Minerals and Vitamins

• Evolved in nearly aspect of living
• Little biochemical functions occur w/out vitamins and minerals playing some role
• They are the bodies regulators, gate keepers & locksmiths.
• Deficiencies and excesses can both be toxic to the animal

Minerals

• Found naturally on Earth.
• Separate requirements for maintenance, gestation and lactation.
• Separated into two categories:
  - Macro minerals – expressed as %
  - Micro minerals – expressed as ppm
  - Minerals can also be either positively charged (cation) or negatively charged (anion)

Macro Minerals

• Ca - Calcium
• P - Phosphorus
• Mg - Magnesium
• K - Potassium
• Na - Sodium
• Cl - Chloride
• S – Sulfur
  - Cation
  - Anions

Calcium (Ca)

• Most abundant mineral in the body.
• Milk – High in Ca (1Kg 4% BF milk = 1.2grms Ca)
• Bone structure
• Cell integrity – membranes
• Higher Ca levels = lower absorption
• Older cows = lower absorption
• Increase Ca w/ high added fat feeding (+4% fat)
• Coarse limestone- hindgut buffer

Calcium Requirements

• Recommendations:
• Milk Cows: 0.7 – 1.0%
  - Increase with higher milk
  - Feed by-products: may need to add extra Ca
  - Around 2:1 ratio (1.7:1)
• Far-off Dry Cows: 0.6 – 0.7%
• PreFresh: 0.7 – 0.9%
• Realize there exist:
  - Super Low Ca: 0.3%
  - Super High Ca: 1.75%
New meta analysis suggests curvilinear relationship of prepartum dietary Ca concentration and milk fever (Lean et al., 2006).

**Phosphorus (P)**

- Milk
- Bone structure
- Reproduction
- Absorption linked to Ca levels and stimulated by Vit D

- Milk Cows – 0.35 – 0.40
- Dry Cows – 0.32 – 0.35
- PreFresh – 0.35 – 0.38

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**Add more Phos if....**

- High producing Jerseys
- High fat levels in diet (+5%)
- High Ca diets (Alf and Whey)
- Sometimes with pica (eating wood)
- Sometimes helps with Milk Fever (rare)
- Sometimes if all the Phos is coming from questionable by-products (CGF, Dist, Midds)

- Historically; Phos fed closer to 0.50%
**Magnesium (Mg)**
- Milk – 0.035%
- Bone Structure
- Some Buffering (low BF%)
- Cell integrity
- Increase Mg during heat stress and early, lush pastures
- Excess Mg (+0.60%) can cause some diarrhea.
- Mg usage has increased over time:
  - Higher producing cows
  - Source of Mg changed (USA vs China)
  - New source in Australia.

**Magnesium**
- Milk Cows – 0.35 – 0.42%
- Dry Cows – 0.35 – 0.38%
- Prefresh – 0.38 – 0.42%
- Add 10 grams for summer feeding
- Add 10 grams for grass tetney
- May add more if Milk Fever persists
- High S in water + Higher Mg = diarrhea

**Potassium (K)**
- Milk – common mineral (0.15%)
- Cell integrity – membranes and osmotic pressure
- Bone structure – protein matrix
- Buffering capacity
- Third most common mineral in body.
- Forages bring a lot of K to the diet.

**Potassium (K)**
- Milk Cows – 1.0% - 1.5%
  - Higher milk = higher levels
  - Heat stress = higher levels +1.25%
  - Higher DCAD levels with heat stress 25+
- Dry cows - < 1.50%
- PreFresh - < 1.30%
  - DCAD < 15 if good numbers
  - DCAD <10 if guessing
  - DCAD <5 with Milk Fever cases

**Sodium (Na)**
- Cell intergery – acid-base balance, osmotic pressure
- Milk – common mineral in milk
- Excess Na in diet = long urination times (16 + secs)
- Short on Na
  - Short urination times - <8 secs
  - Pica – where urine splashes on wood
  - Licking/drinking urine
- Na vs. Salt requirement
  - Interesting question
  - Keep both in mind

**Na/Salt Requirement**
- Na
  - Milk Cows – 0.20 – 0.25%
  - Dry Cows – 0.10%
  - PreFresh - ???
- Salt
  - Milk Cows – 0.12 lbs - .28 lbs (higher milk)
  - Dry Cow/PreFresh – 0.08 lbs
Salt
- Fresh choice Salt
- Fresh Cows – lots of Na to replace
- Heat Stress – increase demand
- Free Choice Bicarb
- Monitor rumen status
- Heat stress
- Grain slugs – sorting, CS inconsistency (bags/silos)
- Max level in diet at 4%
- Watch Waste TMR’s fed to dry cows
- High Na content – salt and bicarb = milk fevers

Chloride (Cl)
- Cell life – fluid levels
- Electron balance – acid/base balance
- Digestive mineral – bile, pancreatic juice
- High quantity from forages (if tested)
- Most Cl comes from Salt intake
- Milk Cows – 0.22 – 0.30%
- Dry Cows – 0.20
- Prefresh - ???

Sulfur (S)
- Bone structure – protein matrix
- Helps rumen bugs w/ N fixation – NPN
- S source for meth/cystine AA and B Vitamins
- Milk – 0.03%
- Milk Cows – 0.25% - 0.35%
- Add 5 grams if NPN is used (N:S ratio 10:1)
- Watch by-product feeding (distillers)
- Dry Cows – 0.22 – 0.30%
- Prefresh – 0.25 – 0.40%
- MgSul/CaSul common DCAD

DCAD Equation
- (mEqNa + mEqK) - (mEqCl + mEqS)
- Sometimes Ca, Mg and Phos added to equation
- Far-off Dry Cows - < 20
- Close-up Dry Cows < 15 or <10 or <5
- Milk Cows < 20
- Summer/Fresh > 25
- Some research > 35
- JDS Meta Analysis

Feed Math
- If you want 55 grams of S in diet, what % is that?
  - 55 grams/454 grams/lb = .121 lbs of S
  - .121 lbs/50.0 lbs of DMI x 100 = 0.24%
- If you have 1% Ca in diet, how many grams is that?
  - Lbs DMI 50.0 x .01 = 0.5 lbs Ca/hd/day
  - 0.5 lbs x 454 gr/lb = 227 grams/hd/day
Trace Minerals
- Fe - Iron
- Zn - Zinc
- Mn - Manganese
- Cu - Copper
- Co - Cobalt
- I - Iodine
- Se – Selenium
  - Anion, Cation

**Iron**
- Primary function
  - Oxygen transport and energy metabolism
  - Immune function
- Excess iron intake – increase risk oxidative stress and reduce availability of other trace minerals
- Deficiency most likely in ruminants fed milk for extended periods
- Research on modern mature cows very limited
- Do we include iron in our trace mineral premixes?
- Despite iron being one of earth’s most common elements, deficiency in humans is a common problem

**Zinc**
- Component of over 200 enzymes affecting things such as
  - Alcohol detoxification
  - Protein synthesis
  - Vitamin A and E absorption and metabolism
  - Keratin formation
  - Immune function
- Maximum tolerable level, 900 ppm
- Liver better indicator of status than blood
- Stores are slowly mobilized

**Copper**
- Enzyme constituent and activator
  - Iron metabolism
  - Connective tissue formation
  - Immune function
- Toxicity
  - Hemolytic crisis, liver necrosis, hemoglobinuria, death
  - Progression from a healthy cow to a dead cow - days
- Maximum tolerable level, 40 ppm
- Interactions
  - Sulfur, molybdenum, zinc and iron also reduce copper availability
  - Status, liver better indicator than blood

**Manganese**
- Functions
  - Cartilage formation - healthy feet and legs
  - Immune system - SCC
- Reproduction
  - Cholesterol formation, precursor for testosterone, progesterone and estrogen
  - Corpus luteum high in manganese and affected by manganese intake
- Calcium, iron, magnesium, phosphorus, cobalt and potassium reduce manganese availability
- Low bioavailability of manganese in feedstuffs
Chromium
- Trace mineral just approved to be feed to dairy cows
- Makes ruminants more sensitive to Insulin
- Pre-fresh cows & Post Fresh cows are very Insulin resistant and therefore, should respond.
- Feed to Sows to increase litter size.

Cobalt
- Required for fiber digestion and vitamin B12 formation
- Deficiency
  - Reduced appetite, weight loss
  - Poor performance
  - Poor hair coat
  - Anemia
- Maximum tolerable level, 25 ppm
- Liver or serum B12 best indicator of status
- Manganese, zinc and iodine may reduce cobalt availability
- Requirement, 0.11 ppm across all stages of lactation

Iodine
- Primary function
  - Thyroid hormone synthesis; regulates energy metabolism
- Cows most susceptible to deficiency, 30 d prepartum through 120 d postpartum, symptoms include:
  - Abortions, stillbirths, retained placentas, weak and silent heats, reduced fertility
  - Gestation period extended by up to 9 d
- Raw soybeans, rapeseed and feeds high in nitrates increase iodine requirement

Selenium
- Required for formation of seleno proteins such as glutathione peroxidase
- Requirement – 0.3 ppm across all stages of calving interval
- Maximum tolerable level, 5 ppm
- Selenium accumulates in fetus at expense of cow
- Copper, zinc, calcium and sulfur increase dietary selenium requirements
- Status, whole blood selenium (long term status) or serum selenium (short term status)
Chelated Minerals

- A mineral (usually a trace mineral) that is chemically or physically bonded to an organic compound or complex that is more biologically available.
- CPM reports Bioavailable of minerals
- Question; is the extra cost worth it?

Bioavailability

- Zinc Sulfate 20%
- Zinc Oxide 12%
- ZinPro 40 Zn 40%
- 4 Plex Cu 10%
- Cu Sulfate 5%
- Cu Oxide 1%

More Bioavailability

- Mn Sulfate 4%
- Mn Oxide 4%
- 4 Plex Mn 2%
- 4 Plex Co 100%
- Co Carbonate 100%
- Co Sulfate 100%
Feed Additive Use -

<table>
<thead>
<tr>
<th>Additive</th>
<th>% of East Herds</th>
<th>% of All Herds</th>
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</thead>
<tbody>
<tr>
<td>Na bicarb</td>
<td>79.6</td>
<td>78.8</td>
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<tr>
<td>Yeast</td>
<td>55.1</td>
<td>58.3</td>
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<tr>
<td>Megalac</td>
<td>53.1</td>
<td>46.2</td>
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<tr>
<td>Zinc meth.</td>
<td>30.6</td>
<td>42.4</td>
</tr>
<tr>
<td>Niacin</td>
<td>32.6</td>
<td>42.4</td>
</tr>
<tr>
<td>Anionic salts</td>
<td>32.6</td>
<td>33.3</td>
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</tbody>
</table>

The Vitamins
- Categorized as either Fat Soluble or Water Soluble
- Fat Soluble – Vit A, D, E & K
- Water Soluble – Vit C and the B Vitamins
- Only Vitamin A and E have “established” requirements in dairy cattle.
- Currently 13 known Vitamins

Vitamins
- Fat Soluble
- Vit A – Cell integrity
- Vit D – Bone structure
- Vit E – Immune function
- Vit K – made by rumen bugs

Vitamin A
- Reproduction
- Immune Functions
- Digestion
- Vision
- Milk Cows – 125 – 200 k IUs/hd/day
- Dry Cows – 150 k IUs
- PreFresh – 150 k IUs
- Little positive research on added beta-carotene
- Beta is converted into Vit A very easy

Vitamin D
- The sunshine vitamin
- Bone structure
- Gene Regulation
- Ca/P/Mg absorption
- Milk Cows – 25 – 50 k IUs/hd/day
- Dry Cows – 35 – 40 k IUs
- PreFresh 35 – 40 k IUs
- May look to bump w/ milk fevers – maybe?
- Maybe a little higher for Jerseys.

Vitamin E
- Immune functions, Immune functions
- Antioxidant
- Synergistic affect w/ Se levels
- Milk Cows – 100 IUs/10 lbs of milk
  - Plus add another 100 if SCC is 250+
  - Good research out there on 3,000 IUs (cost $$$$)
- Dry Cows – 1,000 – 1,250 IUs/hd/day
- PreFresh – 1,250 – 1,500 IUs
**Vitamin K**

- **Blood Clotting**
- **Rumen produces in large quantities**
- **No need to supplement**
  - Unless moldy sweet clover hay
  - Produces Dicoumarol (blood thinner)
  - Main ingredient in DeCon mouse bait
  - Will cause bleeding (nose)
- **Supplement 125 IUs/hd/day**

**Water Soluble Vitamins**

- **Thought no need to supplement**
- **Rumen bugs produce large quantities**
- **Some current re-thinking that theory**
  - Higher production
  - Higher passage rates
- **Research mostly done in 1943-1945**
  - Different cows today?

**Current B Vitamins**

- **Biotin**
  - **Hoof health, nutrient metabolism**
  - 20 mg/hd/day
  - About 2 lbs of milk on high producing cows
- **Choline**
  - **Fat transport and metabolism**
  - **Used for Ketosis prevention – Reashure 2 oz/hd/day**
  - **Decreases 50% of time, 75% in fat cows, 2 lbs milk in 60 days.**
- **Niacin**
  - **Energy Metabolism**
  - 6 – 12 grms/hd/day – 1/3 lower ketosis, 1/3 milk protein up

**The Other B Vitamins**

- **Folic Acid – Amino acid metabolism**
- **Panthethenic Acid – CHO and Fat metabolism**
- **Riboflavin – energy metabolism**
- **Thiamin – CHO and Protein metabolism, appetite**
- **B12 – Amino acid metabolism, rumen function w/ Co**
- **Vitamin C – Antioxidant and AA metabolism**
- **Some positive research studies out there but $$$$**

**Monitoring Min/Vit Levels**

- **How do you know you are in the ballpark?**
  - Production levels
  - Reproductive status
  - SCC
  - Health issues – MFs, RPs,
  - **Blood Test**
    - Done on health cows
    - Several cows
    - **Cost $10 - $20/cow**
<table>
<thead>
<tr>
<th>Mineral</th>
<th>Range</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td></td>
<td>130-150 mg</td>
</tr>
<tr>
<td>Potassium</td>
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<tr>
<td>Calcium</td>
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<td>800-1200 mg</td>
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<tr>
<td>Magnesium</td>
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<td>200-400 mg</td>
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<tr>
<td>Iron</td>
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<td>15-20 mg</td>
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<td>Copper</td>
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<tr>
<td>Zinc</td>
<td></td>
<td>8-12 mg</td>
</tr>
<tr>
<td>Iodine</td>
<td></td>
<td>0.15-0.29 mg</td>
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<tr>
<td>Fluoride</td>
<td></td>
<td>0.5-4.5 mg</td>
</tr>
<tr>
<td>Selenium</td>
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<td>0.15-0.4 mg</td>
</tr>
</tbody>
</table>

Note: Amount values are generally based on the Recommended Dietary Allowance (RDA).