Bedding Management and Udder Health

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Introduction

The role of bedding management in controlling mastitis infection in lactating cows is often underestimated. Bedding management for heifers and dairy cattle that are in their dry period is frequently overlooked and often poorly managed. This is a costly mistake on many dairies.

Reviewing the DHIA (Minnesota) records of more than 85,000 first calf heifers indicates that 35% have an elevated (>200,000) somatic cell count (SCC) on first test. Rates of increased somatic cell counts in older cows indicate also that approximately 35% of those animals have elevated SCC during the first month in milk.[23] Most of the elevated SCCs are due to infections that start during the first 21 days following dry off or during the 14 days prior to calving. Approximately 60% of new intramammary infections in older cows originate during the dry period. Bacterial agents responsible for causing intramammary infections at first calving were most frequently Gram-negative bacteria followed by coagulase negative staphylococcus and environmental streptococci.[6,8,17,18] Dry cow therapy is not an effective means of controlling environmental mastitis, especially those cases occurring during the last one-half of the dry period. Recent DNA studies indicate that 52% of clinical mastitis cases that occur during the first 60 days in milk began during the dry period.[4] In addition, a large percent of environmental mastitis cases have elevated SCCs well into the lactation. It has been estimated that approximately 1500 pounds (lb) of milk was saved among animals that did not freshen infected.[23] At $12.00 per cwt that is $180.00 per animal additional profit. All of which indicates that proper care of the heifer and dry cow environment is critical for good udder health in early lactation.

Bacterial populations found on teat surfaces (teat ends) closely reflect those found in bedding materials.[3,11,13,15,18,20] Poorly managed confinement housing can exacerbate the potential for environmental mastitis by exposing teats to high levels of bacteria present in the bedding material. High bacterial populations in bedding material will result in high bacteria counts on teat surfaces (particularly teat ends). Exposure to high bacterial numbers can potentially result in increased environmental mastitis.[11,16,18] Therefore, a concerted effort must be made to control or reduce the environmental mastitis causing bacterial population in the bedding material. Reduced teat end exposure will ultimately reduce intramammary infections resulting in increased profits on dairies.

Is the bedding adequate for cow comfort and is it clean ?

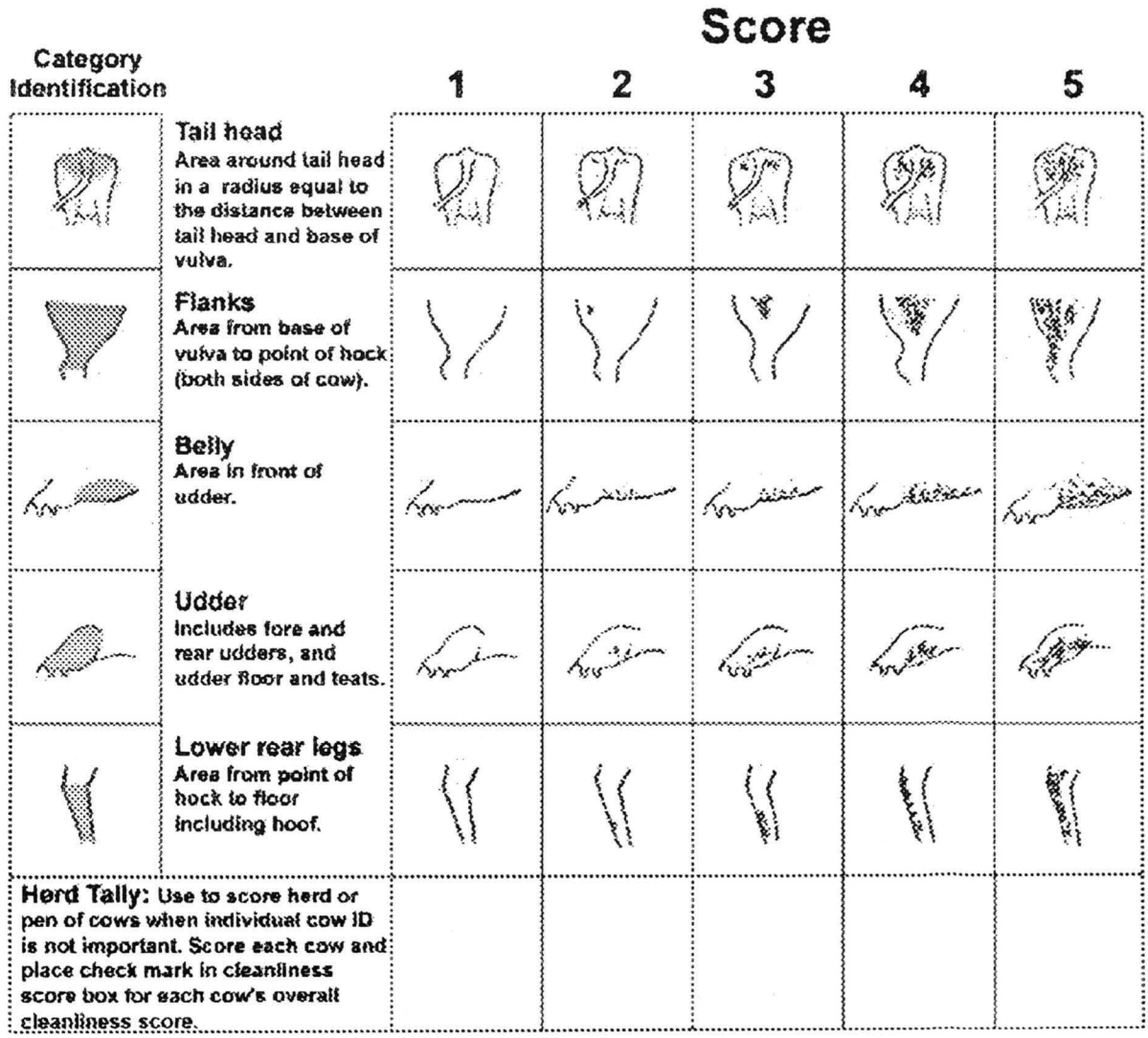
The "knee test" can be used to test if the resting surface is comfortable and clean enough for the cow to lie. Kneel in the stall or dry lot area, and then rock back and forth while on one knee to perform the test. How does this feel on your knee? If it feels comfortable it is probably okay for the cow to use as she shifts in the stall. However, it is recommended that you try the second test. In the stall or dry lot from a standing position, drop quickly to your knees. Does this impact feel comfortable? If the answer is yes, the cows will not be reluctant to lie down. If it hurts, most cows will be reluctant to use this area. Next, stand up and look at your knees. Are they wet or covered with manure? If they are, the stalls need some serious attention as well as fresh bedding. The last, and maybe most telling question, would you lie in that bedding? If not, then recommend that it be changed immediately.

Another measure of bedding management effectiveness is to score the cows for cleanliness and evidence of hock injury. The cow cleanliness scorecard (Figure 1) allows an objective, visual assessment of the cleanliness of the cows or heifers.[21] Hock injury scoring (Figure 2) measures the adequacy of bedding depth and/or adequacy of stall design to prevent abrasions. Both are effective methods to assess cow comfort and cleanliness.

Cows or dairies with low SCC have fewer dry and milking cows with manure on their udders. The amount of manure on the udder is often related to the amount of manure on the feet and legs. We know that the higher on the leg that manure gets the higher probability that the cow will contaminate teat surfaces with manure.[2]

Bulk tank culture records are useful measures of teat surface sanitation. If there are high numbers of environmental bacteria (coliforms, environmental streptococci, coagulase negative staphylococci) on the bulk tank culture report, this indicates that better pre-milking hygiene, and possibly better bedding management,

Figure 1. Cow Cleanliness Score Card. Adapted from: Chiappini *et al,* 1994. Dairy Systems for the 21st Century, p 138.



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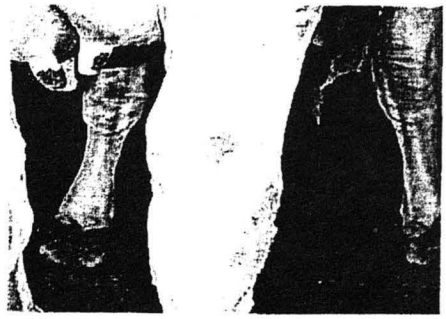
is needed. Elevated bacteria counts on teats are reflective of the bacterial contamination of the bedding material. Therefore, "What is not removed from the teat by pre-milking cow preparation goes in the tank" and elevated bacterial counts of bulk milk will result.

Which bedding is best?

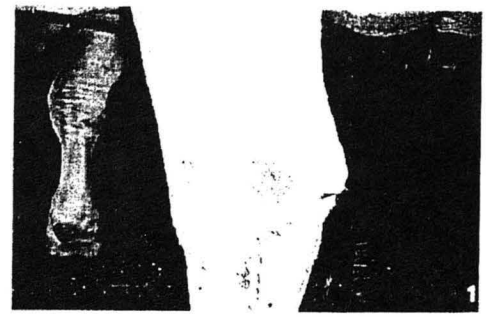
The most obvious answer to this question is to find the one that is cheapest, driest, most comfortable, with low numbers of bacteria (clean), that will not support bacterial growth and that cows find comfortable to lie on. A bonus would be that it never has to be changed! In addition, it must be compatible with the manure handling system. However, everyone knows that not all of these can be obtained. Our goal must be to meet as many of these criteria as possible, all the time.

When deciding which bedding material is best keep in mind bacterial requirements for growth, namely moisture, organic nutrients, appropriate temperature and time. All of which are available in bedding systems on most dairies.

The ability of bedding materials to support bacterial growth varies[5] and is an important factor. Many dairies prefer inorganic bedding like washed sand because it does not support bacterial growth as readily as organic bedding materials like straw or shavings. However, if the manure handling system cannot handle sand it may not be an option without a costly renovation of the farm's manure system. This leaves the producer to choose from organic base bedding material like wood shavings, sawdust, straw, sunflower hulls, corn stalks, straw, paper, ground particle board, oat hulls, barley



Score 0 = normal



Score 1 = hair loss, no swelling

Score 2 = swelling, no hair loss

Score 3 = hair loss + swelling

Figure 2. Hock Injury Score Card

chaff, etc. The major disadvantage of most organic bedding material is the supply of nutrients critical to bacterial growth. The ability to support bacterial growth occurs even in the absence of manure, urine and milk. However, the introduction of manure, urine, or milk into bedding materials greatly enhances its ability to support rapid bacterial growth. In general, pine, cedar and other softwoods do not support bacterial growth as well as oak and the other hard woods. Perhaps this is due to pine containing resin acids, some fats, terpenes and some phenolic compounds, which inhibit microbial growth. Hard woods typically lack significant amounts of terpenes, phenolic compounds and resin acids, thus do not have the bacterial growth inhibiting components while containing more nutrients than soft woods. Newspaper contains mostly cellulose. Other nutrients are partially removed during the paper processing steps. Straw, oat, barley and sunflower hulls contain an abundance of utilizable nutrients such as sugars and amino acids and no inhibitory substances. As expected, these materials support more growth of bacteria than other types of organic bedding material. In addition, organic bedding materials tend to absorb and hold moisture. Sand, on the other hand, allows water to seep away from the surface leaving the bedded surface dryer.

Particle size is important

Particle size of bedding is an important factor in determining the rate of bacterial growth in organic bedding. In a recent study using the bedding incubation count (BIC) it was shown that large particulate bedding materials supported the least amount of growth while finely ground or chopped organic bedding favored rapid bacterial growth (Table 1). In addition, fine particulate material has a tendency to stick to udders and teats. With inadequate pre-milking cow prep, bacteria on the fine particulate material may more readily get introduced into the teat canal, initiating an infection. The BIC gives an indication of both the bacteria present in the bedding prior to use and the growth supporting potential of the bedding under ideal conditions without the confounding addition of contaminating organic animal waste.

Apparently clean bedding may not be "clean" from a bacteria standpoint. Frequently bedding that looks, feels and smells "clean" can have extremely high bacteria counts nearly equal to those in fresh feces. How can this be? During the summer months the ambient temperature is warm enough to allow bacterial growth even in materials not contaminated by feces. This is convincingly demonstrated by the Bedding Incubation Counts in Table 1. It is easy to understand why the greatest bacterial growth occurs in organic bedding material during the first 24-48 hours after being placed in the stall when manure, urine and/or milk are introduced.

It has been found that coliform numbers in excess of one million cfu/cc or per gram of bedding increased udder infections.[5,7] It has also been our general experi-

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Table 1. Bacteria incubation counts on individual samples of unused bedding types after particle size separation at zero time and after 24 hours incubation.

		Particle Size		
		#8 (coarse)	#18 (medium)	Bottom (fines)
		cfu/ml		
Straw	zero time	462	933	1,400
	24 hours	43,000,000	45,000,000	99,000,000
Sunflower hulls	zero time	100	11,700	23,200
	24 hours	37,000,000	37,000,000	93,000,000
Hardwood shavings	zero time	0	0	0
	24 hours	33,200	40,000	90,000
Softwood shavings	zero time	0	20	20
	24 hours	0	100,800	300,000
Aspen sawdust	zero time	110	930	1,160
	24 hours	200	1,200	23,000

This table is not a ranking of bedding types. All of these bedding materials had acceptable zero time bacteria count. These samples demonstrate the speed bacteria grow in the "fines" relative to the coarse and medium particle size bedding material.
cfu – colony-forming units

ence in Minnesota that when bacteria counts in bedding are high (greater than one million per ml of bedding material) there is an increased risk of mastitis. Our experience has also shown that the species of environmental pathogens found in the bedding material corresponds with those found in the bulk tank and/or line samples as well as those responsible for clinical infections. Therefore reducing the exposure at the teat end should reduce the incidence of intramammary infection. This can be accomplished with good bedding management and milking hygiene.

Effect of weather

It is frequently assumed that because ambient temperature is below freezing there will not be as much of a need to change bedding material, or at least there will be a need to do it less frequently. This is not always true. In a recent study, we have shown that the temperature in an occupied stall remains relatively constant (28-30C) (Figure 3). This indicates that even in the winter bacteria can grow in bedding materials and that stall maintenance is critical during the winter months as well as the summer months to reduce the possibility of intramammary infections.

Weather has an affect on the growth and type of bacteria in the stall. As the weather, at least in Minnesota, shifts from warm to cold we have observed a shift in predominant bacteria found in bedding. High coliform counts are frequently seen in organic matter during summer and early fall months. Environmental streps predominate through the winter months. This pattern is reflected in the clinical cases cultured at the University of Minnesota Diagnostic Lab (Figure 4).

Recycled manure solids

Organic bedding materials, sunflower and oat hulls, straw, sawdust, wood shavings, often become limited or very costly due to consumer demand. To circumvent this problem, some dairies are turning to manure solids as an alternative source of bedding. Using dairy wastes is an attractive alternate because they are readily available and cheap. However, not enough thought is given to where it came from (manure). It is often felt or believed that composted bedding material will heat to a temperature sufficient to kill coliform and environmental streptococci bacteria. It is also believed that reducing the moisture will reduce bacteria counts to acceptable levels. However, this is not always the case. Mote *et al*[14] showed that during composing coliform bacteria initially decreased in numbers but then increased to levels close to those found in fresh feces. The composted bedding material we have evaluated did not have decreased coliform or environmental streptococci numbers. When incubated in the laboratory, composted bedding material frequently yielded bacteria numbers approaching 1 billion cfu per cc of bedding.

Initial numbers of bacteria per cc of bedding depend, to a degree, on the amount of moisture present.

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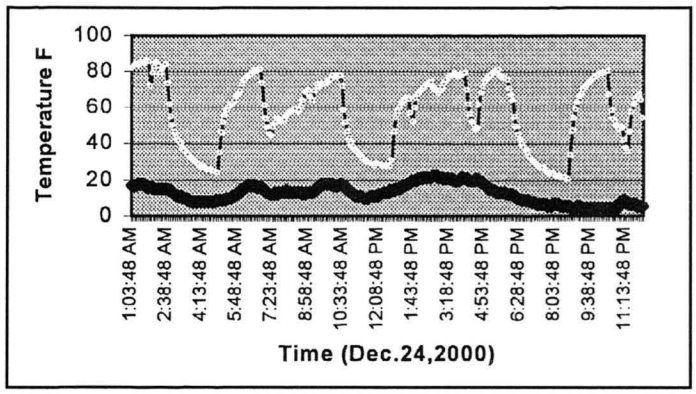

Figure 3. Freestall vs. ambient temperature on a Wisconsin dairy.

Composted manure solid bedding may work in extremely arid conditions but thus far our experience in the upper Midwest is not encouraging. Low moisture levels substantially reduced bacteria numbers when compared to those with a higher level of moisture. Samples in which the moisture was reduced to approximately 50-60% frequently yielded bacterial numbers that were in the range of 500,000 cfu/cc of bedding. However, after being in the stalls for 24 hours those bacterial numbers approached 70 million to one billion cfu per cc of bedding.

Table 2. Bacteria counts in sand bedding at various depths within the bedding layer.

Sand layer	Bacteria numbers (cfu/cc)
Surface	2,897,500
Subsurface	10,235,000
Bottom	5,647,000

Properly used sand is the ideal bedding

From a bacteriologic standpoint sand is the ideal bedding material. Bacterial numbers in sand are usually lower than in organic bedding materials. In addition, it appears that higher bacterial numbers in sand do not substantially increase udder infections. However, to be effective the sand depth needs to be maintained at 7-8" and the sand bed must be smoothed daily for cow comfort. From our limited studies it can be seen that the sand surface has lower bacteria counts than the deeper layers. In the process of leveling sand, some dairies have used a tilling device to level the sand surface. This practice may increase exposure of the teat to environmental pathogens. The damp lower layers of sand may contain millions of bacteria. Turning this layer up generally results in increased udder infections. The practice of tilling sand bedded stalls is not recommended.

Sand has an advantage that it can be washed and then recycled. The objective is to wash the organic matter from the sand in an attempt to return it to its original inert form. This is fine if there are sufficient amounts of good clean water to wash the sand free of organic matter prior to being replaced in free stalls. Care must be used when selecting the water that is to be used for washing the sand. Frequently, wastewater is used to wash sand. This offers little advantage as it contains high numbers of bacteria and organic matter. Often rainwater is used to wash sand. Generally washed sand has low bacteria counts on top of the pile and the deeper you go into the pile the bacteria counts increase Below is an example (Table 3) of bacteria counts in sand bedding on a midwestern dairy. This example serves to reinforce the idea that sand must also be managed carefully.

Table 3. Bedding counts in sand bedding on a Midwestern dairy.

Un-used sand (farm stock pile)	28,375
Un-used sand incubated 24 hrs (lab)	102,875
Incompletely washed sand	811,500
Incompletely washed sand incubated 24 hours (lab)	101,550,000
Freestall	51,375,000
Maternity pen	5,175,000

Bedding procedures

Bedding strategy can have a profound effect on teat exposure to environmental pathogens. Obviously the frequency in which bedding material is changed will affect its bacterial "load". When using organic bedding materials, under environmental conditions found on most dairies, all old, soiled bedding should be removed from the back half of the stall each day and replaced with fresh bedding. Once each week all of the old bedding should be removed from the stall to prevent a build-up of environmental pathogens. It is not yet clear how

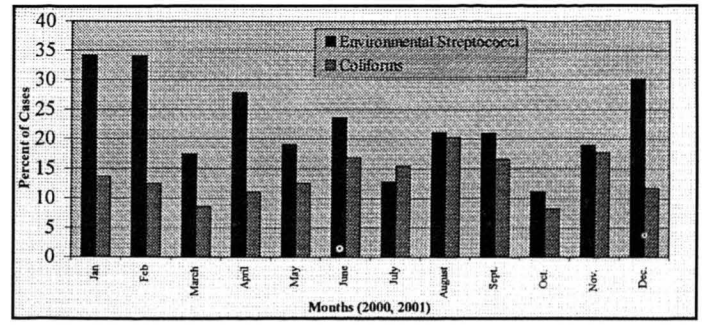

Figure 4. Frequency of environment streptococci and coliform bacteria isolated from clinical mastitis.

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often sand bedding needs to be changed. However, our experience indicates that fresh clean sand should be added to each stall on a 5-7 day interval.

The bedding frequency appropriate to any dairy's specific circumstance can be determined with bedding cultures. The procedure is quite simple. A representative sample of fresh bedding is collected from a representative number of stalls (i.e. every other or every third stall) at specified time intervals until the stalls are re-bedded. For example, if a herd is currently re-bedding every other day, one would take a representative sample from the back half of the stalls at 24 hours and just before re-bedding was about to take place. These samples are then cultured to determine the bacterial growth rate. If the bedding has counts greater than 1,000,000 per ml of bedding at the 24 hour sampling then it is clear that bedding needs to occur at least every 24 hours for this herd.

Many dairies use the somewhat logical method of putting fresh bedding material in the front of the stall and let the cow(s) work it back. Personnel on the dairy remove the soiled bedding from the back of stall and move the apparently clean bedding from the middle and front to the back. Fresh bedding is then added to the front of the stall. Because the bedding looks clean it is assumed that it is low in bacterial contamination. Little thought has been given to the possibility that the cows' feet have inoculated the bedding with manure in the front of the stall as they go in and out of the stall. Then, by lying in the stall, the cows warm and incubate the bedding, increasing the rate of bacterial growth. By the time relatively "clean" looking bedding is moved back under the udder it may be "loaded" with bacteria. The following table shows bacteria counts from samples taken from the front, middle, and rear of the stalls from farms that routinely practiced this bedding strategy. To date we have not found a farm that uses this bedding strategy that does not also have this pattern bedding contamination.

Bedding conditioners

There have been numerous reports and attempts to add chemicals to bedding materials in an effort to control bacterial growth and reduce the need for stall maintenance. Adding approximately 2 lb of hydrated lime to fresh sawdust bedding in the back 1/3 of the stall reduced Gram-negative bacterial growth and environmental streptococci growth for approximately 24 hours.[10] However, within 48 hours all bacterial counts were similar to those of untreated sawdust. The antibacterial properties observed were due to change in pH. Growth of bacteria occurred once the pH returned to a range preferred by bacteria. In another study, by Hogan *et al*,[12] it was found that an acidic conditioner in sawdust had a short-term (2 day) bacteriostatic effect. The same acidifier had no effect on bacterial populations in recycled manure. Only hydrated lime was found to reduce the bacterial populations in recycled manure, based on teat end swabs. Again the inhibitory effect was due to the pH of the material. Other chemicals have been tried but have not gained wide acceptance.[2]

In preliminary laboratory studies in our lab sodium bisulfate was able to inhibit bacterial growth in bedding materials where no urine, feces or milk was present. Using a mixture of oat and sunflower hulls and sawdust as a bedding material the added sodium bisulfate reduced the bacterial population somewhat. However, within 48 hours bacterial growth was at an unacceptable level (>1,000,000 cfu/cc). Further studies are currently in progress to more fully evaluate this material.

Recommendations for bedding stalls

Whatever type of bedding material is used the goal is to keep bacteria counts as low as possible. The current goal is keep bacteria counts to less than 1 million cfu/ml where bedding contacts the udder. Not provid-

Table 4. Bacteria count on bedding taken from the front, middle and rear of stalls on dairies that use the routine practice of stock piling bedding in the front of stalls.

Farm	Bedding type	Front of stall (cfu/ml)	Middle of stall (cfu/ml)	Rear of stall (cfu/ml)
A	Chopped straw and paper	690,000	19,000,000	41,000,000
B	Ground sunflower hulls	3,850,000	9,925,000	27,275,000
C	Sunflower hulls	1,000,000	3,600,000	25,275,000
D	Pine sawdust	401,500		59,900,000
E	Particle board	1,040,000		38,275,000
F	Hardwood	738,000		13,213,500

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ing what bacteria need to grow, moisture, organic matter, proper temperature, time and the right pH, can accomplish this. Keeping stalls as dry as possible is the main way to remove an essential ingredient for bacterial growth.

When using organic based bedding material, use approximately 1-2 lb of fresh dry bedding daily, especially under the udder. This amount is sufficient to prevent hock abrasions and absorb moisture.

How frequently you bed stalls with organic bedding is somewhat dependent on the weather as it influences ambient temperature and humidity. Since bacteria require moisture, in arid areas the frequency of bedding changes will be different than those in areas where there is a high atmospheric moisture level. It is critical to keep clean bedding dry. Generally, completely removing all old bedding material once per week clean and re-bedding with clean fresh bedding is a minimum.

Don't till up sand bedding. Just add fresh clean bedding to the top and level it to maintain a level surface above the height of the curb. Remove the old sand when it becomes heavily contaminated with manure, urine and milk, probably once weekly.

Bedding packs are frequently used for dry cow housing and in calving pens. They frequently feel warm and may be thought to provide a warm place for the calf to lie. The warmth is due to bacterial growth in the bedding material. Cows held on these types of material are exposed to elevated levels of bacteria, therefore increasing the probability of environmental mastitis. Throwing straw on top of contaminated bedding packs does little to prevent the transfer of bacteria to teat ends during calving or in the close-up pens. Using bedded packs in calving pens will lead to increased incidence of environmental mastitis at calving or in early lactation unless carefully managed. Close-up and calving pens must be cleaned daily and fresh bedding material added.

Summary

Using good bedding management will increase income from increased milk production, milk quality premiums, reduce treatments of clinical cases and reduced culling because of poor udder health. Lower bacterial loads at the teat end will reduce the incidence of environmental mastitis. In addition, the incidence of hock injuries will be reduced when bedding is managed properly. Just going through the motions of cleaning stalls daily with no attention to bedding management detail will not reduce the exposure of teats to environmental mastitis pathogens. Alley and walkways need scraping at each milking. It is important to not spray manure on the backs of stalls when scraping the alleys, which results in contamination of fresh bedding material.

Bedding material must be kept as clean and dry as possible to limit bacterial growth. Organic bedding material should be changed daily to limit the growth of bacteria in the stall, which will reduce the possibility of udder infections with environmental pathogens. Certain organic bedding materials (sunflower hulls, straw, corn stalks, grain hulls, or hard wood) can support the growth of large populations of environmental mastitis pathogens because of the large amounts of available nutrients. Particle size is an important consideration when using organic bedding materials. It is also important to use larger particulate material as possible, since these materials do not support the growth of bacteria as readily as fine particulate material.

Sand remains the most comfortable and sanitary bedding material, if properly maintained. Proper maintenance means leveling the sand surface for cow comfort. Do not till the sand as it brings bacteria to the surface that will expose the udder to environmental mastitis causing agents. If sand is to be washed it must be washed with clean water. Enough water should be used to remove all the organic material present.

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Multiple-Day Therapy: Administer daily, a subcutaneous dose of 2.5 - 5.0 mg/kg of body weight (1.1 - 2.3 mL/100 lb). Treatment should be repeated at 24-hour intervals for three days. Additional treatments may be given on days 4 and 5 to animals which have shown clinical improvement but not total recovery.

STORAGE CONDITIONS:

Protect from direct sunlight. Do not refrigerate, freeze or store at or above 40° C (104° F). Precipitation may occur due to cold temperature. To redissolve, warm and then shake the vial.

HOW SUPPLIED:

Baytril® 100 (enrofloxacin) Antimicrobial Injectable Solution:

Code: 0236	100 mg/mL	100 mL Bottle
Code: 0321	100 mg/mL	250 mL Bottle

For customer service, to obtain product information, including the Material Safety Data Sheet, or to report adverse reactions call (800) 633-3796.

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Bayer Corporation,
Agriculture Division, Animal Health,
Shawnee Mission, Kansas 66201 U.S.A.
NADA # 141-068, Approved by FDA

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Repeated Misery Is For Country Songs, Not BRD Treatment.

If your treatment regimen for BRD keeps putting you in the same miserable situation again and again, it's time to try Baytril® 100 (enrofloxacin) as your first line treatment. Baytril 100 works in a unique way that kills infectious bacteria, while most other leading antibiotics only inhibit them. This leads to fast response and quick recovery after treatment. You save time, money, labor and reduce stress because you're not constantly pulling and treating the same cattle. So get it right the first time with Baytril 100. Your job will no longer be the stuff of a sad country song.

Extra-label use of this product in food producing animals is prohibited. For more information, contact your veterinarian, Bayer representative, call 1-800-633-3796 or visit www.baytril100.com.

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