Sorting Through The Value of Feed Additives
2019 Large Herd Conference—Reno NV

Mike Hutjens

Today’s Program
• Feed additives status and selection
• Role of B-vitamins
• A look at bacterial DFM

Feed Additive Concepts
• Margins are tightly, pull out feed additives
• Less than 10 cents a cow per day
• Covers up poor management
• Additives as profit enhancing opportunities

2018 U.S. Feed Additive Use
2018 Hoard’s Market Survey

Buffers 38
Yeast/yeast culture 29
Rumensin 24
Mycotoxin binders 24
Probiotics 11
Niacin 10
Omnigen 8
Don’t use 7
Feed bunk stabilizer 2

2018 U.S. Silage Inoculant Use
2018 Hoard’s Market Survey

Inoculant Usage 36%
Average Expenditure $6,087
Corn silage 90%
Haylage 76%
High moisture corn 30%
Baled hay 13%

Roles of Feed Additives
Energy Balance
• Propylene Glycol
• Encapsulated Calcium
• Niacin
• Calcium Propionate
• Rumenin
• Bypass Fat
• Probiotics

Calcium Balance
• Sequestered Calcium
• Animal Gel
• Citrate
• MgSiO
• CaCO3
• NDF/GI

Immune Function
• Organic Selenium
• Vitamin E
• Organic TM
• Bradex
• Omegagen-AF
• Probiotics

Rumen Enhancers
• Feed Formulator
• DFM
• Rumensin
• Buffers
• K-Carb
• Sugars
• Enzymes
• Aminoblot
• Probiotics

Reproduction
• Bypass Fat
• Repro Formulas
• Agri-biotics
• Organic Selenium

Foot Health
• Biotin
• Organic TM

Protein Efficiency
• Ultramet
• MicroAid

Mycotoxin Binders
• MTB 100
• Omegagen AF
• BioZinc
• Gardbond

Courtesy of Vita Plus
Using The Four R Concept

**Response**
How does it work & will it work on your farm

**Return**
The benefit to cost ratio (>2:1)

**Research**
Impact and results

**Records**
On your farm

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**Benefit to Cost Ratios**

Buffers: 8 : 1
Biotin: 7 : 1
Yeast products: 5 : 1
Ionophores: 5 : 1
Silage inoculant: 3 : 1
Rumen protect choline: 3 : 1

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**When Evaluating Research Ask for:**

**Type I and II Errors (Yeast Culture)**

- **Correct**
  - Type I Error ($0.01/cow/day)
  - Type II Error ($0.35/cow/day)

- **Incorrect**
  - Type I Error
  - Type II Error

**Meta-analysis**

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**Monensin Meta Analysis Milk Performance**

Duffield et al. 2008. JDS. 91:1347

- 36 Papers
- 71 Trials
- 9,677 Cows

**Dry matter intake:** - 0.67 lb
**Milk yield:** + 1.57 lb
**Milk fat test:** - 0.13%
**Milk protein test:** - 0.03%
**Feed efficiency:** + 2.5%
**BCS:** +0.03/+0.13 lb

**Fatty acid milk composition**
- Short chain FA’s: -1 to 12%
- Linoleic: + 22%

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**Your Decision:**
Which Feed Additive(s)
### Additives Recommended for Lactating Cows
- Rumen buffers
- Yeast culture/yeast products
- Monensin (Rumensin)
- Silage inoculants
- Biotin
- Organic trace minerals

### Hutjens Priority
1. Rumensin
2. Silage inoculants
3. Organic trace minerals (Zn, Se, Cr, & Cu)
4. Yeast and yeast culture
5. Sodium bicarb/S-carb
6. Biotin

### Additives Recommended for Close Up Dry Cows
- Yeast culture/yeast products
- Monensin (Rumensin)
- Silage inoculants
- Organic trace minerals + chromium
- Anionic product (if DCAD is > +20 meq/kg or 2 meq/100 gm)

### Additives Recommended for Fresh Cows
- Rumen buffers
- Yeast culture/yeast products
- Monensin (Rumensin)
- Calcium supplement (bolus/drench)
- Silage inoculants
- Biotin
- Organic trace minerals + chromium
- Rumen protected choline

### Hutjens “As Needs” List
- Propylene glycol (300 to 500 ml)
- Calcium propionate (150 grams)
- Niacin (3 g protected; 3 g unprotected)
- Mycotoxin binders (clay mineral or yeast cell MOS compounds)
- Protected choline (15 g per day)
- Anionic products / salts (amount varies)
- Acid-based preservatives (baled hay & high moisture corn 0.5 to 1%)

### Hutjens’ “Watch” List
- Essential oil compounds (0.5 to 1.5 g)
- Direct fed microbial products (probiotics)
- Feed enzymes (fiber and amylase)
Role of B Vitamins

• Essential nutrients for the dairy cow
• Involved in various metabolisms as enzymes cofactors (activators)

B Vitamins: Needed for Liver Glucose Synthesis

Glucose is needed for:

– Milk: 72g glucose /kg milk * 40 kg milk/day = 3 kg of glucose needed daily
– Oocyte: needed for quality
– Immune cells: main source of energy when activated, may need 2 kg/day

B Vitamins: Needed During Different Periods

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Estimated Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lactation Period</td>
<td>Transition Period</td>
</tr>
<tr>
<td>Thiamin (mg)</td>
<td>Sufficient</td>
</tr>
<tr>
<td>Riboflavin (mg)</td>
<td>Sufficient</td>
</tr>
<tr>
<td>Pantothenic Acid</td>
<td>Not Sufficient</td>
</tr>
<tr>
<td>Pyridoxine (mg)</td>
<td>Not Sufficient</td>
</tr>
<tr>
<td>Niacin (mg)</td>
<td>Sufficient</td>
</tr>
<tr>
<td>Biotin (mg)</td>
<td>Not Sufficient</td>
</tr>
<tr>
<td>( B_{12} ) (mg)</td>
<td>Borderline</td>
</tr>
<tr>
<td>Choline (g)</td>
<td>Sufficient</td>
</tr>
<tr>
<td>Folic Acid (mg)</td>
<td>Not Sufficient</td>
</tr>
</tbody>
</table>

*Based on independent research plus specific roles of B vitamins and choline

B Vitamins: Rumen Degradation

Options

• Injection
  – Stressful, impractical and costly
• In the Diet
  – Protected from ruminal degradation
  – Best method

<table>
<thead>
<tr>
<th>Vitamins</th>
<th>Ruminal Degradation/Disappearance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riboflavin</td>
<td>99%</td>
</tr>
<tr>
<td>Choline</td>
<td>99%</td>
</tr>
<tr>
<td>Niacin</td>
<td>98%</td>
</tr>
<tr>
<td>Folic acid</td>
<td>97%</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>80%</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>78%</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>63%</td>
</tr>
<tr>
<td>Biotin</td>
<td>60%</td>
</tr>
</tbody>
</table>

Biotin

Improve hooves by reducing heel warts, claw lesions, white line separations, sand cracks, and sole ulcers; increase milk yield

Level: 10 to 20 mg/cow/day for 6 mo to 1 year
Cost: 4 to 8 cents/cow/day
Benefit to Cost Ratio: 4:1
Ohio State Biotin Data (2001)
- 45 cows
- 14 days prepartum to 100 days postpartum
- No effect on DMI, body weight, or BCS

<table>
<thead>
<tr>
<th>Level</th>
<th>Milk yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>37.0 kg (81.4 lb)</td>
</tr>
<tr>
<td>10 mg/day</td>
<td>37.9 kg (83.4 lb)</td>
</tr>
<tr>
<td>20 mg/day</td>
<td>39.8 kg (87.5 lb)</td>
</tr>
</tbody>
</table>

UW Trial - Treatments
(mg/c/d)

<table>
<thead>
<tr>
<th></th>
<th>BBVIT 1x</th>
<th>BBVIT 2x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biotin</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Thiamin</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>Pyridoxine</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td>B12</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Niacin</td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>0</td>
<td>475</td>
</tr>
<tr>
<td>Folic acid</td>
<td>0</td>
<td>475</td>
</tr>
<tr>
<td>Control (C) was fed none for all of the above</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

UW Trial – Results

<table>
<thead>
<tr>
<th></th>
<th>C</th>
<th>B</th>
<th>BBVIT 1x</th>
<th>BBVIT 2x</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW, lb</td>
<td>1456</td>
<td>1461</td>
<td>1452</td>
<td>1459</td>
<td>9</td>
</tr>
<tr>
<td>DMI, lb/d</td>
<td>55.0b</td>
<td>56.5a</td>
<td>55.0b</td>
<td>53.7b</td>
<td>0.9</td>
</tr>
<tr>
<td>Milk, lb/d</td>
<td>81.8b</td>
<td>85.6a</td>
<td>84.3ab</td>
<td>82.5b</td>
<td>1.8</td>
</tr>
</tbody>
</table>

*ab Means in the same row with different superscripts differ (P<0.05)

Synthesis of Biotin - an in vitro study

Influence of biotin on foot lesions

<table>
<thead>
<tr>
<th>Lesion</th>
<th>Reference</th>
<th>Biotin dose</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole ulcer</td>
<td>Hagemeister</td>
<td>10 mg</td>
<td>Significant reduction in sole ulcers and heel erosion</td>
</tr>
<tr>
<td></td>
<td>Lischer et al.</td>
<td>20 mg</td>
<td>New horn formed more rapidly. Structure of new horn was improved</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>Distl &amp; Schmid,</td>
<td>20 mg</td>
<td>20-37% lower incidence of &quot;heel warts&quot; in an 11 month study</td>
</tr>
<tr>
<td>Vertical fissures</td>
<td>Campbell et al,</td>
<td>10 mg (Beef cows)</td>
<td>Incidence of sandcracks: Control 29.4%, Treatment 14.3%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lesion / Study</th>
<th>Reference</th>
<th>Biotin dose</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>White line Disease</td>
<td>Midla et al,</td>
<td>20 mg</td>
<td>Significant improvement in prevalence of white line lesions at 100 days of lactation</td>
</tr>
<tr>
<td></td>
<td>(1998)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hedges et al,</td>
<td>20 mg</td>
<td>Biotin halved the risk of clinical lameness caused by white line lesions. Biotin supplemented animals required fewer repeat treatments (17.5% v. 30%)</td>
</tr>
<tr>
<td></td>
<td>(2001)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pasture fed Cattle</td>
<td>Fitzgerald et al,</td>
<td>20 mg</td>
<td>Supplemented herds had a significant reduction in lesions causing lameness</td>
</tr>
</tbody>
</table>
The influence of 20mg/day biotin supplementation on the incidence of clinical lameness caused by white line disease in dairy cattle (Hedges et al 2001)

**Rumen Protect B-Vitamins**

**Encapsulation:** Not available in the rumen pH, but available in the lower gut at lower pH

**Embedded:** In lipid which is rumen inert, but released in the lower gut when lipases break down to fatty acids to be absorbed.

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**Niacin - 2015 ADSA Meetings**

- Feeding 3.5 grams of rumen protected niacin (RPN)
- California field study with 672 Holstein cows
- 15 days prepartum to 150 days after calving
- Dry matter increased fresh cow pen (42.5 vs. 46.9 lb)
- Ketosis levels were reduced
- No impact on milk yield, milk components, or fertility
- Higher levels of RPN were not effective

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**Guidelines for RPN**

- 3 grams RPN for transition cows (7 grams lowered feed intake and response)
- 65% rumen protected
- Higher levels for heat stress reduction (15 to 19 grams per day)
- Cost is three cents per gram of RPN

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**R.P. Choline Meta Analysis**

Grummer, 2012

13 research studies
4.9 lb milk responses (P< 0.0001)

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>RPC</th>
</tr>
</thead>
<tbody>
<tr>
<td>DMI (lb/day)</td>
<td>39.9</td>
<td>41.6</td>
</tr>
<tr>
<td>Milk (lb/day)</td>
<td>70.9</td>
<td>75.8</td>
</tr>
<tr>
<td>ECM (lb/day)</td>
<td>76.9</td>
<td>82.8</td>
</tr>
<tr>
<td>Protein (lb/cow)</td>
<td>2.30</td>
<td>2.47</td>
</tr>
<tr>
<td>Fat (lb/cow)</td>
<td>2.78</td>
<td>3.04</td>
</tr>
</tbody>
</table>

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**Commercial Vitamin B Complex/Blend**

- **Biotin** 10 mg/day
- **Folate** 2 mg/day
- **Pantothenic acid** 120 mg/day
- **Pyridoxine** 75 mg/day
Milk Production At First Test

Body condition score + 0.09 unit

More milk (+0.9 kg) and components

Feed efficiency increased by 5.2% (1.81 vs 1.72)

Culling rate reduced by 20%

No change in dry matter intake

Conception rate at first milk production

More cows pregnant until 23 milk protein

Role of DFM / Probiotics

Evans E. et al., 2006

Effect of protected B vitamins on first service conception rate

Morrison et al., 2018

Effect on DMI & Milk Production

Morrison et al., 2018

Effect on milk fat and protein yield

Morrison et al., 2018

Effect on ovulation

Richard et al., 2016

Protected B Vitamins: Improved Reproduction

Effect of protected B vitamins on first service conception rate

University of California, Juchem et al., 2012

- Conception rate at first service increased by 13%
- More cows pregnant until 200 days in milk
- Culling rate reduced by 20%

Improved Reproductive Performance
**Microorganisms in probiotic products (Holzapfel)**

<table>
<thead>
<tr>
<th>Lactobacillus</th>
<th>Bifidobacterium</th>
<th>Other LAB</th>
<th>Non-lactics</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. Acidophilus</td>
<td>B. animalis</td>
<td>E. faecium</td>
<td>Bacillus cereus</td>
</tr>
<tr>
<td>L. Casei</td>
<td>B. bifidum</td>
<td>L. lactis</td>
<td>Bacteroides ovatus</td>
</tr>
<tr>
<td>L. Crispatus</td>
<td>B. breve</td>
<td>L. mesenteroides</td>
<td></td>
</tr>
<tr>
<td>L. Gallinarum</td>
<td>B. infantis</td>
<td>L. thermophilus</td>
<td></td>
</tr>
<tr>
<td>L. Gasseri</td>
<td>B. lactis</td>
<td>S. inulinus</td>
<td></td>
</tr>
<tr>
<td>L. Johnsonii</td>
<td>L. longum</td>
<td>P. acidilacti/ freudenreichii</td>
<td></td>
</tr>
<tr>
<td>L. Plantarum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plus 3 more</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Bacteria With Potential (Kung)**

<table>
<thead>
<tr>
<th>Source</th>
<th>Dose</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. Elsdonii</td>
<td>8.7 x 10^6</td>
<td>Lactic acid prevention</td>
</tr>
<tr>
<td>L. Acidophilus</td>
<td>1 x 10^8</td>
<td>Increase DM intake under stress</td>
</tr>
<tr>
<td>Propionibacteria</td>
<td>1 x 10^9</td>
<td>Increase feed efficiency high carbs</td>
</tr>
<tr>
<td>P. acidpropionici</td>
<td>1 x 10^9</td>
<td>Increase propionic acid</td>
</tr>
<tr>
<td>P. freudenreichii</td>
<td>na</td>
<td>Weight gain in calves</td>
</tr>
<tr>
<td>P. freundreichii + 1 x 10^9 +</td>
<td>L. acidophilus</td>
<td>Improve feed efficiency</td>
</tr>
</tbody>
</table>

**Commercial Products**

**Hoards, 2018**

<table>
<thead>
<tr>
<th>Product</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probios</td>
<td>28%</td>
</tr>
<tr>
<td>Rumen Booster</td>
<td>20%</td>
</tr>
<tr>
<td>Bio-Vet</td>
<td>15%</td>
</tr>
<tr>
<td>Priority One</td>
<td>7%</td>
</tr>
<tr>
<td>Lira Gold</td>
<td>7%</td>
</tr>
<tr>
<td>Bovamine</td>
<td>11%</td>
</tr>
<tr>
<td>Fastrack</td>
<td>4%</td>
</tr>
<tr>
<td>Performance</td>
<td>4%</td>
</tr>
<tr>
<td>Tri-Lution</td>
<td>6%</td>
</tr>
<tr>
<td>Tri-Mic</td>
<td>4%</td>
</tr>
<tr>
<td>Dairyman’s Edge</td>
<td>2%</td>
</tr>
<tr>
<td>Other products</td>
<td>15%</td>
</tr>
</tbody>
</table>

**Review:** The use of direct fed microbials to mitigate pathogens and enhance production in cattle.


**A.** DFM integrate directly into the biofilm through the production of antimicrobials such as bacteriocins and organic acids.

**B.** DFM may either utilize substrates associated with the fluid environment. Concept adapted from McAllister et al. (1994).

**Review:** The use of direct fed microbials to mitigate pathogens and enhance production in cattle.


**A.** Competition for nutrients that limit microbial growth.

**B.** Direct antagonism through the production of antimicrobials.

**C.** Competitive exclusion through occupation of specific binding sites.

**D.** Stimulation of the immune response resulting in host exclusion of the pathogen.

**E.** Enhanced gut health through restoration of epithelial integrity.

**Exclusion of pathogens**

**A.** Competition for nutrients

**B.** Direct antagonism

**C.** Competitive exclusion

**D.** Stimulation of the immune response

**E.** Enhanced gut health

**Adapted from O'Toole and Cooney (2008).**

**Adapted from O'Shaughnessy and Cooney (2008).**
Current Theme / Focus

- Stabilize rumen fermentation
  - Reduce diurnal variation
  - Maintain rumen pH above 5.8
  - Avoid production of trans acids
- "Control" lactic acid production
- Stimulate lactic utilizers via production of lactic acid
- Combination of products (bacteria, yeast products, and micronutrients)

Primary role for supplemental DFM could be following periods of high stress, such as:

- Neonatal calves
- Post weaning
- Following shipping
- During periods of heat stress
- During the early postpartum period
- Following metabolic disorders

Guidelines for DFM

- Add DFM to milk/milk replacer calf diets
- Continue to monitor product research
- Evaluate on-farm responses to DFM
- Determine the criteria of a DFM that you may consider
- May reduce the level of antibiotics needed

Take Home Messages

- Feed additives can be an effective and economic additions to balanced rations
- Ask for research results
- Rumen protect B-vitamins may be needed
- Probiotics applications should be monitored
- Continue to monitor new research results

Questions?