of Excellence competitive research funding program https://www.uvm.edu/cals/dce/**
- **We acknowledge the technical support provided by Thomas Weicht, Michael Leduc, Olivia Schrantz, Jessica Henley, Helen Keen, Natalie Banacos, Mandy Erdei, and Robert Mugabi.**
- **We appreciate the cooperation of the 5 organic dairy farms who allowed us to sample their bedded packs and cattle.**

Definitions and Concepts:

Beneficial microbes – When someone mentions fungi, bacteria and viruses, are your first thoughts of pests? The agents of disease? We all recognize the beneficial microbes in the soil, in compost rows, in fermentation, in your cows' rumens. The potential contributions of microbes to animal and human health is being recognized and one of our future goals is to identify microbes that may benefit udder health.

Colonization – In the context of our work, this is the act of a microbe establishing itself in a specific local environment. Colonization is the first step toward infection for potential pathogens, but not all microbes that colonize a tissue (such as a body site on your cow) are pathogens. Physical factors in the local environment (e.g. pH, nutrient availability, temperature) influence the community structure of the microbes that colonize your bedded pack materials and your cows' skin. One of our future goals is to identify these physical factors.

Commensalism vs. **Mutualism** vs. **Parasitism** – These are all types of **symbiosis** (the ecological relationship between 2 organisms). *Parasitism*, one organism benefits and the other is harmed; you likely have a concept of parasites focused on the macro-parasites such as gastro-intestinal parasites, or the biting flies. Disease causing fungi, bacteria and viruses are broadly described as parasites. *Mutualism*, both organisms benefit. *Commensalism*, one organism benefits and the other is unharmed. Recent work suggests that those beneficial gut bacteria we describe as commensal organisms may be better described as mutualists. One long-term goal of this project is to identify the beneficial microorganisms to reduce parasite burdens in organic dairy herds.

Dysbiosis – A term used to describe an imbalance in the microbial community, typically used in the context of human or animal health, where the dysbiosis is associated with a disease state. In humans, inflammatory bowel disease (IBD) is thought to be associated with an imbalance in the gut microbial community. Our research is exploring the possible presence of a milk microbial community, and whether mastitis is the result of a dysbiosis.

Inflammation – a tissue or cellular reaction to injury or infection; there are 5 signs of inflammation, (heat, swelling, pain, color change/redness, and loss of function). Mastitis is inflammation of the mammary gland, which can be caused by multiple factors, and the most common cause are bacterial infections.

Intramammary Infection – infection of the mammary gland is most commonly caused by bacterial. Intramammary infection typically leads to mastitis. Hundreds of different organisms are able to cause intramammary infection; the most common bacterial species are *Staphylococcus aureus*, the coagulase negative staphylococcoci such a *S. chromogenes*, *Streptococcus agalactiae*, *Streptococcus uberis*, *Streptococcus dysgalactiae*, *Escherichia coli* (*E. coli*) and *Klebsiella* species. It can be helpful to understand the common causes of intramammary infections on your farm, as that can help you decide how to target control.

Mastitis – Inflammation of the mammary gland. Mastitis can be described as **clinical** (cases where you observe obvious signs of mammary gland inflammation, such as abnormal milk or swelling of the gland, or fever) or subclinical (cases that do not present obvious signs). **Subclinical mastitis** is typically identified by an increased milk somatic cell count (SCC), which can be measured by cell counting or by the California mastitis test (CMT). Mastitis can also be classified by the most common source of bacteria causing an infection. For **contagious mastitis,** the source of new infections is other infected cows in the herd and spread is often at milking time by contamination of the milking unit or milker's hands. Milking hygiene and segregation or culling are important for control of contagious mastitis. *Staph aureus* and *Strep agalactiae* are two organisms that commonly cause contagious mastitis. For **environmental mastitis,** the source of new infections is the cow's environment. The organisms that cause environmental mastitis, (*E. coli*, *Klebsiella*, the environmental Streptococci) are often found in manure, so barn hygiene and bedding management are especially important for control. A goal of our research is to understand how bedding management may influence mastitis risk on organic dairy farms.

Macrobiota – organisms that can be seen with the naked eye; in the context of this study we mean the tiny invertebrates inhabiting the bedding and soil on your farm.

Micro-arthropods – in the context of this study we mean the microscopic invertebrates inhabiting the bedding and soil; some of these may be predators of fly larvae. A goal of our work is to identify these beneficial "insects."

Microbiota – microorganisms associated with a particular location or environment or sample.

Microbiome –microorganisms, genes, and their products (proteins, metabolites) in a particular environment or sample.

Metagenome – genes and genomes (collection of genes) of a microbiota