

Mastitis and Nutrition Workshop

Methods for Assessing, Validating, & Monitoring Interventions to Improve Udder Health and Milk Quality On-Farm

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Penn State Dairy Alliance



Dairy Alliance is an initiative of Penn State Cooperative Extension



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Where Will We Go in this Workshop

.....???

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Where Will We Go ...???

- Research Review & Methods for Using Research On-Farm - Key Minerals & Vitamins with 'Known' Connections to Udder Health - 25 minutes
- How Key Nutrients & Immune System of Cow are intertwined - 5 minutes
- Questions from Group - (To be answered thru-out) - 5 minutes
- Tools for Approaching Mastitis Troubleshooting (with a Nutritional Slant) - 10 minutes
- Tools for Determining if a Nutritional Intervention Fits & Monitoring Interventions - 10 minutes
- Working a Mastitis Case - 20 minutes

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Review of Research

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Review of Research

- **Review of Research**

A. Trace Minerals

B. Vitamins

Balanced Rations - Energy & Protein are VERY IMPORTANT for a properly functioning Immune System

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Review of Research

- **Review of Research**

A. Trace Minerals - Association with Udder Health

- Copper



- Manganese



- Zinc




- Components of Superoxide dismutase in phagocytes

» SOD: Enzyme within phagocytes protects the cell and surrounding tissue from toxic chemicals that kill bacteria (neutralizes oxygen radicals)

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
• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Copper 
 - Essential mineral for:
 - » Component of Ceruloplasmin →
 - » Iron Transport
 - » Component of Acute Phase Proteins →
 - » Involved in Defense System with coliform mastitis


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Copper 
 - NRC, 2001 Cu Requirement:
 - » Milking Cows: 16 ppm (313 mg/d)
 - » Dry Cows: 14 ppm (164 mg/d)
 - Reduced Severity of coliform infections when Cu was fed at 20 ppm through the dry period (60 days) & 1-1/2 months post-calving
 - » Fed as Copper Sulfate
 - » Scaletti et al., 2003. Univ. Kentucky


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Zinc 
 - Essential mineral for:
 - » Lymphocyte Function →
 - » Development of T cells
 - » Activation of B cells
 - » Maintenance of Skin Integrity →
 - » Primary defense to udder infection


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Zinc 
 - NRC, 2001 Zn Requirement:
 - » Milking Cows: 63 ppm (1261 mg/d)
 - » Dry Cows: 23 ppm (274 mg/d)
 - Few Peer Reviewed Studies
 - Several studies have evaluated supplemental Zn methionine on SCC
 - » Generally fed at 360 mg Zn/d
 - » Zn Methionine statistically or numerically ↓ SCC


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Zinc 
 - Effect on ↓ing New infections?
 - Effects of Feeding Supplemental Zn as:
 - » Zn Proteinates (250 mg Zn/d) Plus Inorganic Zn (140 mg/d)
 - » or from all Inorganic sources (390 mg/d)
 - » Diets contained 50 ppm Total Zn
 - » No difference on rate of new infections, clinical mastitis or SCC
 - » Whitaker et al., 1997


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Selenium 
 - Essential mineral for:
 - » De-toxifying Oxygen Radicals →
 - » Same function as SOD with different enzyme - glutathione peroxidase
 - » Stimulation of Antibody Production (B Cell Activation)


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Selenium 
 - NRC, 2001 Se Requirement:
 - » Milking Cows: 0.3 ppm (6 mg/d)
 - » Dry Cows: 0.3 ppm (4.5 mg/d)
 - Research combined with Vitamin E
 - » Dry cows fed 1000 IU Supplemental Vit E and/or injected with 50 mg Se (21 d pre-calving)
 - ⊙ Fewer cases of clinical mastitis with reduced length of infection compared with controls (no Supplemental Vit E or Injection Se)
 - Smith et al., 1984


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Selenium 
 - Research combined with Vitamin E
 - » Supplementation of a low Se diet with 0.2 ppm of Se from selenite or selenized yeast ↓ SCC
 - Malbe et al., 1995
 - » Mean SCC over an entire lactation was ↓ when cows were supplemented with 6 to 12 mg Se/d
 - » No difference in clinical mastitis between treatments
 - Wichtel et al., 1994


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Selenium 
 - Research combined with Vitamin E
 - » Feeding cows 2 mg Supplemental Se/d beginning 3 months before calving and thru out lactation ↓ severity and duration of mastitis in cows challenged with E. coli
 - Erskine et al., 1989
 - » Control cows were fed 0.04 ppm Se


• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Selenium 
 - Research combined with Vitamin E
 - » No effect of supplemental Se when cows were experimentally challenged with Staph. aureus
 - Erskine et al., 1990
 - » Feeding 1000 IU/d Supplemental Vit E during the dry period in cows with low Se (0.1 ppm) status ↓ clinical mastitis & reduced new infections at calving and in the first week compared with feeding 100 IU
 - Weiss et al., 1997

• **Review of Research**

A. Trace Minerals - Association with Udder Health

- Selenium 
 - Research combined with Vitamin E
 - » Feeding 4000 IU/d Supplemental Vit E (when Se deficient - 0.1 ppm!!) during 14 days before calving, ↓ clinical mastitis & reduced new infections
 - Weiss et al., 1997

• **Review of Research**

B. Vitamins - Association with Udder Health

- Vitamin E
 - Functions as an anti-oxidant and is found in close association with Se
 - Interchangeable Function (?) to Selenium
 - Most research has shown both are important and are interchangeable only to a point

• **Review of Research**

B. Vitamins - Association with Udder Health

• Vitamin E

- NRC, 2001 Vit E Requirement -
- Supplemental:
 - » Milking Cows: 0.8 IU/kg Body Weight
[545 IU for 1500 lb cow];
 - 20 IU/kg DMI [454 IU for 50 lb DMI]
- Total:
 - » Milking Cows: 2.6 IU/kg BWt.
[1773 IU for 1500 lb cow];
- See NRC for conditions for increasing or lowering supplementation.

• **Review of Research**

B. Vitamins - Association with Udder Health

• Vitamin E

- NRC, 2001 Vit E Requirement -
- Supplemental:
 - » Dry Cows: 1.6 IU/kg Body Weight [1090 IU for 1500 lb cow];
 - 80 IU/kg DMI [1040 IU for 26 lb DMI]

• **Review of Research**

B. Vitamins - Association with Udder Health

• Vitamin A (& β -Carotene)

- Maintenance of Epithelial Tissue Health
- Role in Keratin Secretion

• **Review of Research**

B. Vitamins - Association with Udder Health

• Vitamin A (& β -Carotene)

- Variable Data toward effect on lowering SCC
- NRC, 2001 Vit a Requirement -
- Supplemental:
 - » Milking Cows: 110 IU/kg Body Weight
[72,710 IU for 1500 lb cow];
 - » Dry Cows: 110 IU/kg Body Weight
[72,710 IU for 1500 lb cow];

• **Review of Research**

"Simply because a nutrient is directly involved with immune function does not mean that supplementing diets with that nutrient will improve immunity & lower mastitis"

"When cows are below optimal status, supplementation of a biologically available form of the nutrient should elicit a positive response but once optimal status is obtained, no additional positive responses would be expected when the nutrient is supplemented"

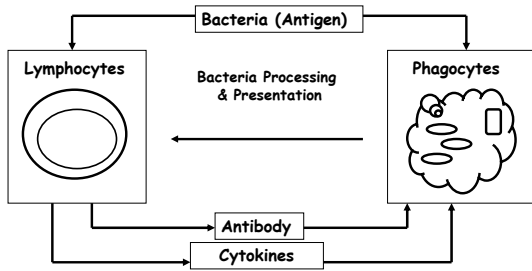
"Excessive supplementation may decrease immune function and increase health problems"

W.P. Weiss. The Ohio State University
From: "Relationship of mineral and vitamin supplementation with mastitis and milk quality"

Where does Nutritional Intervention Fit?

Basic Immunology - Cell Mediated Immunity in Response to Mastitis

Integration of Defense Mechanisms



Adapted From: Immunology, 2nd Edition. Roitt et al. 1989

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Integration of Defense Mechanisms

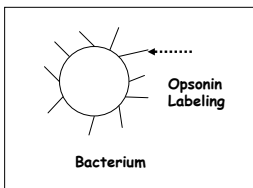
- ☑ Bacteria Penetrates The Udder
- ☑ Phagocytes Flock to Site of Infection (CMI)
- ☑ Bacteria are Processed Within Phagocytes (Killed & Digested) (CMI)
- ☑ Signals from Processed Phagocytes Recruit Lymphocytes (CMI)
- ☑ Lymphocytes Produce Antibody - Further Action against Bacteria (somewhat limited in the mammary gland) (HI)
- ☑ Lymphocytes Produce Cytokines - chemicals to recruit more cells (Lymphocytes & Phagocytes) and special chemicals to kill bacteria (HI & CMI)

HI = Humoral Immunity - Limited in Mastitis Immunity

CMI = Cell Mediated Immunity - Major Defense System in Mastitis Control (Still not real efficient due to 'junk' in milk it has to fight through to work)

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Phagocytosis - The Theoretical Process in a properly functioning Immune System (Cell Mediated Response)



Step 1. Opsonization

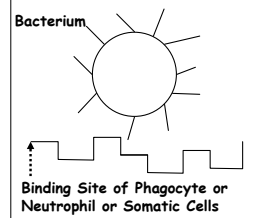
Bacteria enter the udder. They are:

- a). Identified,
 - b). Labeled (Opsonin coating) &
 - c). Detected as foreign
- ☑ To attract phagocytic cells
 - ☑ To attract chemicals to amplify the process quickly
 - ☑ To indirectly produce antibodies-Humoral Immunity which can also launch a defense

Adapted From: Basic & Clinical Immunology, 1987, 6th Edition. Stites et al.

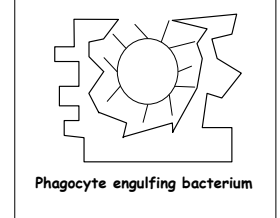
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Phagocytosis - The Theoretical Process in a properly functioning Immune System (Cell Mediated Response)



Step 2. Recognition & Binding to Phagocyte

Phagocyte travels to labeled bacterium and binds with foreign antigen (bacterium)

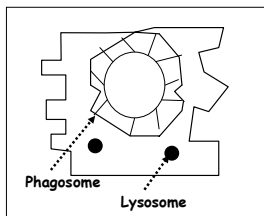


Step 3. Ingestion

Phagocyte engulfs bacteria isolating it and preventing reproduction and growth

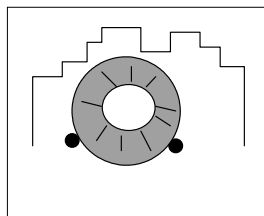
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Phagocytosis - The Theoretical Process in a properly functioning Immune System (Cell Mediated Response)



Step 4. Acidification

Bacterium is completely enclosed or engulfed in phagosome. PH drops (acid environment is bad for bugs)

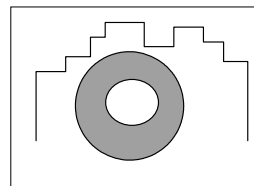


Step 5. Lysosome Binds to Phagosome

Enzymes and oxygen radicals begin to act on bacterium

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Phagocytosis - The Theoretical Process in a properly functioning Immune System (Cell Mediated Response)



Step 6. Killing and Digestion

Bacteria is Killed and Broken down within the Phagosome.

More chemical messages are sent out to alert other cells to action

Enzymes like superoxide dismutase & glutathione peroxidase work to prevent damage to the phagocyte through neutralizing oxygen radicals (part of killing system)

Adapted From: Basic & Clinical Immunology, 1987, 6th Edition. Stites et al.

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Review & Methods for Using Research On-Farm

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Using the Research

- **Methods for Using Research On-Farm:**
 - A. Needs Assessment/Initial Interviewing
 - Is farm situation like research conditions?
 - What factors may impact response?
 - B. Validation of How Intervention Can Solve Producer Challenges
 - Show producer how research is like farm situation and how intervention can be used to solve problem
 - Motivate producer to adopt intervention into on-farm procedures
 - C. Monitoring of Intervention
 - Did intervention work like it should have?
 - D. Evaluation of Intervention(s)
 - Should intervention be continued?
 - Is intervention still economical?
 - Is producer still committed to making intervention work?

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Using the Research

- **Methods for Using Research -**
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**
-
- » **Breed Differences**
 - ⊗ BE CAREFUL when making 'Bioavailability adjustments' for Copper (Cu) in Jersey herds!!!

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Using the Research

- **Methods for Using Research -**
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**
-
- » **Breed Differences**

Questions/Observations:

- What breeds are represented on this farm?
- If Jerseys and Holsteins are on-farm, are they grouped & fed differently?
- What is current ration level of Cu for Jerseys (based on DM intake estimate)?
- Are Jerseys experiencing same Udder Health concerns as Holsteins?
- Are there high levels of Iron or Sulfur in Water that may justify higher Copper Levels?

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Using the Research

- **Methods for Using Research -**
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**
-
- » **Mastitis Pathogen Differences**
 - What are primary pathogens causing infections:
Tool: Use Bulk Tank Culture & Cow/Quarter Cultures from Individual Cows to assess
 - Environmental or Contagious Pathogens?
 - Environmental Streps or Coliform Outbreak?
 - Does research on this nutritional element show a beneficial effect with predominant pathogens seen in this herd?

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Using the Research

- **Methods for Using Research -**
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**
-
- » **Mastitis Pathogen Differences**

Questions/Observations:

- What are major herd pathogens based on Bulk Tank Culture?
- What pathogens are mainly causing clinical mastitis?
- Are infections severe - watery/hot mastitis, cows dying or drop to no milk with systemic symptoms?
- Are infections mainly caused by contagious pathogens from newly purchased cows? E.g., Mycoplasma, Staph. aureus, Strep. ag?
- Are infections caused by Environmental Streps. and Coagulase Negative Staphs?

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- **Methods for Using Research** -
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**

» **Risk Assessment Characteristics**

- Are new infections mainly during the dry period (e.g., show as early lactation infections)?
- Are new infections scattered throughout lactation?
- Is there a seasonal trend in new infections?
- Is Bulk Tank SCC high, mid range, low?
- Are Clinicals higher than usual?
- Are there many chronic cows (long time with infections - clinical or subclinical)?

- **Methods for Using Research** -
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**

» **Risk Assessment Characteristics**

Questions/Observations:

- What is Bulk Tank SCC and what is the trend over the last 6 months?
- What is rate of new infections (subclinical and clinical) and how does that compare with the trend over the last few months?
- What is the % of chronic infections (subclinical and clinical mastitis)? Are they curing through the dry period?
- When are new infections occurring - dry period and early lactation, throughout lactation, hot/wet months, etc.?

- **Methods for Using Research** -
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**

» **Nutritional Characteristics**

- Ration Level of Nutrients by Group
- Dry Matter Intake of Diet by Group
- Factors Contributing to Reduced Bioavailability
- Special Products or Form of Nutrients

- **Methods for Using Research** -
 - **Needs Assessment & Initial Producer Interview**
 - How can research evidence aid YOU in determining true needs of producer?
-
- **What are Unique Dairy Conditions that Match Research Conditions?**

» **Nutritional Characteristics**

Questions/Observations:

- What is ration level of key nutrients for each group?
- What is true dry matter intake of diet and key nutrients for each group?
- Are there factors on-farm that may be impacting bioavailability - mycotoxins, high level of antagonistic minerals in water, stressors?
- What is status of cows for key nutrients (serum level, liver level, etc.)?

Udder Health - Use of Tools for Assessing Need & Monitoring Value of Intervention

- **Udder Health 101**
 - **Herd Level of Infections is Combination of:**
 - # of Cows Infected at any time
 - **New Infections** - a lot of cows becoming newly infected makes herd situation bad
 - **Length of Time Cows are infected (Duration of Infections)**
 - If infections last a long time → herd level is higher
 - The more cows with chronic infections the worse the situation

• Udder Health 101

- UDDER HEALTH is VERY SIMPLE!!

- The more manure cows are exposed to →
 - the greater the chance of new infections!!
- The greater the job at milking time in getting cow's clean →
 - the less impact barn hygiene will have on new infections!! (Milk Cows ONLY)!!
- The cleaner the environment during the dry period →
 - The lower the need for interventions!!

• Udder Health 101

- What causes a lot of new infections?

- THINK HERD STRATEGIES - RISK FOR ENTIRE HERD or GROUP

• Hygiene:

- Cow Score Card Tools
- Bedding Management
- Cleanliness in the Milking Center (Parlor or Stanchion)
- Milking Procedures
- Cleanliness in 'Treating' Cow Udders (Dry Cow and Mastitis Antibiotic Treatments, Teat Dip Container, Towel Use, etc.)

• Udder Health 101

- What causes a lot of new infections?

- THINK HERD STRATEGIES - RISK FOR ENTIRE HERD or GROUP

• Immunity - Natural & Purchased:

- Herd & Cow Immune Status
 - » Presence of other Diseases
 - » Nutritional Status
 - » Knowledge of reduced immune status during dry period and early lactation (RAMP UP CONTROL!!)
 - » Knowledge of reduced immune status during heat stress (RAMP UP CONTROL!!)
 - » Knowledge of reduced immune status when other diseases are present (RAMP UP CONTROL!!)

• Udder Health 101

- What causes a lot of new infections?

- THINK HERD STRATEGIES - RISK FOR ENTIRE HERD or GROUP

• Immunity - Natural & Purchased (cont):

- Herd & Cow Immune Status
 - » Level of bacteria in the environment
 - » Stress to cow (people handling)
 - » Keep cows standing after milking (Keratin plug regeneration)
 - » Use of teat sealants especially through dry period

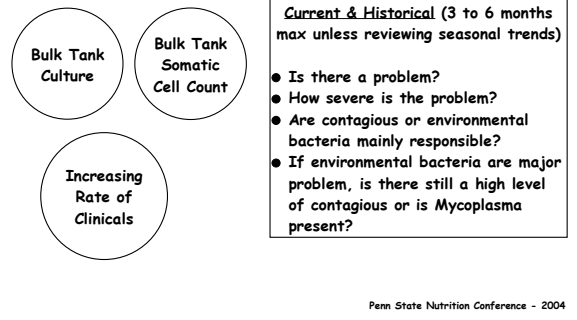
• Udder Health 101

- What causes a lot of new infections?

- THINK HERD STRATEGIES - RISK FOR ENTIRE HERD or GROUP

• People & Machine Impacts on Teat:

- Properly Functioning Equipment
 - » Reduce Overmilking, Pulsation/Vacuum Problems
- Rubber (inflation, hoses) changed as needed
- Milking Procedures to reduce time machine is on cow and maximize milk harvested
- Involve qualified consultants to assist!



Mastitis Troubleshooting

- **If Environmentals are Predominant:**
 - **What is rate of new infections?**
 - Clinical Mastitis Records (many definitions)
 - Actual Records, Producer Observations
 - Somatic Cell Count Records (new > 200,000)
 - **Is rate of new infections high in any particular group?**
 - Physical group within Facilities
 - Early Lactation
 - End of Lactation
 - Heifers
 - Purchased Cows or Heifers

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Mastitis Troubleshooting

- **If Environmentals are Predominant:**
 - **What is rate of chronic cows?**
 - Clinical mastitis records
 - Recurrences
 - Duration (Length of infections)
 - Somatic Cell Count records
 - High Somatic Cell Count over 2 to 3 or more months
 - Recurrences (Can indicate *Staph. aureus* if Bulk Tank Culture also concurs)

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Mastitis Troubleshooting

- **If Contagious Pathogens are Predominant:**
 - **Ask same questions & use similar tools**
 - Consider source of contagious pathogens
 - Purchased Cows
 - Springers
 - High Prevalence in Herd
 - Consider methods contagious pathogens spread within the herd
 - Common towels for drying
 - Milking Machine malfunction (machine impacts/fall-offs, pulsation/vacuum malfunction, air leaks, etc.)
 - Fly Control
 - Purchased Cow with contagious pathogen
 - Reduced Immunity in Herd

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Mastitis Troubleshooting

- **If Contagious Pathogens are Predominant:**
 - Consider methods to reduce spread of contagious pathogens
 - Improve teat condition & immunity of cows
 - Nitrile Gloves for Milking
 - Separate Group for contagious cows
 - Routine Machine Maintenance
 - Reduce level of infections
 - » decreased # = decreased risk of spread
 - Detect & Treat early - Strep ag & *Staph. aureus*
 - Detect *Mycoplasma* quick
 - » special testing - no cell wall -
 - » special diagnostics/special request
 - » limited treatment effectiveness

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Tools for Determining if a Nutritional Intervention Fits & Methods for Monitoring Response

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Determining if Nutritional Intervention Works

- **What Does Mastitis Cost?**
 - **If we could reduce mastitis: new infections, length of infection, and/or severity of mastitis...**
 - What impact would this have on farm profits...\$\$\$??
 - 1. **What does intervention cost vs. what is being done now**
 - Use copper/zinc proteinate product vs. copper sulfate and zinc sulfate for copper and zinc source
 - \$ SPENT Now - \$ SPENT Before = \$ SPENT
 - 2. **What effect does reduction in mastitis have on improving profitability?**
 - Reduced new infections
 - Improved cure rates
 - Decreased severity of response (Coliforms)
 - \$ GAINED

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Determining if Nutritional Intervention Works

- What Does Mastitis Cost & What is the Economic Benefit of the Intervention?

PROFIT or LOSS from Intervention =

\$ GAINED (mastitis benefit) - \$ SPENT (intervention cost)

Determining if Nutritional Intervention Works

- Cost Components of Mastitis:

Reason for Economic Loss	Cost Per Cow (\$)	Percent of Total (%)
Reduced Milk Production	\$121.00	66%
Replacement Cost	\$41.73	22.6%
Discarded Milk	\$10.45	5.7%
Treatment	\$7.36	4.1%
Veterinary Services	\$2.72	1.5%
Extra Labor	\$1.14	0.1%
TOTAL	\$184.40	100%

Determining if Nutritional Intervention Works

- By Reducing Severity of E. coli Cases what are the potential savings?
 - We don't know for sure (unless producer keeps records)
 - Milk Production Loss Savings (Reduced Impact on Milk)
 - Replacement Savings (Cow not culled)
 - Treatment Savings (Reduced time in treatment or no treatment)
 - Veterinary Savings (Response not systemic)
 - Reduced Labor (Systemic and Udder Treatments)
 - Discarded Milk (Reduced)
 - Estimate Savings over time of intervention monitoring and based on E. coli cases & reduced severity

Determining if Nutritional Intervention Works

- By Reducing Bulk Tank SCC what are the potential savings?
 - We don't know for sure (unless producer keeps records)
 - Reduced New Infections
 - Milk Production Loss, etc...
 - Reduced Length (Duration) of Infections
 - Milk Production Loss, etc...
 - Estimate Savings over time of intervention monitoring and based on reduction of Bulk Tank SCC - See Handout

Determining if Nutritional Intervention Works

- Similar methods can be used to determine the value (benefit) based on other improvements to udder health
 - Reduction in Clinicals (new infections)
 - Reduction in Bulk Tank SCC
 - Reduction in Severity of Infections
 - Improvement in Cure Rates

BE CAREFUL ABOUT ATTRIBUTING ALL OF THE BENEFIT TO NUTRITIONAL INTERVENTION ALONE!!!

 - Could the reduction in bulk tank SCC and/or rate of clinicals be due to change in weather (occurred same time)?
 - Could the reduction in rate of new clinicals be due to improved milking management procedures?
 - Could reduction in early lactation infections be due to another intervention initiated thru the dry period?

**Mastitis Case
<See Handout>**