3 B’s of Udder Health: Bedding, Bacteria Load and Better Management

S. Godden¹, E. Royster¹, S. Rowe¹, K. Patel¹, J. Timmerman¹, B. Crooker¹, L. Fox²

¹ University of Minnesota, ² Washington State University
Bedding Functions and Impacts

- Bedding Functions:
  - Comfort / soft surface
  - Traction
  - Absorbency
  - Cow Cleanliness

- Bedding Impacts:
  - Comfort / lying times
  - Lameness / hock lesions
  - Udder health
Impact of Bedding Management on Cow Comfort and Lameness

• Sand bedding is king
  (Lombard et al., 2010; Esser et al., 2019)

• Deep bedding superior to shallow bedding
  (Husfeldt and Endres, 2012; Esser et al., 2019)

• Increased bedding depth on mats improves lying time
  (Tucker and Weary, 2004)

• Dry bedding improves lying time
  (Reich et al., 2010)

• Keep stalls level and full
Bedding Functions and Impacts

- Bedding Functions:
  - Comfort / soft surface
  - Traction
  - Absorbency
  - Cow Cleanliness

- Bedding Impacts:
  - Comfort / lying times
  - Lameness / hock lesions
  - **Udder health**
    - Exposure to environmental mastitis pathogens
My ‘Jenny Moment’ at the BBQ

• The conversation:

Jenny: “So what are you working on, Sandra?”

Me: “I’m studying how to improve bedding management to prevent mastitis in cows.”

Jenny: “So what does that involve? Keeping it clean and dry?”

Me: “Ummm...errr...probably.”

To myself: “Is it really that simple?”
Researchers have learned a lot about bedding management over the years, but there are still many more questions:

- How clean?
- How dry?
- How do we monitor bedding hygiene?
- How can we do a better job managing bedding?
Factors Affecting Udder Health and Milk Quality

(imagined)
Factors Affecting Udder Health and Milk Quality

*imagined*
Outline

• Relationship between bedding bacteria counts (BBC) and udder health

• Benchmarks for monitoring bedding hygiene

• Management strategies to reduce BBC:
  • Choice of bedding material
  • Start with clean fresh bedding
  • Bedding management in stalls
Relationship between bedding bacteria counts (BBC) and udder health?

**Positive Relationship:**
- Bramley and Neave, 1975
- Carroll and Jasper, 1978
- Bramley, 1985
- Smith et al., 1985
- Hogan et al., 1989
- Rowbotham and Ruegg, 2016a
- Patel et al., 2019 (accepted)
- Rowe et al., 2019 (accepted)

**No Relationship:**
- Natzke et al., 1975
- Fairchild et al., 1982

**Limitations of early studies:**
- Smaller studies
- Emphasized coliforms
Objectives

1. Describe relationship between BBC and udder health
2. Establish goals/benchmarks for BBC
3. Investigate differences between bedding materials
4. Identify management practices to reduce BBC:
   - Bedding characteristics (e.g. DM%, OM%, pH)
   - Bedding management strategies to reduce BBC?
Methods

• Cross-sectional study – 168 herds in 17 states
• Herds enrolled by herd vet or local researcher
• Sample twice (Winter/Summer)
  • Herd management questionnaire
  • DHIA test day info
  • Unused/used bedding samples: Culture, DM%, OM%, pH

• Herds selected for bedding type:
  • New sand (NS): 92 samples
  • Recycled sand (RS): 55 samples
  • Manure solids (MS): 66 samples
  • Organic non-manure materials (ON): 111 samples
Data analysis:
Investigate association between BBC and herd-level measures of udder health

- Control for other factors (season, facilities, parlor procedures, etc.)
All bedding materials combined:

Results: As coliform counts in unused bedding increase, udder health gets worse

Avg LS

Coliform count (log10 CFU/cc)

LS ≥ 4 (%)

Coliform count (log10 CCFU/cc)
All bedding materials combined:

Results: As Strep (SSLO) counts in unused bedding increase, udder health gets worse.

![Graph](image)

- Avg LS
- LS ≥ 4 (%)
Summary of relationship between BBC and herd-level measures of udder health

### Unused Bedding

<table>
<thead>
<tr>
<th>Bacteria Group</th>
<th>Avg LS</th>
<th>LS ≥ 4 (%)</th>
<th>New IMI (%)</th>
<th>Chronics (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliforms</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Klebsiella</td>
<td>+</td>
<td>+</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>SSLO</td>
<td>.</td>
<td>+</td>
<td>.</td>
<td>+</td>
</tr>
<tr>
<td>Staph</td>
<td>.</td>
<td>+</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

1. Increased BBC were generally associated with worse udder health

2. It’s not just the Coliforms:
   - SSLO, Staph bacteria also impt.

### Used Bedding

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<td>+</td>
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<tr>
<td>SSLO</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Staph</td>
<td>.</td>
<td>+</td>
<td>+</td>
<td>.</td>
</tr>
</tbody>
</table>

3. Relationships between BBC and udder health:
   - Vary by bacteria group
   - Vary by bedding type:
     - Must stratify analysis by bedding type
     (results not shown)
Cross-sectional study of the relationships among bedding materials, bedding bacteria counts, and intramammary infection in late-lactation dairy cows

S. M. Rowe,¹* S. M. Godden,¹ E. Royster,¹ J. Timmerman,¹ B. A. Crooker,² and M. Boyle³

Objectives

1. Investigate relationship between BBC and quarter-level risk for IMI in late lactation cows

2. Investigate relationship between bedding material and IMI risk in late lactation quarters
Methods

• Cross-sectional study: 80 herds in 10 states

• Herds selected for bedding type
  • New sand (n=20)
  • Reclaimed sand (n=21)
  • Manure solids (n=20)
  • Other organic (n=19)

• Farms sampled twice (summer/winter):
  • Unused & used bedding samples
  • Aseptic quarter milk samples from 20 random late lactation cows: Culture - IMI status (10,460 quarters)

• Data analysis:
  Compare BBC vs risk for IMI at quarter level
Results

• Overall, as total BBC increased, risk for quarter-level IMI increased

• Strongest relationships between BBC and IMI risk were within RS, ON & MS

• Staph and Strep (SSLO) bacteria in bedding were both associated with IMI risk caused by Staph and SSLO, respectively
Summary: Relationships between bedding bacteria counts (BBC) and udder health

- BBC are associated with udder health:
  - Quarter-level (Rowe et al., 2019)
  - Cow-level (Hogan et al., 1989)
  - Herd-level (Patel et al., 2019)

- Pathogen groups of concern:

- Relationships vary:
  - By bedding material
  - Unused vs used bedding
Outline

• Relationship between bedding bacteria counts (BBC) and udder health

• Benchmarks for monitoring bedding hygiene

• Management strategies to reduce BBC:
  • Choice of bedding material
  • Start with clean fresh bedding
  • Bedding management in stalls
How do we monitor bedding hygiene?

<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Before, After Incubation</th>
<th>Bacillus</th>
<th>Coliforms</th>
<th>Environ Strep</th>
<th>Staph species</th>
<th>Non-coliform Gram Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Collected</td>
<td>Colonies/ml</td>
<td>Colonies/ml</td>
<td>Colonies/ml</td>
<td>Colonies/ml</td>
<td>Colonies/ml</td>
</tr>
<tr>
<td>BEDDING NEW</td>
<td>1,625,000</td>
<td>0</td>
<td>1,775,000</td>
<td>25,000</td>
<td>35,000</td>
<td>3,460,000</td>
</tr>
</tbody>
</table>
How do we interpret bedding culture reports?

```
Are my results good or bad?
```

```
<table>
<thead>
<tr>
<th>Sample Description</th>
<th>Bedding Culture: Bedding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before, After</td>
</tr>
<tr>
<td></td>
<td>Incubation</td>
</tr>
<tr>
<td>BEDDING NOW</td>
<td>1,525,000</td>
</tr>
</tbody>
</table>
```
Old goal:
Bedding coliform count < 1 million cfu/g?

• Bramley (NMC, 1985)
  • Randomized trial on 1 dairy
  • Coliform mastitis incidence:
    • Sawdust (11%; 19 of 166)
    • Sand (2%; 4 of 168)
  • Suggested ↑ *E. coli* mastitis if sawdust coliforms > 10^6 cfu/g wet bedding

• Concerns about this guideline?
  • Was derived from only 1 herd
    ...for only one bedding type (sawdust)
    ...for only one group of pathogens (*E. coli*)

• Needs more research
Objectives

1. Describe relationship between bedding bacteria counts (BBC) and udder health

2. Establish goals/benchmarks for BBC

3. Investigate differences between bedding materials

4. Identify management practices to reduce BBC:
   - Bedding characteristics (e.g. DM%, OM%, pH)
   - Bedding management strategies to reduce BBC?
Creating Categories for Benchmarking BBC
eg. Strep (SSLO) bacteria in unused Manure Solids
Suggested Benchmarks for BBC in Bedding
(cfu/cc wet bedding)

*NS: New Sand / RS: Reclaimed Sand / ON: Organic non-manure / MS: Manure Solids*

### Unused Bedding

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<thead>
<tr>
<th>Bacteria Group</th>
<th>Bedding Type</th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staph</em> spp.</td>
<td>NS / RS / ON / MS</td>
<td>0</td>
<td>.</td>
<td>&gt;0</td>
</tr>
<tr>
<td><em>Klebsiella</em> spp.</td>
<td>NS / RS / ON / MS</td>
<td>0</td>
<td>.</td>
<td>&gt;0</td>
</tr>
<tr>
<td>Coliforms</td>
<td>NS / RS / ON / MS</td>
<td>≤ 500</td>
<td>.</td>
<td>&gt;500</td>
</tr>
<tr>
<td>SSLO (<em>Strep</em> spp.)</td>
<td>NS / RS / ON</td>
<td>0</td>
<td>1 – 1,000</td>
<td>&gt;1,000</td>
</tr>
<tr>
<td></td>
<td>MS</td>
<td>≤ 1,000</td>
<td>1,000 – 750,000</td>
<td>&gt;750,000</td>
</tr>
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<tr>
<td>Coliforms</td>
<td>NS / RS / ON</td>
<td>≤ 10,000</td>
<td>.</td>
<td>&gt;10,000</td>
</tr>
<tr>
<td></td>
<td>MS</td>
<td>≤ 10,000</td>
<td>10,001 – 200,000</td>
<td>&gt;200,000</td>
</tr>
<tr>
<td>SSLO (<em>Strep. Spp.</em>)</td>
<td>NS / RS / ON / MS</td>
<td>≤ 500,000</td>
<td>500,001 – 2,000,000</td>
<td>&gt;2,000,000</td>
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Outline

• Relationship between bedding bacteria counts (BBC) and udder health

• Benchmarks for monitoring bedding hygiene

• Management strategies to reduce BBC:
  • Choice of bedding material
  • Start with clean fresh bedding
  • Bedding management in stalls
Manure solids (MS)

New sand (NS)

Reclaimed sand (RS)

Shavings

Straw

- When thinking about BBC..
  - Is there a best bedding?
  - Is there a worst bedding?
Patel et al., 2019

Coliform counts in unused and used bedding
- Lowest in unused bedding (vs used)
- Lowest in NS and ON materials / Highest in MS

![Graphs showing coliform counts in unused and used bedding]
Patel et al., 2019

Strep (SSLO) counts in unused and used bedding
- Lowest in unused (vs used) bedding
- Unused: Lowest in NS and ON / Used: Little difference

Unused: Lowest in NS and ON / Used (from stalls):

```
Log10 cfu/ml
```

 Unused

```
MS  NS  O  RS
```

```
Log10 cfu/ml
```

 Used (from stalls)

```
MS  NS  O  RS
```

```
a, b P < 0.05
```
Relationships between bedding type and BBC

- Tremendous variation between herds within bedding type

- Observational study of 80 U.S. herds (Rowe et al., 2019):
  - NS (n=37), RS (n=39), ON (n=32), MS (n=40)
  - Report $\log_{10}$ CFU/cc wet bedding

![Graph showing bacterial counts in used and unused bedding for different types of bedding.](image)
When thinking about udder health:

- Is there a best bedding?
- Is there a worst bedding?

- Manure solids (MS)
- New sand (NS)
- Reclaimed sand (RS)
- Shavings
- Straw
### Studies Reporting on the Relationship Between Bedding Material and Udder Health

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<th>Finding</th>
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- No difference in LS or milk yield                                                                                                           |
| Esser et al., 2019     | RCT. 1 dairy. 3 yr. Lact=1 | - Fewer clinical cases if bed on NS or RS (vs MS)  
- No difference in LS or milk yield                                                                                                             |
| Robotham & Ruegg, 2015 | Observational. 325 WI herds. 2 yr | - Herds using inorganic (vs ON or MS) bedding had ↓ BT SCC, ↑ milk yield, ↓ % cows with discarded milk or blind quarter                                                                               |
| Wenz et al., 2007      | Observational. 1,013 U.S. farms | - Increased BT SCC in herds using composted MS bedding (vs other)                                                                                                                                 |
| Rowe et al., 2019      | Observational. 80 U.S. farms | - No relationship between bedding material and risk for quarter-level IMI in late lactation cows                                                                                                       |
| Patel et al., 2019     | Observational. 168 U.S. farms | - Increased herd-level DHIA measures (e.g. Avg. LS, New IMI) in herds using MS  
- No difference between NS, RS, ON                                                                                                              |
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                                         |                               | - No difference between NS, RS, ON                                     |

**Sand = Generally best udder health**

**Manure solids = Generally worst**
- 168 herds / 2 seasons
- On average, herd-level udder health was worse in herds using MS (vs anything else)
- No difference in udder health between NS, RS and ON
The next conversation (hypothetical)

Me: “Jenny,...we’ve confirmed that recycled manure solids is risky for udder health.”

Jenny: “Well, duh!!!”

Me: “But...”
But tremendous variation existed between individual herds
E.g. Some MS herds had very good udder health
But tremendous variation existed between individual herds.
- E.g. Some MS herds had very good udder health

What’s their secret?
Summary: Is there a best bedding type?

• On average: - Sand (inorganic) is best
  - Manure solids is worst

• BUT huge variation exists from herd-to-herd

• While a factor, bedding material choice cannot be the most important determinant of udder health
Outline

• Relationship between bedding bacteria counts (BBC) and udder health

• Benchmarks for monitoring bedding hygiene

• Management strategies to reduce BBC:
  • Choice of bedding material
  • Start with clean fresh bedding
  • Bedding management in stalls
How to reduce BBC in stalls?

- Moderate correlation in BBC between unused and used bedding

  ![Graph](image1)

  Relationship between Coliform Counts in Unused and Used Manure Solids

  \[ R^2 = 0.42 \]

  ![Graph](image2)

  Relationship between Strep (SSLO) Counts in Unused and Used Manure Solids

  \[ R^2 = 0.35 \]

- Start by putting clean unused (fresh) bedding into stalls

- What are the bedding characteristics or factors important to reduce BBC in unused (fresh) bedding?
Relationships between bedding characteristics, BBC and udder health

- Bacteria require moisture & organic nutrients to survive/multiply

- Characteristics of potential interest:
  - Dry matter (DM%)
  - Organic matter (OM%)
  - pH

- Previously recommended levels (Hogan & Smith. VCNA, 2012):
  - Manure solids: - DM% > 35%
  - Sand: - DM% > 95%
    - OM% < 5%
  - These goals derived from a lifetime of experience in mastitis research
  - Can we put some data to them?
Questions surrounding the management of unused (fresh) bedding:

1. What bedding characteristics are associated with BBC and udder health?

2. What should the goals be (e.g. DM% in MS)?

3. (How) can we modify these characteristics in a cost-effective manner?
Relationship between DM% and Udder Health - All bedding materials

Increased DM% is associated with improved udder health

But relationships vary by bedding material.
- Let’s look at Manure Solids
Relationship between DM% and Udder Health in Unused MS

n=66

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Avg LS</th>
<th>LS ≥ 4 (%)</th>
<th>New IMI (%)</th>
<th>Chronics (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Matter (%)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Example:
As DM% increases, LS ≥ 4 (%) decreases
(+1 DM% ~ - 0.27 (0.09) % LS ≥ 4)

- Increased DM% is (mostly) associated with improved udder health
Suggested DM% goals for unused MS bedding

Poor (Wet) <35% / Moderate: 35-65% / Excellent: ≥65%

DM% vs Proportion of samples with high coliform count

Prop. of samples with high total coliform count

a, i – significant at p ≤ 0.1
a, b – significant at p ≤ 0.05
Strategies to increase DM% in unused MS - Reclamation and Processing Method?

- **Raw Slurry** (Source: Progressive Dairy)
- **Anaerobic Digester**
- **Manure Screw Press Separator** (DariTech Inc. Lynden, WA)
- **Windrow Composting** (Source: The Progressive Farmer)
- **Drum Composter** (DariTech Inc. Lynden, WA)
- **Rotary Drum Dryer** (McClanahan Inc. HollidaysBurg, PA)
- **Green Solids**
Manure solids processing methods represented in our database

<table>
<thead>
<tr>
<th>Primary Processing</th>
<th>Secondary Processing</th>
<th>Number (56)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composted</td>
<td>Mechanically Dried</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>14</td>
</tr>
<tr>
<td>Digested</td>
<td>Mechanically Dried</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>Green pressed</td>
<td>Mechanically Dried</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>22</td>
</tr>
<tr>
<td>No press</td>
<td>Passive/Sun Dry (CA)</td>
<td>9</td>
</tr>
</tbody>
</table>
Factors associated with DM% in unused manure solids

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Level</th>
<th>Estimate (SE)%</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
<td>South/West</td>
<td>83.7 (4.0)%</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td></td>
<td>MidWest/NorthEast</td>
<td>35.7 (2.6)%</td>
<td></td>
</tr>
<tr>
<td>Season</td>
<td>Summer</td>
<td>63.1 (2.5)%</td>
<td>0.0004</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>56.3 (2.6)%</td>
<td></td>
</tr>
</tbody>
</table>

We also saw an association with mechanical hot-air drying
- However, this varied (interacted) with region, and with primary processing technique
=> Stratified analysis
Association between mechanical hot-air drying and DM% in unused manure solids
(Stratified by primary processing technique and region)
Preliminary results: Important bedding characteristics in unused manure solids

- High DM% ~ reduced BBC and improved udder health in MS herds
- Goals for DM: Poor <35% / Moderate: 35-65% / Excellent: ≥65%
- Much easier to achieve high DM%:
  - In South or West regions
  - In summer months
- Mechanical hot air drying increases DM%
  - Caution:
    - Very small sample size
    - Need larger study to investigate impacts on:
      - BBC
      - Udder health
      - Economics
Management of Sand Bedding

1. What bedding characteristics are important (OM%, DM%)?
2. Can we establish goals/benchmarks?
3. (How) can we manipulate these characteristics in sand?

New Sand (NS)  
Recycled Sand (RS)
Bedding Characteristics in Unused Sand Bedding
(Considers new and recycled sand together)

Median = 1.5% (0 to 15.8%)
New Sand = 0.9%
Recycled Sand = 2.4%

Median = 95.4% (83.6 to 100%)
New Sand = 96.1%
Recycled Sand = 93.5%

Tentative Goals:
- DM > 95% (22% of RS samples achieved this goal)
- OM ≤ 1.5% (36% of RS samples achieved this goal)
Association between unused sand DM category (High/Low) and risk for sample falling into a high BBC category (High/Low) (Considers NS and RS together)

N=92

Results:
- DM%: Odds for falling into a high BBC category tended to be reduced for sand samples with DM% > 95%
  
  OR: 0.47 (0.22, 1.03)

- OM%: No associations detected between OM% category (H/L) and risk for high BBC category (H/L)
  
  OR: 0.45 (0.14, 1.48)
Processing or management factors associated with DM% in unused sand bedding

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameter</th>
<th>Level</th>
<th>Estimate (SE)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Sand</td>
<td>Prior washing</td>
<td>Washed</td>
<td>1.33 (0.59)</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not washed</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Storage time (d)</td>
<td></td>
<td>0.009 (0.006)</td>
<td>0.11</td>
</tr>
<tr>
<td>Reclaimed Sand</td>
<td>Covered storage</td>
<td>Shelter</td>
<td>1.61 (0.99)</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No shelter</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Season</td>
<td>Summer</td>
<td>1.43 (0.59)</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Winter</td>
<td>Ref</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Processing</td>
<td>Mechanical</td>
<td>-0.62 (0.95)</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Passive</td>
<td>Ref</td>
<td></td>
</tr>
</tbody>
</table>

* No parameter tested was associated with OM% in unused sand bedding
Preliminary results: Important bedding characteristics for unused sand bedding

- Small differences observed between NS and RS for DM% or OM%
- High DM% ~ reduction or tendency to reduce BBC (SSLO, Coliforms)
  - Goals for DM% in sand: > 95%
- Organic matter? More research needed
  - Preliminary goal OM% ≤ 1.5%
- New sand processing considerations to increase DM%
  - Washing
  - Increased time in storage
- Reclaimed sand processing considerations to increase DM%
  - Covered storage
  - No association with reclamation system (mechanical/passive)
Outline

• Relationship between bedding bacteria counts (BBC) and udder health

• Benchmarks for monitoring bedding hygiene

• Management strategies to reduce BBC:
  • Choice of bedding material
  • Start with clean fresh bedding
  • Bedding management in stalls
Strategies to reduce BBC in stalls
(Hogan and Smith, VCNA, 2012)

• Frequent (daily) addition of fresh organic bedding to stalls
• Correct stall design & dimensions
• Ventilation
• Remove wet soiled bedding from back third of stalls at least twice/day
• Prevent standing water & manure in alleyways
• Avoid overcrowding: More manure in alleys
• Barn design: 2 row vs 3 row pens
Use of Bedding Conditioners to alter pH?

Hogan et al., JDSci. 1999

• Conditioners reduce BBC for approx. 1 day – must add daily
• Studies lacking: Effects on udder health / economics / soil pH

(Hogan et al.; 1999; Hogan et al., 2007; Godden et al., 2009; Hogan & Smith, 2012)
Summary

• Bedding bacteria counts are associated with udder health (Coliforms, *Klebsiella* spp., SSLO, Staph)

• Benchmarks established for monitoring bedding hygiene

• Management strategies to reduce BBC:
  • Bedding material selection:
    • Inorganic materials generally better / manure solids worse
    • BUT...large herd-to-herd variation
  • Start with clean fresh bedding:
    • Important characteristics: High DM% in unused bedding:
    • Goals for DM% established for MS and Sand
    • Some processing/management factors identified – more research needed
  • Bedding management in stalls important
So...did Jenny have it right?

- Yes, she’s a smart girl

- We still have a ways to go, but hopefully we are a little farther down the path in our understanding of improving bedding management.
Acknowledgements

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  • DMI

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• Participating herds

• DHI Record Processing Centers

AABP members
Thank you