Foot Baths
Solution to a Problem or
A Problem Solution??

Roger Olson
Dairy Specialist
Zinpro Performance Minerals
Footbath Mission Statement

- Disinfect feet for prevention of infectious claw lesions such as digital dermatitis, foot rot, interdigital dermatitis and heel horn erosion
- Does not compromise skin integrity
- Does not harm cattle and/or people
- Is reasonably priced and does not harm equipment, structures and environment during storage, use and disposal
Take Home Message

- **Raw Red (active wart) M2’s Must treat topically!!**

- **Stopping Chronic Warts from growing back to Raw Red (Active Wart) M2’s - Use a footbath**
Poorly Designed and Managed Foot Baths Can *Increase* Foot Health Problems

Why Don’t They Work?
- Poor Design
- Weak Solutions
- Inconsistent Use
- Low wet spots post bath
When is a Footbath, Not a Footbath??
Constant Inoculation is Not Beneficial!!
What Size is Right?

FOOT BATHS
Analysis of Number of Steps for the Rear Feet of Cows Using 6 Different Hoof Bath Dimensions

- 2 dunk
- 3 dunk
- 4 dunk
- >2 dunks

<table>
<thead>
<tr>
<th>Hoofbath Dimensions</th>
<th>% of All Rear Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 inch step 6 feet by 30 inch</td>
<td>40.0%</td>
</tr>
<tr>
<td>10 inch step 6 feet by 30 inch</td>
<td>60.0%</td>
</tr>
<tr>
<td>5 inch step 8 feet by 24 inch</td>
<td>70.0%</td>
</tr>
<tr>
<td>10 inch step 8 feet by 24 inch</td>
<td>80.0%</td>
</tr>
<tr>
<td>10 inch step 10 feet by 20 inches</td>
<td>90.0%</td>
</tr>
<tr>
<td>10 inch step 12 feet by 20 inches</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

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CCC Newsletter, Dec 2010, NB Cook
What Size Footbath?

- **Length?**
  - 10 Feet Minimum to 12 feet Maximum

- **Width?**
  - (Single cow pass) 20 - 24 inches
  - (Multi cow pass) Alley width - Have seen up to 12’ work

- **Slope?**
  - 4% on 6 feet = 2.88 Inches
  - 4% on 10 Feet = 4.8 Inches
  - Must be level to be long!!!
Proper Footbath Design
How to Clean It?? How to Fill it??

- 4 inch drain at one end in floor
- 2 inch hose to fill and wash - preferrably hanging at one end
- Large pump to flush with a sloped exit curb (Ultimate)
What about Winter?

- Floor heat under bath area (electric heat pads)
- Infrared heat over footbath area
- Formaldehyde stored inside > 45° F
- Semi warm area for baths
Do You Need a Pre-bath?

- Pre-bath pre-soaks the claw
- Treatment solution does not stick when the foot is wet
- A wash bath dilutes the treatment bath
- Extra water must be disposed $$
- NO!!!
Critical Success Factors Regardless of Footbath Size

- 10-12 feet long
- 10 inch curbs
- Solid sides
- No place for a foot other than in the bath
- Quick and easy fill
- Drains fast
- Well lit at the exit – no visible barriers
- Clean exit area
Other Keys to Success

- Floor does not cause trauma (Epoxy, rubber)
- Easily bypassed when not in use
- Able to use 365 days per year
Disease...Dimension – Design – Behavior

12’ long, 24” wide, 10” step-in height
Commercial Precast Baths

Works well for many remodel jobs
Factors Affecting Footbath Efficacy

- Frequency bath is used (days/wk)
- Contact between solution and surface you are trying to disinfect (dunks)
- Contact time with solution
  - Time on feet before it gets diluted with other “stuff”
  - Time in solution
How Often Do You Use a Foot Bath?

- How Clean are Your Cows?
  - Three Row verses Two Row Barns
  - Stocking Density
  - Auto scrapers
  - Stall Maintenance
Cow Hygiene Scores

Score 1: Clean, little or no manure contamination of the lower limb
Score 2: Slightly dirty, where the lower limb is lightly splashed with manure
Score 3: Moderately dirty, where there are distinct plaques of manure on the foot, progressing up the limb
Score 4: Very dirty, where there are confluent plaques of caked on manure on the foot and higher up the lower limb
Relationship Between Leg Hygiene and Infectious Claw Disease

$R^2 = 0.4907$

![Graph showing the relationship between leg hygiene and infectious claw lesions]

Data from 8 herds. Data collected from 22,850 Holstein cows and 900 Jersey cows. Data represents a total of 67 months of data (range from 3 to 14 months of data per dairy).

*a* Data from 8 herds. Data collected from 22,850 Holstein cows and 900 Jersey cows. Data represents a total of 67 months of data (range from 3 to 14 months of data per dairy).
## Cow Hygiene Scores And Frequency Of Foot Bath Use

<table>
<thead>
<tr>
<th>Proportion of Cows With Hygiene Scores of 3 and 4</th>
<th>Suggested Foot Bath Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 25</td>
<td>As required</td>
</tr>
<tr>
<td>25 to 50</td>
<td>2 d/wk</td>
</tr>
<tr>
<td>51 to 75</td>
<td>5 d/wk</td>
</tr>
<tr>
<td>&gt; 75</td>
<td>7 d/wk</td>
</tr>
</tbody>
</table>
Chemicals - Label Concentration

What the hell!
It's close enough.
Solution Concentration Issues

- How full is full? 4 inches (3-8 inches)
- Small drain hole**
- Stainless steel marker
- 2x4 mounted at the end of the bath
- Major concern with more concentrated products (acids)
Premixing Systems Work Great!!!

- Can do in heated storage area
- Less mistakes in mixing
- Mixed every time, ahead of time
- Acids work very well in these systems (more accurately measured with greater worker safety)
- Just need an old bulk tank with a pump and agitator or plastic tank or barrel
What to Use in the Bath?

- Economics
- Effectiveness
- Environmental Impact
<table>
<thead>
<tr>
<th>Products</th>
<th>%</th>
<th>$/UNIT</th>
<th>Unit Size</th>
<th>Units</th>
<th>Amt/bath</th>
<th>Added lbs</th>
<th>$/bath</th>
<th>$/cow/yr</th>
<th>$/herd/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copper sulfate</td>
<td>5</td>
<td>$65.00</td>
<td>50 lbs</td>
<td></td>
<td>20.9</td>
<td>CuSO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc sulfate</td>
<td>5</td>
<td>$50.00</td>
<td>50 lbs</td>
<td></td>
<td>20.9</td>
<td>ZnSO₄</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formalin</td>
<td>2</td>
<td>$317.50</td>
<td>55 gal</td>
<td></td>
<td>1.0</td>
<td></td>
<td>$5.74</td>
<td>$6</td>
<td>$2,986</td>
</tr>
<tr>
<td>Double Action</td>
<td></td>
<td>$1,167.00</td>
<td>55 gal</td>
<td></td>
<td>1.0</td>
<td></td>
<td>$21.11</td>
<td>$22</td>
<td>$10,975</td>
</tr>
<tr>
<td>Hoof Zink</td>
<td></td>
<td>$2,609.75</td>
<td>147 gal</td>
<td></td>
<td>1.2</td>
<td></td>
<td>$22.07</td>
<td>$23</td>
<td>$11,478</td>
</tr>
<tr>
<td>Healthy Foot</td>
<td></td>
<td>$1,237.50</td>
<td>55 gal</td>
<td></td>
<td>0.5</td>
<td>6</td>
<td>$18.95</td>
<td>$20</td>
<td>$9,853</td>
</tr>
<tr>
<td>Rotational Zinc</td>
<td></td>
<td>$2,087.25</td>
<td>55 gal</td>
<td></td>
<td>0.5</td>
<td>6</td>
<td>$24.84</td>
<td>$26</td>
<td>$12,918</td>
</tr>
<tr>
<td>Hoof Pro</td>
<td></td>
<td>$2,087.25</td>
<td>55 gal</td>
<td></td>
<td>0.5</td>
<td>6</td>
<td>$26.63</td>
<td>$28</td>
<td>$13,849</td>
</tr>
<tr>
<td>PediCuRx trifusion</td>
<td></td>
<td>$1,140.00</td>
<td>55 gal</td>
<td></td>
<td>0.5</td>
<td>12</td>
<td>$25.83</td>
<td>$27</td>
<td>$13,429</td>
</tr>
<tr>
<td>Your dry product here</td>
<td></td>
<td></td>
<td></td>
<td>50 lbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your liquid product here</td>
<td></td>
<td></td>
<td></td>
<td>55 gal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Your product inclusion rate</th>
<th>lb/gal</th>
<th>qt/gal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Prebath Info.

Times Footbath Used/Wk: 5
Cow Passes per Bath: 250
Herd Size: 500

Footbath Size Calculator

Length: 120 inches
Width: 24 inches
Depth: 4 inches

Volume: 50 gallons
Water Composition Varies!

USA – 5549 Samples

Range

This is why milking equipment companies test water to determine the proper amount of detergent to add!

Not all water is clean and pure!
Chlorine Residual Needed To Disinfect Water Varies!

Amount of chlorine needed disinfect water affected by:
- Temperature
- Contact time
- Cloudiness of water
- pH (5500 water samples, pH 2.8 to 10.7)
- Water composition (Fe, Mn, H₂S, NH₃)

<table>
<thead>
<tr>
<th>Water Temperature, F</th>
<th>Contact Time, min</th>
<th>Residual Chlorine, mg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>30</td>
<td>0.3</td>
</tr>
<tr>
<td>32-40</td>
<td>30</td>
<td>0.4</td>
</tr>
<tr>
<td>50</td>
<td>10</td>
<td>0.8</td>
</tr>
<tr>
<td>32-40</td>
<td>10</td>
<td>1.2</td>
</tr>
<tr>
<td>50</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>32-40</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

Ohio State University Bulletin 795. Bacteria in Drinking Water
Water Quality Affects Detergent Concentration Needed to Clean Milking Equipment

- When water hardness exceeds 10 grains per gallon, it may be necessary to increase detergent concentration.
- In very hard water (30 grains per gallon or more), a water softener should be used.
- The bicarbonate, sulfates, and chlorides of calcium or magnesium present in hard water can neutralize detergents, decrease rinsability, create films on equipment, and cause problems with water heaters.

[Picture from Delaval.com/Global/PDF/Efficient-cleaning.pdf]
Does Water Quality Affect Efficacy of Copper Sulfate Foot Baths

- 3 to 5% copper sulfate
- Antibacterial and hardening agent\(^a\)
- Bacterostatic properties of copper sulfate attributed to Cu\(^{+2}\) reacting with protein thiol groups in target organisms\(^b\)

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Effect of Temperature and pH on Copper Species

As temp increases ionic copper decreases

Change does not seem big, but you are going from 0.01 to 0.0001
Effect of pH on Copper Species – Temperature 25°C

- Cu²⁺
- SO₄²⁻ (free soluble ions)
- Cu(OH)₂ (solid)
- Cu(OH)₂ (aq)
- Cu(OH)₃⁻


3 PH is max for ionic copper
Formaldehyde

- 2 to 3% solution, more is not better!
- Antibacterial and hardening agent
- Advantages
  - Tends to be the least expensive foot bath solution
  - Bacteria do not develop resistance
  - If diluted, will become inactive and not create an environmental hazard
  - Highly soluble in water
  - Minimal effect on permeability of the claw horn
  - Antibacterial activity (2.2% solution) retained up to 330 cow passes
  - Highly researched; Shown to reduce incidence and severity of claw lesions

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Arkins et al., 1986. Vet Rec. 118:580*
Formaldehyde

**Disadvantages**

- Suspected carcinogen
- Not effective below 45°F
- Use a totally enclosed system
- Not suitable for open lesions
- Must use in well-ventilated areas and wear eye protection
- Toxic if consumed, do not let animals drink from foot baths
- Will kill vegetation if foot bath solution is always dumped in one location
- If solution strength incorrect, splashes of overly concentrated solution will harm skin of cow’s claws and teats
Copper Sulfate Foot Baths

- 3 to 5% copper sulfate
- Antibacterial and hardening agent
- Appears to effectively control infectious claw lesions
- Relatively inexpensive
- Goes into solution somewhat easily (at the right pH)
- Disposal is a concern
  - 50 gallon bath, 5% CuSO₄ solution, used 4X/wk, changed every 200 cow passes, 21.7 lb CuSO₄ disposed per cow/year

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Acidified Copper Sulfate

- Improves copper solubility, may be able to reduce copper sulfate use by \( \frac{1}{2} \)
- Solution pH...Lower is better, only to a point
- Skin pH is \( \sim 3.6 \) - If issues I suggest pH 3+
- Have seen chronic wart issues with very low pH's, due to excessive addition of acids
- Have also seen a rise in foot rot with very low footbath pH solutions
- Research by Dr. Dopfer and workers at the University of Wisconsin Vet School showed problems with low pH
How Do We Know If Footbaths Are Compromising Skin Integrity?
We Need to Start Recording Number of Proliferative and Hyperkeratotic Lesions!

Proliferative lesions reflect use of harsh chemicals

Flaps reflect healing

Dopfer, University of Wisconsin-Madison Veterinary School
Zinc Sulfate

- 10 to 20% solution
- Antibacterial activity; Hardening agent?
- Reports from field, controls infectious claw lesions when used at 10 to 20%; but controlled research is lacking
- Relatively inexpensive (75% CuSO₄)
- Does not readily go into solution
  - Form is very important (ZnCl)
- Zinc is commonly applied to corn
  - Application varies depending upon soil Zn concentration and application method (band, 0 to 2 lb/acre; broadcast, 0 to 10 lb/acre)
  - 10% zinc sulfate foot bath results in 17.6 lb Zn disposed per cow/year

DG - 838

*a 50 gallon bath used 4X/wk, changed every 200 cow passes
Soap and Water

- Can use on none chemical footbath days
- Herds with accumulation of crust on the claws
- 1 quart of soap per 25 gallons of water (1%)
How Often Do We Need To Change The Bath?

- Manure load
- Size of bath
- Water quality
- pH
- Chemicals used
- Concentrations used
- Test It!

Please note that the scales on the y-axis are not the same between the two graphs. Aerobic microbial counts are always higher than anaerobic counts.
Soil copper = Variable

Plants are neutral accumulators of copper. Generally, the plant’s content is slightly below the soil content. Legumes accumulate more Cu than grasses. Corn is a grass.
Trim Records

- Monitor the results of a system change
- Monitor the results of a footbath solution change
- Can then answer the question of what is the most efficacious solution!!
Conclusions

- Footbaths need more science but are the best we have now.
- Can prevent DD and re-occurrence of DD but M2’s must be treated topically.
- More dunks/claw increases footbath effectiveness,
  - Longer (10-12’), 10 inch curb with level, smooth floor design.
- Keeping cows clean will reduce need for footbaths.
- Make your system very repeatable and easy to use.
- Make the system safe for people, cows and environment.
- Test your footbath solution for efficacy.
- Use records to evaluate what works (Try to go less).
Performance

Milk SCC

Milk Yield

Lameness

Reproduction

Lameness

Lameness

Milk Yield