# Vitamin and Mineral Nutrition for the Cow Herd

Blake K. Wilson
Department of Animal and Food Sciences,
Oklahoma State University

## Vitamin and Mineral Nutrition Fundamentals

- Balance nutrient supply and nutrient requirements
  - Overfeeding any nutrient is unnecessary and expensive
  - Ignoring substantial deficiencies can be devastating
- Optimize…
  - Cost, performance, health, convenience, and ancillary benefits

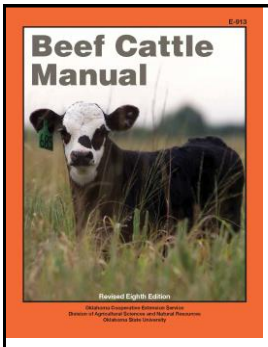
## Resources

Animal Requirements
- Beef Cattle Manual
- Beefextension.com: Bulletin E-974
- Computer software: OSU Cowculator and OSU Ration Calculator

Forage and Feed Nutritive Value

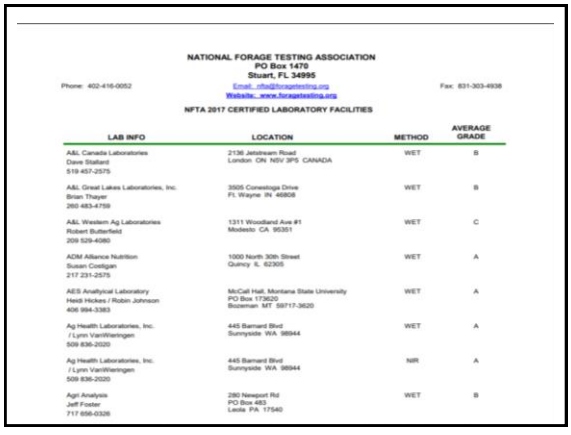
Book values
- Beef Cattle Manual: Chapter 17
- Extension bulletins and other publications: ANSI-3018
- National Academies of Sciences: Nutrient Requirements of Beef Cattle

Forage Testing
- National Forage Testing Association (foragetesting.org) lists certified commercial laboratories
- Test for moisture, protein, digestibility (TDN) and possibly minerals
- Consistency and continuity over time is key




- Available at beefextension.com
- $50 + shipping
- Nutrition, health, reproduction, genetics

  10 chapters related to forage, nutrient requirements, nutritive value of feeds, supplementation, etc.
- Marketing and risk management
- Natural resources
- Beef Quality Assurance
- Biosecurity

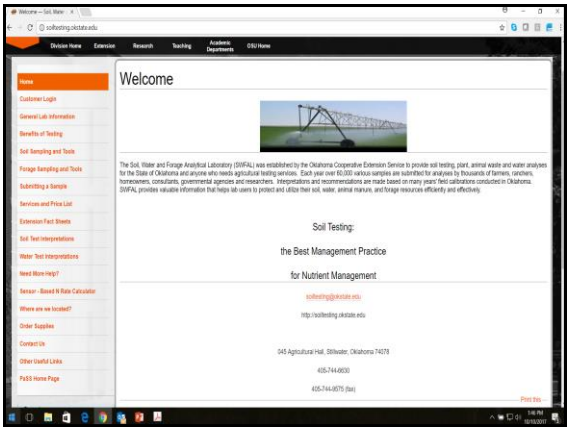


NATIONAL FORAGE TESTING ASSOCIATION
PO Box 1470
Stuart, FL 34995

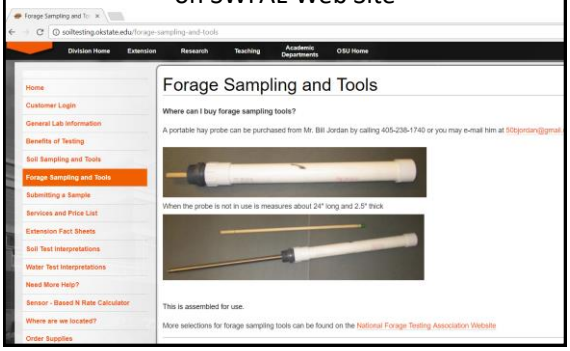
Phone: 402-416-0052 Email: nfta@foragetesting.org Website: www.foragetesting.org Fax: 831-303-4938

NFTA 2017 CERTIFIED LABORATORY FACILITIES

| LAB INFO | LOCATION | METHOD | AVERAGE GRADE |
|---|---|---|---|
| A&L Canada Laboratories<br>Dave Stallard<br>519 457-2575 | 2136 Jetstream Road<br>London ON N5V 3P5 CANADA | WET | B |
| A&L Great Lakes Laboratories, Inc.<br>Brian Thayer<br>260 483-4759 | 3505 Conestoga Drive<br>Ft. Wayne IN 46808 | WET | B |
| A&L Western Ag Laboratories<br>Robert Butterfield<br>209 529-4080 | 1311 Woodland Ave #1<br>Modesto CA 95351 | WET | C |
| ADM Alliance Nutrition<br>Susan Costigan<br>217 231-2575 | 1000 North 30th Street<br>Quincy IL 62305 | WET | A |
| AES Analytical Laboratory<br>Heidi Hickes / Robin Johnson<br>406 994-3383 | McCall Hall, Montana State University<br>PO Box 173620<br>Bozeman MT 59717-3620 | WET | A |
| Ag Health Laboratories, Inc.<br>/ Lynn VanWieringen<br>509 836-2020 | 445 Barnard Blvd<br>Sunnyside WA 98944 | WET | A |
| Ag Health Laboratories, Inc.<br>/ Lynn VanWieringen<br>509 836-2020 | 445 Barnard Blvd<br>Sunnyside WA 98944 | NIR | A |
| Agri Analysis<br>Jeff Foster<br>717 656-0326 | 280 Newport Rd<br>PO Box 483<br>Leola PA 17540 | WET | B |

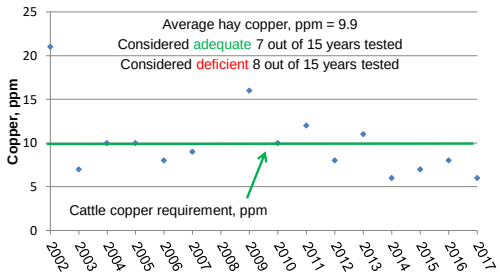


## Sampling Guidance Provided on SWFAL Web Site




## Be consistent and keep a record: Value of consistent, quality data grows over time!

## OSU North Range Bermudagrass Hay Meadow Copper Concentration by Year




What if you only tested in 2009?

## About What Will it Cost?

## Feed & Grain Sample Analyses

**Feed & Grain Sample Analyses**

| Analysis | | Price |
|---|---|---|
| **TN or C or Both** | Total Nitrogen and Carbon (Dry Combustion - LECO) | $8.00 |
| **Minerals** | Ca, P, Mg, K, S, Cu, Fe, Zn, Mn and Moisture | $15.00 |

## 2016 Beef NASEM Macro Minerals[1]

- Calcium
- Chlorine
- Magnesium
- Phosphorus
- Potassium
- Sodium
- Sulfur

**Macro mineral requirements and maximum tolerable concentrations of trace minerals for cattle (%)[1]**

| Mineral | Growing and finishing | Gestating cows | Lactating cows | Max tolerable concentration |
|---|---|---|---|---|
| Ca | 0.19-0.71 | 0.13-0.70 | 0.13-0.70 | |
| Cl | ------ | ------ | ------ | ------ |
| Mg | 0.10 | 0.12 | 0.20 | 0.40 |
| P | 0.12-0.34 | 0.10-0.21 | 0.10-0.21 | |
| K | 0.60 | 0.60 | 0.70 | 2.00 |
| Na | 0.06-0.08 | 0.06-0.08 | 0.10 | ------ |
| S | 0.15 | 0.15 | 0.15 | 0.30-0.50 |

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.

## 2016 Beef NASEM Micro/Trace Minerals[1]

- Chromium
- Cobalt
- Copper
- Iodine
- Iron
- Manganese
- Molybdenum
- Nickel
- Selenium
- Zinc

**Trace mineral requirements and maximum tolerable concentrations of trace minerals for cattle (mg/kg)[1]**

| Mineral | Growing and finishing | Gestating cows | Lactating cows | Max tolerable concentration |
|---|---|---|---|---|
| Cr | ------ | ------ | ------ | 1000 |
| Co | 0.15 | 0.15 | 0.15 | 25.0 |
| Cu | 10.0 | 10.0 | 10.0 | 40.0 |
| I | 0.50 | 0.50 | 0.50 | 50.0 |
| Fe | 50.0 | 50.0 | 50.0 | 500 |
| Mn | 20.0 | 40.0 | 40.0 | 1000 |
| Mo | ------ | ------ | ------ | 5.00 |
| Ni | ------ | ------ | ------ | 50.0 |
| Se | 0.10 | 0.10 | 0.10 | 5.00 |
| Zn | 30.0 | 30.0 | 30.0 | 500 |

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.

## 2016 Beef NASEM Vitamins[1]

- Vitamin A
- Vitamin D
- Vitamin E

**Vitamin requirements and maximum tolerable concentrations of vitamins for cattle (IU/kg)[1]**

| Vitamin | Growing and finishing | Gestating cows | Lactating cows | Max tolerable concentration |
|---|---|---|---|---|
| A | 2200 | 2800 | 3900 | ------ |
| D | 275 | 275 | 275 | ------ |
| E* | 35 | 35 | 35 | ------ |

*400-500 IU/hd/d for newly received/stressed calves

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.

## Cattle Requirements and Recommendations of Feedlot Consulting Nutritionists Survey

**Macro mineral requirements and recommendations of consulting nutritionists**

| Mineral | NASEM requirement[1] | Tolerable concentration[1] | Average[2] | Maximum[2] | Minimum[2] |
|---|---|---|---|---|---|
| Ca (%) | 0.19-0.71 | | 0.73 | 5.0 | 0 |
| P (%) | 0.12-0.34 | | 0.30 | 60.0 | 10.0 |
| Mg (%) | 0.10 | .40 | 0.20 | 40 | 0 |
| K (%) | 0.60 | 2.0 | 0.68 | 100 | 0 |
| Salt (%) | 0.06-0.08 | | 0.30 | 140 | 20.0 |

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.
[2]Nutritional recommendations of feedlot consulting nutritionists: The 2015 New Mexico State and Texas Tech University survey. J. Anim. Sci. 94:2648-2663.

## Cattle Requirements and Recommendations of Feedlot Consulting Nutritionists Survey

**Trace mineral requirements and recommendations of consulting nutritionists**

| Mineral | NASEM requirement[1] | Tolerable concentration[1] | Average[2] | Maximum[2] | Minimum[2] |
|---|---|---|---|---|---|
| Co (mg/kg) | 0.15 | 25.0 | 0.82 | 5.0 | 0 |
| Cu (mg/kg) | 10.0 | 40 | 17.0 | 60.0 | 10.0 |
| I (mg/kg) | 0.50 | 50.0 | 0.73 | 2.5 | 0 |
| Fe (mg/kg) | 50.0 | 500 | 13.8 | 100 | 0 |
| Mn (mg/kg) | 40.0 | 1000 | 47.9 | 140 | 20.0 |
| Se (mg/kg) | 0.10 | 5.00 | 0.24 | 0.50 | 0.13 |
| Zn (mg/kg) | 30.0 | 500 | 87.3 | 175 | 34.0 |

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.
[2]Nutritional recommendations of feedlot consulting nutritionists: The 2015 New Mexico State and Texas Tech University survey. J. Anim. Sci. 94:2648-2663.

## Cattle Requirements and Recommendations of Feedlot Consulting Nutritionists Survey

**Vitamin requirements and recommendations of consulting nutritionists**

| Vitamin | NASEM requirement[1] | Tolerable concentration[1] | Average[2] | Maximum[2] | Minimum[2] |
|---|---|---|---|---|---|
| A (IU/kg) | 2200 | | 4715 | 25000 | 2000 |
| D (IU/kg) | 275 | | 142 | 100 | 0 |
| E (IU/kg) | 35 | | 25.1 | 40 | 0 |

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.
[2]Nutritional recommendations of feedlot consulting nutritionists: The 2015 New Mexico State and Texas Tech University survey. J. Anim. Sci. 94:2648-2663.

## Vitamin and Mineral Concerns for the Beef Cow Herd

- Probably deficient in
  - Phosphorus
  - Sodium
  - Copper
  - Zinc
  - Vitamin A
  - Selenium
- Possibly deficient in
  - Magnesium
  - Potassium
  - Cobalt
  - Iodine
  - Sulfur


[1]Lalman, D. and C. McMurphy. 2005. Vitamin and mineral nutrition of grazing cattle. E-861. Department of Animal Science, Oklahoma State University.

## Trace Mineral Requirements of Lactating Cows and Average Forage Composition

**Trace mineral requirements and average forage trace mineral concentrations**

| Item | NASEM requirement[1] | Tolerable concentration[1] | Native range | Bermuda | Fescue |
|---|---|---|---|---|---|
| Cobalt (mg/kg)[1] | 0.15 | 25.0 | 0.24 | **0.12** | **0.14** |
| Copper (mg/kg)[2] | 10.0 | 40 | **5.70** | **6.30** | **5.00** |
| Iodine (mg/kg)[3] | 0.50 | 50.0 | **0.20-0.30[4]** | **0.20-0.30[4]** | **0.20-0.30[4]** |
| Iron (mg/kg)[2] | 50.0 | 500 | **190** | **114** | **110** |
| Manganese (mg/kg)[2] | 40.0 | 1000 | **51.6** | **83.9** | **122** |
| Selenium (mg/kg)[2] | 0.10 | 5.00 | 0.21 | 0.15 | **0.09** |
| Zinc (mg/kg)[2] | 30.0 | 500 | **22.5** | **22.4** | **17.8** |

[1]NASEM. 2016. Nutrient requirements of beef cattle. 8th rev. ed. Natl. Acad. Press, Washington, DC.
[2]Lalman, D. and C. McMurphy. 2005. Vitamin and mineral nutrition of grazing cattle. E-861. Department of Animal Science, Oklahoma State University.
[3]Peers, D., K. Phillips., and H. Fuller. 2011. Trace element supplementation of beef cattle and sheep. EBLEX division, Agriculture and Horticulture Development Board, Kenilworth, Warwickshire.
[4]Typical range for pasture grasses (Can range from 0.10 to 0.50).

## Forage Analysis from Cow/Calf Herds in 18 states[1]

| Trace mineral analysis of native grass (n = 30) | | | | | | |
|---|---|---|---|---|---|---|
| | Cu | Mn | Zn | Co | Se | Cu:Mo |
| Mean conc. (mg/kg) | 6.4 | 104 | 18.3 | 0.31 | 0.25 | 6.9:1 |
| Adequate (%) | 33.3 | **80.0** | 0.00 | 23.3 | 18.5 | **53.3** |
| Marginal (%) | **50.0** | 3.3 | 36.7 | 23.3 | 14.8 | ---- |
| Deficient (%) | 16.7 | 16.7 | **63.3** | **53.3** | **48.2** | 46.7 |
| High (%) | ---- | ---- | ---- | ---- | 16.5 | ---- |

[1]Corah, L. R., and D. Dargatz. 1996. Forage analyses from cow/calf herds in 18 states. USDA Animal and Plant Health Inspection Service (APHIS).

## Forage Analysis from Cow/Calf Herds in 18 states[1]

| Trace mineral analysis of Bermuda (n = 36) | | | | | | |
|---|---|---|---|---|---|---|
| | Cu | Mn | Zn | Co | Se | Cu:Mo |
| Mean conc. (mg/kg) | 8.50 | 125 | 22.4 | 0.22 | 0.20 | 14.7:1 |
| Adequate (%) | **55.6** | **91.7** | 2.8 | **44.4** | 9.1 | **80.6** |
| Marginal (%) | 38.9 | 2.8 | **47.2** | 13.9 | 18.2 | ---- |
| Deficient (%) | 5.6 | 5.6 | **50.0** | **41.7** | **63.6** | 19.4 |
| High (%) | ---- | ---- | ---- | ---- | 9.1 | ---- |

[1]Corah, L. R., and D. Dargatz. 1996. Forage analyses from cow/calf herds in 18 states. USDA Animal and Plant Health Inspection Service (APHIS).

## Forage Analysis from Cow/Calf Herds in 18 states[1]

| Trace mineral analysis of fescue (n = 26) | | | | | | |
|---|---|---|---|---|---|---|
| | Cu | Mn | Zn | Co | Se | Cu:Mo |
| Mean conc. (mg/kg) | 6.2 | 122 | 17.8 | 0.22 | 0.06 | 11.9:1 |
| Adequate (%) | 34.6 | **100** | 0.00 | **46.2** | 0.00 | **84.6** |
| Marginal (%) | **50.0** | 0.00 | 19.2 | 7.7 | 4.4 | ---- |
| Deficient (%) | 15.4 | 0.00 | **80.8** | **46.2** | **95.6** | 15.4 |
| High (%) | ---- | ---- | ---- | ---- | ---- | ---- |

[1]Corah, L. R., and D. Dargatz. 1996. Forage analyses from cow/calf herds in 18 states. USDA Animal and Plant Health Inspection Service (APHIS).

## Macro Mineral Concerns

- Deficient
  - Phosphorus
  - Salt (NaCl)
- Marginal or potentially deficient (or it just should be in there)
  - Calcium
  - Magnesium
  - Potassium
- Likely not deficient
  - Sulfur

## Trace Mineral Concerns

- Deficient
  - Copper
  - Zinc
  - Selenium
- Marginal or potentially deficient
  - Cobalt
  - Iodine
- Should not be deficient
  - Iron
  - Manganese

## Vitamin Concerns

- Deficient
  - Vitamin A
- Probably ok, but doesn't hurt
  - Vitamin D
  - Vitamin E

## Phosphorus

- Functions
  - Building and maintaining bones and teeth
  - Metabolizing fat, carbohydrates, and protein
  - Producing milk
  - Increasing feed/forage intake
  - Rumen environment
- Deficiency symptoms
  - Decreased forage intake
  - Poor growth
  - Reduced fertility
  - Decreased milk production
  - "Peg leg"
  - Weak/brittle bones and bone deformities in severe cases

## Salt (NaCl)

- Functions
  - Reproduction
  - Nerve and muscle functions
  - Blood flow
  - pH regulation within the body
  - Water retention, osmotic balance, cell homeostatis
  - Maintenance of normal appetite and body weight
  - Encouragement of water consumption
- Deficiency symptoms
  - Craving salt/consumption of dirt, manure, and urine
  - Weight loss
  - Decreased milk production
  - Reduced appetite
  - Reduced water intake

## Cobalt

- Functions
  - Building block for vitamin $B_{12}$
  - Coenzyme for propionate metabolism
  - Role in TCA cycle
- Deficiency symptoms
  - Reduced appetite
  - Reduced growth
  - Pale skin and mucus membranes
  - Reduced disease resistance
  - Reduced abilities of neutrophils

## Cobalt

- Functions
  - Building block for vitamin $B_{12}$
  - Coenzyme for propionate metabolism
  - Role in TCA cycle
- Deficiency symptoms
  - Reduced appetite
  - Reduced growth
  - Pale skin and mucus membranes
  - Reduced disease resistance
  - Reduced abilities of neutrophils

## Copper

- Functions
  - Cofactor in enzyme systems
  - Hemoglobin formation and iron absorption
  - Bone and connective tissue metabolism
  - Immune function
  - Reproduction
- Deficiency symptoms
  - Anemia
  - Reduced growth
  - Depigmentation of hair and rough hair coat
  - Abomasal ulcers
  - Reduced immune function
  - Increased bacterial infections
  - Decreased calving rate and early calf deaths

## Iodine

- Functions
  - Lactation
  - Energy metabolism
  - Muscle function
  - Immune function
  - Blood and lymph circulation
  - Seasonality of reproduction
- Deficiency symptoms
  - Goiter
  - Reduced bone growth
  - Reduced milk production
  - Weak or stillborn calves
  - Blind calves
  - Decreased fertility/increased reproductive issues

## Selenium

- Functions
  - Catabolism of peroxides
    - Antioxidant role with vitamin E
  - Cell membrane integrity
  - Muscle health
- Deficiency symptoms
  - White muscle disease
    - Degeneration and necrosis of muscle
  - Reduced growth
  - Increased calf mortality
  - Reduced immune function
  - Reproduction and fertility issues

## Zinc

- Functions
  - Component and activator of metabolic enzymes
    - Protein, carbohydrate, and nucleic acid metabolism
  - Component of carbonic anhydrase
  - Bone and skin development
  - Immune function
- Deficiency symptoms
  - Listlessness
  - Reduced feed intake and growth
  - Swollen and cracked hooves
  - Skin lesions
  - Reduced wound healing
  - Reproduction and fertility issues

## Vitamin A

- Functions
  - Maintenance of vision
  - Maintenance of epithelial tissue and mucous membranes
  - Bone development
  - immune function
- Deficiency symptoms
  - Reduced feed intake and growth
  - Rough hair coat
  - Night blindness
  - Edema, diarrhea, seizures
  - Increased susceptibility to infection
  - Low conception rates, abortions, stillbirths
  - Weak calves

## Conclusions

- Forage based beef production programs are often deficient in
  - P, salt (NaCl)
  - Co, Cu, Se, I, and Zn
  - Vitamin A
- These vitamins and minerals are essential
  - Production
  - Growth and performance
  - Health and immune function
- When cattle are deficient
  - Supplementation must occur
  - Levels exceeding requirements (initially)

## If you know you have a deficiency...

- Necessary for trace mineral supplementation!
- Level?
  - Forage sample
  - Serum sample
  - Liver sample
  - Assume cattle in a drought/on poor quality forage are deficient
- Options
  - Injectable vitamins and minerals
    - Injectable A, D, E, K, Multimin® 90, etc.
  - Trace mineral bolus
    - Respond ® Cattle Bolus
  - Formulate supplement to contain 2X or 3X requirements
    - Supplement cost $300-$350 (25% increase for added trace minerals)
    - Additional supplement cost $0.04/hd/d

## Recommendations

- Feed a good mineral product
- If you can't find what you want, have one made
- Make only what you will feed up in a month or two

## General thoughts...

- There are several good products out there
  - But you need to read the tags carefully
- Just because the mineral is in there
  - Does not mean there is enough in there to do you any good
  - Source matters too (see below)
- If you can't find you want or need
  - Make your own
- Even though cows should get enough Ca from the forage
  - You still want more Ca in your mineral than P
  - Maintain a proper Ca:P ratio overall
  - Generally a Ca:P of 1.25-1.5:1 or greater (some exceptions)

## General thoughts...

- In times of lush pastures (spring green up, etc.)
  - You may want higher levels of Mg (14% or greater) in your mineral
  - Grass tetany and high Mg supplementation are usually short term
- Salt should be included in your mineral
  - A minimum of about 15%
  - Meet the requirements of Na and Cl
  - Also to control consumption
  - Adjust salt to decrease consumption (if needed)

## General thoughts...

- The bioavailability of important micro or trace minerals (especially Cu, Zn, etc.) should be considered in addition to just the inclusion rate
  - Consider hydroxy/organic sources of trace minerals if you are concerned about a trace mineral deficiency
  - Organic ≥ Hydroxy > Sulfates > Oxides
- Be aware of and pay attention to feed additives
  - VFD, products, label instructions, feeding rates, etc.
  - Especially if formulating your own mineral

## General thoughts...

- If cows are under consuming mineral
  - Move the mineral feeder to a higher traffic area
    - Near water source, natural crossing, etc.
  - Consider mixing the mineral with something palatable
    - Cottonseed meal, dry molasses, distillers grains
- If cows are over consuming mineral
  - Mix added salt with the mineral to limit intake to desired level

## General thoughts...

- Mineral feeders
  - Wood, plastic, or rubber (never metal)
  - Covered (no open tubs)
    - Yes weather/rain resistant mineral helps
    - But it is not weather/rain proof
  - Make sure you have enough feeders for your cows
  - Make sure there is always mineral in those feeders