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Practical Hygiene and Disinfection on Dairy Farms

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INTRODUCTION

The production and processing of safe, wholesome and high quality milk obviously begins on the farm. Today's consumer expects that the milk they consume is not only of high quality and safe to drink with extended shelf life. They also expect milk to come from animals that are raised with the utmost care concerning their health and welfare. Increased pressure will continue to be put on the milk supply chain to deliver products that are produced from animals managed in this fashion that results in milk and milk products with the quality, safety (free of pathogenic microorganisms), and shelf life parameters in mind. "The further dairy products and milk-derived ingredients are moved and the longer the time of storage, the more important milk quality becomes" (Dave Barbano, Cornell University).

There is a need for the industry, in this case, the dairy industry; to increase measures for disease control and food safety. The number of animal diseases and food safety issues, which are of concern to the dairy producer, are numerous. *E. coli* 0157:H7 and Johne's Disease provide a good example of the magnitude of the current problem. As an example, *E. coli* 01 57:H7I prevalence in cattle has been documented in several studies. In a recent study by Hancock, 63 percent of feedlots and 75 percent of dairy farms showed at least one positive fecal sample. Also, a limited amount of research indicates that farms traced to a human disease had a significantly higher number of positives. A survey of the farm environment indicates not surprisingly, a high percentage of positives in feces.

E. coli 0157:H7 and *Salmonella* are for the most part asymptomatic in cattle but are major food safety concerns. The only way to significantly reduce the incidence of foodborne disease is to provide effective intervention strategies along the entire food chain. Today there is a great deal of effort to improve procedures at the processor level. In addition, the intervention efforts at the food service and food retail level are increasing. However, very little is being done at the production level, where in fact, many of the organisms of concern actually enter the food chain. HACCP (Hazard Analysis and Critical Control Points) has been implemented in processing plants and food service establishments. Since many pathogens enter the food chain at the production level, we believe it is only a matter of time until HACCP becomes mandated at the farm level.

There are many factors that lead to a safe and wholesome milk product and healthy animals. These include, but are not limited to, cow genetics, udder health, animal housing and husbandry, equipment maintenance, on-farm sanitation, pest and animal control, and many others.

This module will address practical hygiene and disinfection on dairy and calf production facilities. Total farm sanitation influences the quality of our milk supply. However, quality begins before the cows' are milked. Sanitation can be as much of an attitude as it is a process. There are simply differences in people and their perspectives on what is clean or not clean. For many, I would argue that their goals are to profitably and sustainably produce high quality, safe, milk and meat products. In addition, regulatory influence regarding public health standards and positive market influence, like quality premiums, can have a significant influencing factor. It is just a difficult environment at times as the process of sanitation is multifactoral and includes many elements that can potentially foster and spread potentially harmful organisms to animals and people. A sanitation program based on both safety and quality is the best choice for producers that are committed to their customers, workers and the environment.

One doesn't need to go far to examine potential benchmarks regarding sanitation programs in livestock production. Examining both the swine and poultry industries can give us a reasonable comparisons of the level of sanitation and hygiene that may be necessary for our industry and addressing the consumer concerns mentioned above. The single greatest driver of this level of sanitation would seem to simply be the health of the animals and crisis avoidance. Dealing with diseases such as pseudo rabies in swine and avian influenza in poultry through depopulation can put a serious dent in on-farm profitability. Therefore, implemenation of concepts like "shower-in/shower-out" have become the norm in large swine operations and at the least the breeder farms in poultry. In addition, particularly in poultry, influence toward decreased use of antibiotics have caused integrators and growers to rethink their disease control programs and sanitation is taking a leading role in that regard. In fact, the largest meat company in the world, Tyson, said in 2002 that, "it has cut back on antibiotics that are similar to those used on humans, and now uses only two when a flock is at risk of disease." New York Times article, February 10th, 2002

In general, dairy production facilities are far from this level of sanitation despite that fact that they are becoming increasingly vulnerable. Driven towards gaining efficiencies, they continue to contain larger numbers of animals in concentrated areas; many producers purchase or move animals between facilities, and frequently depend on outside sources for supplies. Larger herds are seemingly more at risk, but we also must realize that many producers' livelihoods are dependent on the health of their herd. So from a loss of income or livelihood standpoint, any sized herd is a risk.

CLEANING, SANITIZING AND DISINFECTING

Bacteria are everywhere, in soil, in water, on humans and animals and on plants. So it is very likely and very easy for bacteria to contaminate our food, especially milk. Bacteria will not grow however unless they have the proper conditions to reproduce. And, like humans, they require six factors to grow: water, nutrients (food), proper temperature, proper pH, air and lack of inhibitors such as sanitizers or chemical preservatives. Bacteria, once in an ideal environment, will multiply.

Bacterial Reproduction

Unlike humans or higher forms of life, bacteria can reproduce from one organism, or double. This process is known as binary fission, one becomes two, two become four, four become eight and so on. The time for one organism to double (become two) is called the generation time. The generation time can be 20 – 30 minutes, or for some bacteria, it can be as short as about 10 –12 minutes. In a very short period of time one bacterium can produce millions of bacteria. Sanitation is one means of keeping the population of microorganisms low.

Under ideal conditions, bacteria will grow in phases and in a short time will be very high in population numbers. The first phase, called the lag phase, typically lasts three to four hours. During this time, binary fission occurs relatively slowly as the bacteria adapt to their environment. After that, they reproduce faster and faster-this is known as the logarithmic growth phase- and contamination becomes more difficult to control. Eventually they will reach a plateau, called the stationary phase, where the population remains stable. Finally, after exhausting nutrient sources or other keys to survival, they enter the death phase and the population declines. The key to food safety, quality and sanitation is to keep the bacteria in the lag phase. One of the ways to do this is to use the six growth factors temperature, moisture, air, pH, inhibitors and water as a means of control.

Temperature

The growth and survival of bacteria is dependent upon temperature. Refrigerated temperatures slow the growth rate of bacteria considerably, while freezing can stop growth. Freezing does not necessarily kill bacteria. High temperatures will kill all organisms if the temperature is high enough for a long enough period of time. Many food processes are dependent upon elevated temperatures to kill potentially harmful bacteria. (i.e. pasteurization)

Like humans, bacteria have preferred temperatures for survival and growth. Each species of microorganism has an optimum growth temperature, a minimum growth temperature and a maximum growth temperature. Organisms that grow best at 69 – 113 degrees F (20-45 degrees C) are termed mesophiles, or mesophilic bacteria. The optimum growth range for mesophiles is 86 – 98 degrees F. Psychrophilic organisms grow best at cooler temperatures while thermophilic organisms prefer temperatures above 113 degrees F. There is overlap in these temperature ranges. For instance, mesophilic organisms may grow at colder temperatures, and are called psychrotrophic organisms. The psychrotrophs are significant to the dairy industry because they can grow at refrigerated temperatures. Heat is often used as a means of destroying microorganisms. Some organisms are tolerant of minimal heat processes and these are called thermoduric organisms.

Water

Bacteria cannot grow and multiply without water. Water is necessary to help transport nutrients into the cell and to assist transport of waste out of the cell. Likewise, sanitizers diluted in water are allowed to enter the cell or interact with the cell to kill microorganisms. Obviously, milk contains a high level of water and thus is very susceptible to spoilage due to microorganisms. This is why dried foods such as crackers, cereals and dried fruits can be stored without refrigeration.

Air

Microorganisms, including bacteria, are also grouped according to their requirements for oxygen. Some grow only in the presence of oxygen and are called aerobes. Anaerobes grow only in the absence of oxygen.

pH

pH is a measure of the relative acidity or alkalinity of a fluid, with a range of 1-14. A pH of 1 is highly acidic while a pH of 14 is highly alkaline. Most bacteria prefer the middle ranges of pH, near 7. Some bacteria, notably the lactic acid bacteria, produce lactic acid which lowers the pH. In milk systems, this results in fermented products such as cheese and yogurt. Yeast and mold grow over a wide pH range. The pH of raw milk is 6.7 which allows the growth of most bacteria.

Inhibitors

Chemicals such as sanitizers can inhibit or slow the growth of microorganisms. In fact, some chemicals are put directly in food products to inhibit the growth of bacteria and fungi and are called preservatives. An example is sorbic acid and benzoic acid. For milk, antibiotics can be inhibitors and is closely monitored by processors.

THE SANITATION PROCESS

With the variety of detergent choices that are available, a basic understanding of cleaners and sanitizers is beneficial to achieving this goal.

Five factors impact the choice of detergents and the sanitation process:

1. The type or nature of the soil to be removed different soils require different cleaners

2. More than 99% of the cleaning solution is water so it is important to understand how water quality can impact the cleaner.
3. The surface or material to be cleaned what the material is composed of, plastic, rubber, stainless steel and the surface condition (smooth, rough, pitted) will need consideration.
4. Detergent application method there are a variety of methods to apply detergent and clean surfaces; manual, clean-in-place (CIP), foam cleaning and spray cleaning.
5. Environmental considerations all cleaners and sanitizers eventually enter the waste treatment system, whether public or private waste treatment. Restrictions on effluent may apply.

Soils

Soil on dairy equipment consists of any material that in undesirable to producing safe, quality and wholesome milk products. Soils can be visible or invisible. Invisible soils include the microorganisms, which cannot be seen with the naked eye. Visible soils on equipment surfaces can be dirt, deposits, residues or films, all of which must be removed. Anything that contacts equipment surfaces causes soiling, which can result in a soil complex, which can vary in composition. Predominant soil complexes on dairy equipment are the residues from milk and water, but can also include soils from personnel and other sources.

Milk soils, which are found on equipment, are comprised of fats and proteins, which can be removed with alkaline detergents; minerals, which are, solubilized with acid detergents and carbohydrates, primarily sugars, which can be removed with water. Milk is primarily water, but also contains protein (3.4%), fat (3.7%), sugar as lactose (4.9%) and minerals (0.7%). Proteins are one of the more difficult soils to clean from equipment. For removal of protein soils depends on several factors nature of the protein degree of denaturization of the protein (physical change due to heating) the condition under which the protein is deposited.

Fresh unheated milk is easily removed by rinsing. But if the milk soil is allowed to dry on the surface, a more aggressive cleaning treatment is required. Low temperature water (below 140 degrees F) with detergent may not be sufficient to remove protein deposits. As the temperature of the cleaning solution drops during the wash cycle, proteins can gel and deposit on surfaces. These deposits cannot be removed with rinses. Detergents at the proper temperature can prevent protein deposits. The detergent solution temperature will be dependent upon the cleaning method, manual versus mechanical. For mechanical cleaning, wash solution temperatures should be in the range of 140 to 160 degrees F. Temperature of 160 degrees F is preferred. It is important to monitor the return temperature to confirm that the entire circuit being cleaned was at the appropriate temperature. Manual cleaning is done at lower temperatures than mechanical because workers cannot tolerate higher water temperatures on the skin.

Alkaline detergents will dissolve proteins and are generally are the product of choice. Oxidizers, such as sodium hypochlorite are often added to alkaline detergents. Oxidizing agents will hydrolyze the protein breaking it into smaller components, which are more easily dissolved. The chlorinated alkaline detergents often are employed. Enzymes, specific to proteins, which are termed proteases, also may be used to remove protein soils. Proteases also hydrolyze proteins, and provide an option for equipment that cannot withstand harsh alkaline or acid cleaners.

- Lactose (milk sugar) is a carbohydrate soil that is easily removed with warm water. The cleaning process should remove milk carbohydrates.
- Fats are present in milk as an emulsion. The primary method for removing fats is to raise the temperature of the cleaning solution above the melting temperature of the fat. Residual fat can be removed by using detergents that emulsify (disperse or break up the fat), or saponify (solubilize) the fat.

- Mineral salts may come from both the water supply and from the food itself. Milk contains 0.7% minerals. Mineral films can be some of the more difficult soils to remove. Calcium and magnesium salts in their insoluble form are responsible for most mineral salt deposits.

Soils in combination with minerals are referred to as "stone". Milk stone is one of the more complex soil deposits on milking equipment. Usually an alkaline wash followed by an acid wash will remove milk stone.

The Role of Water

Water is the most influential, if not the most important component in sanitation. As stated, water makes up as much as 99% of the cleaning solution and can carry impurities such as minerals and microorganisms.

Water is sometimes called the "universal solvent" because it has the capability of dissolving a wider variety of materials than any other solvent known. The basic purpose of the detergent is to increase the universal solvent characteristics of water. This is the main reason for the versatility of water and also why pure water is not found in nature. There *will* be impurities in water. Many of the impurities, such as hardness ions, metals such as iron and manganese, and microorganisms have an impact on the sanitation process.

Regardless of the source, however, most water contains various impurities, which hamper cleaning. It is recommended that source water be tested periodically, at least annually. Also, an occasional test for hardness due to calcium deposits and other impurities such as iron and magnesium helps point in the best direction for cleaning effectiveness of any water supply.

While there are many impurities in water, the type and amount of impurities we can tolerate in the water supply depends on how we plan to use the water. Sanitation is affected by a number of factors, including water hardness, pH the presence of metals, and microbial contamination.

<u>Hardness</u>
Salts of calcium and magnesium, collected by water as it percolates through the earth, are responsible for what is commonly called "hardness". They aren't objectionable in drinking water; bur for cleaning, hardness is of primary concern. Typical detergents are designed to handle water hardnesses of 15 grains per gallon or higher at normal use concentrations. If excessive hardness exists, causing problems with sanitation and raising costs, it may be economical to soften the water with a separate water softening system.

<u>Iron and Manganese</u>
Soluble iron or manganese oxides in well water, and in municipal water, are troublesome because they produce the reddish-brown to black stains often seen on milk equipment. As little as 3/10 of 1 ppm (0.3 ppm) is objectionable and produces stains on fixtures or equipment. Further, these metals will react with oxidizers such as chlorine, iodine, and peroxides very quickly which can result in diminished activity of these components of sanitizers or if they are present in detergents.

<u>pH</u>
The pH of natural waters is generally in the range of 6.5 to 8.5. If it is outside of this range, it may be detrimental to the antimicrobial activity of sanitizers, but detergents will be unaffected. It is a good idea to have the pH of water checked periodically.

Microorganisms

Microbial contamination of municipal supplies is seldom a problem because regulatory agencies frequently test the water and make certain bacterial counts are below established standards. Occasionally, supplies are contaminated with coliform bacteria and must be treated. Reports of the presence of parasites such as Crytosporidium also are a concern. Deep private wells are ordinarily satisfactory but cracks in the well casing, improper location or installation could allow contamination by surface water. Surface and shallow well supplies are always subject to contamination and should be treated for positive removal of such contamination. Drinking or water used for sanitation should always be free of pathogens and have a standard plate count of less than 500 colony forming units per milliliter (cfu/ml).

Water Chlorination

In many areas of the country, addition of a chlorine solution for treating farm water supplies is recommended. In some of these areas, it is impossible to obtain suitable drinking water, at least during part of the year. Farm pond water supplies and flowing wells are typical examples of this problem. Reasons for treating water with chlorine include elimination of psychrophilic bacteria. These are not generally a health hazard but are responsible for spoilage and organoleptic defects in milk and milk products.

It is always recommended to consult local health or regulatory agencies for assistance and before treatment of the water supply.

Surface to be Cleaned

The nature and composition of the surface to be cleaned needs consideration. Stainless steel is the preferred material of construction, especially for milk handling equipment. The design and construction of equipment for sanitary or cleanable characteristics are addressed by 3-A Sanitary Standards Committees in the USA.

Cleaners and sanitizers can corrode aluminum, copper and brass and their cleaning must be done carefully. Non-metallic surfaces such as plastics can crack or cloud in the presence of some cleaning products but generally are compatible with many detergents for extended use. Overtime, these materials likely will require replacement.

The nature of the surface is also important. The degree of polish for stainless steel is specified by the 3-A Standards. It is also important to make sure that any welds comply with sanitary standards. Rough, cracked surfaces will harbor soils and bacteria and can be difficult, if not impossible to adequately clean and sanitize.

Method of Application

In selecting the method of application of cleaners and sanitizers, two primary concerns must be considered: the worker and the type of equipment being cleaned. There are four methods of cleaning: manual, high pressure spray, foam cleaning and mechanical cleaning.

1. Manual or hand cleaning exposes the worker to the cleaning solutions so care must be taken to properly protect the employee from physical harm. This generally means using less aggressive chemicals and lower cleaning temperatures. This is generally accomplished with a cleaning brush when it comes to a dairy farm. Aggressive use is critical to remove the contaminant.
2. High pressure spray cleaning is a good first step particularly with removement of organic soils. However, it can cause mists, which may be irritating or harmful to the air passages. Highly alkaline or acidic products should be avoided.

3. Foam cleaning is now widely adapted on milk and food processing plants. Its benefits of lowered water consumption, increased contact time, and visual inspection of application make it ideal for many applications. However, if equipment isn't properly adjusted, atomization can occur and less contact is likely.
4. Mechanical cleaning (C.I.P.) provides the most protection for the worker as the cleaning solutions are contained.

On the dairy farm, lines and tanks often can be cleaned with mechanical or CIP processes. Smaller pieces of equipment may be manually cleaned. As the soils generally are not tenacious, milder detergents can often be used to accomplish the cleaning.

Special Note: All sanitation chemicals, along with the soils, are rinsed down the drain. Here, they either go to municipal treatment facilities or to private treatment. In either case, excessive alkalinity, acidity or BOD can be a potential problem. Changes in the cleaning program or neutralization of the cleaning chemicals may have to be considered.

THE FOUR-BY-FOUR FORMULA

In the dairy industry, cleaning consists of three distinct steps; pre-rinsing, washing, and post-rinsing. The fourth step to quality and safety is sanitizing and/or disinfecting depending on product and EPA claim that is applicable.

- The Pre-Rinse step removes a large portion of the milk soil.
- Washing removes any remaining visible soils.
- The Post-Rinse clears away the detergent and soils
- Sanitizing and/or disinfecting kills the invisible soils, the microorganisms that may cause spoilage, animal disease or foodborne disease.

Along with these four quality steps, are four interrelated variables that impact the effectiveness of your efforts. These are:

1. Concentration of the cleaning agent
2. Water temperature
3. Time required for the cleaning cycle
4. Amount of mechanical or manual force required

These four factors can be adjusted to specific needs or cleaning applications. For example when a worker washes equipment by hand, the water temperature must decrease to avoid burning or extreme discomfort, and the manual force and time cleaning increase. On the other hand, strong cleaner concentrations and high water temperatures characterize a clean-in-place mechanical system, so less time and force are required to achieve the same degree of cleanliness. The four factors-Concentration, Temperature, Time, and Force-apply to every cleaning operation, although the intensity and/or amounts will vary according to the different soil conditions and cleaning operation.

Cleaners

Cleaners can be either alkaline detergents or acid detergents. The components of detergents are:

- Surface-active agents also termed "surfactants" or wetting agents to reduce surface tension of water and the surface allowing the water to spread on the surface.

- Builders: includes alkaline builders, acid builders, water conditioning agents, enzymes and oxidizing agents are substances that increase the cleaning of the detergent.
- Fillers
- Miscellaneous agents

Sanitizers

Just like there are many types of soils, cleaners, and cleaning methods, there are many different microorganisms, different sanitizing agents and different methods of applying the sanitizing solution. Our task is to "Make the Right Choice", meaning choosing the right sanitizer and the right method to achieve sanitary milking equipment.

A sanitizer is a substance that reduces the microbial contamination on inanimate surfaces to levels that are considered safe from a public health standpoint. In the United States, food surface contact sanitizers are regulated and registered by the Environmental Protection Agency. Sanitizers are a different classification than sterilants and disinfectants. A sterilant will destroy all microorganisms including bacterial spores. Disinfectants will kill all microorganisms but may not kill spores. Both sterilants and disinfectants are used in the hospital and medical markets, not in the dairy or food processing markets.

The cleaning process, that is the application of the 4 x 4 formula, does not necessarily remove or kill microorganisms. That is why we apply sanitizer as the last step in the sanitation process. Likewise, sanitizers cannot kill microorganisms it cannot come in direct contact with, and that is why the first steps in the sanitation process are rinses and detergent application, to remove the soils that can protect microorganisms from the sanitizer.

There are several classes of sanitizers; chlorine, chlorine dioxide, iodophors, quaternary ammonium compounds (quats), acid anionic sanitizers, carboxylic acid sanitizers and peroxy-acid compounds. The most common sanitizers used in the dairy industry are chlorine, iodophors, carboxylic acid sanitizers and acid sanitizers. Peroxy acid, also known as peracetic acid sanitizers, are the newest type of sanitizing compounds. Quats are very commonly used sanitizers, but to a lesser degree in the dairy industry due to the fact that small levels in milk can inhibit the activity of starter cultures. Following is a brief discussion on the more commonly used sanitizers.

<u>Chlorine</u>
Chlorine-based sanitizers have two major advantages; excellent broad-spectrum antimicrobial activity and low cost. The major disadvantages of chlorine sanitizers are they are corrosive to many materials of construction and they are easily inactivated organic materials and soils. They are commonly used but care must be taken to never mix them with acids because toxic chlorine gas will be generated.

<u>Carboxylic Acid</u>
In the 1980's, a new category of acid sanitizers was developed. The carboxylic acid sanitizers are also called fatty acid sanitizers. They combine an acidulant, such as phosphoric acid or citric acid with a fatty acid such as octanoic acid. They have the dual function of providing an acid rinse to remove mineral films and kill microorganisms. They have good broad-spectrum activity and, because of their low foaming characteristics, are very good for CIP applications.

<u>Iodophors</u>
Iodine is not very soluble in water. To improve this, a surfactant is mixed with the iodine to form a complex known as an "iodophor". To this combination is added a mineral acid such as phosphoric acid because iodine kills best at an acidic pH. Iodophors have very good broad-spectrum antimicrobial

properties and provide an acid rinse. They cannot be used at temperatures above 120 degrees F however, and do stain some materials of construction. Because of their natural amber color, it is easy to see if iodine is present in the sanitizing solution, and they are sometimes used as udder washes.

Peroxy Compounds

Combining hydrogen peroxide with short chain organic acids such as acetic acid makes these sanitizers. The resulting peracid is an excellent broad-spectrum sanitizer with the added benefit of providing an acidified rinse to remove mineral films. A big advantage is their ability to kill microorganisms at temperatures as low as 40 degrees F, which can be important on the dairy farm in certain regions of the country in the winter.

Disadvantages include the fact that peroxy sanitizers lose effectiveness in water that contains iron at levels of 0.2 ppm and higher. Also, they will corrode soft metals such as brass and copper. Peroxy sanitizers are reported to be the best against biofilms.

Hot Water

We should also mention the fact that water at elevated temperatures for extended exposure periods is a very good sanitizer. The Pasteurized Milk Ordinance specifies that hot water, as a sanitizer must be applied at 170 degrees F for a period of five minutes. This time and temperature combination is critical to achieving proper sanitizing activity. Hot water can cause burns and may be expensive sue to the cost of the volumes of water needed to achieve sanitization and the heating of the water. On the other hand, hot water, properly used, will kill most microorganisms and is non-corrosive. Care must be taken to not leave mineral films associated with the source water.

Special Note: Cleaning Milking Equipment

It should be emphasized that milking machines and all milking equipment and utensils must be thoroughly cleaned and sanitized after each milking. Milk can generate protein films, which are bluish in color, that may be difficult to remove if allowed to dry and persist. Milk fat films usually appear as a greasy film on the surface. Mineral films may appear as grayish films or spots. With proper rinsing, as much as 90% of the milk soil is removed. The remaining 10% soil load can be removed with sound CIP (clean-in-place) procedures. Any manual cleaning should be done with good quality brushes, designed for specific cleaning applications to effectively clean milk equipment and parts not washed by the CIP procedures.

Since rubber is porous, milking machine inflations and other rubber parts can be ideal harborages of bacteria. To keep rubber in good condition, use a chlorinated alkaline detergent for removing the fats and proteins. Use an acidified rinse to remove mineral deposits. Be cautioned that rubber can crack and check with use; so when physical deterioration is visible, replace the rubber parts. It is best to replace all rubber components at intervals recommended by the manufacturer.

Cleaning of teat cup assemblies is normally done by clean-in-place wash-up procedures, this mechanical teat cup washers use the milking machine vacuum line to clean conventional assemblies without dismantling.

IMPLEMENTATION THROUGH CRITICAL CONTROL POINTS

Biosecurity is a misused and misunderstood term at different levels. As an example, the "Biosecure" sign at the front entrance, in most cases, gives both the operator and visitors a false impression of disease security. Biosecurity on farm has often been the term applied to safeguarding animals from disease. It should encompass not only the prevention of animal disease but also the prevention of disease transmission to humans. By adding sanitation and disinfection to the current practices used today (diagnostics, quarantine & vaccination), livestock producers will significantly increase the opportunity to prevent disease by minimizing risk and increase food safety.

Animals themselves are of course one of the main potential disease vectors. The disease can be introduced whether through direct contact or through surfaces to the farm by new animals, spread by the fecal-oral route, from cow to cow, and even through the watering systems. Especially under times of stress (calving, moving, etc.) the effectiveness of an animal's immune system is reduced and thus is more susceptible to disease.

A successful program can be accomplished by implementing several means of control at critical control points. It should be designed to address hygiene methods covering the areas of general cleaning, udder health, milking system, vehicles, and personal hygiene (boots, hands, clothes). Pest elimination and water care are additional key areas that should not be overlooked. Then, to be done effectively the approach should include processes, equipment and products that are easy to use, economical, safe (cows, people, environment) and effective (viral, bactericidal, tuberculocidal, and fungicidal). A producer should prioritize their control efforts based on the disease that most visibly causes them lost income

Disinfectant

A key component of a program that includes disinfection, is a product that carries the Environmental Protection Agency's (EPA) claims for disinfection. You'll know this very quickly by locating an EPA Registration number on the product's label. Secondly, observing the label to determine if the product has been proven efficacious against the target organisms you are concerned with.

Infectious agents vary in their resistance or susceptibility to disinfectants. As you can see, the infectious agent involved with Johne's disease, *Mycobacterium paratuberculosis*, and foot-and-mouth disease, Apthovirus, are among the most resistant. In some of the early studies on FMD virus, it was found that the virus can be inactivated by very high or very low pH. While this may be effective against the virus in a very clean environment, the presence of organic load will drastically affect pH and thus efficacy. In actual farm applications, a disinfectant with some tolerance for organic soil would be the product of choice. In the selection of a disinfectant as a part of the total biosecurity program, it is important to look at the total spectrum of activity, registration status and tolerance for conditions, which will be encountered, in actual use. It should also be non-corrosive, safe to handle, and not have negative environmental impact. Use cost is also a factor to be considered as well as safety and environmental impact.

Unfortunately, no commercial product available today meets all of these criteria. Oxy-Sept 333, from Ecolab, can be a key component as it utilizes and effective sanitizer in peroxy acetic acid along with surfactancy. The key benefits on farm to this product include the wide EPA claims, and the capacity to break down into acetic acid, water, and oxygen for disposal down drain or into lagoon systems. For these reasons this disinfectant is included in the United States official plan should Apthovirus (Foot and Mouth Disease) every be diagnosed here.

Personal Hygiene

In terms of human vectors at greatest risk, an effective biosecurity program must address the potential spread of disease by individuals who move regularly within and between farms and have direct or indirect contact with animals or animal excretions (e.g. manure) or secretions (e.g. milk). This would include veterinarians, artificial insemination (AI) technician, hoof trimmers, neighbors, and employees. The best

scenario is limiting people and vehicles from getting near direct contact with animals. Access to livestock should be limited to essential people. And of course, their boots, hands and clothes all present possible vectors for disease. For that reason, they should either be changes or cleaned and disinfected before they enter and leave your facility.
Providing some sort of a hand sanitizer is a good idea as well for the protection of animals, but for people and especially children as well.

The flow of any vehicles or people into a facility should be carefully monitored.
Vehicles may also transfer the disease between farms. All vehicles visiting the production facility must be considered as potential disease vectors.

Footwear

Boot covers or cleaned and disinfected boots should be mandated for all visitors crossing the key line of defense. Footbaths or mats may be more of a problem than a solution. If not changed regularly, they can actually be a source of contamination between footwear and the farm environment. Footbaths our footpads are simply not suitable for the accomplishment of cleaned and disinfected boots. Therefore you must institute a cleaning step first. To keep things simple, we developed the concept of a Sanitation Station. With Sanitation Station, you have sanitizer, water, a brush and a bucket. The procedure is to simply remove any gross contamination and then brush clean the surface.

In The Facility

It should be noted that calf/heifer ranches can potentially increase risk of disease spread as identified by UC-Davis researchers. They looked at the number of direct or indirect contacts that could potentially spread disease and found these locations to have the highest incidence. The size of these operations can range from a few hundred to 15,000 or more in some locations. Due to the animals congregating from many different locations, the risk of disease spread is significant.

After preventing people and vehicle flow into an operation, the key areas to concentrate control in are the cow freshening pens, the calving facilities, calf housing facilities (hutches, pens), the hospital pens. For each area identified the protocol for cleaning and sanitizing most typically consists of a cleaning with alkaline cleaner followed by disinfecting with an approved disinfectant finished with a rinse if possible, but not essential.

Freshening Pen

Each freshening pen should be thoroughly cleaned of any contamination after each calving.
The reality of this happening at most production facilities today is rare, but it should still be attempted. Most essential of course is removing fecal matter on as regular of a basis as possible. This is made easier by having a pre-calving and calving area. Not until key signs of imminent birth are obvious should the animal be moved into the calving are. Consideration could also be given to have the final calving area bedded with a non-organic bedding (i.e. sand) to lower bacterial growth.

Avoiding "Three Manure Meals"[i] is an idea submitted by Dr. Sheila McGuirk. (Hoards Dairyman, February 2004)

- 1st when the calf tries to stand within 30 minutes and often ends up falling nose first.
- 2nd when the calf looks to suckle 90 minutes after birth, looking on the inside of legs, etc.
- 3rd when the calf suckles for the first time teats may be covered with manure

Of course prompt treatment of the navel area and umbilical cord with a 7 percent tincture of iodine solution (naval dip) is an important step in prevention of infections in this area. The concept is designed to wash away dirt and pathogens, kill pathogens, and dry the umbilical cord to prevent further infections (Calving Ease May 2004: Navals and Newborns).

A newer technology of concern would be calf blankets. Properly laundering the blankets between uses should be considered, particularly if they were used on a sick calf. But, undoubtedly, the blankets will become soiled and should be cleaned and sanitized after use.

Calf Housing

Baby calves of course are highly susceptible to disease. Keeping bacterial populations low in their environment is essential. As important is limiting vectors of transmission. Keep these things in mind:

- Avoid calf to calf contact especially is feeding waste milk
- Fly control is key
- Each calf pen/hutch should be cleaned and disinfected (foamed) between uses.

While most hutch environments are power cleaned and allowed to dry between uses, this is likely not enough to destroy pathogens such as *Salmonella*. Therefore once again a disinfectant applied after cleaning should be considered.

Pasteurizers/Milk Feeding Equipment (buckets, pails, nipples)

These are all key component raising calves today. Buckets, pails, and nipples are used at virtually every dairy farm. Following fundamental good cleaning procedures will ensure that disease spread is minimized. Ensuring that the 4X4 formula is in use ensures the producer that all their hard work is being effective.

Common mistakes of too hot of water prior to a rinse will virtually "bake" milk soils to this equipment. Also, many of these are also of plastic components that deteriate overtime making them more difficult to clean and sanitize. A common mistake of "glugging" in too much chlorine decreases useable life and increases worker safety concerns. More and more automated calf bottle washers are showing up on dairy farms or calf ranches. Adding automation to this procedure brings it one step closer to ensure consistency and accuracy of process between operators.

Pasteurizers can present special problems as waste milk that could be harboring disease and large numbers of bacteria go through them. They are also important to clean properly, especially the HTST (high temperature/short time).

Cleaning Procedure For HTST

1. Pre-rinse with clear water until rinse water runs clear at drain.
2. Caustic wash with 1.5% concentration of one of our built caustic cleaner. Caustic wash at 10 degrees F over processing temperature for approx. one hour on most units.
3. Rinse with clear water until pH is nearly neutral.
4. Acid wash at .5-1% with one of our acid cleaners . Acid wash at 150 degrees F for 30 min.
5. Rinse with clear water until pH is nearly neutral.
6. Sanitize by circulating solution for 2 minutes minimum at use concentration.

Feeding Equipment

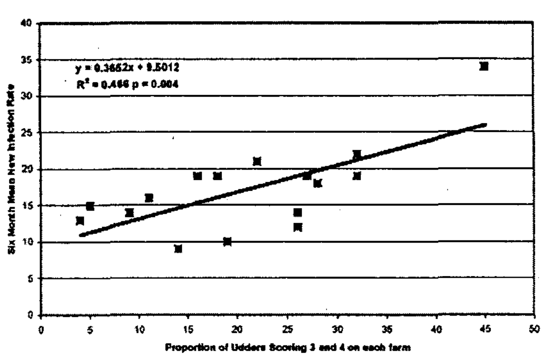
A recent tip in Hoard's Dairyman from an USDA Dairy 2002 indicated that 58.8% of dairy farmers continue to use the same equipment to feed and handle manure. Rinsing the equipment with water or steam is not enough, it must be disinfected.

Hoof & Foot Care

Perhaps the best recent example demonstrating the susceptibility of our national herd to the spread of disease is Mortellero's Disease or Hairy Hoof warts. The economic loss associated with this disease to the U.S. dairy industry is untold. How did it spread is a key question we should all ask ourselves. Strict prevention and treatment protocols are a necessity on any dairy with any level of incidence. As mentioned previously, a combination of diagnosis, quarantine, vaccination, and sanitation all go together to manage this disease. A new concept of Foot and Hoof foaming with EPA approved sanitizing is also now available.

Udder health

There is no area in dairy production that argues more strongly for the proper use of sanitation. Forty-plus years of solid research and practical experience argue successfully for the necessity of sanitation to preventing mastitis infections. Yet mastitis is still the leading cause of producer loss income the world over. A 2002 study by Cook N.B. once again presents data that suggests that the new infection rate increases as proportion of dirty udders increases.



The udder hygiene scoring system developed by the University of Wisconsin is a terribly practical quantitative approach to remove opinion from this issue and provide a key metric for managing this disease—particularly the environmental sources.

Summary

There is a need for the dairy industry to increase measures for disease control and food safety. The critical control point driven process has proven successful in many industries including our own in other applications. Undoubtedly consumer preference will continue to drive our production systems at an increasing rate. One only needs to look across the Atlantic to observe consumer driven perception being now driven by the legal system rather then proactively implemented in advance. Practical Hygiene and Disinfection is an attitude and a vision in which all of us play a key role in its successful implementation.

"Not Try...Do!" Yoda