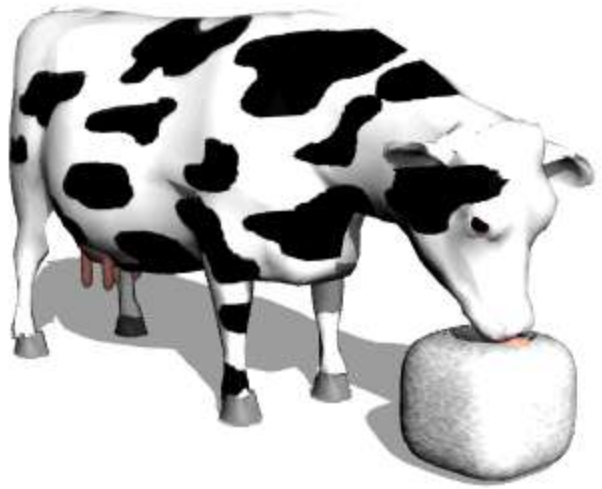
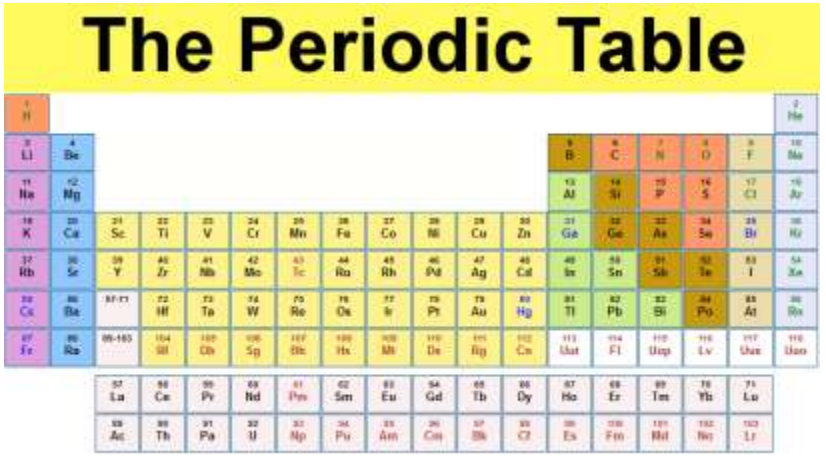
Update on Mineral Nutrition of Dairy Cows





THE OHIO STATE UNIVERSITY
COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Bill Weiss
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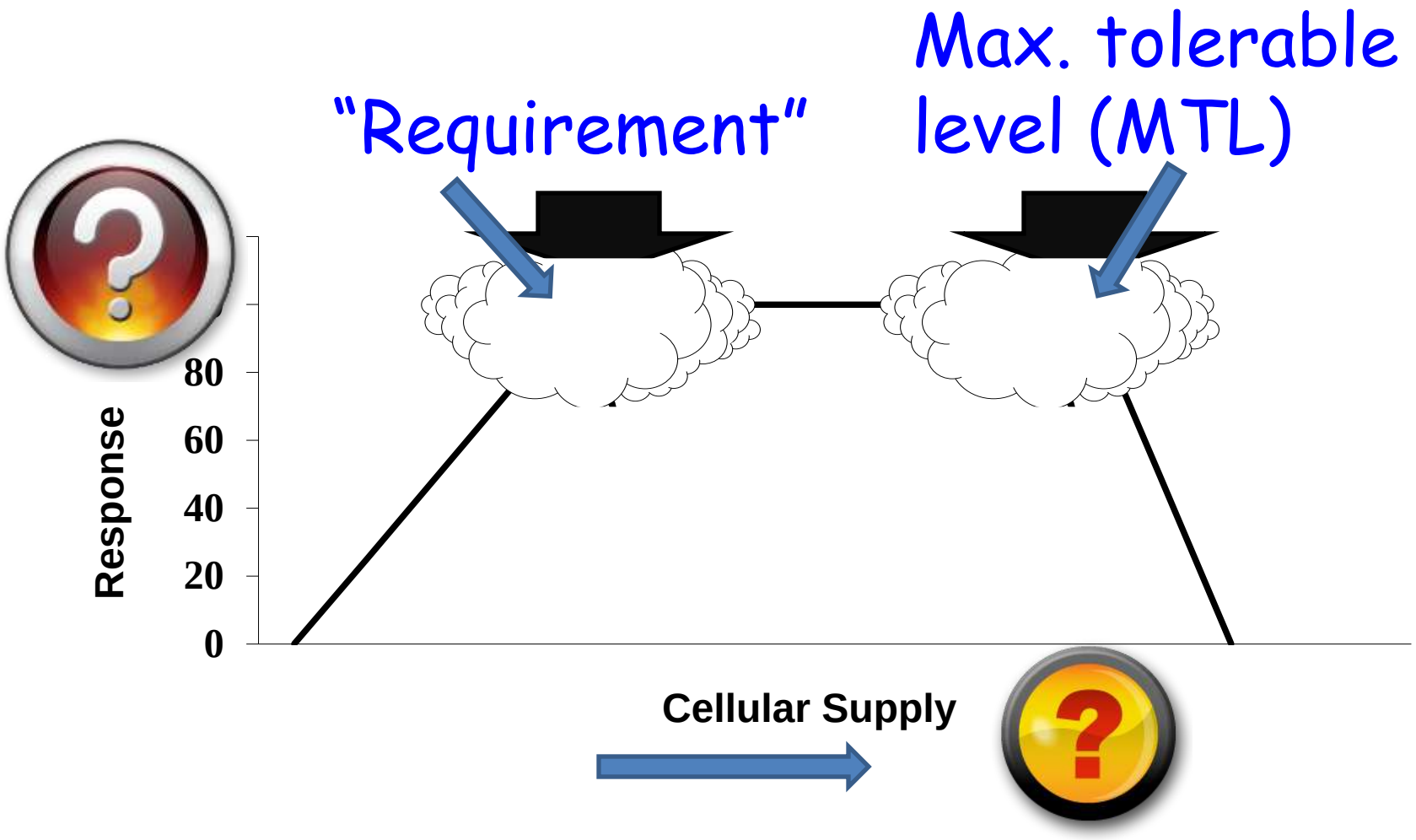
Establishing Mineral "Requirements"



NRC 2001 Factorial Approach

Inputs		Requirements
BW (DMI)	→	**Maintenance**
Days pregnant	→	Gestation
Age	→	Growth
Milk yield	→	Lactation

Effic. = 100%

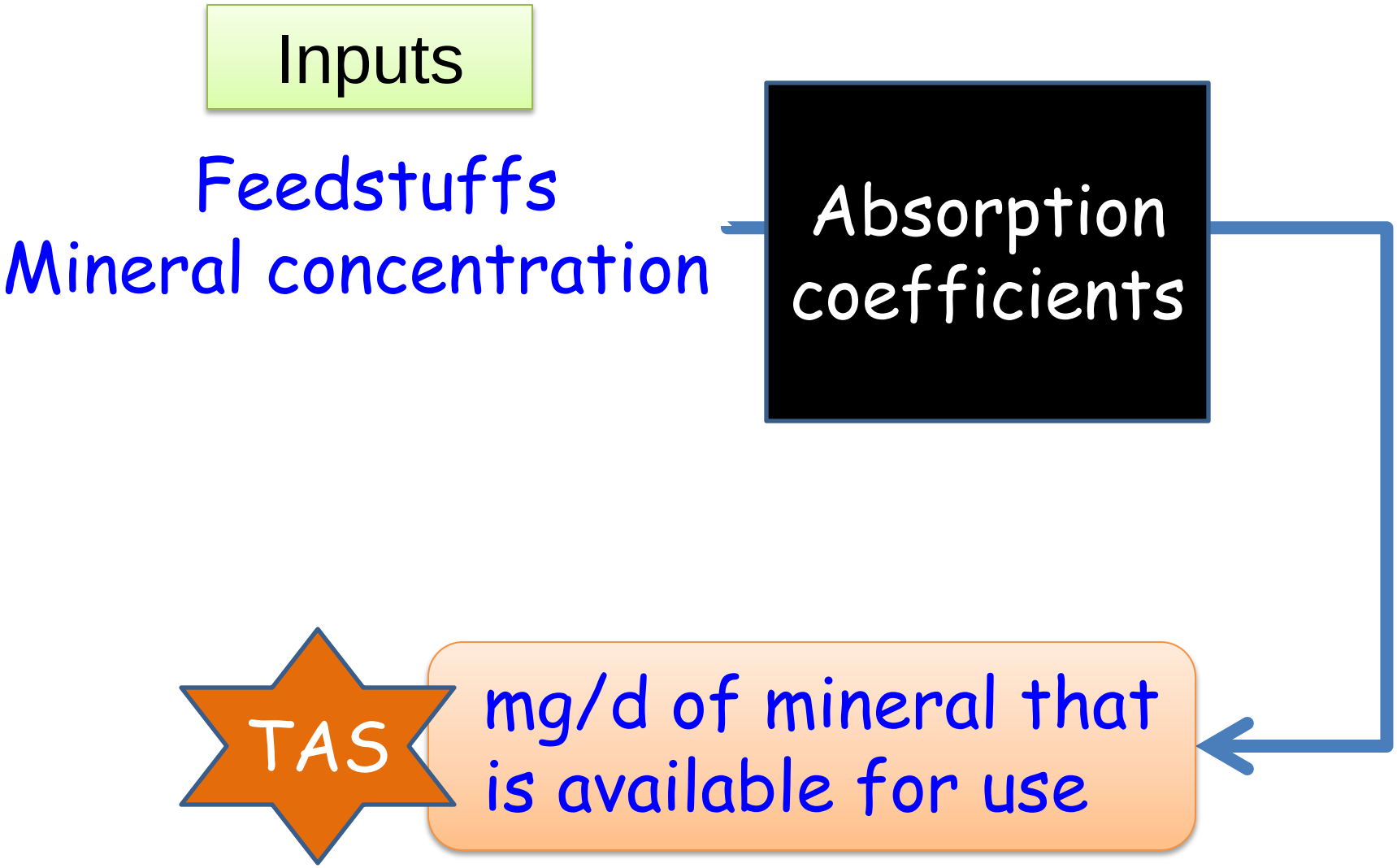
mg/d of absorbed mineral excreted, accreted in fetus, secreted in milk, and retained in new tissue

A lot of uncertainty with respect to requirements

1. 'Maintenance' vs. health ?
2. Milk secretion vs. milk synthesis ?
3. Getting pregnant vs. being pregnant ?

Uncertainty increases risk
Formulation must consider risk

NRC 2001 Factorial Approach

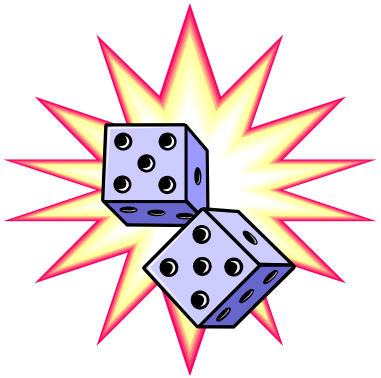


The AC is a weak link in formulating for available TM

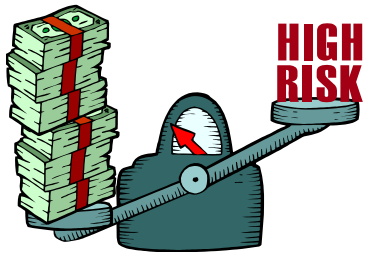
1. Very difficult to measure
2. Diet and source dependent
   - e.g., high S diet and Cu
   - e.g., organic vs inorganic
3. Animal status dependent

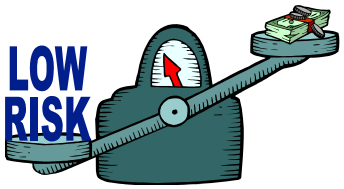
Uncertainty increases risk
Formulation must consider risk

For Minerals (and vitamins) substantial uncertainty exists



- *requirements*
- *absorption*





You must evaluate: risk/reward

If you are wrong does it cost more to over or underfeed???

Trace Minerals Recommendations

Think mg/day, not ppm

at 20 ppm

	30 kg milk	42 kg milk
Cu intake	490 mg	560 mg (+70)
Milk reqt	102 mg	129 mg (+27)

Concentrations of some TM should decrease as production increases;
but concentrations may be higher for dry cows

Trace Minerals Recommendations

Think mg/day, not ppm

	Dry cow	36 kg milk
Cu reqt*	175 mg	250 mg
Diet conc	14 ppm	10 ppm

:Concentrations may be higher for dry cows

* Assumed AC = 0.04

Trace Minerals Recommendations

Basal feeds provide TM

Problems with the data

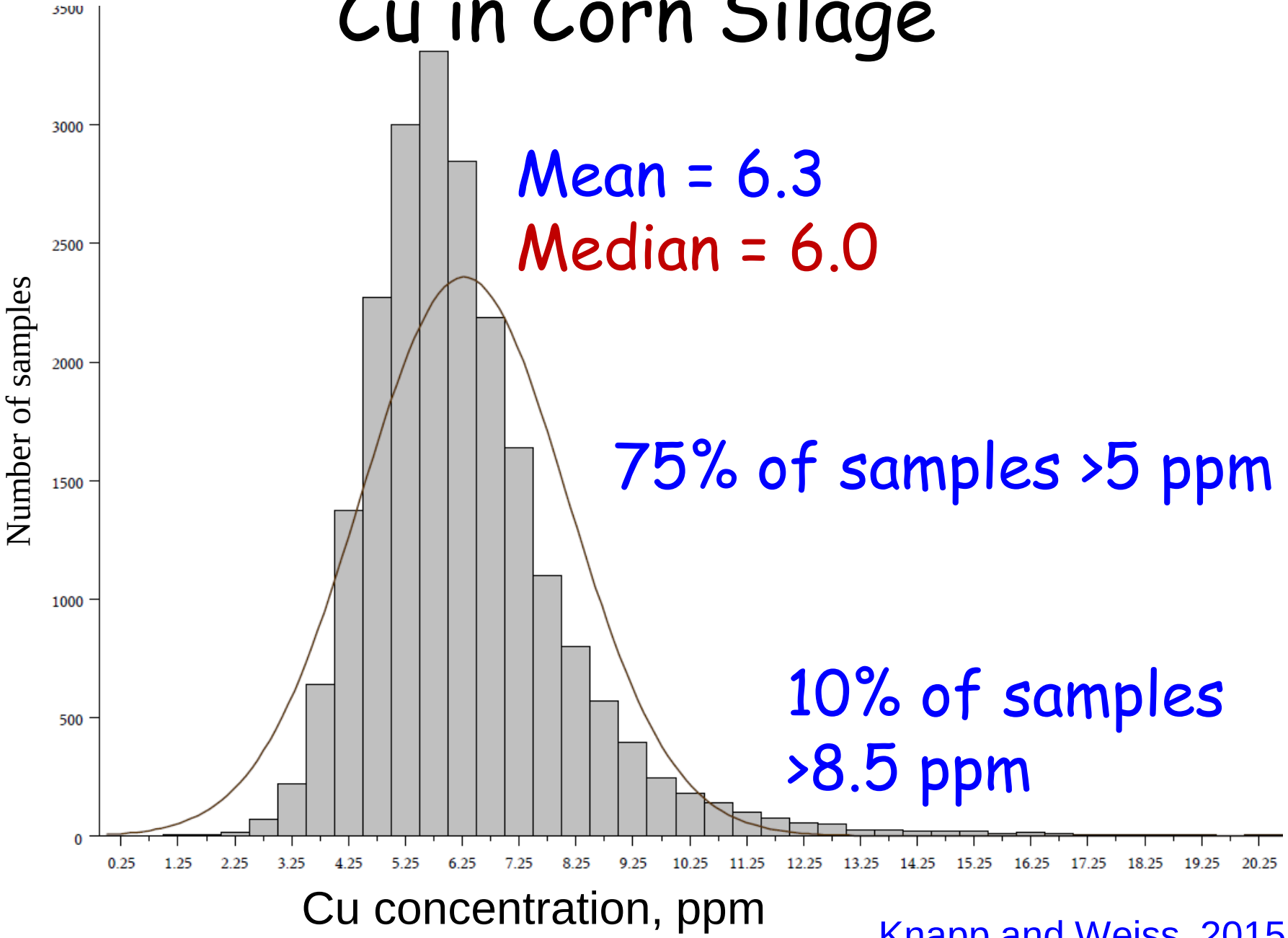
- Variable
- High sampling error
- Non-normal distribution

Get enough samples

Use median

Problems do not justify ignoring basal supply

Cu in Corn Silage



Mean = 6.3

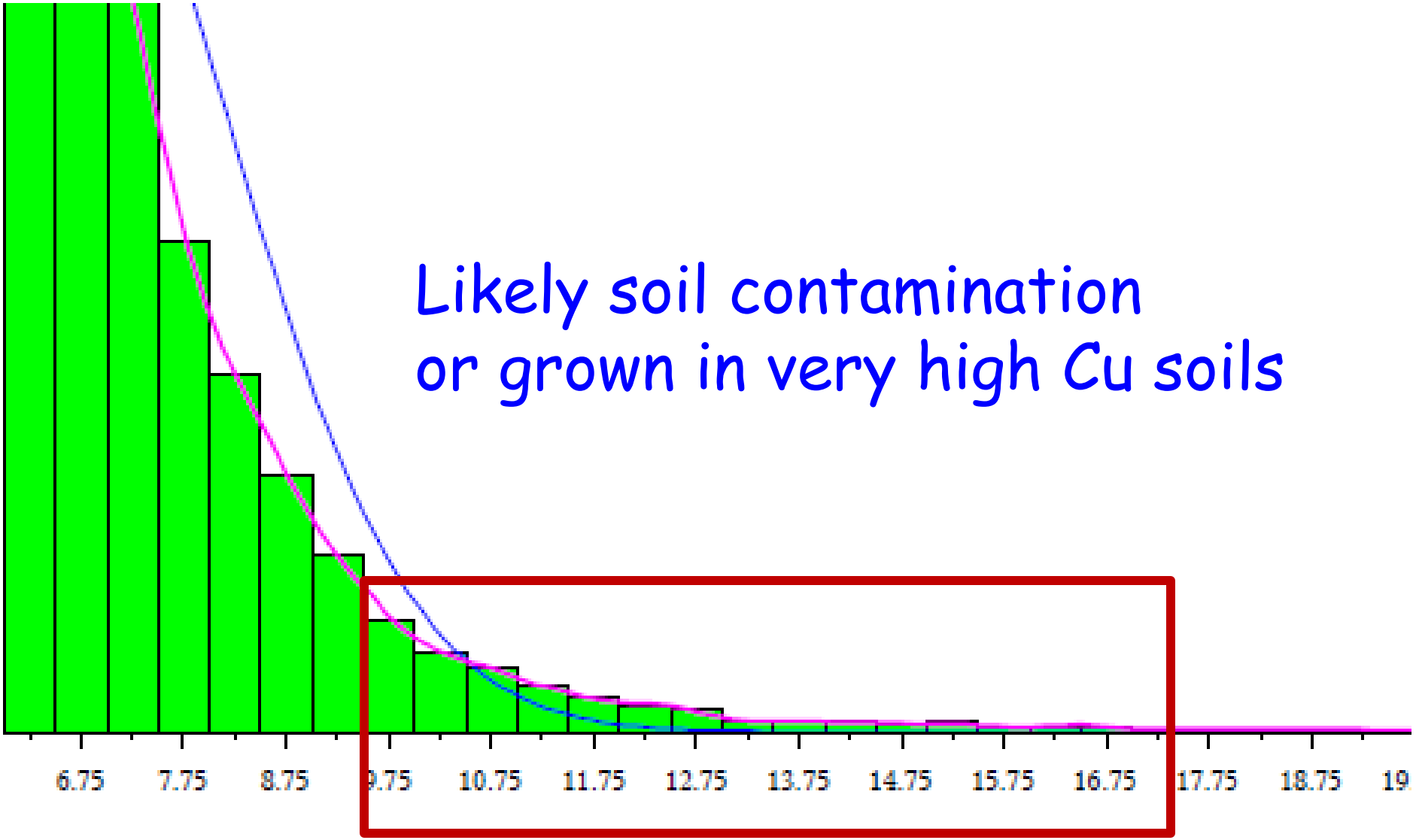
Median = 6.0

75% of samples >5 ppm

10% of samples >8.5 ppm

Knapp and Weiss, 2015

Cu in Corn Silage



High TM in Basal Feeds

With high ash/and Fe

- likely soil contamination
- availability probably low

Without high ash

- could be interior metals
- availability may be similar to inorganic supplements

Trace Minerals Recommendations

Capture value from high availability TMs

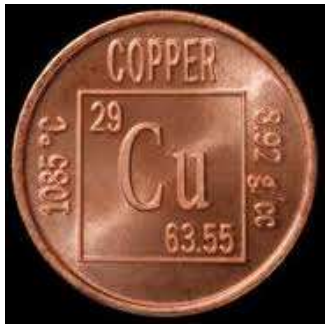
Need 6 mg absorbed Cu to meet reqt

Copper sulfate = 25% Cu; *AC* = 0.05

Product X® = 25% Cu; Relative *AC* = 2X

(6/0.05)/0.25 = 480 mg $CuSO_4$ *or*

(6/(0.05 **X 2**)/0.25 = 240 mg of Product X®



Copper (NRC = ~10-12 ppm)

Feed Enough !

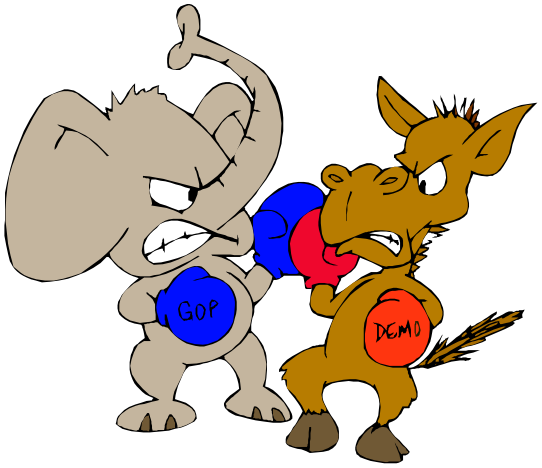
Reduced mastitis
Improved immunity
Reduced RP

Don't feed too much !

Real world toxicity (i.e., death)
Accumulation of liver Cu

Copper: Lots of Real World Antagonists

1. High Sulfur (Forage, DDG, water)
2. High reduced Fe (water)
3. Grazing (soil ingestion)
4. High Mo

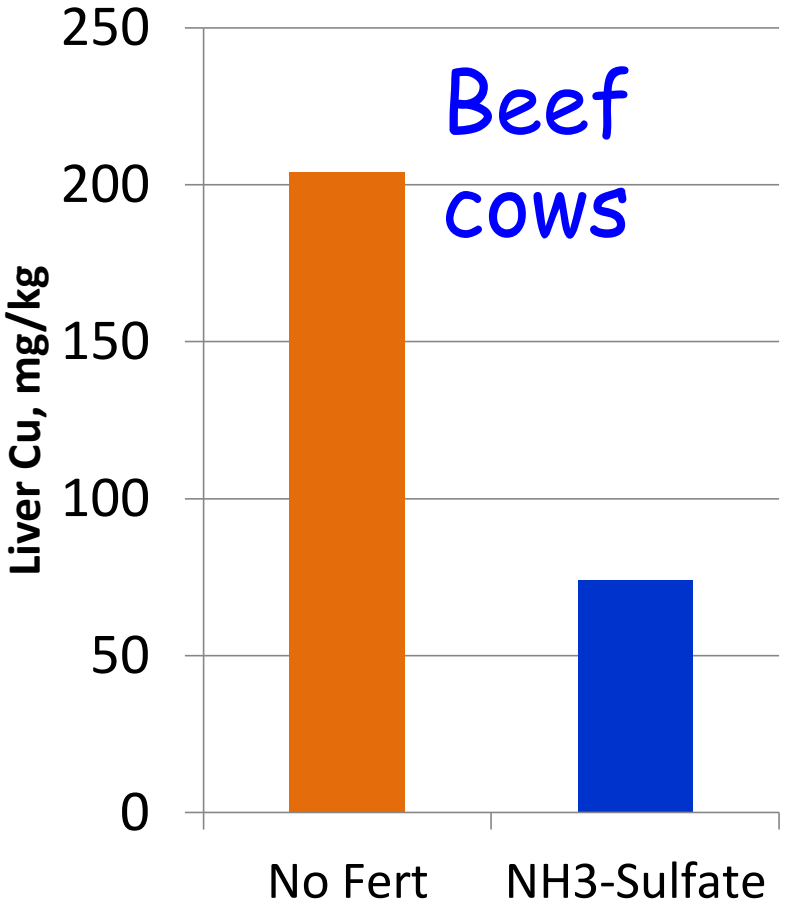


NRC assumes minimal antagonism:
Real world situations justify increased Cu

High S forage = Reduced Copper Stores

- Grass fertilized with
  - Nothing
  - NH3-Sulfate
- Forage S
  - 0.2%
  - 0.5%

High S + normal Mo reduces Cu status



Arthington et al., 2004

Remember Water

Water with 250 ppm Sulfate-S

= +0.1% dietary S

Water with 700 ppm Sulfate-S

= +0.3% dietary S

Take water samples occasionally

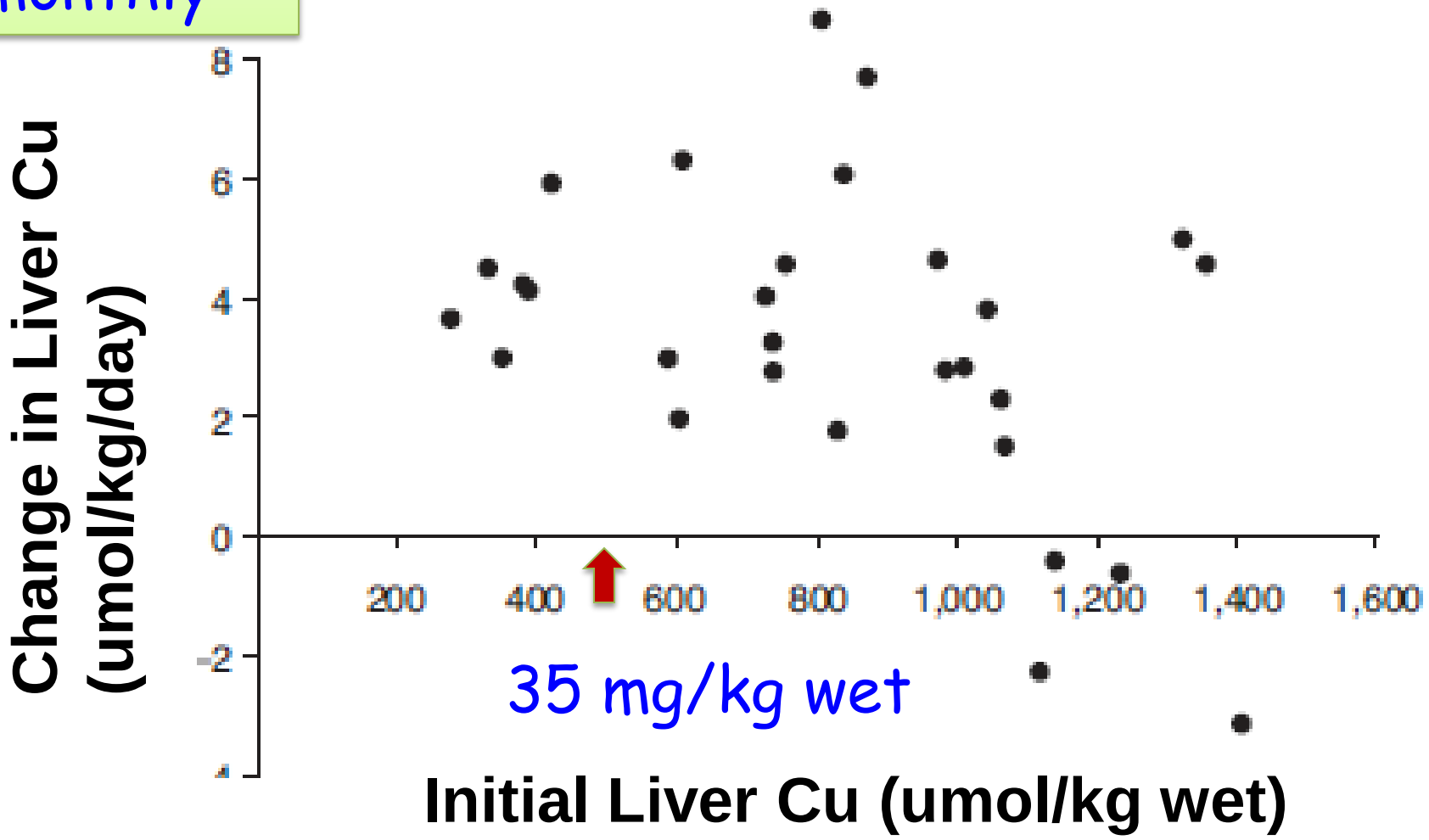
Sulfur (NRC = 0.2%)

Watch total S (diet + water)

1. Reduces copper availability
2. Reduces selenium availability
3. Reduces DCAD (milk and DMI)

+4 to 7 mg/kg monthly

Liver Cu continues to accumulate (diet = ~20 ppm)



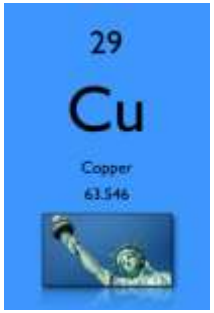
Balemi et al., 2010 (NZVJ)

Cu Recommendations

No DDG, good water:

- **1.2** to 1.5X NRC (12 to 17 ppm **TOTAL** Cu when using $CuSO_4$)
- If using high bioavailability sources, feed less (balance for available mineral)

Lifetime moderate overfeeding of Cu may be causing problems !



Cu Recommendations

With Antagonists (eg. DDG, bad water …)

- Maybe 2 to 3X NRC (20 to 30 ppm)
- Use proven 'High available' Cu
- Evaluate status (liver Cu from cull cows, biopsies)

Lifetime moderate overfeeding of Cu may be causing problems !

Se: 0.3 to 0.6 ppm added

Lactating cows, normal situation

- all or predominantly inorganic

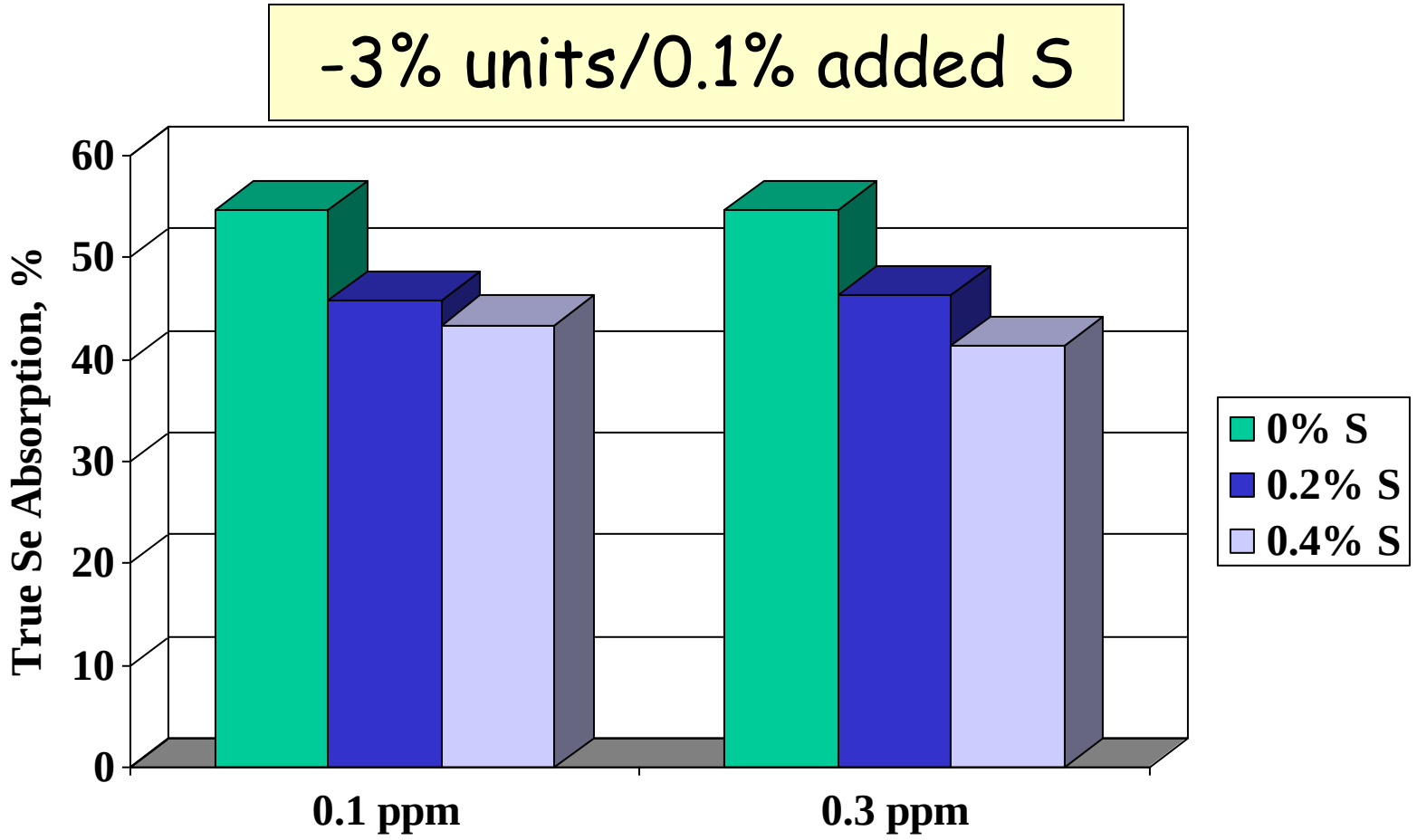
Lactating cows, antagonists (e.g. S)

- substantial amount from Se-yeast

Dry cows (0.6 ppm)

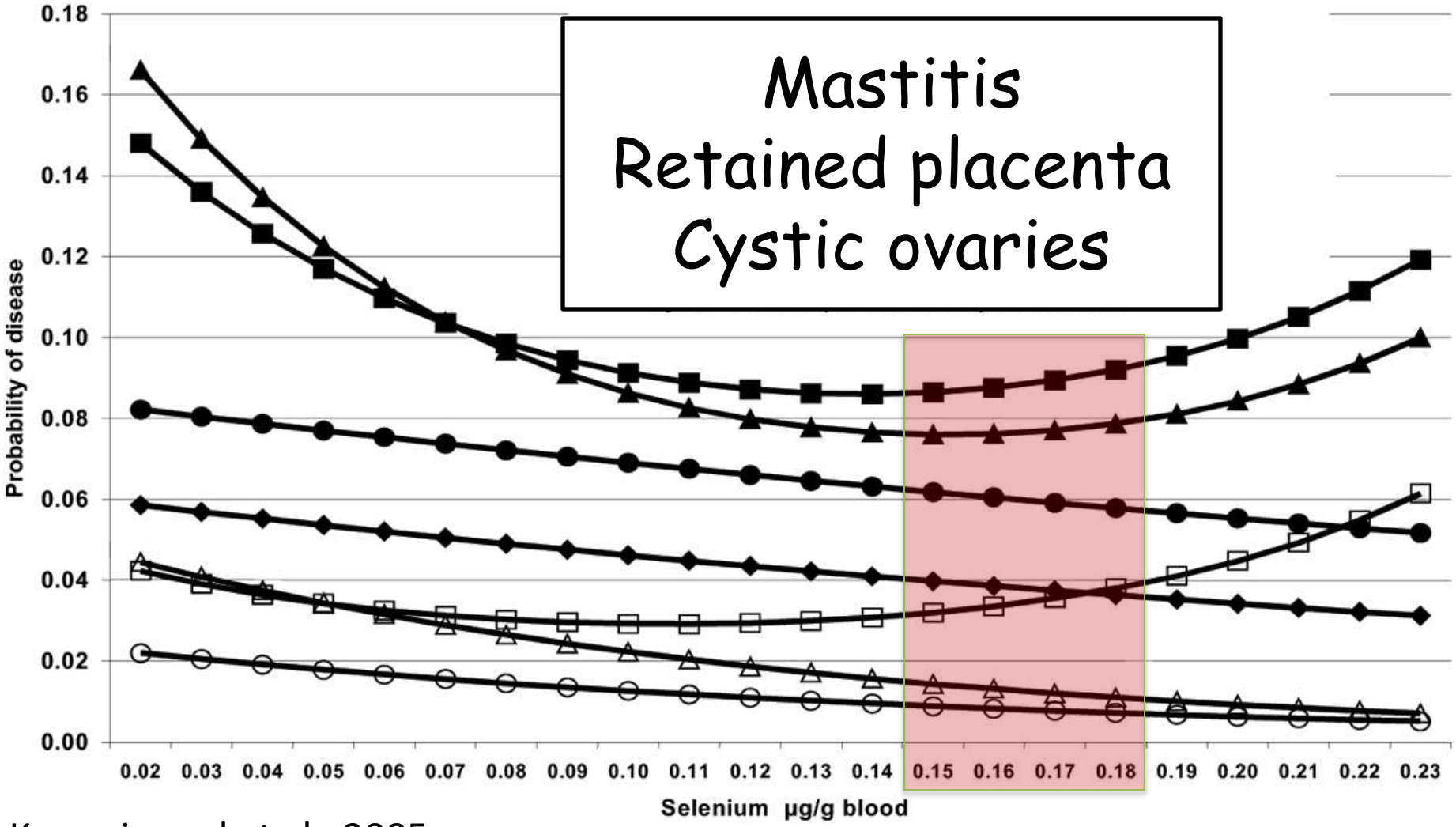
- mix of inorganic and Se-yeast

Se and Sulfur



Ivancic and Weiss, 2001

Probability of Disease vs Blood Se



Kommisrund et al., 2005

Whole blood = 0.16 – 0.18 ug/ml

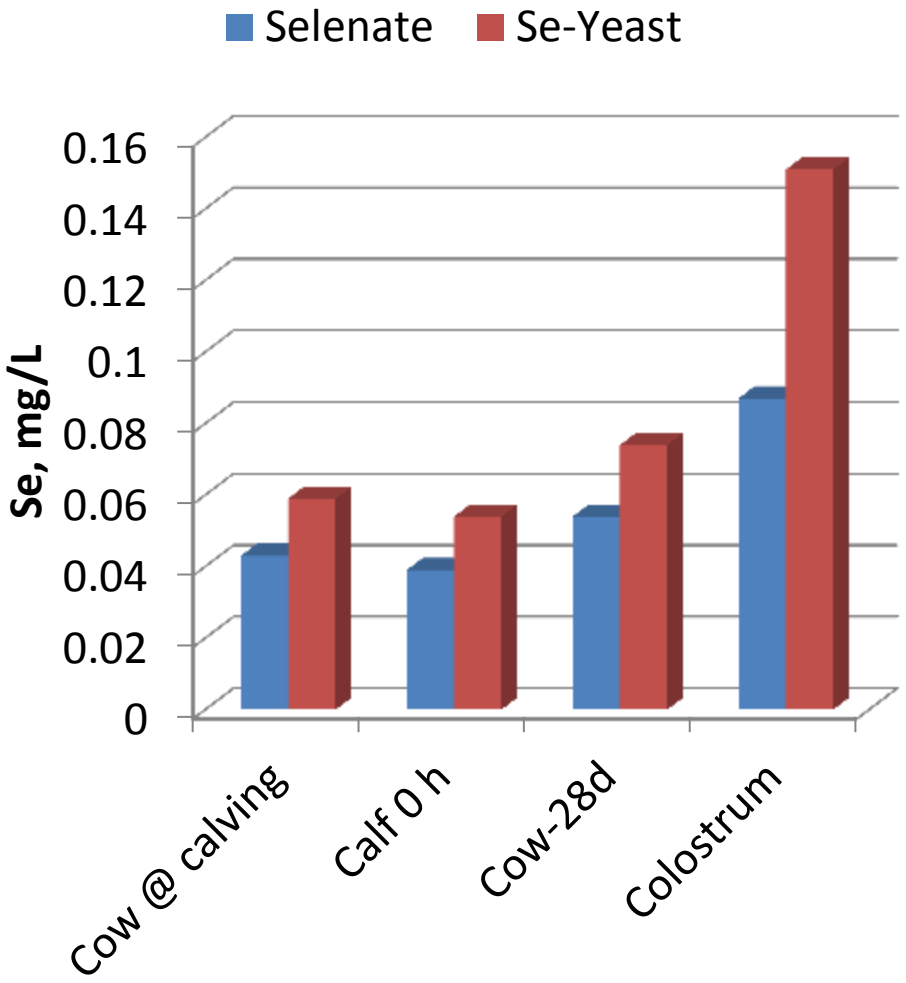
Selenium Yeast

Benefits:

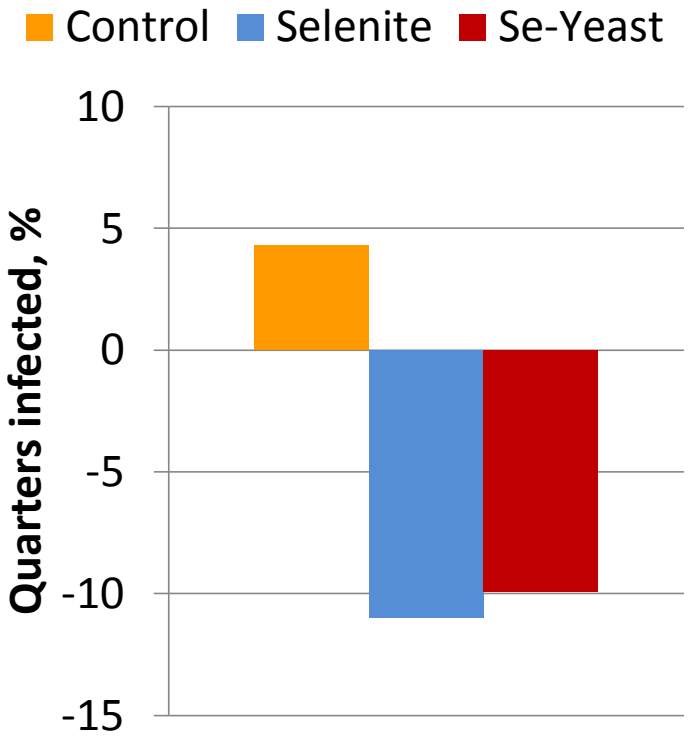
- 1.2 to 1.3 X more available
- Builds up body Se reserves
- Increases milk Se (humans)
- Transfer to fetus and colostrum
- Limited absorption antagonists

Disadvantage: Cost

Relative Response: Selenite vs Se-yeast



Weiss and Hogan, 2006



Malbe et al., 1995

Data support NRC Zn (but you need a safety factor)

Zn Requirement:

~ 140 to 250 mg absorbed/day

~ 1000 to 1800 mg total/day

Zn Recommendation:

1.25 X NRC (with sulfates)

~ 55 to 65 ppm (with sulfates)

1 X (or less) with high available TM

~44 to 55 ppm

NEWER DATA QUESTION NRC FOR COBALT AND MANGANESE

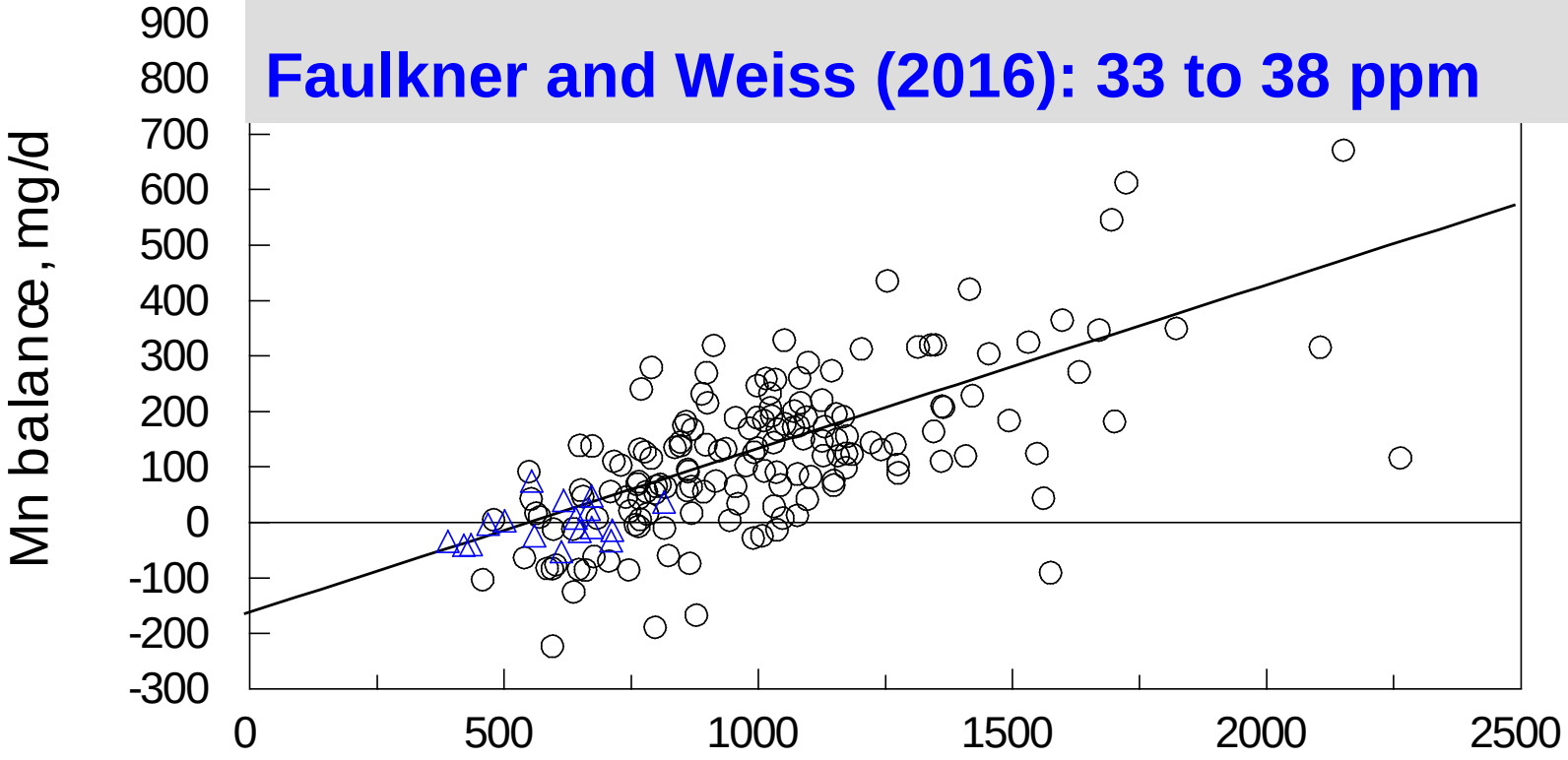
	NRC, ppm	Suggested rate, ppm
Cobalt	0.11	0.2 to 0.9
Manganese (dry)	~18	50
Manganese (lactation)	~17	30 to 40

Use of Mineral balance to estimate maintenance requirement (diet, not TAR)

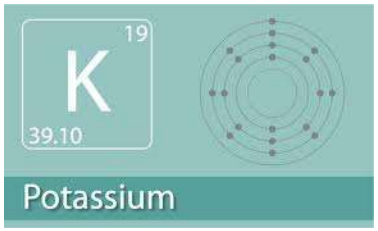
Mn bal = -151 +0.26 X

580 mg/d = 0 balance: At mean DMI; 28 ppm

Faulkner and Weiss (2016): 33 to 38 ppm



Weiss and Socha, 2005



Potassium (NRC = ~1.1%)

Feeding more (~2%): The Good

1. Can improves milk fat (DCAD, not K)
2. Helps with heat stress (K)
3. Improves feed efficiency

Feeding More: The Bad

1. **Reduces Mg absorption (K)**
2. Increases manure and manure K

Higher K (DCAD) improves fat and FE

Diet K% (DCAD)

Cont: 1.3 (32)

K carb: 2.1 (53)

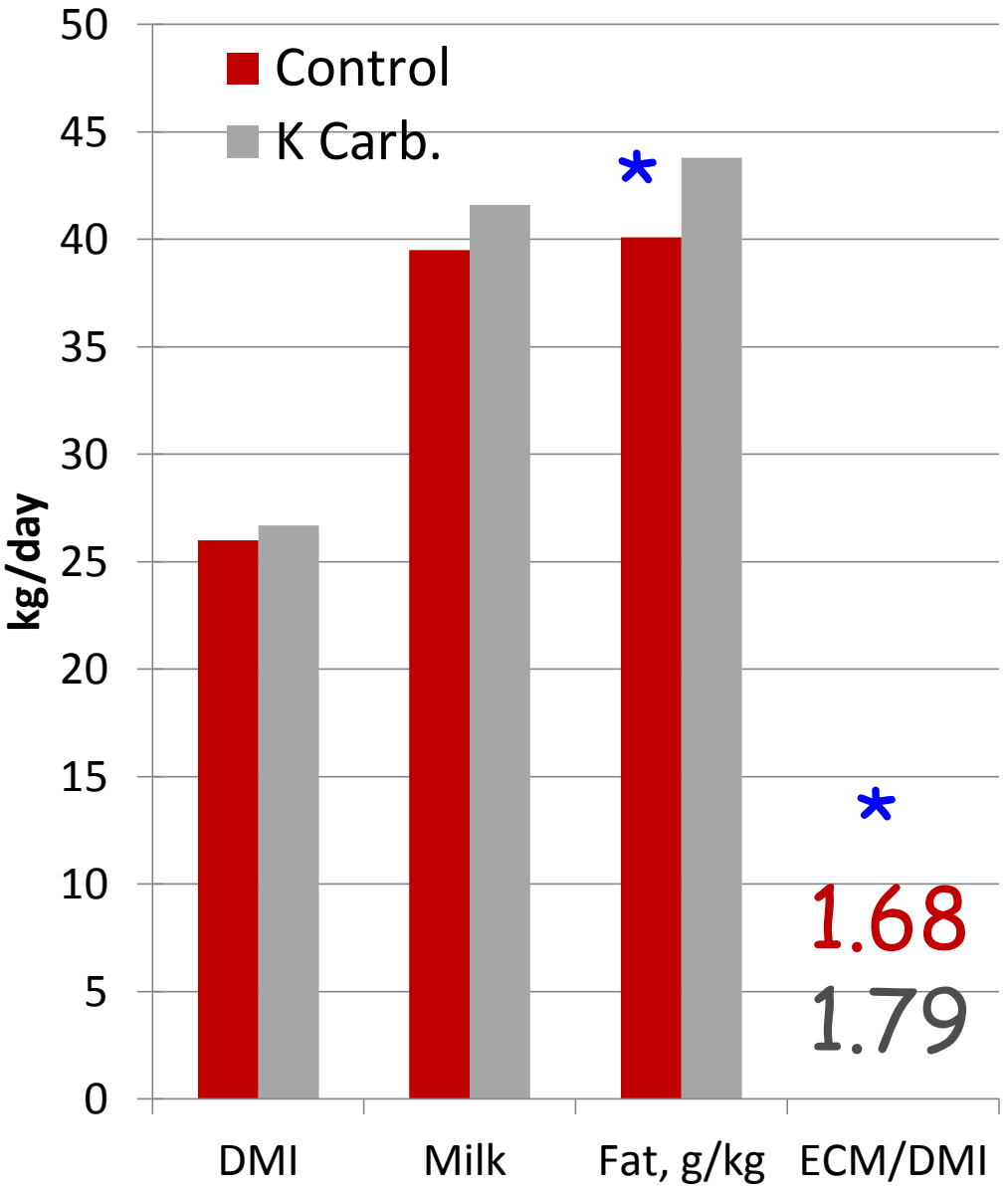
Both diets

34% forage

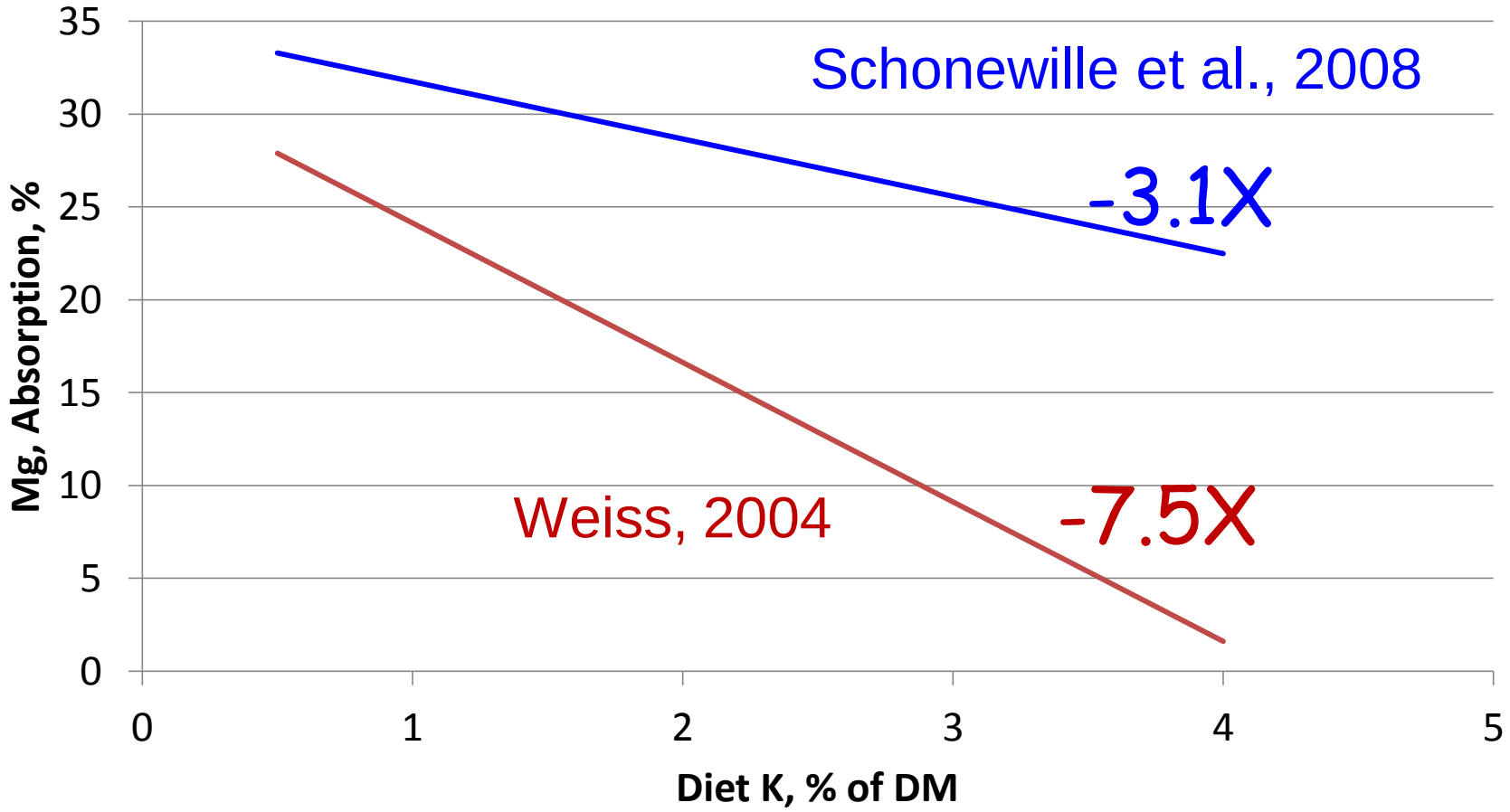
6% DDG

Early lact. cows

Harrison et al., 2012



K and Mg Absorption in Dairy Cows



Dietary K and Mg Absorption (dairy cows)

Weiss, 2004	Schonewille et al 2008
Slope = -7.5	**Slope = -3.1**
Mostly lact cows	Mostly dry cows
Avg DMI= 20.2 kg/d	8.8 kg/d
Alfalfa/corn silage	Grass/suppl. K
Avg Mg; 0.27%, 57 g/d	0.45%, 42 g/d
K: 1 to 2.7%	1.2 to 3.1% (7.5)

Magnesium

1. Absorbed from rumen

2. Real world antagonists
   - K
   - LCFA (not big)
   - Rumen ammonia (RDP)
     Acute vs. chronic

3. Minimal homeostatic control of absorption

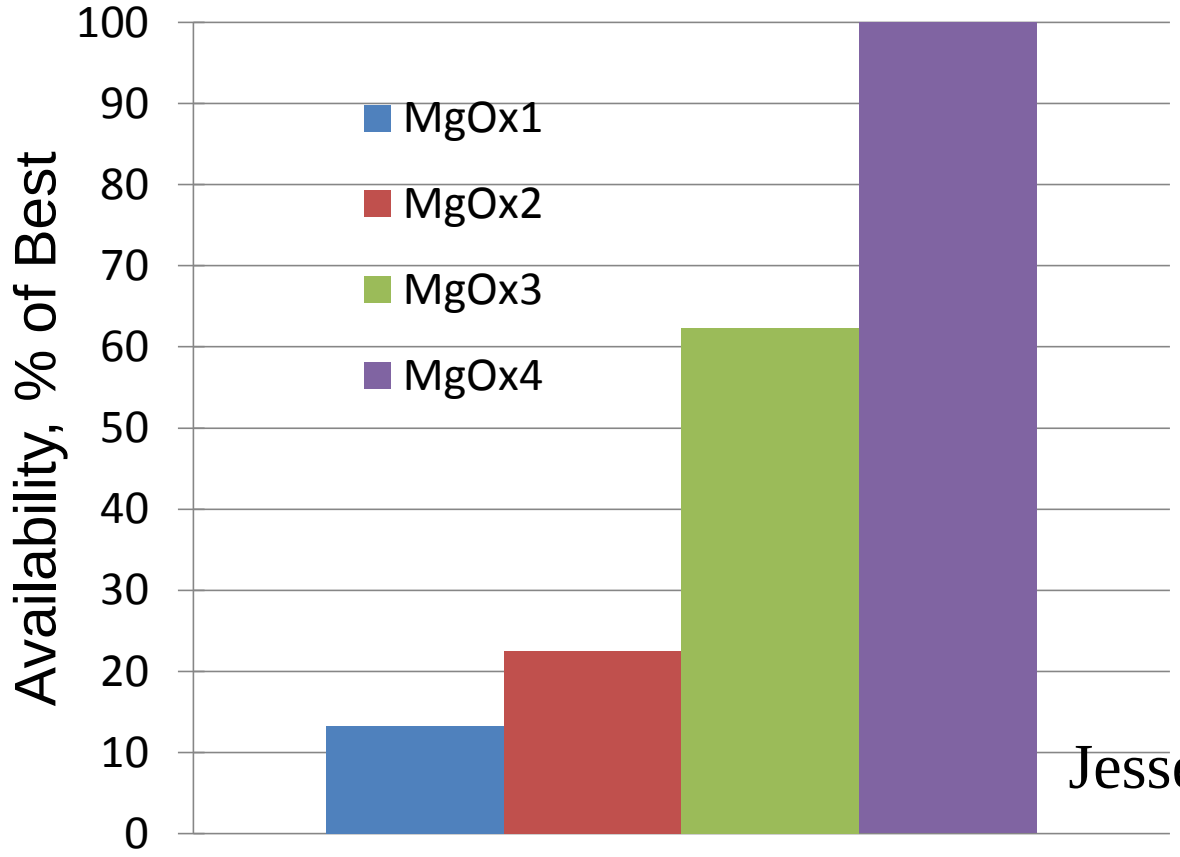
Magnesium

	NRC 2001	'Correct'
Basal feeds	0.16	0.30* **±0.16**
Good MgO	0.7 or 0.5	0.20 to 0.25
$MgSO_4$	0.9 or 0.7	0.35 to 0.40

* @1.2%K

Feeds are better than we thought
Supplements are worse than we thought

Mg Availability from 4 sources of MgO



Jesse et al., 1981

Uncertainty increases risk
Formulation must consider risk

Summary

1. Uncertainty and risk management justifies **moderate** overfeeding of MANY minerals

Moderate = +20 to 50% of NRC

2. Safety factors should be farm, mineral, and mineral source specific

3. Consider long term effects of overfeeding

Summary

4. Do **not** ignore minerals in basal ingredients (use means or medians for TM)

5. If specialty TM is more absorbable, capture that value
   - feed less
   - reduce safety factor
   - use when antagonist present

http://dairy.osu.edu

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EXTENSION

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