Characteristics of Separated Manure Solids Following Anaerobic Digestion or After Composting for Dairy Freestall Bedding Use (preliminary data)

A.S. Leaflet R2203

Leo Timms, associate professor of animal science;
Dan Meyer, ISU Extension ag engineering field specialist;
Joanne M, Kinyon, clinical microbiologist, VDPAM

Summary and Implications

This summary provides preliminary data regarding dry matter content and environmental mastitis pathogen counts in separated manure solids following anaerobic digestion, after composting, and used in free stalls for bedding. These data are part of a larger trial evaluating the characteristics of separated manure solids, starting from the raw product (manure) and following the material through it's usage in stalls, including its overall impact on herd health performance, and economics, and provide insight into proper conditions and management techniques that are necessary to make this technology successful both now and in the future.

Introduction

Bedding materials are used in most types of housing for dairy and other animals and are generally required to improve animal comfort and cleanliness, and assist in removal of moisture from the stall / housing environment. The choice of bedding materials by farms is related to the manure system used, availability and cost of materials, and personal preference with a desire to optimize or maximize the above requirements.

Technology to separate solid material from the liquid portion of cow manure and the use of this material as animal bedding has been known for > 30 years. Many dairies in the western US are dry lot dairies where the lots and resting areas are dried and managed manure solids (dried naturally due to limited precipitation and humidity, and raking or grooming). Most dairies in the rest of the US have never used manure solids or have abandoned them for dryer materials such as sawdust, etc. A major reason for these decisions and concerns relates to elevated incidence of environmental mastitis in some herds, as well as higher humidity and precipitation which hinder materials from drying appropriately. On the other hand, some research shows manure solids can be a suitable bedding if it is dried and managed properly.

There is a resurgence of interest in using manure solids that is growing from an increase in the instillation of methane digesters, and regulations involving manure storage and application. Also the scarcity and high price of certain organic beddings (sawdust) has also increased interests.

The overall focus of this work is to evaluate the characteristics of separated manure solids, starting from the raw product (manure) and following the material through it's usage in stalls, including it's overall impact on herd health performance, and economics, and provide insight into proper conditions and management techniques that are necessary to make this technology successful. The objective of this paper is to present data on certain characteristic (dry matter content and environmental mastitis bacterial load) from the initial manure through anaerobic digestion (1 dairy), solid separation, then followed by using fresh, or piling/ composting before stall usage, and finally through stall usage and performance. Data on animal health and performance and concurrent studies from farm 1 and 2 other dairies that receive the product from farm one will be summarized following completion of sample and data collection in March 2007.

Materials and Methods

Study participants:

Dairy # 1 is a 700 cow dairy in NE IA. They have 2 lactating cow free stall barns and manure goes to and through an anaerobic digester. In early March 2006, the dairy put in a screw press solid separator post digester and started using the separated solids (mainly fresh) for bedding freestalls. Excess separated solids were piled up and used as needed or remained piled until another part of the project where those solids were transported (starting August 2006) and used for bedding on 2 other 120+ cow dairies also (current work and study on all 3 dairies in progress to be completed in March 2007). New bedding material was added every 7- 10 days, and stalls were groomed and maintained during every milking.

Sample collection

Samples were collected on a biweekly basis from Dairy 1. Samples included 1) raw manure from alleys in both barns; 2) manure effluent flowing from the digester outlet (post anaerobic digestion but prior to separation); 3) fresh separated manure solids (right off separator; 4) excess separated solids stored in a pile; and 5) separated solids bedding samples from the freestalls. Samples from freestalls were obtained from compiling grab samples from 5% of stalls within a pen or barn. Samples were frozen and transported monthly to ISU for subsequent analysis.

Bulk tank milk samples were also taken and both creamery and DHI data was and is available (trials still

underway and data being analyzed). Manure and separated solids were also evaluated for presence of Salmonella and Johne's organisms (ongoing).

Dry matter content:

Samples were thawed and 25 grams of each sample was placed in an individual aluminum tray or pan. Trays were placed in a drying oven for 24 hours, then reweighed, and dry matter content was calculated.

Environmental mastitis organism counts

10 grams of sample material were added to 90 ml of phosphate buffered saline and mixed thoroughly. Samples were then serially diluted with 6 dilutions (10^{-2} – 10^{-6}) plated on MacConkey agar (total gram negatives and coliforms) and Trypticase soy blood agar (alpha streptococci). Plates were read and colonies counted at 24 and 48 hours

Results

Dry matter contents:

Dry matter contents of freshly separated and piled separated solids, and freestalls from the north and south barn are shown in Figures 1 and 2, respectively. Dry matter content of fresh separated solids was ~ 35-41% (28% on 1 sample) with stockpiled solids running approximately 2-5% higher DM. Early piles showed temperatures < 140^0F, while after 1 month, temperatures exceeded 160^0F. Dry matter content of north and south barn solids bedding was 65-72% and 75-83%, respectively (in stall at least 1 day) with north barn oat hull bedding at ~ 85% DM.

Environmental mastitis organism counts

Environmental mastitis organism counts (total gram negative (GN), coliforms (C), and environmental streptococci (ES)) are shown for raw manure and digester effluent (Figure 3), freshly separated and stockpiled separated solids (Figure 4), south barn separated solids free stalls (Figure 5), and north free stall (separated solids and oat hulls – Figure 6). There were different numbers of organisms in raw manure over different days and periods, evidencing different shedding patterns and/ or temperatures. GN and C were > 10^4 and ES > 10^5 in raw manure samples. Digester effluent samples showed a 2-3 log fold reduction in GN and C, with lower reductions (1 log) in ES showing that digestion does not kill all organisms. Samples in late May-early June showed coliforms < 100 CFU/ gram following digestion. Organism loads in fresh separated solids mimicked digester effluent results. Stockpiled solids that were unheated or not heated properly saw similar or higher organism loads than fresh solids, while samples above 150^0F showed further reduction in GN, C, and ES. Organism loads in free stall barns (north or south, separated solids or oat hulls) showed increased organism loads by 24-48 hours (10^4 – 10^6) and were somewhat constant and plateau over time due to excellent free stall management on a daily basis. During this time SCC decreased and animal cleanliness and stall usage increased.

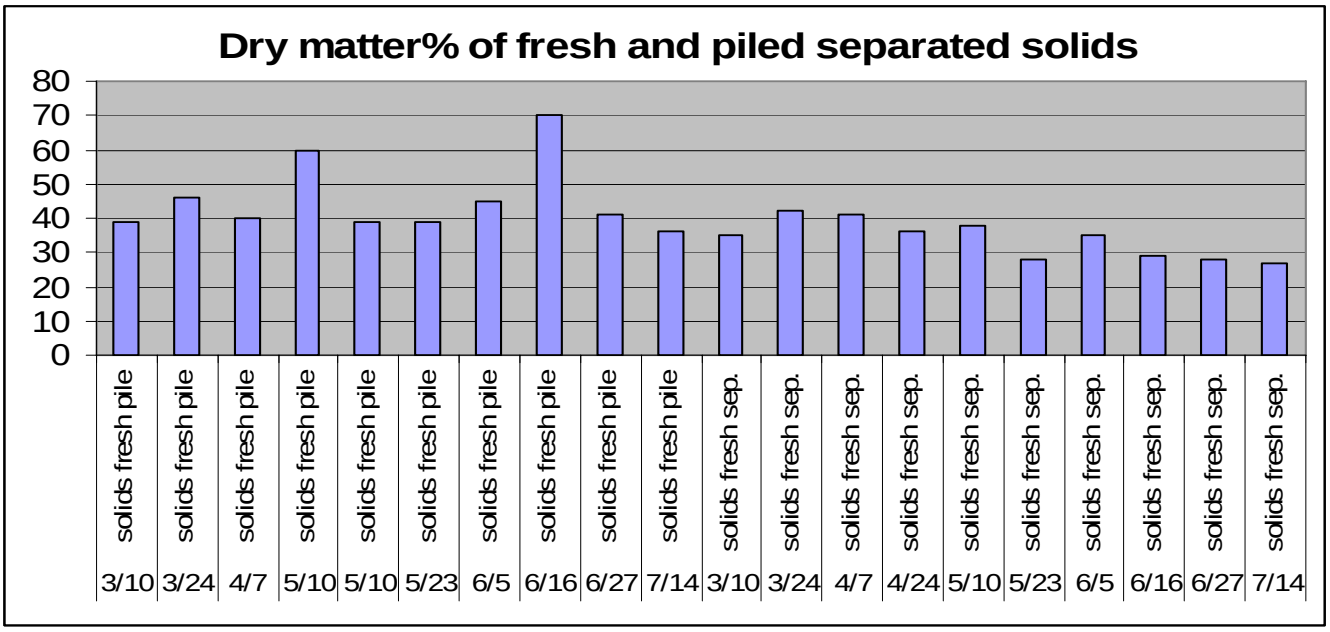

Figure 1. Dry matter content of fresh and piled separated manure solids from Dairy 1 (screw press separator).

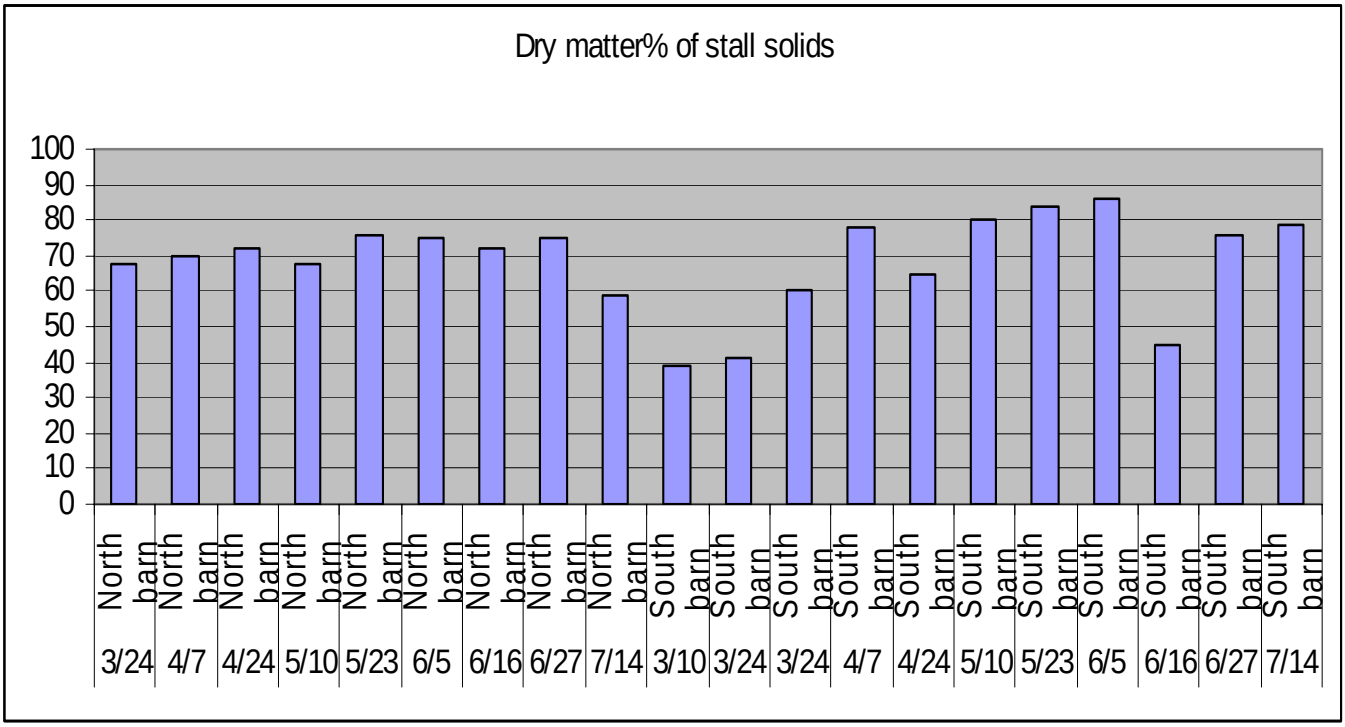

Figure 2. Dry matter contents of manure solids in north and south freestall barns of Dairy 1.

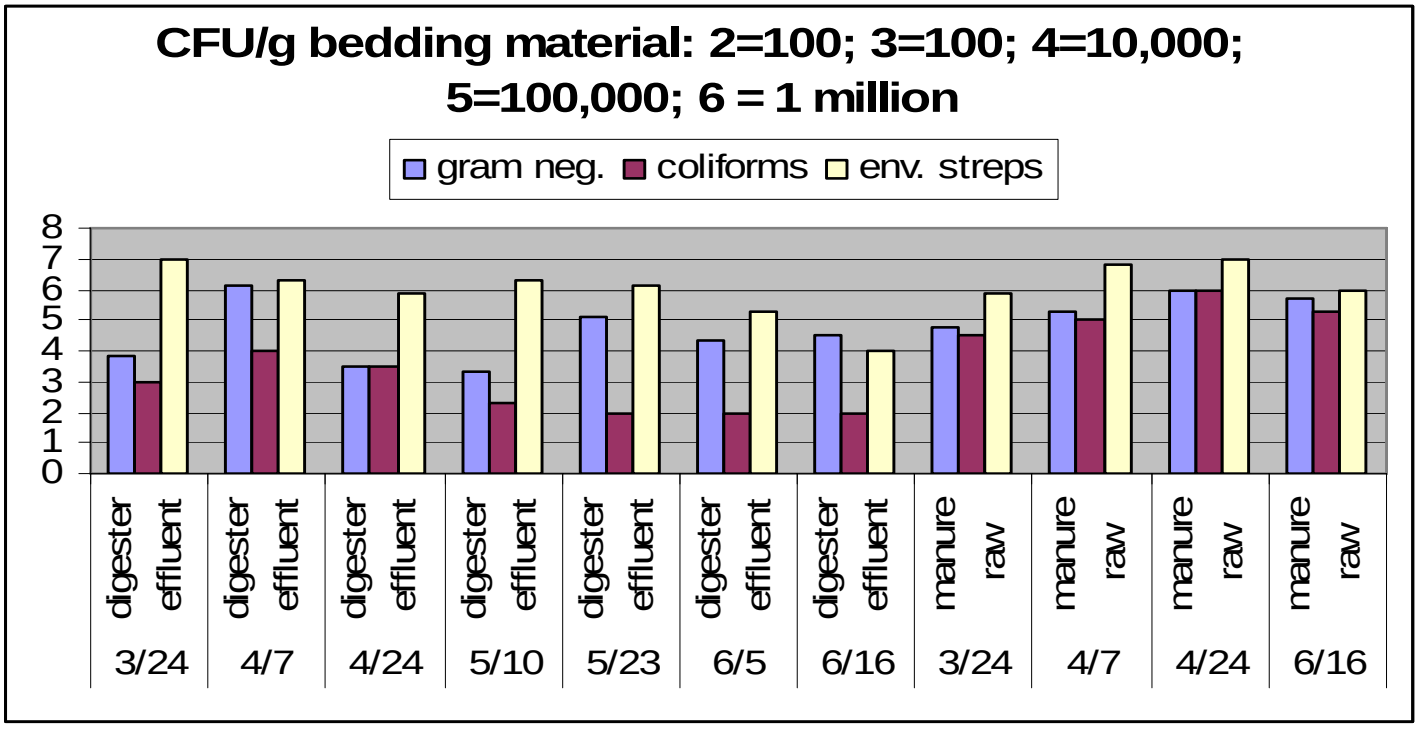

Figure 3. Bacteria counts (total gram negative, coliform, and streptococci)/ gram of raw manure and digester effluent.

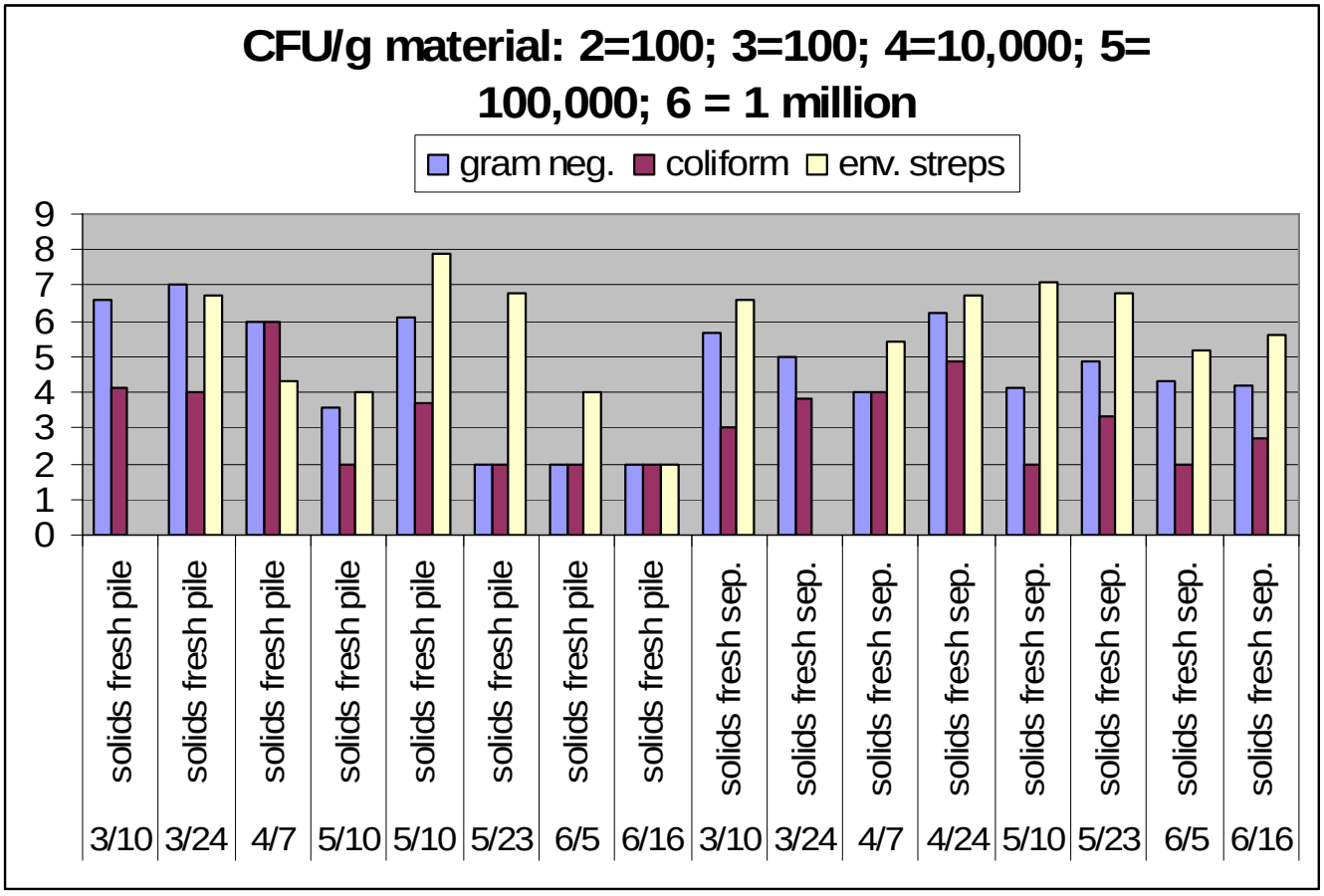

Figure 4. Bacteria counts (total gram negative, coliform, and streptococci)/ gram of freshly separated and stockpiled manure solids.

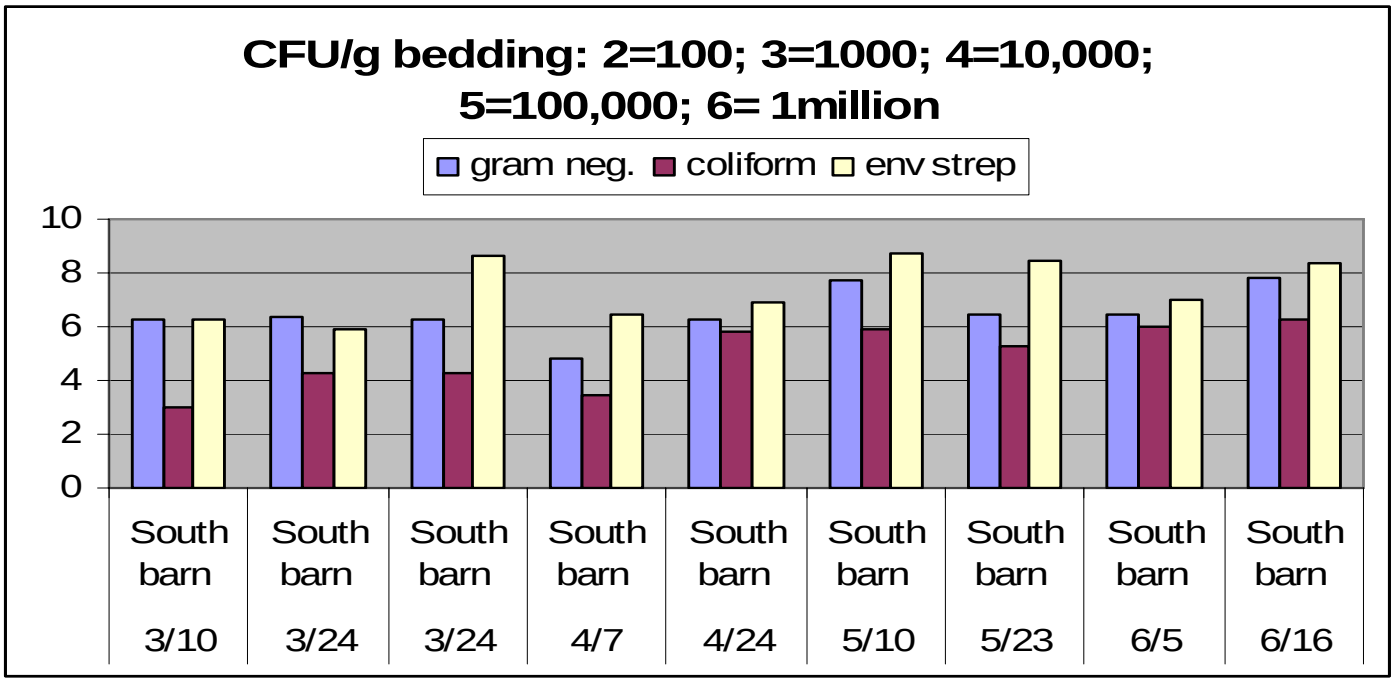

Figure 5. Bacteria counts (total gram negative, coliform, and streptococci)/ gram of free stall bedding in the south free stall barn.

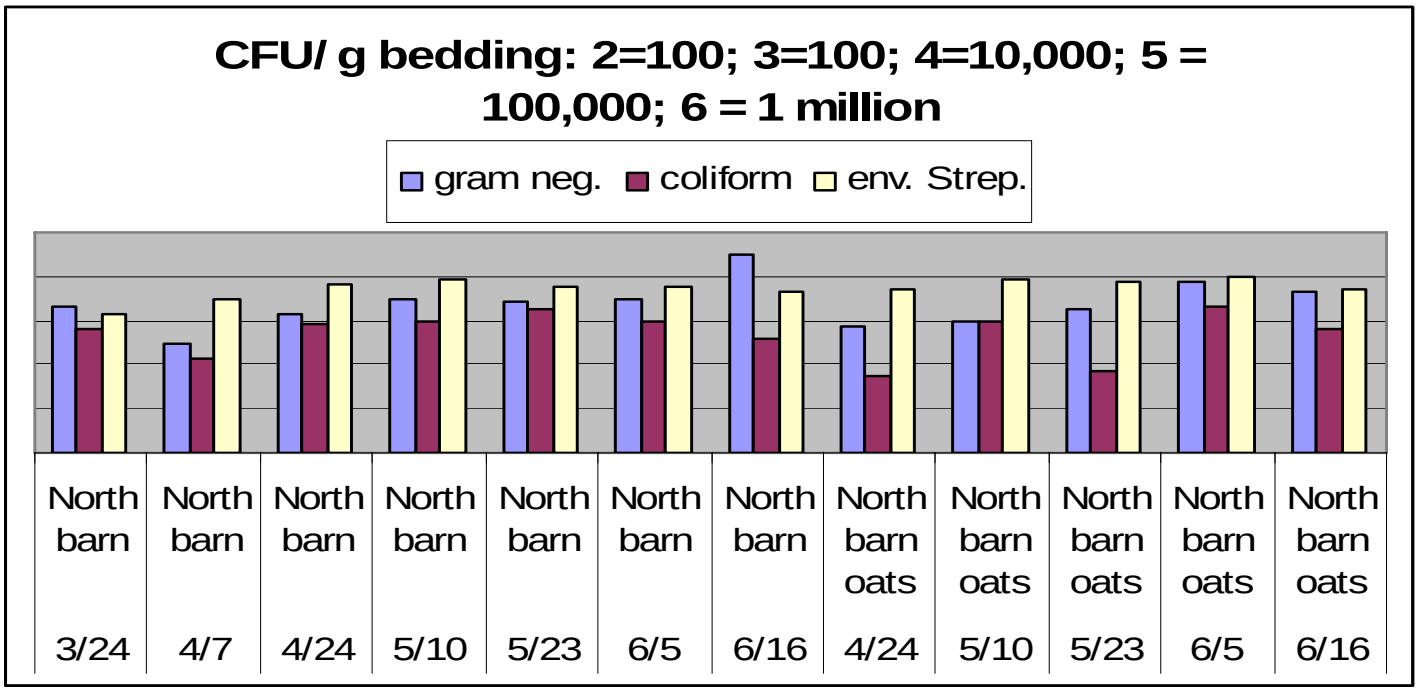

Figure 6. Bacteria counts (total gram negative, coliform, and streptococci)/ gram of separated manure solids and oat hull free stall beddings in the north free stall barn.