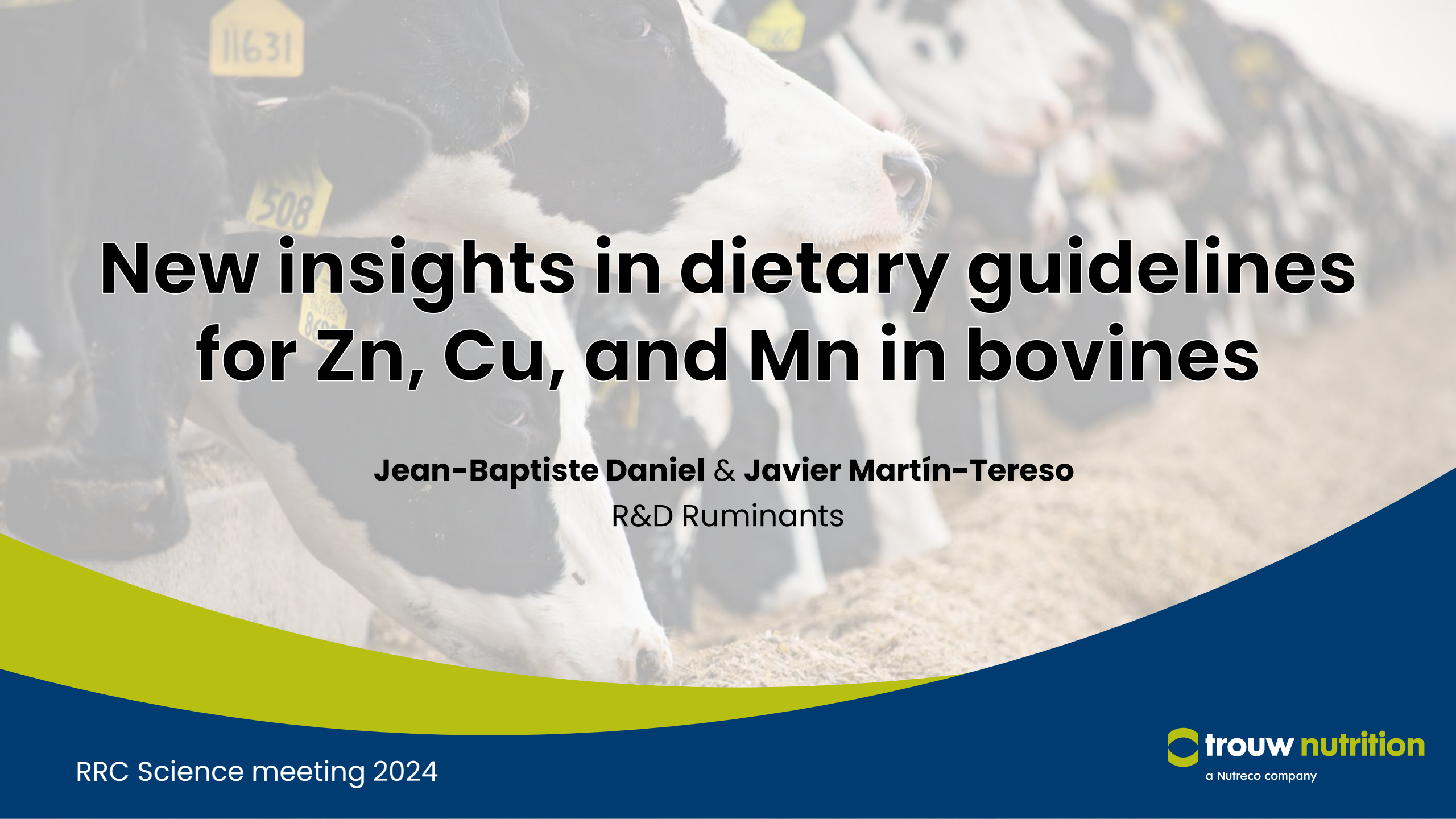
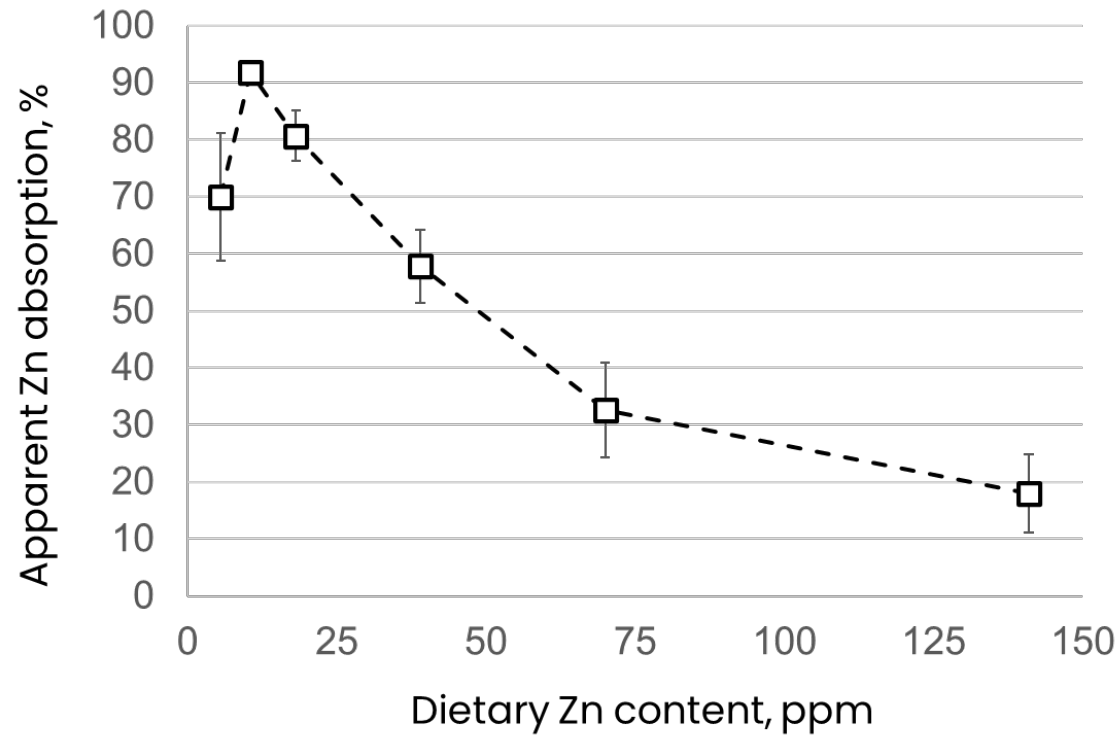




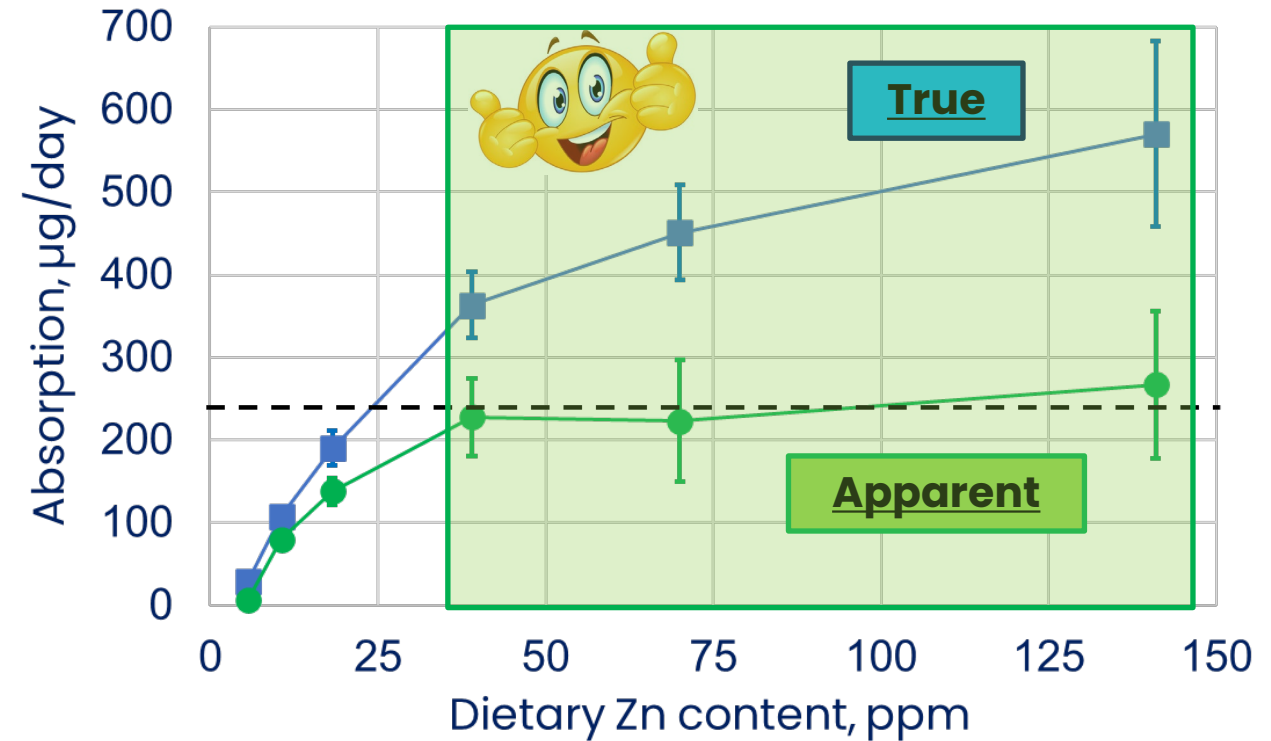
New insights in dietary guidelines for Zn, Cu, and Mn in bovines

Jean-Baptiste Daniel & Javier Martín-Tereso
R&D Ruminants

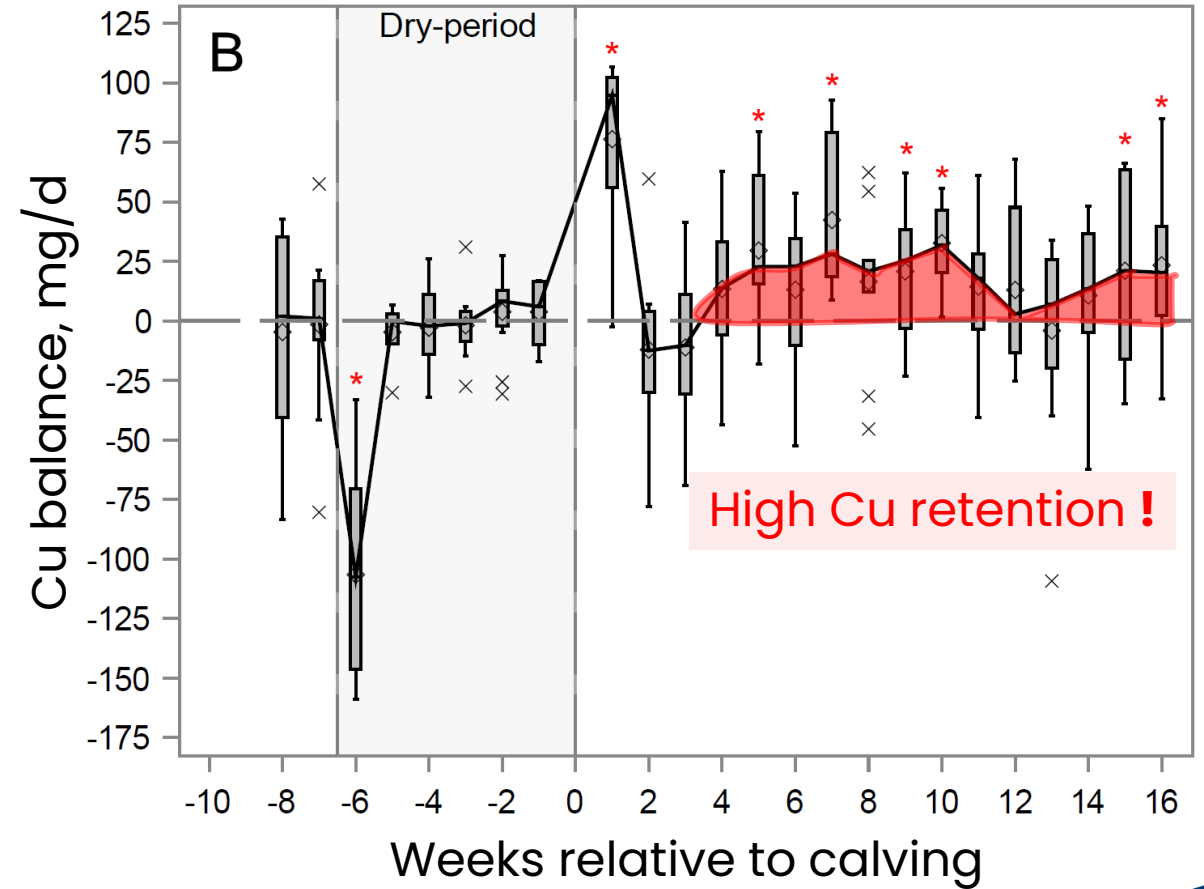
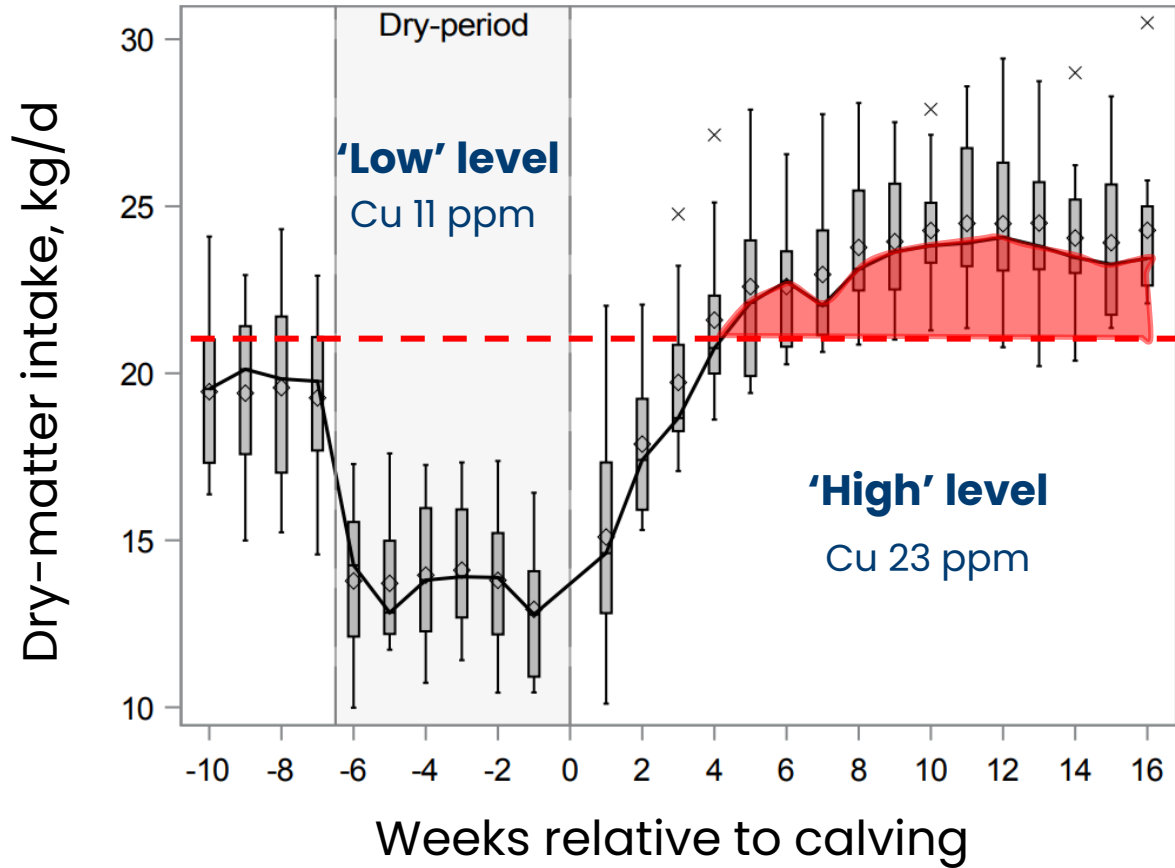
Key aspect of trace metal regulation



- **Decrease true absorption efficiency (%)**
- **Increase fecal endogenous loss (mg/d)**

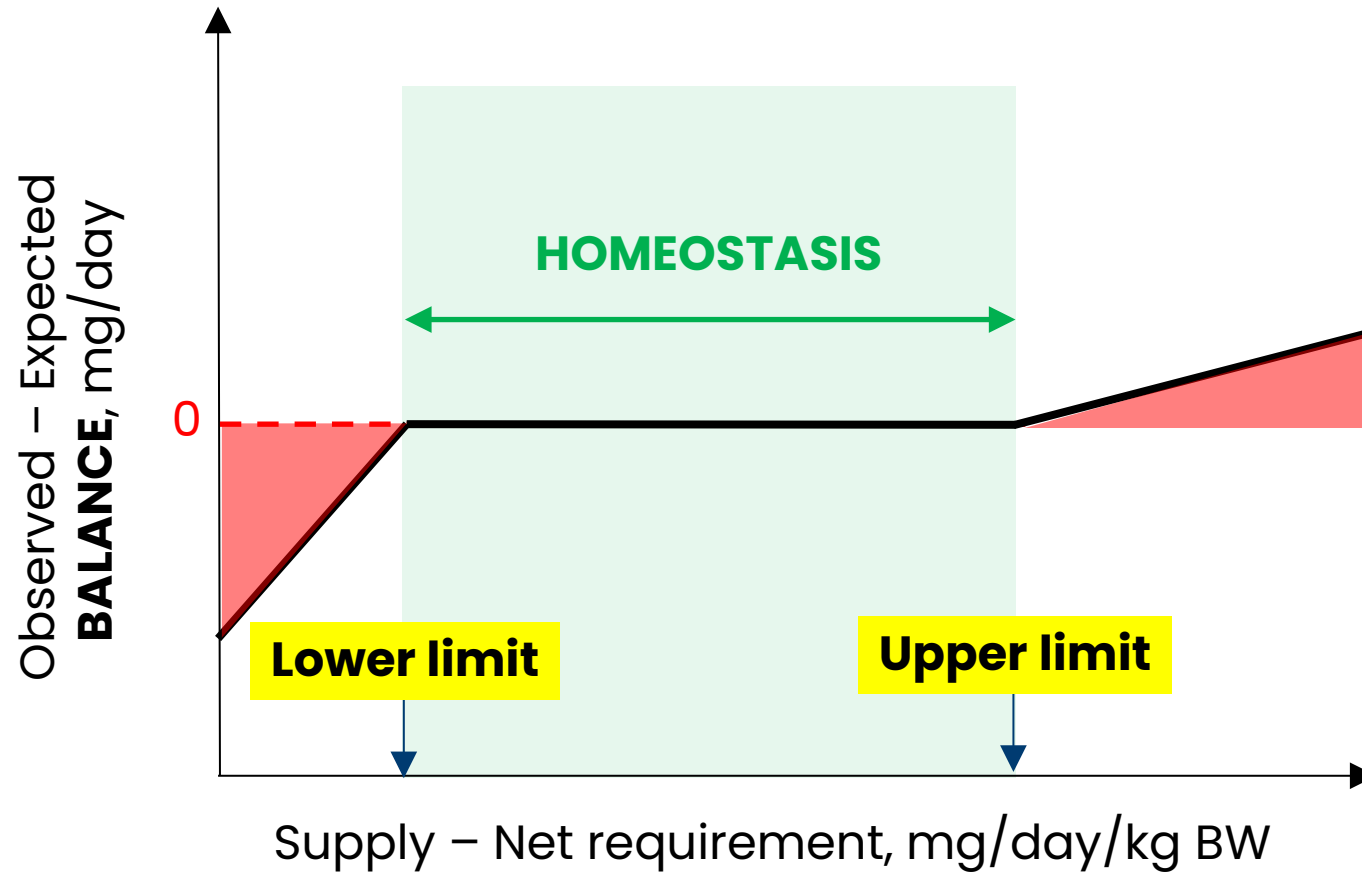


Unexpected accumulation of trace metal in dairy cattle



Similar observations with Zn and Mn

Defining lower and upper limits of adequacy for Cu, Zn, and Mn



Estimating maximal apparent absorption for LOWER LIMIT



PUBLISHED PAPERS

Cu: 75 dietary treatments

Zn: 34 dietary treatments

Mn: 32 dietary treatments

Eligibility of study

Experimentally induced changes in available supply

Reported DMI and performance

Minimum duration of 50 days

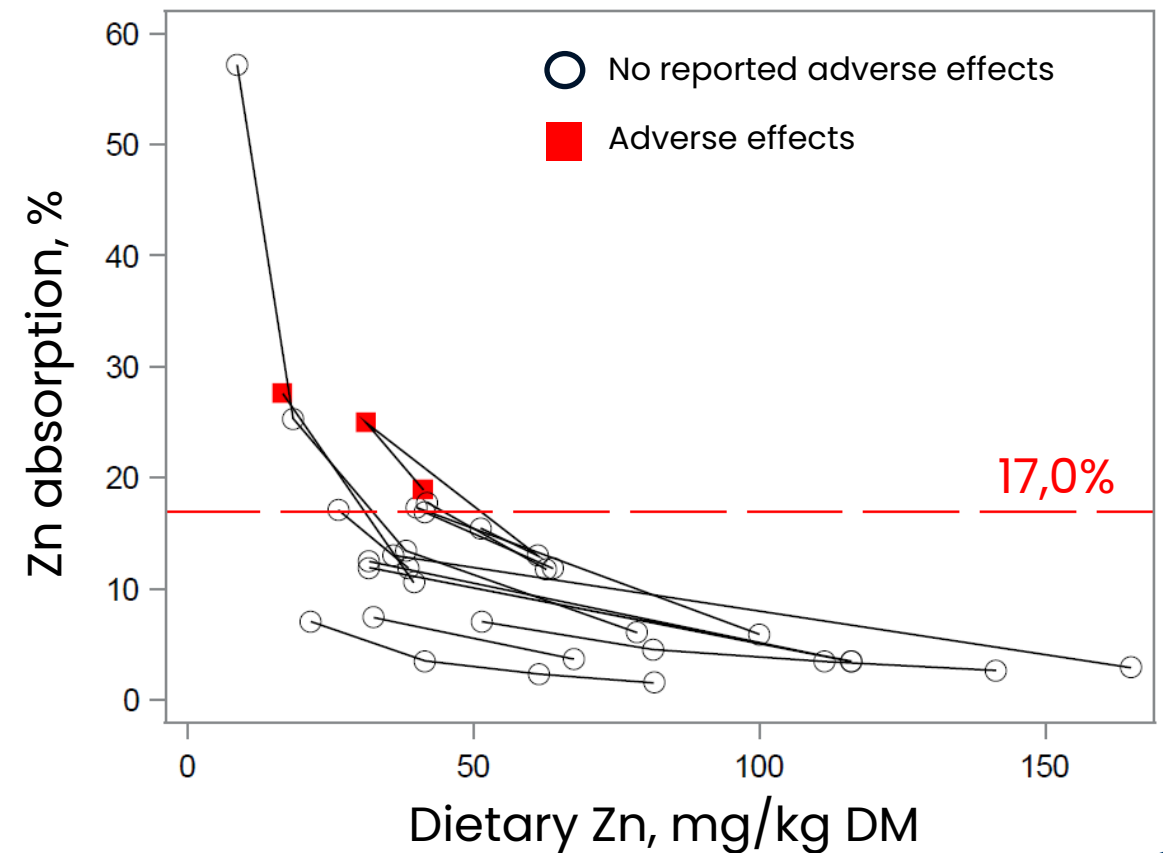
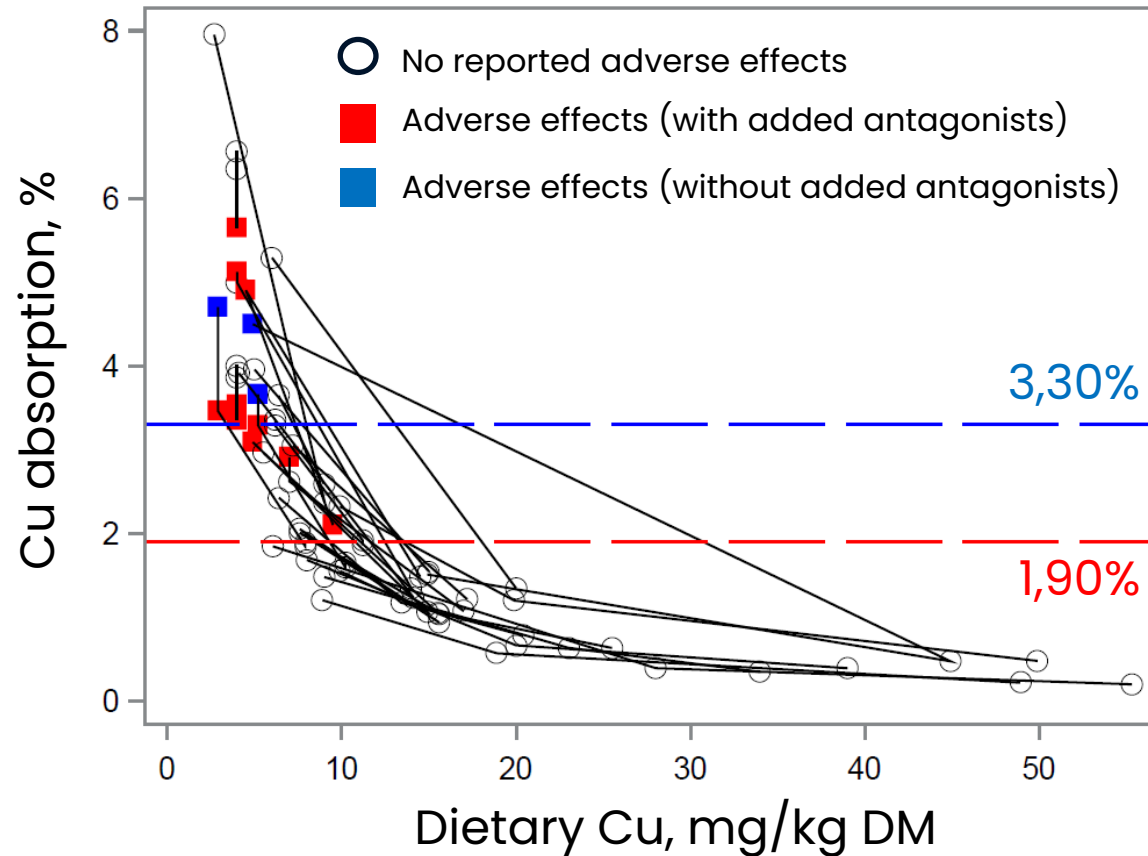
Standard set of calculations

Net requirement

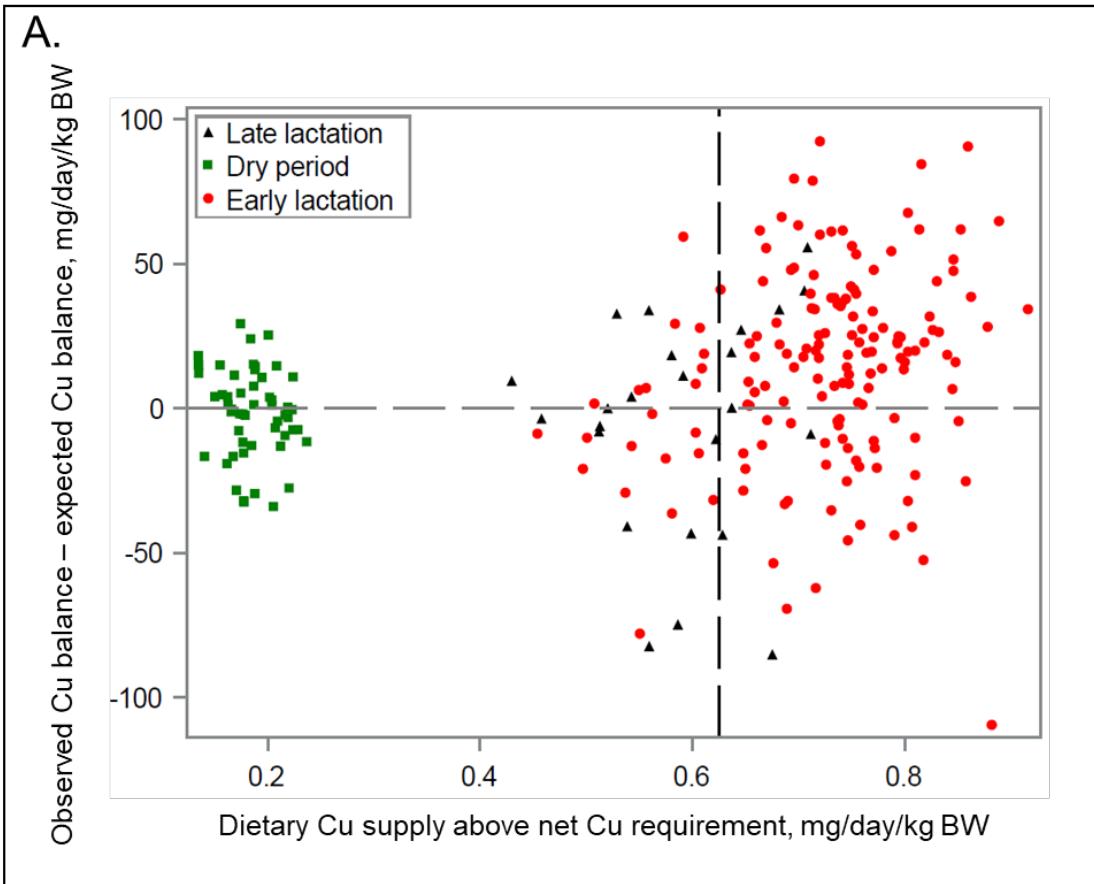
Required apparent absorption efficiency

Presence/Absence of adverse effects

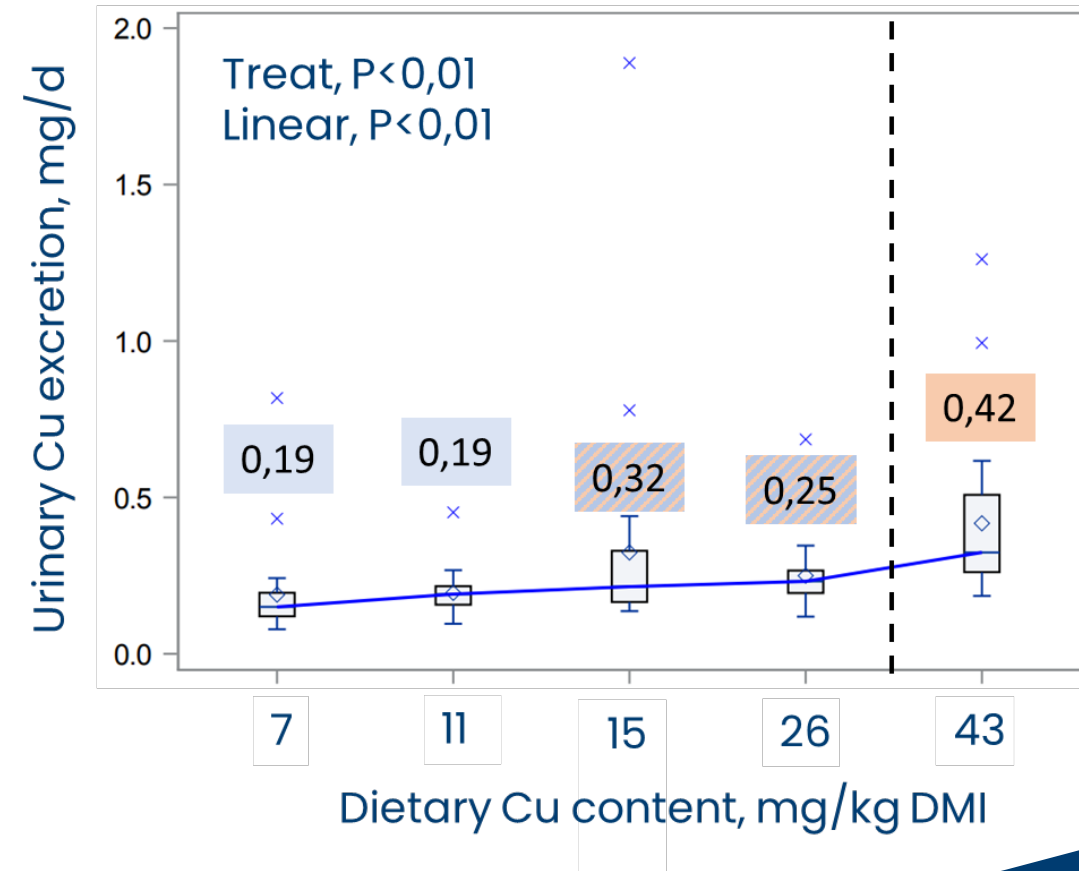
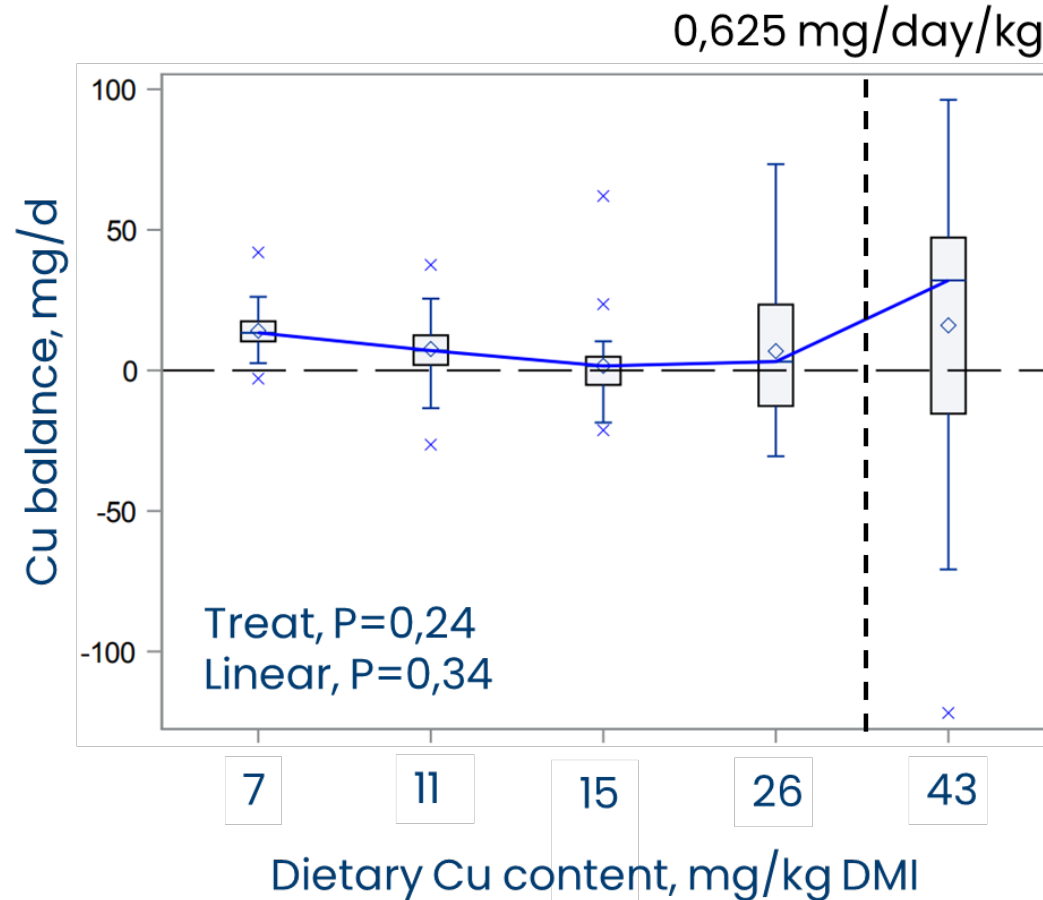
Estimating maximal apparent absorption for LOWER LIMIT



Estimating maximal supply for UPPER LIMIT



Substantiation of upper limit of adequacy for Cu supply



Novel guidelines for trace metals supplementation

- **Lower and Upper boundaries** of regulation
- Quantification of **probability density functions**
 - For gross native supply of trace metal
 - For animal net trace metal requirements
- Defining **confidence interval of supplementation**



Modeling variability in DIET trace metals composition



Grass forages

Cu	$12,0 \pm 7,0$
Zn	$26,5 \pm 12,8$
Mn	$38,1 \pm 20,8$



Corn silage

Cu	$8,1 \pm 4,4$
Zn	$30,8 \pm 21,5$
Mn	$57,3 \pm 40,0$



Concentrate

Cu	$8,9 \pm 1,0$
Zn	$48,7 \pm 5,7$
Mn	$48,8 \pm 7,8$

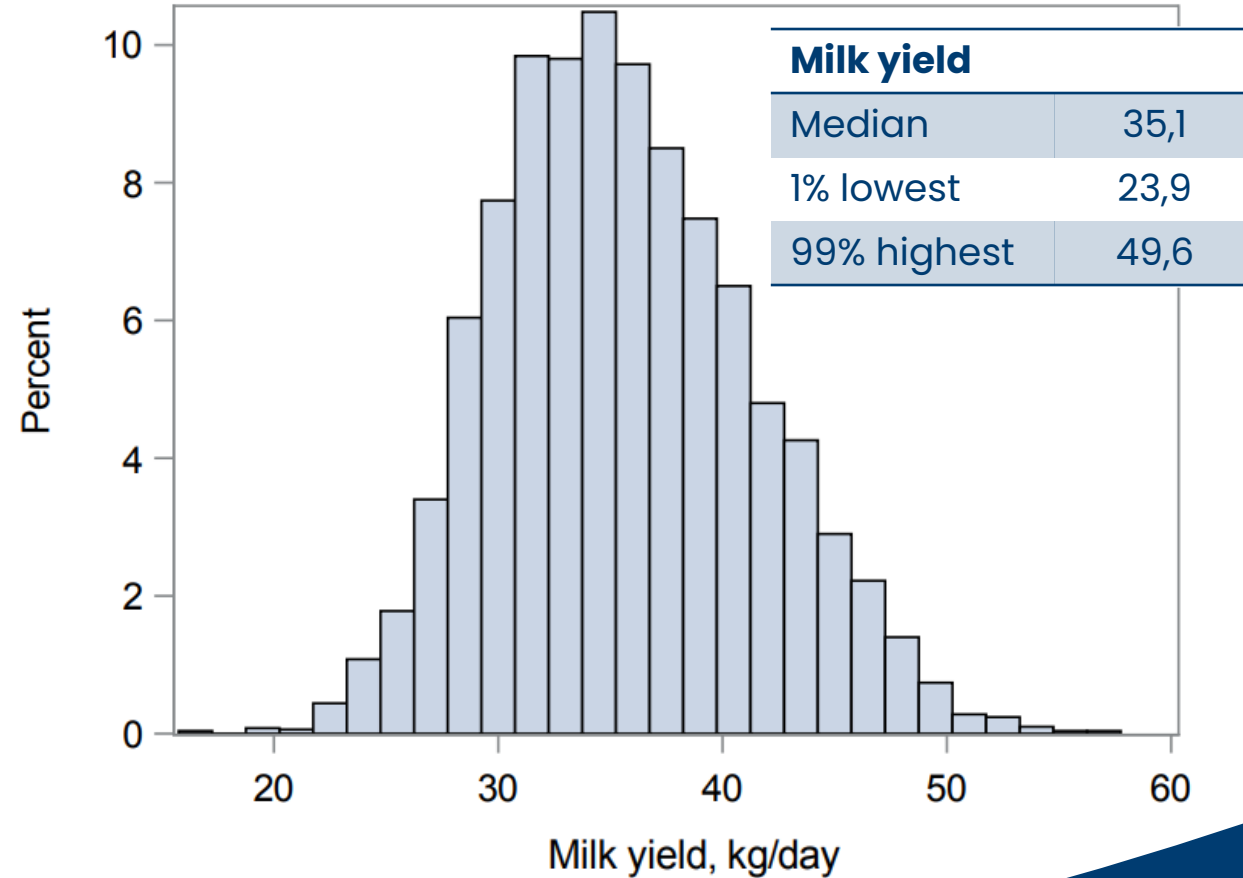
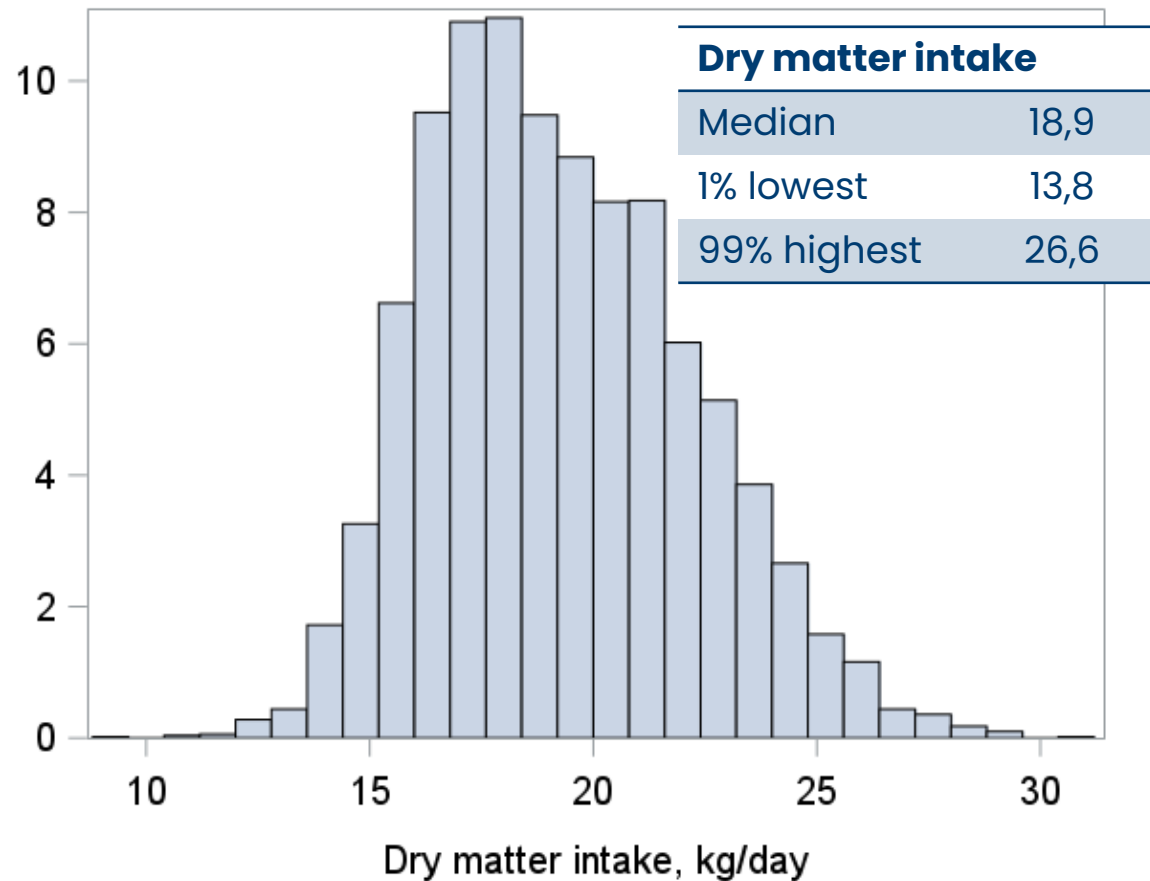
Adams et al., 1974
Feedipedia

Remaining %DM
Random
(0% to 100% CS)

$47 \pm 13 \% \text{ DM}$
Daniel et al., 2016

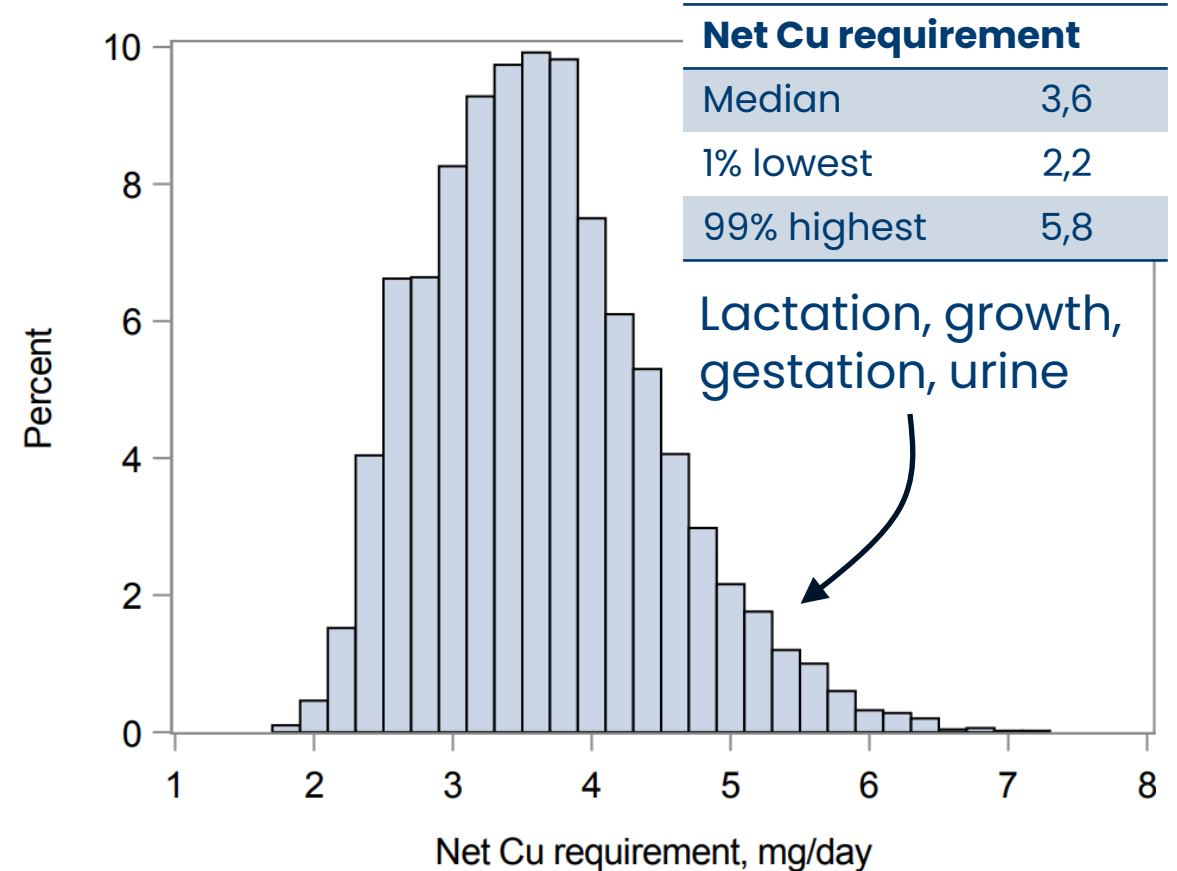
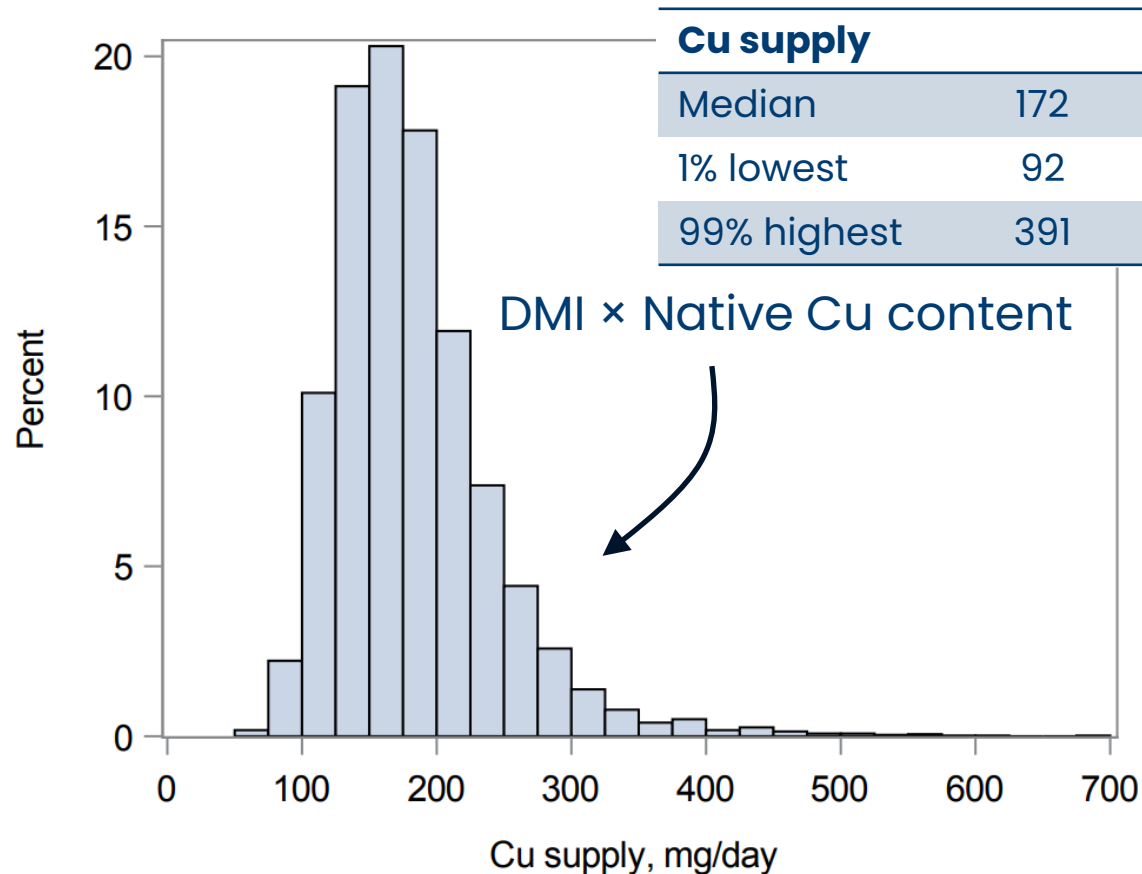


Modeling variability associated to ANIMAL



30% primiparous and 70% multiparous ; Mean ($\pm$ SD) from meta-analysis of Husnain and Santos, 2019

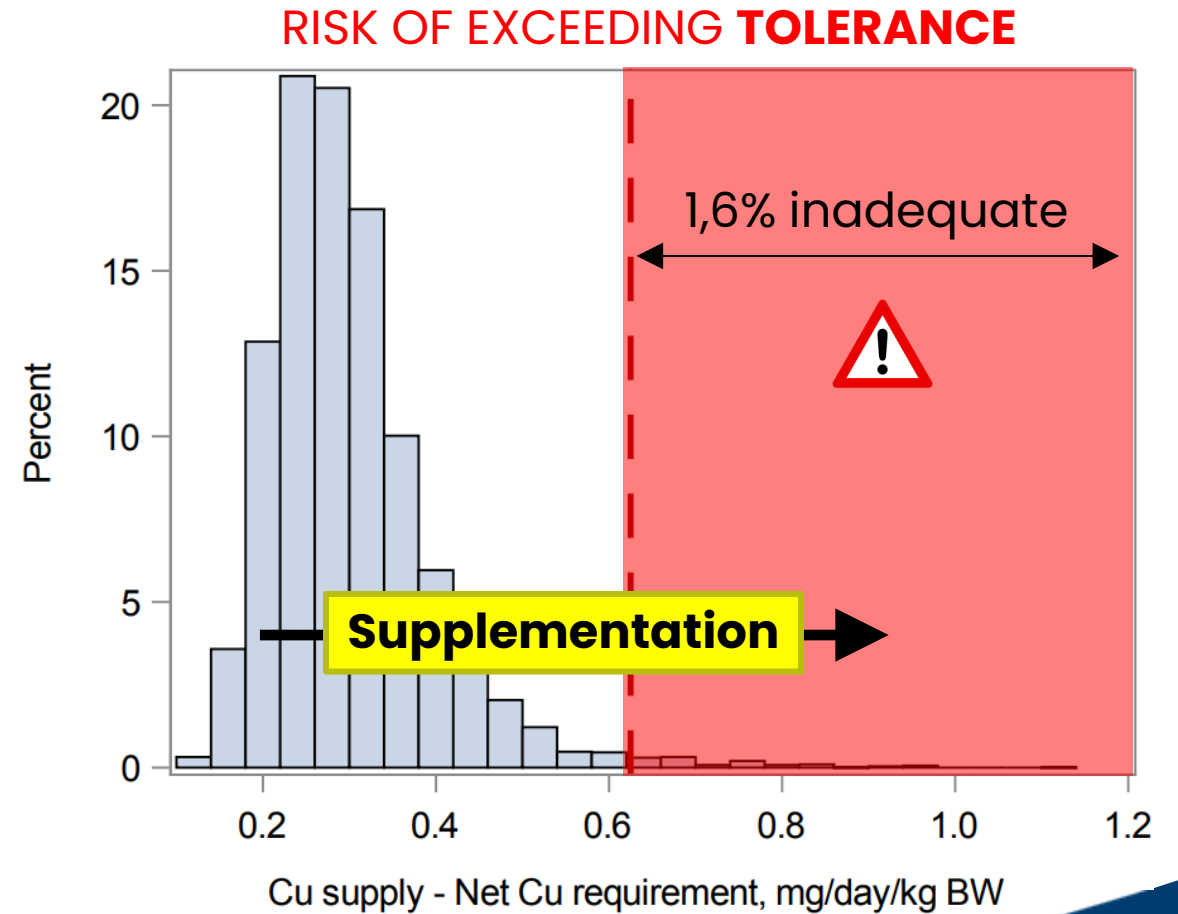
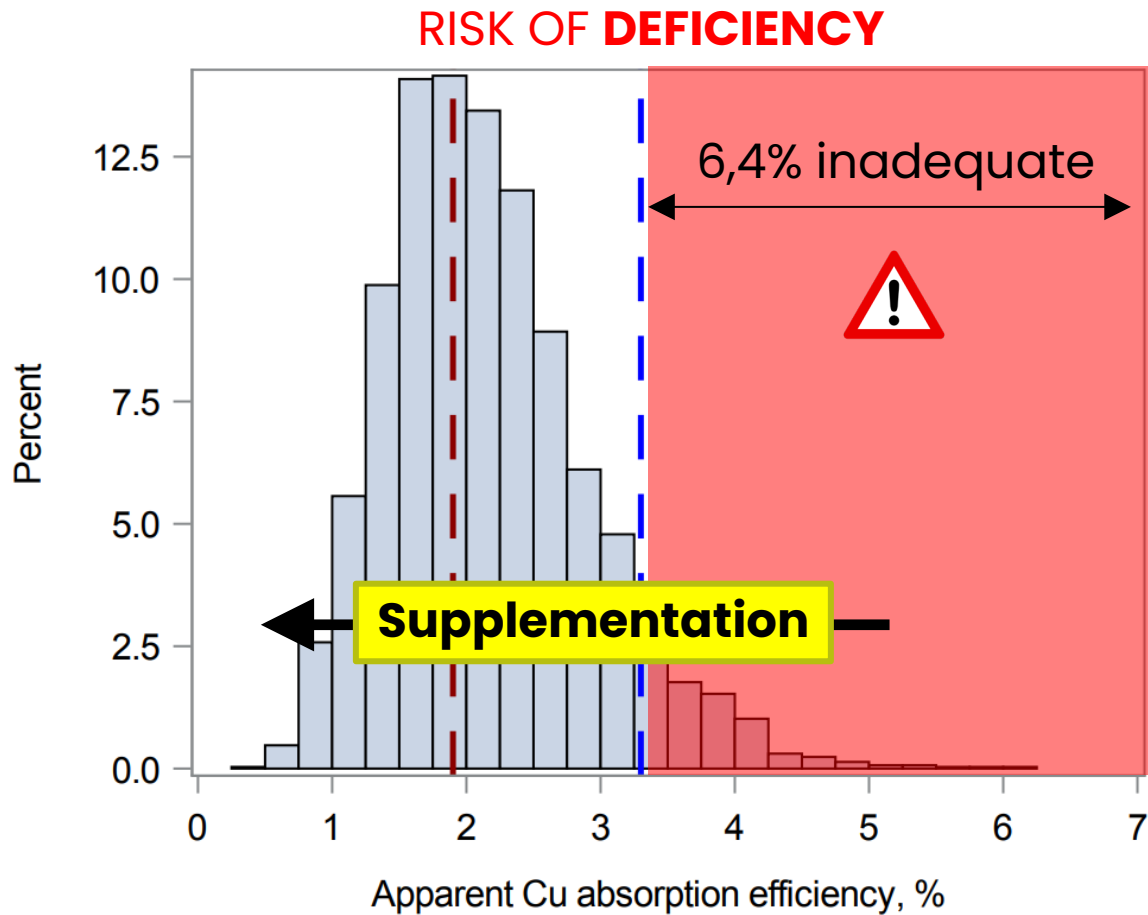
Modeling trace metal supply and net requirement



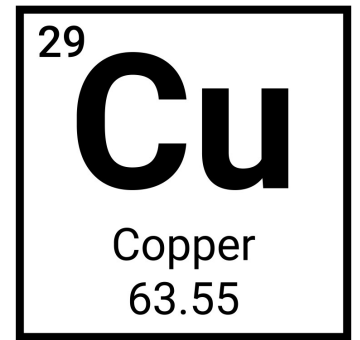
Apparent absorption efficiency for LOWER limit

Gross supply above net requirement for UPPER limit

Impact of supplemental feeding strategy



Range of supplemental Cu compatible with homeostasis



	Boundaries of adequacy	
	LOWER limit	UPPER limit
Growing heifers (4 to 20 mo.)	2	8
Prepartum heifers (0 to -3 mo. prior to 1 st calving)	5	22
Lactating cows	2	4
Dry-cows (0 to -3 mo. prior to 2 nd (or >) calving)	3	17

Less than 1% < lower limit AND less than 5% > UPPER limit

Take home messages

- **Unregulated retention of trace metals** in bovines is a **biological anomaly** induced by supplementation practices and the high DMI of dairy cattle.
- Supplementation guidelines should consider:
 - **Opportunity** of **UP regulation** competence
 - **Risk** of exceeding **DOWN regulation** competence
- These novel guidelines confirm the value of supplementation BUT expose the potential risk of excess supplementation