The Best Alternative Bedding Source with Regards to Mastitis and Cow Comfort

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Abstract

There are many different bedding sources that you can choose to help prevent mastitis and overall cow comfort and wellness. Many aspects are involved when searching for the best alternative source of bedding. The goal of this literature review is to determine the optimum alternative-bedding source in regards to mastitis control and cow comfort.

This literature review was guided by analyzing thirty-five journal references, which regards mastitis and sources of bedding. The most common sources of bedding are sand, recycled manure, mattresses, and sawdust. Each bedding sources has advantages and disadvantages, which you can make the case for each bedding source to be the best. Keeping cows housed in well maintained bedding is extremely important to ensure your quality product. Bedding that is wet or dirty will increase your likeliness of mastitis and jump your somatic cell count up. Cows do not always react well to mastitis and your milk production will go down as well as your cull counts will increase. This review of literature will determine the best bedding sources to help prevent mastitis and raise cow comfort.

Introduction

Dairymen have always been searching for the most efficient way to produce milk at a low cost. There have been many options such as lower feed cost or cut down on labor expenses. One area that is very vital to dairymen is mastitis control. Mastitis can be transmitted from cow to cow be means contagious mastitis (Burvenich et al., 2007). This usually happens via the milking parlor due to employees not following the correct protocols or using the same towels for many different cows. Environmental mastitis occurs outside or the milking parlor in the living areas for the cows (Godden et al., 2008). Having poor corrals for cows or poor bedding in free-stalls causes environmental mastitis. Keeping your bedding clean with little to no moisture with help ensure that you reduce the chances of getting mastitis in cows. Many different bedding sources are available and all have advantages and disadvantages. Dairymen have to figure out what is the best for their dairy.

It is recorded that the dairy industry on production alone loses 1.2 to 1.7 billion dollars due to mastits (Shim et al., 2004). It is a staggering number, which is about 6% of all production in the United States. Mastitis is the most prevalent disease in dairy herds (Barkema et al., 2009) and needs to be addressed by every dairymen if they want to create the best possible product. Many steps can be taken in regards to mastitis such as keeping up your bedding spaces and choosing the correct alternative bedding sources.

Mastitis

Mastitis is the most devastating disease affecting adult dairy cows, and the associated economic losses continue to present a serious burden to producers (Sordillo et al., 1997). In the United States, it is estimated that the annual cost of mastitis per cow per year is around two hundred dollars (Kristula et al., 2005). Milk production loss is the largest factor. Nationally, mastitis is estimated to cost dairy producers 1.2 to $1.7 billion per year or approximately 6% of the value of production (Shim et al., 2004). Discarded milk due to mastitis alone cost dairymen over one hundred dollars per year per cow.

Mastitis is the most common and costly contagious disease affecting dairy farms in the western world (Barkema et al., 2009). Mastitis is how many milk creameries judge the product that is coming into their plants. Dairymen have to keep their somatic cell count under a certain amount to qualify for grade A milk. Somatic cell count is the most frequently used indicator of subclinical mastitis in dairy cattle. Elevated SCC leads to decreased raw milk quality, which is the determining factor for its processing value. Elevated SCC was associated with decreased shelf life of dairy products, edible food loss, and lower cheese yields. The most important cause of increased SCC is a bacterial infection of the mammary gland. Nonbacterial factors that affect SCC include age, stage of lactation, season, stress, management, day-to-day variation, and diurnal variation (Olde Reikerink et al., 2007).

Major steps have been taking by dairymen to help prevent the spread of mastitis. Management of milking, dry period, and housing environment are some of the most note worthy (LeBlanc et al., 2005).

Table 1. Estimated annual losses due to mastitis.

Source of loss	**Loss per cow**	**% Of total**
Reduced production	$121.00	66.0
Discarded milk	$10.45	5.7
Replacement cost	$41.73	22.6
Extra labor	$1.14	0.1
Treatment	$7.36	4.1
Veterinary Service	$2.72	1.5
Total	$184.40	100

Source: Current Concepts of Bovine Mastits. The National Mastits Council (NMC). 1996.

Mastitis occurs when there is bacteria present able to gain entry via the teat canal of the cow. It is defined as inflammation of the mammary gland. The first signs of mastitis will be evident in the milk of the cow then followed by an inflamed udder. In the milk, it will tend to be chunky in texture and possibly have bloody milk. Mastitis can be evident in cows without the dairymen even knowing. This is the sub-clinical mastitis, which, in time, can lead to more severe cases if not taken into account and dealt with. Several contagious mastitis pathogens are endemic in most countries with a dairy industry, but not necessarily within every farm. The most notable ones are *Streptococcus agalactiae* and *Mycoplasma* spp. Introduction of such pathogens into herds should be avoided through biosecurity measures (Barkema et al. 2009). Occurrence of mastitis is modeled to have direct effects on feed intake, body weight, milk yield, somatic cell count in the milk, subsequent mastitis cases within the cow and

in herd mates, voluntary and involuntary culling, mortality, and milk withdrawal (Ostergaard et at., 2005).

The cow's udder is made up of four mammary glands all with a specific function in infection control. The mammary gland is a complex organ that provides neonatal offspring with milk for nourishment and disease resistance. Specific and innate immune factors associated with mammary gland tissues and secretion also play a vital role in protecting the gland from infectious disease. The mammary gland is a complex organ that pro-vides neonatal offspring with milk for nourishment and disease resistance. Specific and innate immune factors associated with mammary gland tissues and secretion also play a vital role in protecting the gland from infectious disease (Sordilo et al. 1997). The teat canal is lined with keratin, which is crucial to the maintenance of the barrier function of the teat end, and removal of the keratin has been correlated to increased susceptibility to bacterial invasion and colonization. Keratin is a waxy substance that is derived from the epithelium.

The mammary gland of a lactating cow is the most important defense against disease infections (Burvenich et al., 2007). The elimination of even one subset of innate immune effector cells may be sufficient to cause a profound state of immunodeficiency. Intramammary innate defense against invading pathogens relies heavily on the number of circulating PMN before infection and their capacity to produce reactive oxygen species (Mehrzad et al., 2004).

Subclinical mastitis affects milk quality and quantity causing great economic loss for producers. Several studies have estimated milk production loss due to subclinical mastitis. There was no significant effect of DIM class and season of calving on the

change of milk, fat, or protein production. This was most likely because predictions of milk, fat, or protein were already corrected for DIM and season of calving (Halasa et al. 2009).

Table 2: Symptoms of each clinical case of mastitis

Degree of Infection		**Extent of Symptoms**	
	Milk	**Udder**	**Cow**
Subclinical	No	No	No
Mild Clinical	Yes	Maybe	No
Severe Clinical	Yes	Yes	Maybe
Systemic	Yes	Yes	Yes

Clinical mastitis is often classified according to severity as mild (milk looks abnormal), moderate (milk looks abnormal and the udder or quarter is swollen), or severe (the cow exhibits systemic signs). Although immediate action using systemic treatment is generally recommended for severe cases of clinical mastitis, selective treatment based on the causative pathogen is often recommended for mild and moderate cases (Pinzon-Sanchez et al, 2010).

Mastitis pathogens are categorized as being contagious or environmental. Contagious pathogens are traded from infected cows to cows with no infection. This can happen in the milk parlor via poor machine cleaning or bad milking protocols from milkers (use the same towel for many different cows). Environmental mastitis roots

from places all over the dairy, which can infect the cow. This usually occurs in the open corrals or in free-stalled barns where most of the pathogens tend to live.

The environmental infecting agents are Strep uberis, Strep dysgalactiae, Coagulase-neg Staphs, and E. Coli. The primary reservoir of environmental pathogens is the dairy cow's environment, and exposure of uninfected quarters to environmental pathogens can occur at any time during the life of a cow. The contagious infecting agents, which are most notably transferred through the milking parlor, are Strep ag, Staph aureus, and mycoplasmas.

Types of Mastitis

Staphylococcus aureus is an important cause of udder infections in dairy herds. Both lactational and dry cow therapy are part of *Staph. aureus* control programs. Reported cure rates for *Staph. aureus* mastitis vary considerably. The probability of cure depends on cow, pathogen, and treatment factors. Cure rates decrease with increasing age of the cow, increasing somatic cell count, increasing duration of infection, increasing bacterial colony counts in milk before treatment, and increasing number of quarters infected. *Staphylococcus aureus* mastitis in hindquarters has a low cure rate compared with front quarters. Antimicrobial treatment of intramammary infections with penicillin-resistant *Staph. aureus* strains results in a lower cure rate for treatment with either *β*-lactam or non-*β*-lactam antibiotics (Barkema et al. 2006).

Streptococcus dysgalactiae adheres to epithelial cells from the bovine mammary gland and to extracellular matrix proteins in vitro and invades mammary epithelial cell cultures, all of which can be potentially important pathogenic mechanisms. *Streptococcus dysgalactiae* is related to summer mastitis in 37% of cases. In spite of this relatively high prevalence, little is known about bacterial and host factors that

contribute to the establishment and persistence of IMI caused by *Strep. dysgalactiae* and the natural reservoir of the bacteria. Controlling *Strep. dysgalactiae* by treatment strategy, at drying-off or during the lactation, may be a solution. The cure rate is expected to be close to 100% for *Strep. dysgalactiae* during the dry period, and treatment of *Strep. dysgalactiae* mastitis during the lactation has shown some promising results (Whist et al. 2007).

Streptococcus uberis is known worldwide as an environmental pathogen responsible for a high proportion of cases of clinical and subclinical mastitis in lactating cows and is also the predominant organism isolated from mammary glands during the nonlactating period. Accurate and cost-effective methods of identifying mastitis pathogens are important for the diagnosis, surveillance, and control of this economically important disease among dairy cows. *Streptococcus uberis* is the most common isolate from cases of clinical mastitis and is commonly found in subclinical infections in early lactation and at the end of lactation in dairy cows. *Streptococcus uberis* can be isolated from a number of sites on the cow including the vagina, tonsils, and escutcheon as well as from bedding and pasture. The main route of transmission appears to be from environmental sources (McDougall et al. 2004).

Dairy cattle with acute coliform mastitis, caused primarily by *Escherichia coli,* exhibit a wide range of systemic disease severity, from mild, with only local inflammatory changes of the mammary gland, to severe, with significant systemic signs including rumen stasis, dehydration, shock, and even death. Studies have shown that up to 23% of clinical coliform mastitis presents with acute systemic disease signs (Wenz et al. 2006).

The bacteria multiply in the mammary secretion without attachment to epithelial surfaces. Previous studies have shown that cows base an inflammatory response to *E. coli*, but the efficiency of the response is variable in protecting the gland. Differences in severity have mainly been attributed to the promptly of influx of polymorphonuclear neutrophils (**PMN**) from peripheral blood into milk and to the killing capacity of PMN. PMN are the first line of immunological defense against *E. coli* invading the bovine mammary gland. They are produced in the bone marrow and are released into the blood circulation. After circulating for a few hours, the PMN migrate to the peripheral tissues, where they undergo apoptosis. During infection, PMN production is escalated by the action of inflammatory cytokines and growth factors that activate more immune cells and recruit them to the site of infection. After migrating out of the blood vessels into the udder compartment, PMN phagocytose bacteria and kill them by secreting bactericidal substances and producing oxidative metabolites. Next, PMN die by apoptosis and are phagocytosed by macrophages, thereby minimizing the release of PMN granular contents that are damaging to tissues. Sometimes inflammation itself can damage healthy cells, which further stimulates inflammation and can lead to chronic inflammation, organ failure, and death (Detilleux et al., 2005).

Klebsiella spp. are common causes of milk loss, mastitis, and culling of dairy cows (Zadoks et al. 2011). Cows with *Klebsiella* spp. mastitis are more likely to die or to be culled than are cows with other types of mastitis. *Klebsiella* spp. mastitis causes a considerable and often sustained decrease in milk production. Identification of potential sources of *Klebsiella* is important for implementation of preventive measures that decrease exposure and limit the risk of udder infections. Bedding materials from wood

byproducts such as sawdust and shavings can be sources of *Klebsiella* on dairy farms (Munoz et al. 2008).

Treatment

Treatment of mastitis is important to dairymen in the fact that it can save them cost in milk yield and quality of milk. The best treatment of mastitis is to prevent it from happening at all. This can be accomplished by keeping certain cows away from other cows, quick treatment of the cow, or by culling the infected cow. The available control strategies against mastitis are numerous and the application of these varies from herd to herd. As the biological knowledge about mastitis is continuously enhanced and new control measures are provided, the evaluation of alternative control strategies has become a repeatedly important decision problem for herd management. Furthermore, there is a trend toward larger herds implying less labor time per cow and increased risk of spread of infections due to more cows per milking unit (Ostergaard et al. 2005). Farmers may differ in their preferences, which means that a certain set of technical and economic effects of a mastitis control strategy will be considered appealing in one herd but not in another herd.

For clinical mastitis, treatment choices can be based on herd-level knowledge of the sensitivity patterns of predominant strains. Such herd-level knowledge can be obtained through sensitivity testing of clinical isolates after treatment has been initiated. Results from previous clinical cases can then be used to develop a herd-level treatment plan for subsequent clinical cases (Barkema et al. 2006). When a cow is diagnosed with CM, it is helpful to the dairy farmer to know what type of CM agent is causing the disease. The bacterial species causing the inflammation is partly responsible for the inflammatory response and clinical severity of a mastitis case. The species often

determine the severity of the immune response of the cow and are often related to the amount of milk loss and severity of more systemic effects. It is therefore seen as important to determine, whenever feasible, the etiologic agent responsible. Treatment protocols are often specifically based on the knowledge of whether a clinical case is caused by a gram-negative or a gram-positive bacterial organism (Shukken et al, 2009).

β-Lactam antibiotics (penicillins and cephalosporins) are antimicrobial drugs widely used in veterinary medicine for preventing and treating mastitis and other bacterial infections in dairy cattle (Roca et al., 2011). These antimicrobials interfere with bacterial cell wall growth. Improper use of -lactam antibiotics may lead to residues in milk, especially when withdrawal times are not respected. These residues can be toxic and dangerous for human health, and may cause allergic reactions and antimicrobial resistance. They may also represent a technological problem for industry production affecting bacterial fermentation processes in dairy products such as yogurt and cheese.

Table 3: Influence of prepartum antibiotic treatment of dairy cattle mammary glands with penicillin/novobiocin or pirlimycin hydrochloride on intramammary infections during early lactation in two different dairy herds.

Herd	Treatment	No. Cows (Quarters) enrolled by treatment	No. Quarters infected before calving	No. Quarters infected in early lactation	Cure Rate (%)
Herd 1	Penicillin/novobiocina	24(95)	72	18	75
	Pirlimycina	23(92)	70	9	87
	Untreated control	23(92)	57	25	56
Herd 2	Penicillin/novobiocina	19(74)	25	6	76
	Pirlimycina	19(73)	29	12	59
	Untreated control	17(66)	19	14	26

Source: Oliver et al., 2004

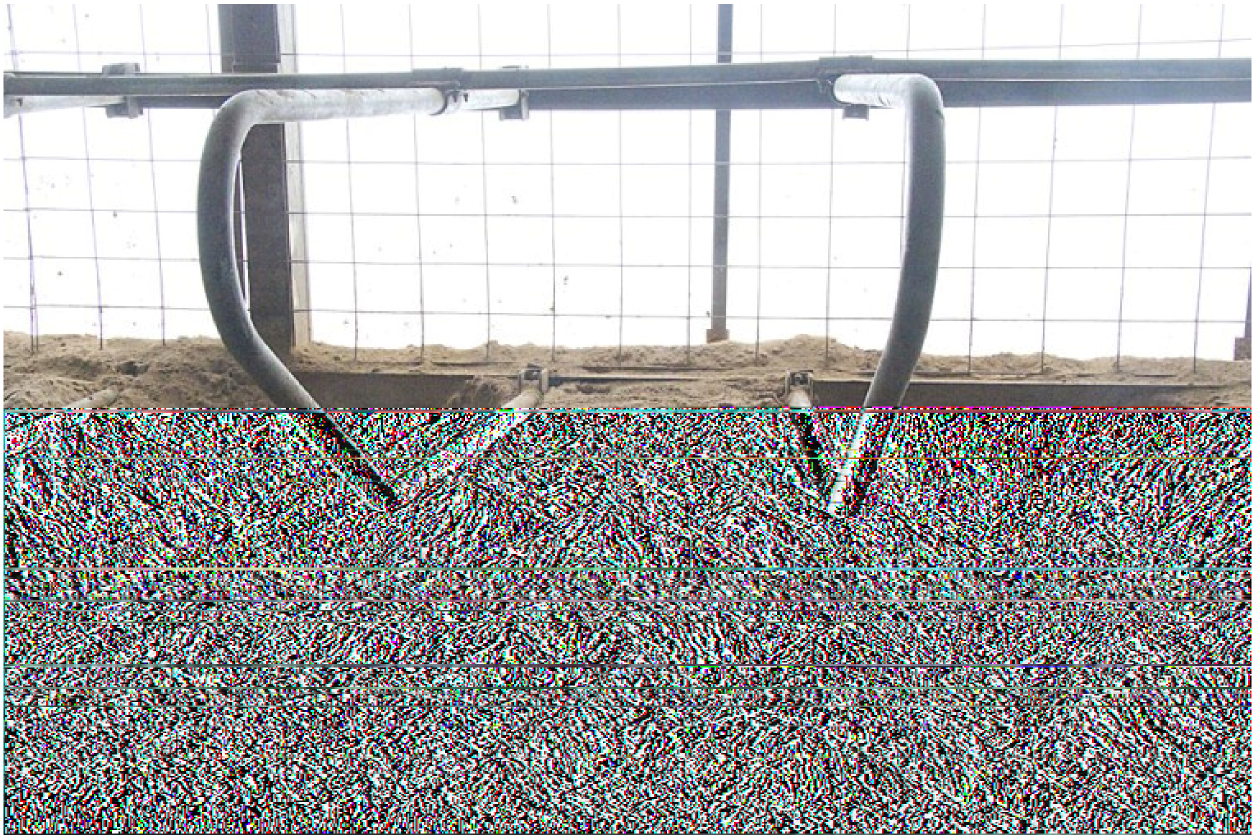
Sources of Bedding

Sand

Sand bedding is an alternative-bedding source for dairymen all throughout the nation. Recycled sand is the most commonly used and the cheapest. Such bedding as straw or sawdust carry many pathogens which can lead to disease in a dairy herd. These reasons lead dairymen to start using sand bedding for their cows. They noted that cows preferred to lie in sand rather than in sawdust materials and their number of lame cows decreased as a result (Norring et al. 2008). Sand is a great way for dairymen to keep their cows clean and comfortable. In a test by Norring et al., cows lying in sand bedding were much more clean. Every section on the legs and belly of the cow were predominantly cleaner and healthier looking. This may be because cows are able to conform the sand to their body, which could in fact condone better effects.

Although sand bedding is more likely better for the cows overall wellness, they do not always prefer sand. Bedding sources such as straw can be much more softer and sought after. A study by Cook et al. showed that when comparing sand to mat bedding, there is not much of a difference in lying time between the two. But, in regards to lameness, cows in sand do not alter their daily time budgets and lame cows in mat bedding stand by more than 4 hours a day. Lameness is a detrimental issue for dairymen. Dairymen experience lower fertility and milk production in their lame cows. In a test by Drisseler et al., they determined that cows prefer sand in overall lying time. Cows lay for longer periods than mattresses in the test when the sand was first place into the free stall. During the duration of the study, the amount of lying time decreased each day. It is important to keep refilling the sand and to maintain with raking.

Figure 1.



Picture taking from Vista Verde Dairy, Chowchilla, CA.

This is a picture of recycled sand that has not been raked for four days. Cows will exhibit longer standing time in stalls when sand is not maintained or refilled. In a study by Norring, et al., the duration of time spent lying was longer when cows had access to straw-bedded stalls than when they had access only to sand-bedded stalls. In addition, cows tended to prefer straw-bedded stalls, especially if they had been kept previously with straw-bedded stalls. Prior familiarity with sand increased the acceptance of sand, but did not lead to greater preference for sand over straw. Despite these effects on behavior, cow cleanliness and hoof health were better for cows kept on sand-bedded stalls. Drissler et al. observed that the depth of sand bedding decreased with use and its surface became concave, which in turn reduced the total lying time of cows.

Inorganic bedding such as sand has been shown to have significantly lower bacterial numbers than organic bedding and is widely considered the best bedding for cow comfort. Recently both active (mechanical sand separator) and passive (gravity) manure systems have been developed that enable the sand to be separated from the manure. In most cases, the separated sand is recycled as bedding for the free stalls (Kristula et al, 2005).

In a study performed by Kristula et al., 2005, they came to a conclusion that recycled sand is just as safe to use for bedding in prevention of mastitis as clean sand. The results for this study were obtained from multiple herd comparisons, and herd was a significant effect, suggesting that different management systems influence the number and types of bacteria in both CS and RS. Compared with organic bedding, cows bedded on CS or RS should have fewer mastitis infections caused by coliforms.

Recycled Manure

In a study done by Godden et al. 2008, manure solids promoted the greatest amounts of growth of *K. pneumoniae*, followed by recycled sand and then shavings, whereas clean sand promoted the least. There would seem to be a tradeoff in selecting shavings as a bedding material, because it supported moderate growth of *K. pneumoniae* but caused a rapid decline in the numbers of *E. faecium*. However, recycled sand and clean sand each only supported relatively small amounts of growth of *E. faecium*, so the benefit of shavings relative to other bedding materials is limited.

Recycled manure can either be scraped in the lanes where the cows live or be flushed. Once flushed or scraped, the manure is dried out or passed through a

separator to be dried faster. For cow comfort, many dairymen add almond shells to the recycled manure to provide a more comfortable bed for the cows.

Hogan et al, 2007, provided that recycled manure treated with conditioner had lower gram-negative bacterial and streptococcal counts than did untreated recycled manure on d 0 and 1. Coliform and *Klebsiella* spp. counts were reduced by addition of the conditioner on d 0, but not on d 1. None of the bacterial counts measured in recycled manure differed between conditioner-treated and untreated bedding on d 2 and 6. Recycled manure treated with conditioner had a lower pH on d 0, 1, and 2 compared with untreated bedding. On d 0, the DM content of bedding treated with conditioner was higher than that of untreated recycled manure. Treatment with conditioner did not affect the DM content of recycled manure on d 1, 2, and 6 ($P<0.05$). Addition of approximately 1kg of commercial bedding conditioner containing 93% sodium hydrosulfate was used for the study against a control.

Composted manure is relatively new to the dairy industry and it reduces the number of microbial bacteria in the manure (Cook et al., 2004). Compost manure is heated in piles, which essentially burn out the bacteria. This is done over a period of time mostly during summer months when it is not raining.

Figure 2

Picture taken at Rockshar Dairy in Merced, CA.

Figure 3

Picture of a duel separator screen. Red Rock Dairy, Merced, CA.

Figure 4

Figure 6

Compost rows. Red Rock Dairy, Merced, CA.

Geotextile Mattresses

Deep-bedded stalls are preferred over stalls with concrete or geotextile mattresses. Lying times also tend to be longer and standing times shorter for deep-bedded stalls compared with wood-covered stalls or mattresses. In contrast, longer lying times on mattresses than on sand stalls has also been reported. In addition to longer lying times in deep-bedded stalls, cows housed on deep-bedded sand were less likely to experience clinical lameness (11%) than those housed on geotextile mattresses (24%) (Drissler et al., 2005).

Tucker et al., 2004, suggest that adding sawdust to the geotextile mattresses would improve lying time and overall more cow comfort. The number of lying bouts, time spent standing with only the front hooves in the stall, and the number of head swings all changed in response to the amount of sawdust on the geotextile mattress. Based on these changes, increased amounts of sawdust bedding appear to increase the suitability of the surface in terms of the decision to lie down. Indeed, all cows could clearly distinguish between the 3 treatments and showed clear preferences for lying and standing in stalls with more sawdust. Thus, to promote comfort, geotextile mattresses are best managed with copious bedding.

To prevent mastitis on mattress bedding you can apply treatments. In a study by Kristula et al., 2008, they used hydrated lime, CAC, coal fly ash, kiln-dried wood shavings, and a no-bedding control. Hydrated lime was the most effective treatment in suppressing bacterial growth on the mattresses, with the lowest bacterial counts for tested types of bacteria. The commercial product CAC provided the next lowest

bacterial counts and was more effective than fly ash, shavings, and the no-bedding control for coliforms, *Klebsiella* spp., and *Streptococcus* spp. Fly ash effectively reduced coliform populations compared with the no-bedding control or shavings. However, populations of *Klebsiella* spp. and *E. coli* with the fly ash treatment were similar to that of the control. The shavings and control treatments had the highest *Klebsiella* spp. counts. Shavings had no effect on the coliform and *E. coli* counts compared with the no-bedding control. *Streptococcus* spp. counts were highest for the no-bedding control.

Figure 6

Picture of mattress bedding at Rockshar Dairy in Merced, CA.

Sawdust

Organic materials such as straw, corn fodder, and sawdust often contain >106 cfu/g of coliform bacteria when used as bedding. Bacteria counts also differ within organic beddings; wood products often contain the greatest number of coliform bacteria. Wood products, such as sawdust and shavings, have been found to be heavily contaminated with Klebsiella spp. Sawdust and wood shavings continue to be popular choices as bedding despite evidence that outbreaks of coliform mastitis within a herd are commonly attributed to contaminated bedding (Hogan et al., 1997). Sawdust can be placed on top of mattresses like in the study Hogen et al., 1997 performed, or it can be in a deep bed for maximum softness.

It is imperative that you maintain your sawdust bedding and not let moisture soak into it. In a study by Reich et al., 2010, Cows spent 10.4±0.4 h/d lying in the stall on the wettest bedding (34.7% DM) versus 11.5±0.4 h/d on the driest treatment (89.8% DM). When bedding was wet, cows appeared to compensate for reduced lying time by spending more time standing idle in the alley (not including feeding time). Cows spent 1.1 h/d less time lying on the wettest treatment compared with the driest.

A study between sand and sawdust, Zdanowicz et al., 2004, noted that actual bacterial counts varied during the course of the week for both sand and sawdust bedding. Bacterial counts in sawdust increased at the beginning of the week, reaching their maximum population numbers by d 2. The initial bacterial populations may be due to the availability of nutrients in fresh sawdust. As the week progressed, the sawdust bedding became more contaminated with manure, possibly resulting in differences in

nutrient availability for bacteria. However, competition between bacterial populations also likely increased over this period.

Item	**Herd A**	**Herd B**	**Herd C**	**Herd D**	**Herd E**	**Herd F**	**Herd G**	**Herd H**
Housing type	Freestall	Freestall	Freestall	Freestall	Freestall	Freestall	Freestall	Tie stall
Stall base	Mattress	Mattress	Deep bed	Deep bed	Mattress	Mattress	Deep bed	Mattress
Bedding	Shavings	Sawdust	Sand	Sand	Shavings	Shavings	Sand	Shavings
Size of Herd	1,001	299	197	1,602	1,795	568	1,754	144
RHA (KG)	10,500	10,227	12,818	12,318	9,591	12,425	11,563	9,545
SCC	261,000	296,000	192,000	334,000	182,000	223,000	535,000	237,000
Cases (%)								
No growth	47	28	31	23	35	22	24	33
Gram (-)	15	17	19	39	34	67	43	3
Gram (+)	35	53	44	38	26	11	24	63
Mixed Infection	3	2	6	0	5	0	9	1

Sources: (Lago et al. 2011)

Results and Conclusion

After reviewing all the literature regarding mastitis and cow comfort for sand bedding, sawdust bedding, recycled manure bedding, and mattress bedding, there is not a significant best alternative source for bedding. All of the different bedding sources have pros and cons. Mattress bedding is the worst for cow comfort and cows end up standing longer in the pens than other conventional beddings (Tucker et al., 2004). This can be relegated by adding sawdust or shavings to the top of the mattresses, which improved overall comfort for the cows as Tucker et al. explained. Mattresses are easy for maintenance and upkeep, as you do not have to rake them. To ensure that you get low mastitis counts; the best way to do this is by adding treatment. The best treatment for mattresses is by adding hydrated lime (Kristula et al., 2008).

Sand is probably the most common used bedding source of them all. Sand bedding is inorganic bedding that keeps much of the moisture out (Kristula et al., 2005). Sand can be problematic as it can easily get into your separator screens. Sand is also not available for every dairymen and can be quite hard to access. Sand typically has the lowest mastitis counts by studies done by Zdanowicz et al. and Kristula et al., 2005.

Recycled manure collects the most moisture and has high bacteria content if not maintained properly. Although recycled manure bedding is an easy choice for dairymen, it is not the best to prevent mastitis and improve milk quality. Of the four bedding sources, recycled manure had the highest mastitis counts.

Sawdust is a very popular choice, especially for Mid-western dairymen (Hogan et al., 2007). Sawdust is extremely good for overall cow comfort as in studies Cook et al., 2005 pointed out that cows will choose sawdust over the likes of sand and recycled manure. Being an organic bedding source, it is likely that sawdust will gain moisture

after a couple of days. The importance of raking and maintaining the sawdust bedding is essential to keeping mastitis counts down. In a study by Zdanowicz et al., 2004, cows had dirtier rear udders when housed on sand than on sawdust, but udder cleanliness was not consistently correlated to bacteria counts on the teat end.

Sawdust and sand are generally considered the best alternative bedding sources with mastitis control and cow comfort. Many studies have been done to prove resistance to mastitis and cow comfort levels. The information is not always conclusive as studies receive different results such as Hogan and Smith 1997, and Janzen et al., 1988.

Table 4: Bedding Sources in relation with SCC

Item	**Herd A**	**Herd B**	**Herd C**	**Herd D**	**Herd E**	**Herd F**	**Herd G**	**Herd H**
Housing type	Freestall	Freestall	Freestall	Freestall	Freestall	Freestall	Freestall	Tie stall
Stall base	Mattress	Mattress	Deep bed	Deep bed	Mattress	Mattress	Deep bed	Mattress
Bedding	Shavings	Sawdust	Sand	Sand	Shavings	Shavings	Sand	Shavings
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Gram (+)	35	53	44	38	26	11	24	63
Mixed Infection	3	2	6	0	5	0	9	1

Sources: (Lago et al. 2011)

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