

## HYGIENIC PROPERTIES OF ORGANIC VERSUS INORGANIC BEDDING

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### Introduction

Bedding in dairy cattle stalls has been used traditionally to provide a comfortable surface for recumbent animals, and less concern has been directed toward footing. Cattle with locomotor deficits have difficulty standing on surfaces which tend to allow slippage. With traditional bedding materials such as wood shavings or straw, the feet easily penetrate through the bedding to the underlying concrete where traction is poor especially when wet due to urination. Cows with a history of parturient paresis are predisposed to the downer cow syndrome (1). Sand has been proposed as a bedding material to assure proper footing for prevention and treatment of the downer cow syndrome (1). Since soil surfaces are not permitted in grade A dairy barns, the hygienic status of sand is open to question. The following study is an attempt to investigate hygienic and management properties of sand as a bedding for calving stalls, but the lessons learned herein could be applied to mounting areas for cows or bulls, stallions, and boars.

### Materials and Methods

Four cows weighing 470-636 kg were used for 8 two week trials on both sand and wood shavings in equal in size stalls of 100.7 m<sup>2</sup> each. A cross over design was used so that the animals alternated between the two bedding types. Water and hay were provided *ab libitum* and manure was removed twice daily. No attempt was made to remove urine soaked sand, but urine saturated shavings were removed with manure. At the end of the 2 week trial all remaining shavings were removed and the stall was thoroughly washed and then sanitized with sodium hypochlorite. After drying, 1.4m<sup>3</sup> (2 yards) of fresh shavings were spread for the next trial. During the trial an additional 0.7m<sup>3</sup> of shavings were added. Thus 2.2m<sup>3</sup> (3 yards) of bedding were used for each shavings trial except in the first two of Table 1 for which half as much was used. The sand stall was washed with 4000-6000 l of fresh water and allowed to drain for 2 days and then the surface was agitated twice with an electric rotatiller. After 7-10 days fresh sand was applied to the surface of the stall. On average 0.4m<sup>3</sup> of sand (0.5 yard) were applied to the surface of the stall before each 2 week trial to replace that removed with the manure during the previous trial. This was done to maintain an approximate depth of 20 cm of sand.

## Sample collection and preparation

Every other day the animal was moved out of the stall and samples of bedding were taken for bacteriological analysis. After removal of manure the bedding was leveled, and then a grid of 9 sample points was constructed by stretching 3 equally spaced strings across the stall. Each string was marked with 3 equally spaced loci which marked the sampling sites. At each sampling site 40 cc of sand or 100 cc of wood shavings was collected. The 9 samples were thoroughly mixed using a rock tumbler for the sand and a stirring rod for the shavings. Next, 100 cc of bedding was measured out and placed in a rubber rock tumbler. After 1000 cc of sterile deionized water were added, the contents of the tumbler were mixed for 30 minutes. Then a 6 cc fluid sample was withdrawn with a sterile syringe and 16 gauge needle, transferred to a sterile 10 cc vacutaner tube and frozen for batch analysis. A specially constructed 100 cc clear plastic graduated cylinder was used to accurately measure out the final bedding sample before wash out of organisms. A tight fitting 1.0 kg brass plunger was used to equalize packing of the samples in the graduated cylinder. All containers in contact with the sample were sanitized by thorough washing in hot tap water followed by 3 rinses with sterile water.

## Bacteriological analysis

No sample was used if subjected to more than one freeze/thaw cycle. After thawing of batches of bedding wash samples, total aerobic counts were determined by plating diluents of each bedding wash on tryptose agar/5% sheep blood plates. Serial dilutions of the wash yielded plates with 5x, 50x, 500x, etc. dilutions. The plates were inverted and incubated at 37° for 24 hours when a preliminary count was made and then after 48 hours final plate counts were made. Plates with 30-300 colonies were counted to determine the number of colony forming units/cc (cfu/cc). Once the cfu/cc of wash was determined, it was multiplied by a factor of 10 to give the cfu/cc of bedding since each cc of bedding was washed with 10 cc of sterile water.

## Chemical and physical analysis

Sand samples were dried in an oven overnight to determine the dry weight of the sample. After weighing the sample was placed in an electric furnace where the organic material was burned off at 600° C and the sample was reweighed. The percent organic material was calculated to be 100 times the difference between the oven dry weight minus the furnace weight divided by the oven dry weight. A total of 52 surface samples from 10 trials and 12 deep samples were analyzed. Approximately 6m<sup>3</sup> of fresh sand was added during 12 trials.

## Results

Oven drying of the shavings revealed that the moisture content was 20.8%. The weight of 100 cc of dry shavings based on 10 trials was found to be  $6.1 \pm 0.9$ g (mean  $\pm$  s.d.) while the weight of 100 cc of dry sand was found to be  $160.5 \pm 1.6$ g. Therefore, sand was found to be 26.6 times heavier than the shavings when compared on a volumetric basis.

The results of the bacteriological counts are shown in Table 1 below. All values in Table 1 are millions of cfu/cc of bedding. A paired Student's t test of all sand values vs. all shavings values revealed a significant difference between the 2 populations at the 0.05 level. Trials 1-3 and 6 are not included due to procedural problems with one or both of the stalls (cow off feed and insufficient bedding).

**Table 1** A summary of total aerobic cfu/cc  $\times 10^{-6}$  of both stalls

Trial	Cow#	Sand	Wood Shavings
		mean $\pm$ s.d.	mean $\pm$ s.d.
4	205	$10.1 \pm 3.9$	$30.5 \pm 9.8$
5	204	$30.2 \pm 18.2$	$2477.9 \pm 1261.7$
7	201	$6.3 \pm 1.8$	$33.8 \pm 15.5$
8	204	$21.1 \pm 6.5$	$2312.3 \pm 1848.7$
9	204	$9.8 \pm 2.3$	$120.6 \pm 45.0$
10	208	$4.3 \pm 3.5$	$2.7 \pm 2.9$
11	208	$11.2 \pm 9.8$	$14.6 \pm 17.4$
12	208	$18.1 \pm 21.9$	$0.8 \pm 1.2$
composit means		$13.8 \pm 22.2$	$633.5 \pm 2367.2$

Analysis of sand samples from the surface revealed that the organic matter content rose from 0.65% during the first trial to 1.87% during the fifth trial and then the organic content remained under 2% thereafter. The deep sand was black and foul smelling but the organic content was always less than the corresponding surface organic content. After 27 weeks of cow use, the organic content of 9 deep samples was a mean of 1.1% with a range of 0.9-1.4%, the highest being in the center of the stall.

## Discussion

Slipping on concrete is an important livestock management problem in several species. The most thorough study of the problem has been conducted with young pigs (2). The preference of cattle for soil rather than concrete has been shown for estral cows (3). In this study estral cows mounted 3-15 times more often on soil than concrete when other estral cows were available on either surface. Therefore, the availability of a soil surface is advantageous for heat detection. Since dirt surfaces are extremely difficult to clean, sand has been proposed as a surface which provides good footing; and the management effort required to clean it is not prohibitive (1). The usefulness of sand in aiding recovery of a typical downer cow was the subject of a recent report (4).

While a number of studies have been done on bacterial growth in bedding (5-9), few have dealt with sand (5). Because sand is more than 25 times heavier than wood shavings, comparing counts of equal weights of each would give much lower counts in sand since the volume would be considerably less for sand. Therefore, a chamber was constructed which allowed measurement of similar volumes of both sand and wood shavings. When taking both wood shavings and sand samples we tried to avoid the inclusion of large clumps of manure in the sample to prevent biasing the sample towards very high counts. The very different physical properties of sand and wood shavings necessitated the development of "separate but equal" methods of handling the bedding material at certain steps. Because the shavings were so light they did not appear to mix well in the rock tumbler when dry and therefore more vigorous mixing was assured with a sterilized mixing rod. Once water was added both materials seemed to mix well in the rock tumblers.

Cow 204 was very loose and therefore the manure tended to mix with the bedding more and the stall was harder to keep clean. She had the highest counts in every case but one. This cow was used as a "worse case" scenario to test the system under the most adverse conditions. Normally downer cows have reduced food consumption and manure production with relatively dry stools so care is relatively easy. If, however, a sand stall is to be used for prevention with prepartum ambulatory cows, a situation similar to our two week trials would exist.

Since the shavings stall was completely cleaned out after each trial while the sand stall was used continually with fresh sand being added only to replace that which was removed, the experiment was biased in favor of the shavings stall. Ultimately the counts will depend upon the amount of manure contamination since sand itself will not support bacterial growth and shavings will contribute little to bacterial growth, but recycled manure supports vigorous growth of bacteria (8). The amount of manure in the bedding depends upon the rate of contamination and the amount of dilution. Since shavings were being used at a rate of  $2.2 \text{ m}^3$  per 2 wk trial but only  $0.4 \text{ m}^3$  of fresh sand was used on average for 2 week trial, the dilution of manure was much greater in the shavings stall. Another factor affecting counts was the degree of urine contamination as urine has been shown to inhibit bacterial growth in bedding possibly due to ammonia formation (8).

The organic content of less than 2% in the surface sand was probably due to manure contamination since feed contamination was minimal. Apparently an equilibrium was reached such that manure removal and contamination were similar. Some of the organic matter apparently was broken down and washed out since the organic matter content of the deep samples was less than that of the surface. About  $6 \text{ m}^3$  of fresh sand was added during the 24 weeks of use. Since the total sand volume was about  $20 \text{ m}^3$ , the sand replacement was about 30% of the total. Therefore sand is a reusable bedding that can be cleaned by washing which is not true of any other bedding material.

## Summary

Cattle with locomotor deficits have difficulty standing on surfaces which tend to allow slippage. With traditional bedding materials such as wood shavings or straw, the feet easily penetrate through the bedding to the underlying concrete where traction is poor especially when wet due to urination. Sand has been proposed as a bedding material to assure proper footing for prevention and treatment of downer cows. Since soil surfaces are not permitted in grade A dairy barns, the hygienic status of sand is open to question. The following study is an attempt to investigate hygienic and management properties of sand as a bedding for calving stalls, but the lessons learned herein could be applied to mounting areas for bulls, stallions, and boars.

Cows weighing 470-635 kg were used for two week trials on both sand and wood shavings in equal size 100.7 m<sup>2</sup> stalls. A cross over design was used so that the animals alternated between the two bedding types. Manure was removed twice daily. No attempt was made to remove urine soaked sand, but urine saturated shavings were removed with manure. Comparisons of equal volumes of sand vs. wood shavings revealed significantly lower bacterial counts in the sand. We conclude that sand filled stalls are both hygienic and useful for prevention and treatment of downer cows.

## Zusammenfassung

Rinder mit Defiziten im Bewegungsapparat tun sich schwer wenn sie auf schlüpfrigen Fussböden stehen müssen. Klauen durchdringen leicht die gewöhnliche Einstreu von Holzspänen oder Stroh, und stehen dann auf dem Zementboden der durch Urin schlüpfrig geworden ist. Die Einstreu von Sand wurde vorgeschlagen um bessere Fussung zu gewährleisten, auch als Verhinderung und Therapie von "Festliegen". Weil Erdreichfussböden in den erstrangigen Milchkuhställen nicht zugelassen werden, ist die Hygiene von Sand in Frage gestellt. Unsere Untersuchung versucht die hygienischen und stallhalterischen Eigenschaften von Sand als Einstreu in Gebärställen zu klären. Was wir davon gelernt haben lässt sich aber ebensogut auf Sprungställe für Bullen, Hengste, und Eber anwenden.

Kühe von 470-635 Kg Gewicht wurden für die zweiwochigen Versuche benutzt wo sie sowohl auf Holzspänen als auch auf Sand in einem 100,7 m<sup>2</sup> Gebärstall stehen mussten. Die Tiere wechselten zwischen beiden Einstreutypen. Der Stall wurde zweimal täglich ausgemistet. Der mit Urin vollgesogene Sand wurde nicht weggeschafft, wohl aber derartige Holzspäne. Vergleiche von gleichen Volumen von Sand versus Holzspänen zeigten signifikant geringere Keimzahlen im Sand. Wir schliessen daraus, dass sand-gefüllte Ställe hygienisch sind und auch zur Verhinderung und Therapie von "Festliegen" beitragen.

## Resumen

Bovinos con problemas locomotores tienen dificultad para pararse sobre superficies resbalosas. Las patas de los animales atraviesan fácilmente los materiales de las camas tradicionales, viruta o paja, hasta llegar al cemento donde la tracción es pobre, especialmente cuando se humedecen por la orina. La arena ha sido propuesta como material para cama que aseguraría un estado apropiado del pie en la prevención y tratamiento de la vaca caída. Teniendo en cuenta que el piso de tierra no está permitido en ambos grados A, el estado higiénico de la arena está abierto a cuestionamientos. El siguiente estudio trata de investigar las propiedades sanitarias y de manejo de la arena como cama en establos de parición, pero la información obtenida aquí podría ser aplicada también a los lugares dedicados a la monta con toros, padrillos o verracos.

Vacas pesando entre 470 a 635 Kg fueron usadas durante dos semanas en un ensayo con arena y viruta en establos de igual tamaño, 100.7m<sup>2</sup>. Se empleó un diseño cruzado para que los animales alternaran entre los dos tipos de cama. Las deposiciones fueron removidas dos veces por día. No se intentó remover la orina absorbida por la arena pero sí fue removida la que saturaba la viruta junto con el estiércol. Volúmenes iguales de arena y viruta mostraron en las cuentas bacterianas valores significativamente menores para la primera. Por lo cual concluimos que la arena en los pesebres es higiénica y útil para la prevención y el tratamiento de la vaca caída.

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