The American Heritage Dictionary defines environment as “the combination of external physical conditions that affect and influence the growth, development, and survival of an organism or group of organisms”. Relative to bovine mastitis, the environment influences both of the principal groups of participants: bacteria and cows.

Specifically, environmental conditions will affect the rate and magnitude of bacterial growth in the cows’ surroundings. The other primary factor determining the incidence of environmental mastitis is the mammary gland host defenses. The same environmental factors that increase the growth of common mastitis pathogens often have a negative effect on mammary defenses.

The Bacteria’s View

The primary environmental mastitis pathogens include Escherichia coli, Klebsiella pneumonia, and Streptococcus uberis. These bacterial species require organic material to utilize as food. Bedding materials commonly used for lactating and nonlactating cows provide an excellent environment for propagation of mastitis pathogens.

Populations of the bacteria in bedding are related to the number of bacteria on teat ends and rates of clinical mastitis. Therefore, reducing the number of bacteria in bedding generally results in a decrease in environmental mastitis.

Coliforms and streptococci cannot live on teat skin for long periods of time. If these bacteria are present in large numbers on teat skin, it is the result of recent contamination from a source such as bedding. Thus, the number of these bacteria on teat skin is a reflection of the cow’s exposure to the contaminating environment.

One of the environmental factors that has the greatest impact on bacteria in the cows’ surroundings is the choice of bedding materials. The bacterial view of life apparently is very simple: eat, drink, and reproduce. Unfortunately, many materials used to bed dairy cows allow for bacteria to accomplish these meager goals with astounding proficiency. Many organic materials provide adequate nutrition for both coliforms and environmental streptococci to reach populations in excess of 10 million colony forming units per gram of bedding.

Common organic bedding materials such as sawdust and straw usually contain very few mastitis pathogens before use as bedding. However, mastitis pathogens that contaminate the cows’ environment establish residence in the bedding and often reach maximum populations within 24 hours after fresh bedding is added to stalls. The rapid increase in bacterial populations often preclude the soiled appearance of bedding. Therefore, the gross appearance of bedding has little correlation with bacterial load.

Bacterial populations tend to remain constant for up to 7-to-10 days, then start to decline due to the exhaustion of nutrients in bedding. The common practice of adding “fresh” bedding to stalls or manure packs replenishes the essential nutrients and maintains bacterial populations.

Particle size of bedding influences bacterial populations. Finely chopped materials support greater bacterial numbers than the same bedding with larger particle...
rates of coliforms and environmental streptococci are greater during warm, wet weather. The effects of season on bacterial populations in bedding are quite dramatic in regions that experience a wide variation of temperatures within a year. In general, the impact of bedding on exposure of cows in confinement housing decreases during cold weather and increases as temperatures and humidity increase.

Previous trials have shown a strong correlation between bacterial counts in bedding and both ambient temperature and relative humidity. Therefore, proper ventilation of barns is essential to moderate the effects of heat and humidity in housing areas.

Climatic factors affecting exposure in herds where cows are maintained on dry lots differ from those of traditional Midwestern and Eastern herds. Dry lots are used primarily in hot, arid areas where temperatures are seldom below freezing for an extended time. In these areas, the rainy seasons of late Fall through early Spring are when bacterial populations are greatest. Manure in dry lots during the Summer tends to be desiccated, thus limiting the moisture essential for bacterial growth.

The Cow's View

Much like bacteria, the primary goals of a cow are to eat, drink, and to continue propagation of the species. The latter of these is an environmental factor that greatly affects the incidence of mastitis.

Parturition, lactation, mammary involution, and lactogenesis (initiation of milk secretion) are each reproductive events that influence the susceptibility of the mammary gland to infection. Rates of new intramammary infections caused by environmental streptococci and coliforms are greater during the dry period than during lactation. During the dry period, susceptibility to intramammary infection is greatest the two weeks after drying off and the two weeks prior to calving.

Many infections acquired during the dry period persist to lactation and become clinical cases. Research has shown that 65% of coliform clinical cases that occur in the first two months of lactation are from intramammary infections (IMI) that originated during the dry period.

Streptococcal infections during the dry period account for 56% of clinical cases during the first two months after calving. Rate of intramammary infections during lactation is highest at calving and decreases as days in milk advances. (Figure 1.)

Therefore, the thrust of herd management strategies for controlling environmental mastitis should focus on reducing intramammary infections during the dry period and early lactation.

Housing and other environmental concerns for dry and maternity cows often are precluded by the comfort and housing needs of lactating cows. However, given the impact of intramammary infections acquired during the dry period on the subsequent lactation, providing cows with a clean and dry environment is not limited to during lactation.

Dry cow and maternity facilities should be managed similar to lactating cow housing. Dry cow areas should be well drained and free of excess manure. Dirt covered areas can expose cows to pathogen levels comparable to those in free stalls. Box stalls and loose housing areas should be cleaned to the foundation base regularly. Manure packs are to be avoided because they generally contain extremely high counts of pathogens dangerous to both dam and calf.

Bedding Management

The bedding material that we recommend most for controlling environmental mastitis is washed sand. Ideally, bedding should be inorganic materials that are low in moisture content and contain few nutrients for bacteria to utilize.

Washed sand has little nutritive value to common mastitis pathogens, thus limiting their growth. Washed sand consistently contains fewer mastitis pathogens compared with organic materials such as sawdust, recycled manure, straw, and dirt.

On-farm separation sand from manure by mechanical devices or passive settling in ponds has gained popularity as a means to reduce hauling charges and allow the recycling of sand. Care must be taken to assure the reclaimed sand has minimal organic contamination. A rule of thumb is the ash content of sand (estimate of organic load) should be below 3% for use as dairy cow bedding.
Many free stall barns are forced to use organic bedding materials that are compatible with liquid manure handling systems. There appears to be little advantage in using one organic material over the use of another.

For example, straw tends to have highest streptococcal counts, while sawdust and recycled manure have highest coliform counts in comparisons among these bedding materials.

Recycled manure bedding has regained popularity as dairies strive to be more ecologically responsible by separating manure solids and installing methane digesters. Recycled manure solids often have bacteriological properties similar to those of sawdust when used as bedding. Composting and heating recycled manure and sawdust can initially reduce bacterial populations before use as bedding, however these treatments have minimal effect on reducing teat end exposure after 24 hours in free stalls.

Any material to be used as bedding should be stored in a dry area to prevent saturation by rain and ground moisture. Composting organic materials such as manure is an effective way to reduce bacterial counts before use as bedding. However, although many organic bedding materials have relatively few mastitis pathogens prior to use, the pathogen populations often increase 10,000-fold within a few hours when used as bedding.

Fresh bedding tends to absorb moisture from the cows’ environment for use by the great number of bacteria that are constantly present in manure and soiled bedding.

Regardless of the bedding used, removing wet and soiled material from the back one-third of stalls will significantly reduce the bacterial counts. Stalls should be raked a minimum of twice daily when animals are moved to be milked. Spraying bedding with disinfectant and adding powdered lime or conditioners to bedding have met with little practical success in reducing bacterial counts.

These practices cause an initial decline in bacterial populations, but pathogen numbers quickly recover. Twice a day application of powdered lime may be necessary to sustain an advantage in lowering bacterial numbers. Avoid standing water and mud in free stalls, holding areas, and corrals.

Dirt and manure covered corrals are commonly used to house cows in semi-arid and arid areas. Exposure to pathogens generally is low during the dry seasons as moisture content of the dirt-manure mixture is low.

However, as density of cows increase under shade structures and around feeding areas and water troughs, excess wet organic matter should be removed or spread out to be dried. Cows’ access to dirt-manure lots should be limited during rainy seasons. Outbreaks of coliform mastitis are common during rainy seasons when cows are exposed to dirt-manure lots and alleys leading to the milking parlors.

**Conclusions**

An old, but popular, mastitis cliche is that environmental mastitis control is based on keeping cows clean, dry and comfortable. While this is true, the other half of the mastitis equation must also be accounted. Mastitis pathogens must be kept cold, thirsty and hungry.

Engineering decisions and husbandry practices should consider the importance of maintaining cow comfort and a healthy immune system while simultaneously minimizing pathogen populations in the environment.
Nutrigenomics and Gen-Active Technology™
Target Improved Herd Health

By David Calabotta, Ph.D.
Vice President Marketing and Business Development
Prince Agri Products, Inc.

A new science referred to as Nutrigenomics, which has emerged as a result of significant developments in genetic research, is evaluating the role of some non-traditional nutrients in maintaining a healthy immune system.

Through the use of microarray technology, we can now study the impact of nutrients on specific genes and their genetic expression. Subtle changes in animal diets can “turn on” or “turn off” specific genes responsible for cellular health. This gene regulation in turn impacts the overall health of the animal.

Nutrigenomics is now making its way out of laboratories and onto the farm, where improved knowledge about the role of dietary nutrients in activating gene expression is having an impact on herd health and productivity.

Prince Agri Products has harnessed these key, scientific findings from this revolutionary new science through its Gen-Active Technology™ platform and is using it to develop innovative nutritional products designed to support normal animal health.

A healthy immune system is paramount in protecting dairy cows against bacterial pathogens while reducing a wide range of diseases associated with these pathogens.

The Immune System of Ruminants

The immune system in the dairy cow consists of two distinct but interactive systems. The innate system is comprised of natural barriers (skin, stomach acids, enzymes, etc.) and white blood cells (neutrophils and macrophages) which continually monitor for sites of infection and pathogens and are the “first responders.” The adaptive or antibody system consists of other types of white blood cells whose function is to provide “long-term” protection against disease through the production of pathogen-specific antibodies.

Benefits of a Properly Functioning Immune System

The benefits of a healthy immune system are many, and include reduced mastitis and metritis, lower somatic cell count, less death loss and culls, better reproductive efficiency and increased milk production. Proper management and good nutrition can help reduce the occurrence of disease in your herd, which can result in lower treatment costs and more days spent in profitable milk production, which can increase your total dairy income.

Estimated Economic Impact of Disease

<table>
<thead>
<tr>
<th>Disease</th>
<th>Average $/case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mastitis (a)</td>
<td>$300</td>
</tr>
<tr>
<td>Metritis (b)</td>
<td>$285</td>
</tr>
<tr>
<td>Abortion (a)</td>
<td>$200</td>
</tr>
<tr>
<td>DA's (a)</td>
<td>$340</td>
</tr>
<tr>
<td>HBS (a)</td>
<td>$2500</td>
</tr>
<tr>
<td>Dead Cows (c)</td>
<td>$2500</td>
</tr>
</tbody>
</table>

[c] Estimated Replacement Costs