

# The Role of Bedding Management in Udder Health

Russell F. Bey, Jeffrey K. Reneau, and Ralph J. Farnsworth  
University of Minnesota, St. Paul

Heifers and dairy cattle that are in their dry period are frequently forgotten and poorly cared for. They are given adequate feed and water and provided with a ventilated shelter in which space is often limited. Other than the minimum essential conditions, they or their environment is often not thought about. This is a costly mistake many dairies make.

Reviewing the DHIA (Minnesota) records of more than 85,000 first calf heifers indicates that 35% enter lactation with an elevated (>200,000) somatic cell count (SCC) (Stewart). Rates of increased somatic cell counts in older cows indicate that approximately 35% of those animals have elevated SCC during the first month in milk (22). Most of the elevated SCC is due to infections that occur during the first 21 days or so following dry off or during the first 14 days prior to calving (approximately 60% of new intramammary infections in older cows occur 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 (5, 7, 16, 17). Standard dry cow therapy is not an effective means of controlling environmental mastitis especially those occurring during the last one-half of the dry period as they are often less responsive to antimicrobial therapy. Recent DNA studies indicate that 52% of clinical mastitis cases that occur during the first 60 days in milk began during the dry period (3). In addition, a large percent of environmental mastitis cases have elevated SCC well into the lactation. All of these cost the producer money. In a study by Stewart (22) it has been estimated that you can save approximately 1500 pounds of milk if the animal did not freshen infected. At \$12.00 per hundred pounds 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 early lactation udder health.

Bacterial populations found on teat surfaces (teat ends) closely reflects those found in bedding materials (2, 10, 12, 14, 17, 19). Poorly managed confinement housing can exacerbate the potential for environmental mastitis in both and milking cows by exposing teats to high levels of bacteria which is present in the bedding material. High bacterial populations in bedding material will result in high bacteria counts on teat surfaces (particularly teat ends) or at least exposure to high bacterial numbers potentially resulting in increased environmental mastitis pathogen associated mastitis (10, 15, 17). Therefore, a concerted effort must be made to control or reduce the environmental mastitis causing bacterial population (load) in the bedding material which will reduce teat end exposure ultimately reducing intramammary infections which results in increased profits and profit margin.

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

Frequently, the "knee test" can be used to test if the resting surface is comfortable and, to a degree, clean enough for the cow to lie. Kneeling in the stall or dry lot area then rock back and forth while on one knee performs the test. How does this feel on your knee? If it feels comfortable it is probably OK 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 your 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 change it immediately.



management is needed. Bacteria counts on the teats are reflective of the bacterial contamination of the bedding material. The old adage works here “What is not removed from the teat by pre-milking cow preparation goes in the tank”.

### **What bedding is best?**

Most people know the answer to this question but do not want to acknowledge or think about it for a variety of reasons. The obvious answer is the cheap, dry, comfortable, bacteria free (clean), does not support bacterial growth and when placed in an area or stall which the cows find comfortable and are not reluctant to lie down. 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 all of these are not realistic. Our goal must be to meet as many of these criteria as possible all the time.

When deciding which bedding material is best you should keep in mind what bacteria need to grow; moisture, organic nutrients and appropriate temperature. All of which is available with on most dairies.

Differences do exist in the type of wood shavings. 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 adversely effect microbial growth. Hard woods typically lack significant amounts of terpenes, phenolic compounds and resin acids, thus do not have the bacterial growth inhibiting components. Newspaper contains mostly cellulose and other compounds which are partially removed during the processing steps. Straw, oat, barley and sunflower hulls contain more potentially utilizable nutrients such as sugars and amino acids and no inhibitory substances. Thus one would expect these materials to support better growth of bacteria than other types of organic bedding material, and they do. One major disadvantage of most organic bedding material is that it has the ability to support bacterial growth relatively well due to the available nutrients. The ability to support bacterial growth occurs in the absence of manure, urine and milk. The amount of available nutrients varies with the bedding material being used (4). In addition, fine materials tend to absorb and hold water better than sand which allows water to seep away from the surface leaving it dryer. Fine materials generally settle to the bottom of the pile either in transit or on the dairy, thus mastitis cases may increase sharply when this (fine) material is used as bedding.

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 will favor rapid bacterial growth (Table 1). In addition, fine particulate material will have a tendency to stick to cow's udders and teats more readily. With poor cow prep fine particulate material may get introduced into the teat canal initiating an infection. The BIC will give you an idea of the bacteria present in the bedding sample and the growth supporting potential of the bedding under ideal conditions without contaminating organic animal waste.

Clean appearing bedding may not be clean, from a bacteria standpoint. Frequently bedding that looks, feels and smells clean, and was just delivered can have extremely high bacteria counts nearly equal as high as 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 Count (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 where manure, urine and/or milk are present.

Our studies and others (4) found that coliform numbers in excess of  $10^6$  cfu/cc or /gram in bedding increased udder infections. It has been our general experience, in Minnesota, that when bacteria counts in bedding are high there is an increased risk of mastitis. Our experience has shown that environmental pathogens found in the bedding material corresponds with those found in the bulk

tank and line samples as well as those responsible for clinical infections. Reducing the exposure at the teat end will reduce the incidence of intramammary infection. This can be accomplished with good bedding management and milking hygiene.

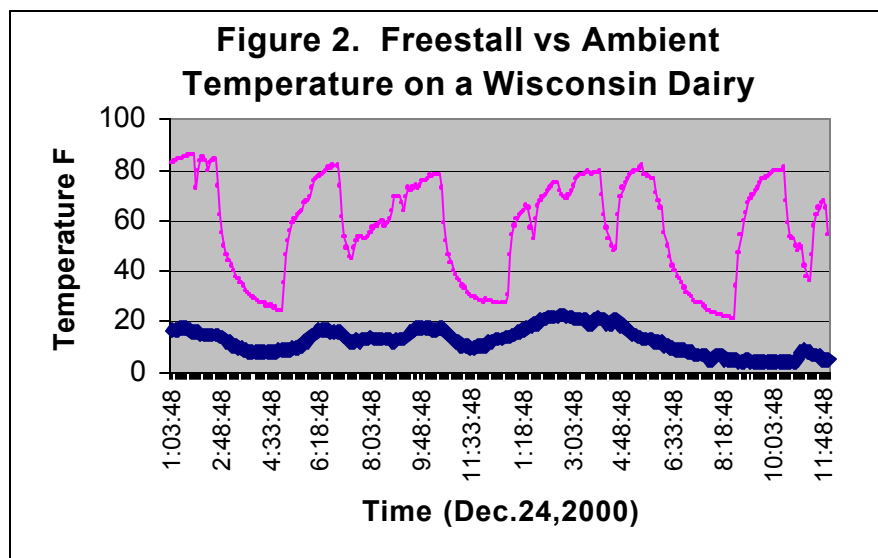
**Table 1. Bacteria incubation counts on individual samples of un-used bedding types after particle size separation at zero time and after 24 hours incubation.**

		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

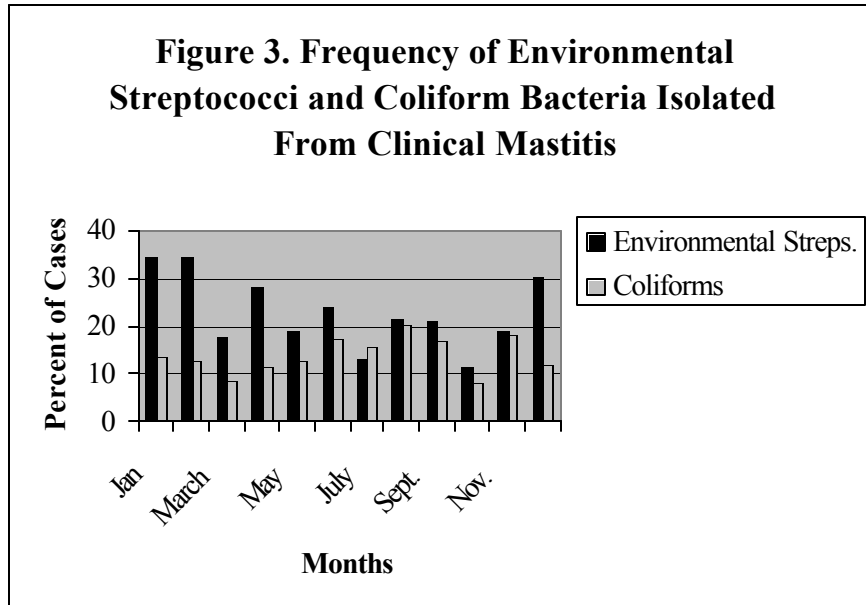
*cfu – colony-forming units*

This table is **not** a ranking of bedding types. All of these bedding materials had acceptable zero time bacteria counts. These samples demonstrate the speed bacteria grow in the “fines” relative to the coarse and medium particlesize bedding material.

It is frequently assumed that because the ambient temperature is below freezing there is not as much of a need to change bedding material (or at least do it less frequently). In a recent study we have shown that the temperature in an occupied stall remains relatively constant (28-30C) (Figure 2). 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.



Freestall 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 it is readily available and cheap. Little thought is given about where it came from (manure). It is often felt or believed that composted bedding material will heat to a sufficient temperature that kills coliform and environmental streptococci bacteria. It is also believed that reducing the moisture will reduce bacteria counts to acceptable levels. However, this is not the case. Mote, et al. (13) showed that initially coliform bacteria decrease in number but then increased to levels found in fresh feces under normal composting conditions. Composted bedding material we have evaluated did not have decreased coliform or environmental streptococci numbers. When incubated, in the laboratory, composted bedding material frequently yields 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.

In low moisture conditions, levels are substantially reduced when compared to those of higher level moisture. Samples in which the moisture has been reduced to approximately 50-60% frequently yield bacteria numbers that are in the range of 500,000 cfu/cc of bedding. However, after being in the stalls for 24 hours those bacteria numbers approach 70 million to one billion cfu per cc of bedding.

From a bacteriologic standpoint sand is the ideal bedding material. Bacteria numbers in sand are usually lower than in organic bedding materials. In addition, it appears that sand can tolerate higher bacterial numbers and not substantially increase udder infections. However, sand depth needs to be maintained at 7-8" and the sand bed must be smoothed daily for cow comfort. In the process of leveling sand, some dairies have used or are using a rake type device, a double-edged sword. Turning up damp under layer of sand that contains millions of bacteria can and generally

does result in increased udder infections. From our limited studies it can be seen that the sand surface has lower bacteria counts than the deeper layers.

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

Sand has an advantage in that it can be washed and then recycled. The object is to wash the organic matter from the sand in attempt to return it to its original inert form. Care must be used when selecting the water that is to be used for washing the sand. Frequently, wastewater is used wash sand. This offers little advantage as it contains high numbers of bacteria and organic matter. Often rain water is used to wash sand. This is fine if there are sufficient amounts of water to wash the sand free of organic matter prior to being replaced in freestalls. Generally washed sand has low bacteria counts on top of the pile and the deeper you go into the pile the bacteria counts increase. In addition, when scooping the sand from the pile or ground, care must be used not to scoop up manure and place it back in the stall. Below is an example of this from one farm.

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

### **Proper bedding procedure**

Most dairies use the traditional and 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 little thought goes into where the cow's feet have been before she stepped into the stall. In actuality, what dairies are doing is moving bacteria with the supposedly clean bedding under the udder. The table below shows bacteria counts from samples taken from the front, middle, and rear of the stall.

<u>Farm</u>	<u>Bedding type</u>	<u>Front of stall (cfu/ml)</u>	<u>Middle of stall (cfu/ml)</u>	<u>Rear of stall (cfu/ml)</u>
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	

## **Bedding treatments**

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 pounds of hydrated lime to fresh sawdust bedding in the back 1/3 of the stall was able to reduce Gram-negative bacterial growth and environmental streptococci growth for approximately 24 hours (9). 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 was buffered back to a range preferred by bacteria. In another study, by Hogan et al. (11), 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 (1). In preliminary laboratory studies sodium bisulfate was able to inhibit bacterial growth in bedding materials where no urine, feces or milk was present. However, preliminary studies in the stall using a mixture of oat and sunflower hulls and sawdust as a bedding material the sodium bisulfate it 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.

<u>Bedding</u>	<u>Bacterial counts cfu/ml</u>
Time 0 sunflower/oat hull mix with sodium bisulfate	61,750
48 hours in the stall with sodium bisulfate	1,730,000

## **Bedding stalls**

Whatever type of bedding material is used the goal is to keep bacteria counts as low as possible. A goal is keep bacteria counts to less than 1 million cfu/ml where bedding contacts the udder. This can be accomplished by remembering what bacteria need to grow; moisture, organic matter, proper temperature and pH. By keeping stalls as dry as possible you remove an essential ingredient for bacterial growth. For organic based material use approximately 1-2 pounds of fresh dry bedding daily especially under the udder. Once per week clean out the stall completely removing all old bedding material before re-bedding with clean fresh bedding.

Don't till up sand bedding. Just add fresh clean bedding to the top and level it maintaining 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.

How frequent you bed your stalls with organic bedding is somewhat dependent on the weather and moisture level in the air. 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.

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 increasing the probability or at least risk 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 packs or other organic matter in calving pens will likely lead to increased incidence of environmental mastitis at calving or early in lactation. Close-up or calving pens must be cleaned daily and fresh bedding material added.

## **Summary**

Using good bedding management will increase income from milk quality premiums and improve udder health. Lower bacterial loads at the teat end will reduce the incidence of environmental mastitis. In addition, the incidence of hock injuries should be reduced as well. Just cleaning stalls daily with no attention to bedding management will not reduce the incidence of environmental mastitis. Alley and walk ways will need scraping at each milking. When scraping it is important to not spray manure on the backs of stalls, 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 support the growth of large populations of environmental mastitis pathogens. It is also important to use large particulate material, as 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.

## **References**

1. Bashandy, E.Y. and L.E. Heider. 1982. The effect of disinfectants on the density of coliforms in sawdust bedding. *The Bov. Pract.* 17:16.
2. Bishop, J.R., J.J. Janzen, A.B. Bodine, C.A. Caldwell, and D.W. Johnson. 1981. Dairy waste solids as possible source of bedding. *J. Dairy Sci.* 64:706.
3. Bradley, A.J. and M.J. Green. 2001. *J. Dairy Sci.* 83:1957.
4. Bramley, A.J. and F.K. Neave. 1975. Studies on the control of coliform mastitis in dairy cows. *Brit. Vet. J.* 131:160.
5. Bray, D.R., F. Elzinger, R.L. de la Sota, et al. 1989. Prevalence of infection in mammary quarters of nulliparous heifers and efficacy of intramammary infusion of antibiotics three weeks before parturition. *J. Dairy Sci.* 65(Supp 1):20.
6. Carrol, E.J. and D.E. Jasper. 1978. Distribution of Enterobacteriaceae in recycled manure bedding on California dairies. *J. Dairy Sci.* 61:1498.
7. Cook, W.F., E.A. Fiez, and L.K. Fox. 1992. Mastitis in first lactation Southwest Idaho dairy cows. *J. Dairy Sci.* 75(Supp 1):158.
8. Eckes, V., M. LaValle, R. Bey, R.J. Farnsworth, and J.K. Reneau. 2001. Environmental pathogens in bedding materials. *Proc., Natl. Mastitis Council Ann. Mtg. Feb 11-14, 2001, Reno, NV.*
9. Hogan, J.S. and K.L. Smith. 1997. Bacteria counts in sawdust bedding. *J. Dairy Sci.* 80:1600.
10. Hogan, J.S. K.L. Smith, K.H. Hoblet, et al. 1989. Bacterial counts in bedding materials used on nine commercial dairies. *J. Dairy Sci.* 72:250.

11. Hogan, J.S., V.L. Bogacz, L.M. Thompson, et al. 1999. Bacterial count associated with sawdust and recycled manure bedding treated with commercial conditioners. *J. Dairy Sci.* 82:1690.
12. Janzen, J.J. J.R. Bishop, A.B. Bodine, C.A. Caldwell, and D.W. Johnson. 1982. Composted dairy waste solids and crushed limestone bas bedding in free stalls. *J. Dairy Sci.* 65:1025.
13. Mote, C.R. B.L. Emerton, J.S. Allison, et al. 1988. Survival of coliform bacteria in static compost piles of dairy waste solids intended for freestall bedding. *J. Dairy Sci.* 71:1676.
14. Natzke, R.P. and B.J. LeClair. 1976. Coliform contaminated bedding and new infections. *J. Dairy Sci.* 59:2152.
15. Neave, F.K., F.H. Dodd, and R.G. Kingwell. 1966. A method of controlling udder disease. *Vet. Rec.* 78:521.
16. Oliver, S.P. and B.A. Mitchell. 1983. Intramammary infections in primigravid heifers near parturition. *J. Dairy Sci.* 66:1180.
17. Pankey, J.W. 1989. Premilking udder hygiene. *J. Dairy Sci.* 72:1308.
18. Pankey, J.W., E.E. Wildman, P.A. Drechsler, and J.S. Hogan. 1987. Field trial evaluation of premilking teat disinfection. *J. Dairy Sci.* 70:867.
19. Rendos, J.J., R.J. Eberhart, and E.M. Kesler. 1975. Microbial populations of teat ends of dairy cows, and bedding materials. *J. Dairy Sci.* 58:1492.
20. Reneau, J.R. 2001. Managing the environment for low SCC in first calf heifers. 4-State Dairy Management Seminar, February, 2001 pp. 19.
21. Smith, K.L. 1983. Mastitis control: a discussion. *J. Dairy Sci.* 66:1790.
22. Stewart, S. Personal communication. 2001.