Class PowerPoints & materials are on-line

Google "wsu jmgay index"

http://people.vetmed.wsu.edu/jmgay/courses/

Scenario: You manage youngstock on a large operation

As youngstock manager, you need to be able to explain the "why's" sufficiently to:
- Establish standard operating processes (SOP’s) for youngstock
- Hire, train, motivate, monitor and evaluate employees following the SOP’s
- Solve and prevent problems

What do you need to know to:
- Explain the ‘Nuts & Bolts’
- Manage employees?
- Find reliable resources for solving problems?

Calf Scours: Information sources

Diarrhea in Neonatal Ruminants

Google ‘Cornell Consultant’
Select species of interest
Enter ‘diarrhea’ in Diagnosis
Select disease of interest

How big a problem is calf scours? How much is it costing (or could cost) the operation?

First step for determining management strategy:

• Total Mortality (death) prior to weaning – USDA NAHMS
  – 6% Beef
  – 11% Dairy

• Scours as reason for Mortality:
  – 18% Beef
  – 60% Dairy

• Tracking on your operation
  – What you don’t routinely measure, you can’t manage!

Diarrhea is the disruption of normal gut physiology

• Body water cycles in and out of intestinal tract as part of digestion
  – 25% of body water cycles thru intestinal tract daily

• Two forms of disruption:
  – Normal secretion into intestine, reduced (malabsorption) back out
    • Most infectious diarrheal agents
    • Fermentative diarrhea
  – Excess secretion (hypersecretion) into intestine, overloaded reabsorption back out
    • E. coli K99, cholera

Balanced intake and output are essential to normal fluid balance

Diarrhea causes dehydration and electrolyte imbalance

• Body water loss => Dehydration
  – Circulation effects - Skin “tents”, sticky mouth, cold limbs and ears, sunken eyes
  – Urine output drops and stops if severe

• Body electrolyte (salts) loss and imbalance
  – Affects heart and skeletal muscle function
    • If shifts are severe enough, heart stops
  – Depresses CNS

What is it? (the really simple version of “what?”)

Diarrhea: Loss of body water & salts (electrolytes)
Malabsorption causes diarrheal imbalance

- Imbalance = Shrinking Body Fluid Volume
- Water Intake → Intestine → Electrolyte Shifts → Urine Loss → Fecal Loss

Hypersecretion causes diarrheal imbalance

- Shrinking Body Fluid Volume
- Water Intake → Intestine → Electrolyte Shifts → Urine Loss → Fecal Loss

The most important treatment is replacement fluid

- **Detect** scouring calf before fluid loss becomes profound so oral replacement works
- **Replace** both lost body fluid (water) and electrolytes (salts) in **large enough quantity often enough** that loss does not become profound

What to buy: Oral rehydration solutions (ORS) have 4 key ingredients besides water

- Dextrose (glucose) – for energy
- Glycine – for absorption
- Salts: potassium chloride, salt, dicalcium phosphate, magnesium sulfate
- Sodium bicarbonate - buffer

2.3% glycine and 44 grams dextrose (glucose)

- “high energy” label – required to fuel absorption
- **Caution:** Still only ½ the energy of milk!

Feeding only fluids too long leads to death by starvation / hypothermia

Use high energy electrolytes with glycine

- Entrolyte H.E.
- Re-sorb

Use esophageal feeder to quickly transfer fluids

- Must be inserted carefully and sanitized between calves!

http://u.osu.edu/beef/2016/03/23/tube-feeding-colostrum-an-essential-skill-for-all-producers/
For several reasons, antibiotics are the least important treatment!

- Agents that cause calf scours are often:
  - Viruses or protozoa that antibiotics have no effect upon
  - Bacteria that are usually resistant to OTC antibiotics
- Antibiotics, particularly OTC (over the counter) oral antibiotics, are usually ineffective!
  - Antibiotics in scour boluses
  - Antibiotic-containing milk replacer
  - Antibiotic-containing starters

To be successful, treatment must be early!

Determine how to treat a scouring calf by classifying it into one of three categories

- **Degree of dehydration**
  - Early < 5% Body Wt – supplemental oral fluids
  - Moderate 7% Body Wt - high energy oral fluids
  - Severe > 9% Body Wt - emergency IV fluids

- **5 classification components - LOBES:**
  - **L**imbs
  - O**r**al membranes
  - **B**ody Position
  - **E**yes
  - **S**kin

**Dehydration Sign** – skin "tenting" pinch test

**Early Fluid Loss (<5% BW)**

- Calf:
  - Limbs - warm
  - Oral membranes - moist
  - Body position - bright, standing
  - Eyes - bright
  - Skin - "tents" for < 4 seconds
- Calf will suckle electrolyte solution from a bottle
- Leave calf on milk and add several 2 quart electrolyte feedings per day until scouring slows
- Reason: If calf doesn't have adequate fat reserves, feed removal can cause death by starvation/hypothermia before scours stop

**Moderate Fluid Loss (7% BW)**

- Calf:
  - Limbs - cold
  - Oral membranes - warm but sticky
  - Body position - dull, lying down but ***upright***
  - Eyes - sunken slightly with a slight gap
  - Skin - "tents" for 5 secs
- **RX:** to survive 1/2 gallon of warm special "high energy" electrolyte solution (Enterolyte HE) by esophageal feeder twice several hours apart
- Move to warm area where calf can be monitored

Loose skin of neck, chest

Eyelid

“You’re too late!”
Severe Fluid Loss (>9% BW)

- **Calf:**
  - Limbs - cold
  - Oral membranes - cold, pale and dry to touch
  - Body position - lying flat in a coma
  - Eyes - deeply sunken with a big gap
  - Skin - stays “tented”

- **RX:** Only 1 gallon of special electrolyte fluids by IV drip will save the calf
  - SQ and oral fluids won’t be absorbed because circulation is too poor

- Unless you or your employees can do IV’s safely and humanely, take calf to veterinary clinic

Fluid volume must replace loss and keep up with continuing losses

- Enough balanced electrolyte fluids must be given to:
  - **Replace** % of body weight (BW) lost
  - **Meet** maintenance requirements (50 ml / kg BW per day)
  - **Keep up** with ongoing loss of 1 to 4 Liter per day in the diarrhea

- For a 7% dehydrated 80 lb calf, this is **6 to 9 quarts** of electrolyte solution **the first day**
  - 1 Enterolyte H.E. pack is only 2 quarts! -> 4 packages

Commonest Infectious Diarrheal Agents

Three Agent Types:
- **Bacteria**
  - *Escherichia coli* (E. coli) strains
  - *Salmonella* serotypes dublin, typhimurium, newport and others
- **Viruses**
  - Rotavirus
  - Coronavirus
- **Protozoa**
  - Cryptosporidia
  - Coccidia

Zoonotic!

Key *E. coli* characteristics

- Normal gut flora of all mammals so *E. coli* is ubiquitous (everywhere)
- Three disease forms:
  - Colisepticemia - any strain
  - Enterotoxigenic - specific strains
  - Enteropathogenic - specific strains
- A most common cause of calf death
- OTC antibiotics are usually not effective
- Some very effective ones are illegal to use!
Baytril cannot be used off-label, even by veterinarians

“Federal law prohibits the extra-label use of this drug in food-producing animals”

A complete veterinarian’s label doesn’t protect you both from prosecution by the FDA

Colisepticemia is caused by any *E. coli*

- Spreads through calf’s body to cause abscesses in the brain, eyes, kidneys, and joints
- Occurs when calf ingests manure, mud or other material before or along with colostrum
- Virtually impossible to treat successfully
- Prevented by:
  - calving in clean, dry areas
  - cows having clean udders
  - Harvesting colostrum cleanly and keeping refrigerated or frozen
  - feeding 4 qts of high quality colostrum within 4 hours of birth

*E. coli* are everywhere in manure-contaminated mud!

Bad conditions > First mouthful is *E. coli*!

Low density, no mud > Excellent conditions!

Calving on Winter Feedground

High density, lots of manure, carrier cows > Very poor conditions!
Enterotoxigenic *E. coli* (ETEC)

- **Specific strain (K99)** attaches to intestinal cells and causes a hypersecretory diarrhea
  - Toxin turns on cell’s fluid pump
- Almost the only diarrhea that **occurs within first 3 days of life**, often in first day
  - Calf can die of dehydration **before diarrhea appears**!
- Prevented by feeding colostrum containing K99 antibodies
- Cow vaccine available

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Corona & Rotaviral Diarrhea

- Virus kills cells of intestinal villi, causing malabsorption diarrhea
- **Calf begins shedding** $10^{11}$ virus per gram of feces **3 days after infection**
- **Carrier cows** continually shed low numbers of virus
- Virus survives **weeks** in the environment
- Vaccines available
- Antibiotics are ineffective (virus)

**3 Keys to Management and SOP’s**
Sandhills Beef Calving System

"The Sandhills Calving System" was developed to reduce viral diarrhea in beef herds
- Developed in Nebraska by Dr. David Smith and colleagues
  - http://www.rangebeefcow.com/powerpt/smith.pps

Cryptosporidial Diarrhea
- Ubiquitous organism that survives for months in the right environment
- No practical antibiotics are effective
- Not killed by most disinfectants at practical concentrations
  - Exception: Chlorine dioxide
- Killed by complete drying
- This is a zoonotic disease, particularly for the immunocompromised

Salmonella Diarrhea
- Calves can shed it in feces, urine, saliva and nasal secretions, contaminating everything they touch and everything that touches them (hands, esophageal feeders, nipples, ...)
  - The reason for sanitizing esophageal feeder between calves
- Salmonella survive in the environment for months
  Only direct sunlight kills it in the environment
- Usually resistant to OTC antibiotics

The major Salmonella transmission cycle is typical of most enteric pathogens: fecal-oral with fecal exposure being the major risk

Most are unaware of the other Salmonella transmission routes and exposure risks
Salmonella Diarrhea

- **Antibiotics:**
  - Depress the normal bacterial flora, making the animal more susceptible to infection and prolonging the diarrhea
  - May be required if infection is systemic; use legend injectable

- Vaccines of questionable effectiveness
- This is a **zoonotic disease**, meaning that humans get it!
  - Practice careful personal sanitation with hands, boots, clothes

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Low level Salmonella contamination can cause problems

- **Cross-Contamination?**
- **Weather, misters?**
- **Summertime, enclosed barn?**
- **Low level Salmonella Contamination**
- **Favorable Environmental Temperature**
- **Moist Foodstuff**
- **Repllication**
- **Sufficient Time**
- **Infectious Dose!**

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Salmonella has superb survival abilities, surviving well under common farm environmental conditions

- Salmonella survives for months in materials that dried without heating, such as fecal pats and dust
  - Killed by exposure to **direct sunlight**
- Salmonella survives well in water
  - Slowly removed by microbial predators in water
- Salmonella replicates in moist environments (< 85% dry matter) even with scarce nutrients
  - Salmonella will grow on a **wet board!**
- Moist feedstuffs
- Salmonella replicates in the intestinal tract of every species in the farm environment
  - Livestock, humans, domestic pets, vermin, wild animals

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For more information, **Veterinary Clinics of North America** are an excellent review series

- Each issue has ~10-15 review papers by invited authors focused on a theme
- Available on-line through **WSU Libraries**

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For an excellent review of calf scour:

**Veterinary Clinics of North America: Food Animal Practice** 25(1), March 2009

- Bovine Neonatology
  - Pathophysiology of Diarrhea in Calves
  - Treatment of Calf Diarrhea: Oral Fluid Therapy
Undifferentiated Bovine Respiratory Disease Complex (BRD)

Aka:
  • “Shipping Fever” - beef industry
  • Enzootic Calf Pneumonia - dairy industry
  • Bovine Pasteurellosis - technical

BRD Information Sources

Google ‘Cornell Consultant’
Select species of interest
Enter ‘pneumonia’ in Diagnosis
Select disease of interest


BRD is one of the most costly cattle diseases

BRD causes a significant % of pre-weaning calf deaths

<table>
<thead>
<tr>
<th>Cause</th>
<th>Beef</th>
<th>Dairy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calving Problems</td>
<td>33%</td>
<td>14%</td>
</tr>
<tr>
<td>Scours</td>
<td>17%</td>
<td>60%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>10%</td>
<td>24%</td>
</tr>
</tbody>
</table>

BRD causes a higher % of post-weaning calf deaths (USDA NAHMS)

<table>
<thead>
<tr>
<th></th>
<th>Beef Feedlot</th>
<th>Beef Replacement</th>
<th>Dairy Replacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digestive</td>
<td>13%</td>
<td>7%</td>
<td>14%</td>
</tr>
<tr>
<td>Respiratory</td>
<td>64%</td>
<td>7%</td>
<td>45%</td>
</tr>
</tbody>
</table>

BRD is caused by a sequence of events

- Interaction between pathogens, environment and the bovine host
  - Complex set of causal factors (ammonia, dust, stress, . . .)
- Final stage:
  - Pneumonia – acute, severe lung bacterial infection
  - Normal host flora in the wrong place

A disease of Man(agement) with clinical signs in the bovine
Stress + virus + bacteria = BRD

Five steps lead to BRD occurrence:

1. Stress and upper respiratory ciliary damage
2. Growth of normal bacteria in upper airways
3. Failure of mucocilliary mechanism to clear the ventral lung (gravity)
4. Proliferation of normal nasal bacteria (Mannheimia hemolytica A1) out of place in ventral lung
5. Vicious cycle of infectious inflammation in dependent ventral lung

Mannheimia hemolytica is the most common BRD pathogen

- Normal bacterial flora in tonsillar crypts
- Spreads easily between calves
- Proliferates when:
  - Animal is stressed (weaning, trucking, mixing)
  - Viral upper respiratory infection (IBR, PI3, ...)
  - Certain feeds are fed (silage)

The mucociliary clearance mechanism removes particles from lungs

- Moves mucous from respiratory tract to throat
  - swallowed
- Moves at 1.5 cm / min with 1,500 waves / min
- Clears 90% of bacteria in 4 hrs
- Damaged by infectious agents, dust and fumes
  - IBR, PI3 virus (commingled salebarn calves)
  - Ammonia (enclosed dairy calf barns)
  - corral dust, diesel smoke (weaned beef calves)

Normal Cilia (Electron Micrograph)
Ciliary damage slows or stops the clearance mechanism.

IBR “Sewer pipe” Trachea

In BRD normal bacteria proliferate, move to lung, are not cleared, and cause inflammation.

BRD lung damage is due to a vicious cycle of inflammation.

Old whole antigen bacterins make the problem worse by attracting more white cells.

Animal’s natural response causes the lung damage!
What does classic BRD look like in the dead animal?

Necropsies are important for diagnosis

Pneumonia is in the ventral lung due to mucociliary clearance mechanism failure and gravity

Normal: pink-colored area

Abnormal: purple-colored area

In chronic cases, abscesses form that contain pus

Early abscesses

Abnormal edema

What are the best ways to deal with herd infectious disease problems?

Given that most infectious agents remaining as problems (we’ve gotten rid of the easy ones):
- Are ubiquitous (holoendemic)
  - If they haven’t been found on a farm, they likely haven’t been looked for hard enough
- Are opportunists
- Survive well in the environment, often months
- Aren’t reliably curable with drugs
- Establish carrier states in herdmates who then shed it
- Vaccines are not 100% effective (if even available)
- Often co-evolved with their bovine host

What is the best approach and what is needed for that approach?

Vaccination program recommendations are local and herd specific

“Vaccine Program Recommendations” in:
Basic Concepts for Cow-Calf Herd Health Programs
http://people.vetmed.wsu.edu/jmgay/courses/FDUCowCalfHH.htm
TAMU Ranch to Rail: Value Added Calf (TexVAC) Vaccination Management Guidelines
The disease "Iceberg" means most diseased animals are not detectable visually

- Most infections are subclinical
  - Typically > 10:1
- Can’t identify every infected animal easily
- Important because some animals are more susceptible than normal
  - Neonates
  - Animals with other diseases

Goal: Separate the susceptible from the potential subclinical

The economic loss from subclinical disease is usually greater than from clinical disease

469 steers followed from birth to feedlot to slaughter
- 35% (164) treated for BRD
- Pulmonary lesions at slaughter:
  - 78% (128) of treated steers
  - 68% (207) of untreated steers (subclinical!)
- 0.2 lb ADG reduction
- 46 lb slaughter weight reduction

Prevention is key to preventing production loss!

Clinical cases are the “tip of the iceberg” red flags

Consider clinically affected animals Red Flags!
They indicate the presence of a serious herd problem
They are not the full extent of the problem

Goal: Get $R_0$ less than 1 so agent disappears from herd

Reduce infection transmission between infected and susceptible in a herd

- Reproductive Ratio ($R_0$) is the number of secondary infections due to each infection
  - $> 1$: Infection spreads
  - $= 1$: Infection is stable
  - $< 1$: Infection dies out
- Hard to reduce in intensive management
  - agents co-evolved and survived with hosts when they were extensive, free-ranging

Infection transmission occurs in two forms

- Vertical
  - In utero – born infected!
  - During birth
  - Infected colostrum
  - Suckled milk

Transmission has three attack points – escape, environmental survival, and infection

Mammalian Portals of Entry and Exit
- Into susceptible animal
- Out of infected Animal
- Environmental survival phase
Infectious agents get out and in many ways. Mammalian Body from bug’s perspective

Production systems are dynamic relationships between animals, infectious agents, and their environments.

When disease problems occur:
- After asking “What’s wrong?”, ask “How did the system get to this point?”
- Ask “What changed?”
  - A change in one point of the system often leads to unintended consequences elsewhere
  - “A common error is to define the problem not by what’s happening in the system but by the lack of our favorite solution” (D Meadows)


Clinical disease doesn’t occur when resistance is high relative to exposure dose.

A particular infectious dose results in differing severity in a herd.

Goal: Reduce infectious dose, increase host resistance.

Pattern of Host Resistance - Calves.
Most vaccines provide marginal protection but not absolute protection.

Clinical disease outbreaks result from a breakdown that initiates a vicious cycle.

Albert Einstein’s more relevant quotes:

We do this a lot in disease problems like calf scours and bovine respiratory disease.

Focus on the entire husbandry system rather than individual diseases.

Disease severity is determined by many factors.
Horizontal Transmission Chain

Infected Host → Sheds Agent in oral & nasal secretions, urine, feces

Contaminated Environment → Agent survives at Infectious Dose

Susceptible Host → Becomes Infected

Herd "Hardening" is applying strategies that reduce dose and shift the curve

- Take advantage of increasing resistance with age
- Separate groups with high shedding risk from those with high acquiring risk
- Decrease survival opportunities of agents
- Attack all the agent transmission routes

The greatest weakness of most strategies is the failure to address all the transmission routes

Know key characteristics of the prevalent infectious agents

Example - Corona & Rotoviral Diarrhea:
- Virus kills cells of intestinal villi, causing malabsorption diarrhea
- Calf begins shedding $10^{11}$ virus per gram of feces 3 days after infection
- Carrier cows continually shed low numbers of virus
- Virus survives weeks in the environment
- Vaccines available, labeled “aid in preventing”
- Antibiotics are ineffective (virus)

Maximize passive transfer by monitoring it

Passive antibody level vs. scours

Apply the general principles to the entire farm system

The newborn calf is the most susceptible animal on most farms
- Maximize the calf’s natural resistance and acquired immunity
- Delay and minimize the infectious dose the calf is exposed to
  - Because these agents are ubiquitous, calf must eventually acquire the infection and develop an active immunity

This flow will eventually occur if the agent isn’t present now but the risk factors are!
Handle colostrum and liquid calf feed like grade A milk for sale

- Disease-causing bacteria grow just as well in colostrum as in milk
- These bacteria are transferred with the colostrum into the blood stream
- Harvest into sanitized containers and refrigerate or freeze it if not used immediately
- Don’t pool!
  - BLV, Salmonella, and Johnes are transferred by colostrum

Avoid food (or feed) temperature abuse

Minimize time liquid feed is between 140°F and 41°F after cooking (< 6 hrs)
- Thaw in refrigerator
- Rapid heating
- Rapid cooling
  - In freezer or refrigerator
  - In shallow pans
  - Sufficient air space

Low level Salmonella contamination is very common

Cross-Contamination?
- Weather, misters?
- Favorable Environmental Temperature
- Sufficient Time

Infectious Dose!

Good food handling practices apply everywhere

Colostrum refrigerator on large farm

See anything wrong here?
- When was the temperature last checked?
- Appliances are often cast-offs from the house

Colostrum was not cooling quickly, resulting in excessive bacterial counts

Apply sufficient cleaning and sanitizing criteria

General Rules:
1. Look Clean
2. Feel Clean
3. Smell Clean

If it doesn’t, it ain’t
Agents die by exponential decay in the environment

\[ \text{Half Life Curve} \]

\[ \text{Number of Infective Particles} \]

\[ \text{Agent shed into Environment} \]

\[ \text{Time} \]

\[ \text{Time to } \frac{1}{2} \text{ Level} = \text{Half Life} \]

\[ \text{Infected Host Shedding Level} \]

\[ \text{Time reduces exposure dose, reducing exposure consequences} \]

\[ \text{Clinical Disease} \]

\[ \text{Subclinical Infection} \]

\[ \text{Clinical Infection Threshold} \]

\[ \text{Subclinical Infection Threshold} \]

\[ \text{Agent shed into Environment} \]

\[ \text{Time} \]

\[ \text{Number of Infective Particles} \]

\[ \text{Infected Host Shedding Level} \]

\[ \text{Clinical Disease} \]

\[ \text{Subclinical Infection} \]

\[ \text{Clinical Infection Threshold} \]

\[ \text{Subclinical Infection Threshold} \]

Proper sanitation breaks the half-life curve

\[ \text{Half Life Curve} \]

\[ \text{Sanitation Applied} \]

\[ \text{Number of Infective Particles} \]

\[ \text{Agent shed into Environment} \]

\[ \text{Time} \]

Goal: Reduce agent level below infectious dose for typical susceptible animal

Chemical disinfection requires an effective agent at concentration with full contact time

- Use a disinfectant with labeled effectiveness against target agents
  - Many are not effective, such as Pinesol
  - Environmental surfaces – 1-stroke Environ, chlorine dioxide
  - Tissue contact - Nolvasan or tamed iodine
  - General use - Virkon S

- Allow adequate contact time (temperature dependent) at sufficient concentration
  - Organic material (milk, manure, blood) inactivates most disinfectants, especially chlorine-based
  - Chlorine begins evaporating when mixed (detectable odor)

VirkonS is one of the best overall disinfectants

- 1.3 ounces of Virkon S per gallon or water
- One gallon of solution treats 135 square feet
- ~$80 per 10 lbs
- Chlorine dioxide is an emerging disinfectant

For more information, see CFSPH "Disinfection 101" at http://www.cfsph.iastate.edu/BRM/resources/Disinfectants/Disinfection101.pdf
The final step of full drying is critical!

- Some agents are not killed by common disinfectants, only full drying
- Low levels of other agents will likely remain that can begin replicating later
  – Salmonella will grow on a wet board!

A common error is to leave the items in the final tank with the disinfectant, assuming they will be sterile when removed.

Most important is cleaning hands frequently and effectively

To wash hands:
- Wet hands (avoid HOT water – dries skin -> cracking)
- Apply soap
- Rub hands together for at least 15 seconds
- Cover all hand surfaces
- Rinse with water and dry thoroughly
- Use a paper towel to turn off faucet

Why all the fuss about Hand Washing?

* A most common mode of pathogen transmission is via hands! *

- CDC estimates proper hand washing reduces foodborne illness by 50%
- Proper hand washing reduced respiratory illness 45%
- Infections acquired in healthcare

Proper hand washing is the single biggest weapon against transmission of common human infectious diseases

Basic Personal Hygiene for Humans

Although 92% of people say they washed their hands, only 66% of men and 88% of women do. (www.washup.org)

The House Fly *Musca domestica*

Although 92% of people say they washed their hands, only 66% of men and 88% of women do. (www.washup.org)
What do you suppose the calf ingests besides water when drinking?

Flies transmit dangerous disease agents

Don't overlook the cycles of the vermin (flies, rodents, birds!)

Colostrum cooling on the parlor floor

Damp straw bedding is a fantastic fly incubator

Parasitic wasp raisers grow their flies in damp straw!

Most of all, avoid PPM!

Bad Management overwhelms the Best Vaccine every time!

General Livestock Food and Water Safety Rule

If you wouldn't eat off of it or drink out of it, don't expect a cow or calf to either!

DD Hancock