HIGH OUTPUT DAIRY SYSTEMS: PROFIT FROM PERFORMANCE

BALANCING DAIRY COW MINERAL NUTRITION

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Mineral Advice - Dr Annie Williams

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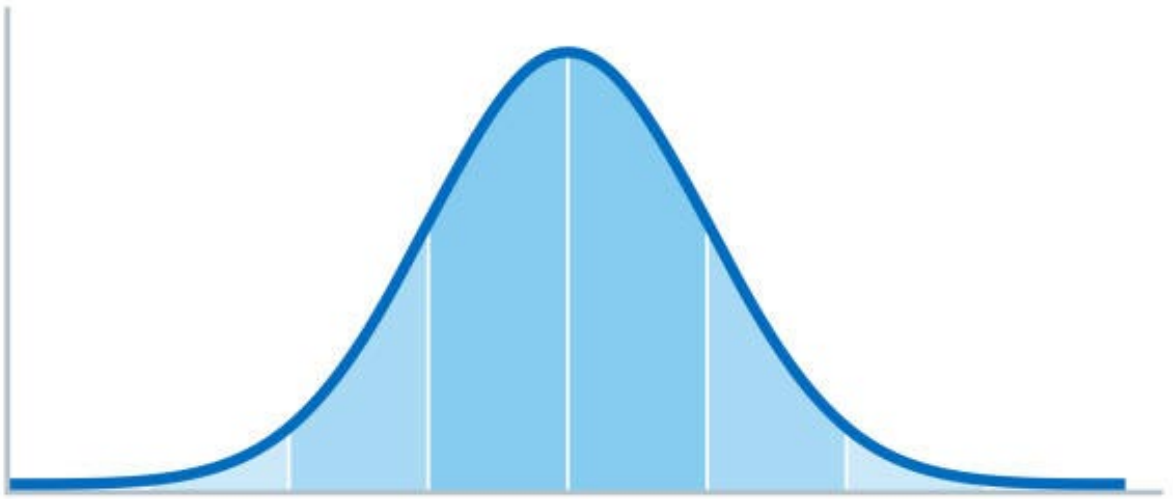
MINERALS – WHY ARE THEY IMPORANT?

Involved in almost every process in the body

The animal may take longer to respond to mineral imbalances, but they can have a severe detrimental effect on performance



Undersupply: Risk of deficiency Oversupply: Risk of toxicity

Meeting requirement

MINERAL NUTRITION IS A BALANCE

FOR SOME MINERALS THE RANGES ARE CLOSER THAN OTHERS

DOES THE DIET MEET REQUIREMENT? THE MINERAL GAP

Dietary supply

Is there a gap?

Is there an excess?

Animal requirement

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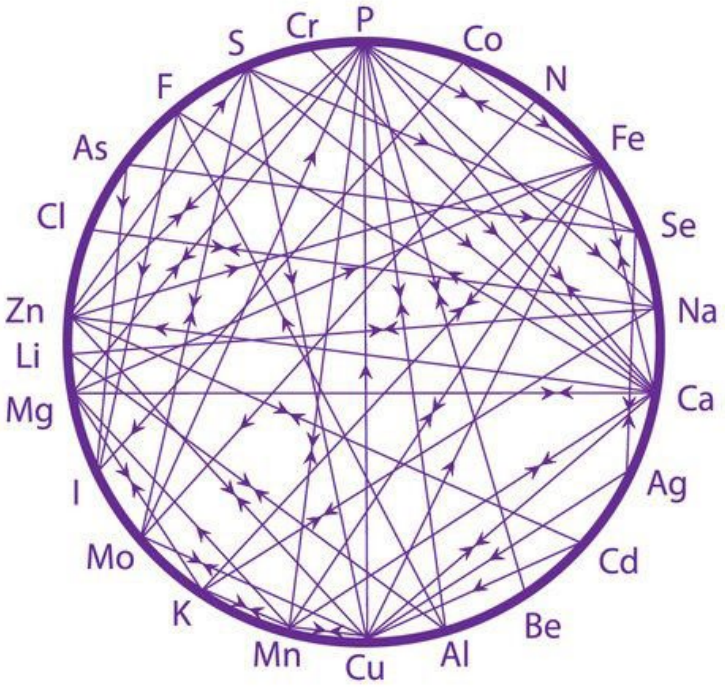
MINERALS FOR CATTLE

Macro Minerals – Required in g/kg DM (also includes electrolytes)

- Calcium
- Phosphorus
- Magnesium
- Sodium
- Potassium
- Sulfur
- Chloride

Trace Elements – Required in mg/kg DM

- Copper
- Zinc
- Selenium
- Iodine
- Manganese
- Iron
- Chromium?



HOW SURE ARE WE ABOUT REQUIREMENTS?

- It depends!
  - On the mineral
  - On the cow

Requirement vs Adequate Intake vs Response

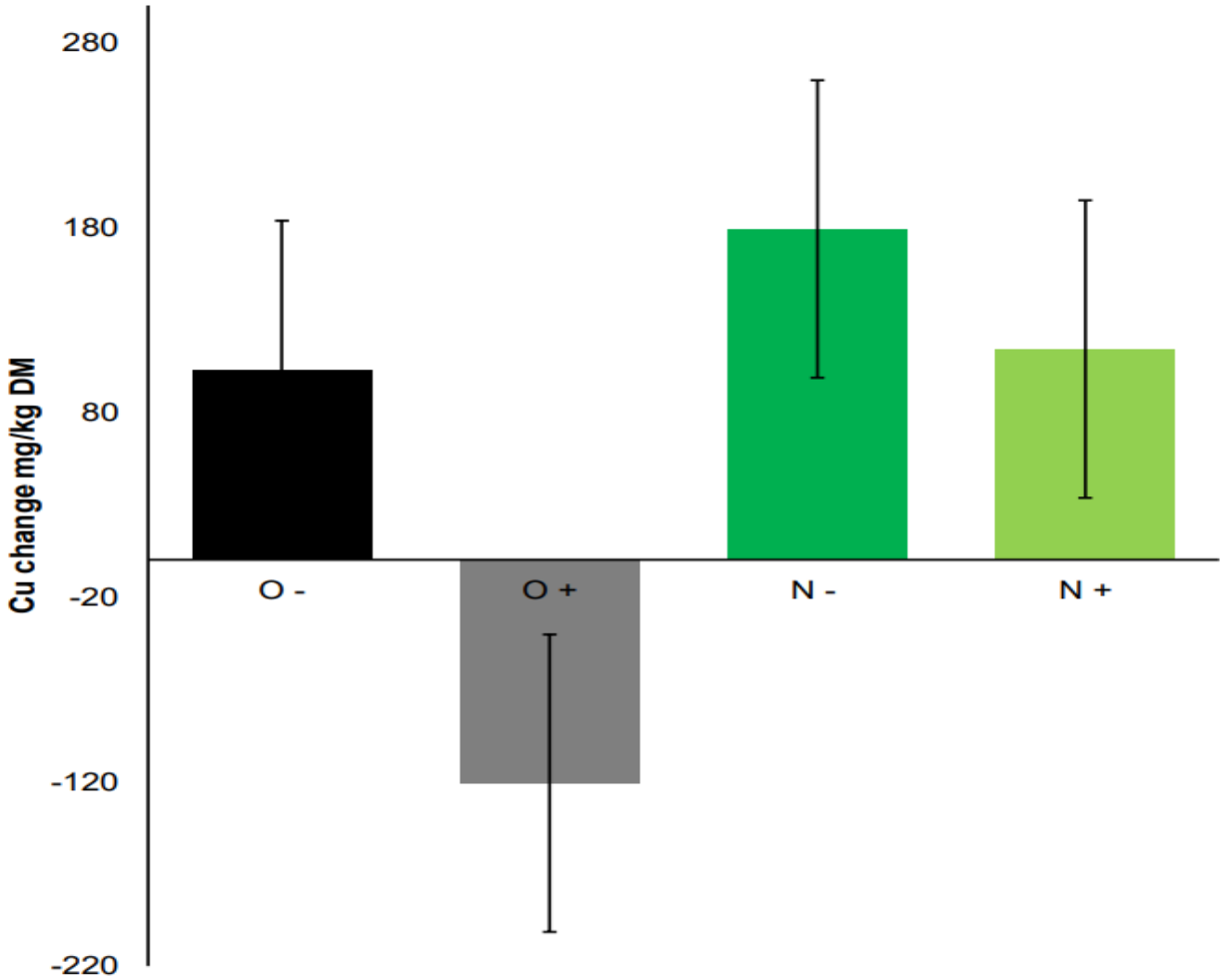
Supply an adequate, but not excessive amount, and consider response

MINERAL AUDIT

- Analyse mineral input
  - Diet, forage & concentrates
  - Water
  - Other supplements
- Are there antagonists in the diet?
- What source is the mineral in?

Can analyse animal performance and use veterinary diagnostics

MINERAL ELEMENT (DM BASIS)			ASSAY	VERY LOW	LOW	MEAN	HIGH	VERY HIGH
Calcium	Ca	%	0.61	0.3	0.5	0.6	0.7	0.9
Phosphorus	P	%	0.35	0.2	0.3	0.35	0.4	0.55
Magnesium	Mg	%	0.19	0.1	0.15	0.2	0.25	0.4
Potassium	K	%	2.73	0.5	1.5	2	2.5	5
Sodium	Na	%	0.25	0.1	0.2	0.25	0.3	0.4
Chloride	Cl	%	0.98	0.3	0.6	1	1.4	2
Sulphur	S	%	0.24	0.1	0.15	0.2	0.25	0.4
Cation-Anion Balance		meq/kg	381	50	100	200	300	500
Manganese	Mn	mg/kg	106	50	75	100	125	200
Copper	Cu	mg/kg	7.5	5	8	10	12	15
Zinc	Zn	mg/kg	30.1	25	40	60	80	130
Cobalt	Co	mg/kg	0.25	0.1	0.2	0.25	0.3	0.4
Iodine	I	mg/kg	0.49	0.25	0.5	1	1.5	2
Selenium	Se	mg/kg	0.09	0.05	0.1	0.15	0.2	0.25
Boron	B	mg/kg	7.5	1	2	4	6	10
Iron	Fe	mg/kg	427	50	100	150	200	350
Aluminium	Al	mg/kg	156	25	50	100	150	300
Molybdenum	Mo	mg/kg	1.91	0.1	0.35	0.8	1.25	2
Lead	Pb	mg/kg	0.76	1	2	2.5	3	10
Relative Copper Antagonism								
Soil Contamination Index								



THE LATEST RESEARCH, NOT ALL MINERAL SOURCES ARE EQUAL

Williams *et al*, 2024

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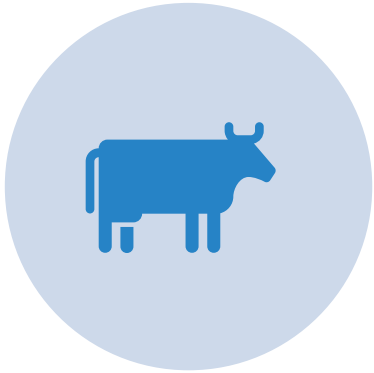
WHAT ABOUT EXCESSIVE SUPPLY?

For some minerals this is more important than others

EXPENSIVE!



EFFECT ON ANIMAL PERFORMANCE

EXCRETION INTO ENVIRONMENT

COPPER

- Generally, over supplied to dairy cows in the UK
- Essential as a mineral, but negative effects if over-supplied
- Think of life-time of the animal

Paper

OPEN ACCESS

Liver copper concentrations in cull cattle in the UK: are cattle being copper loaded?

N. R. Kendall, H. R. Holmes-Pavord, P. A. Bone, E. L. Ander, S. D. Young

With the release of the Department for the Environment, Food and Rural Affairs/Advisory Committee on Animal Feed Guidance Note for Supplementing Copper to Bovines it was noted that the current copper status of the national herd was not known. Liver samples were recovered from 510 cull cattle at a single abattoir across a period of three days. The samples were wet-ashed and liver copper concentrations determined by inductively coupled plasma mass spectrometry analysis. Breed, age and previous location information were obtained from the British Cattle Movement Service. Dairy breeds had higher liver copper concentrations than beef breeds. Holstein-Friesian and 'other' dairy breeds had 38.3 per cent and 40 per cent of cattle above the Animal Health and Veterinary Laboratories Agency (AHVLA) reference range (8000 μmol/kg dry matter), respectively, whereas only 16.9 per cent of animals in the combined beef breeds exceeded this value. It was found that underlying topsoil copper concentration was not related to liver copper content and that age of the animal also had little effect on liver concentration. In conclusion, over 50 per cent of the liver samples tested had greater-than-normal concentrations of copper with almost 40 per cent of the female dairy cattle having liver copper concentrations above the AHVLA reference range, indicating that a significant proportion of the UK herd is at risk of chronic copper toxicity.

Intake → Liver → Blood

COPPER

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Accumulation in the liver happens throughout the lifetime of the cow.

Starting *in utero*.

Lifetime consideration is a MUST for optimum animal performance.

Insufficient

Insufficient copper, reduces milk yield, fertility, growth rates and impairs the immune system

Balanced/ Optimum

Excess

Excess copper, reduces milk yield in early lactation and reduces conception rates. And causes liver damage

New research from Harper Adams University on optimum liver copper concentration, coming very soon!

Marsh *et al*, 2025 (under review)

IODINE

- Lots of herds being fed above the recommended iodine intake
- Milk is the major excretory pathway for iodine
- Directly impacts iodine concentration in milk

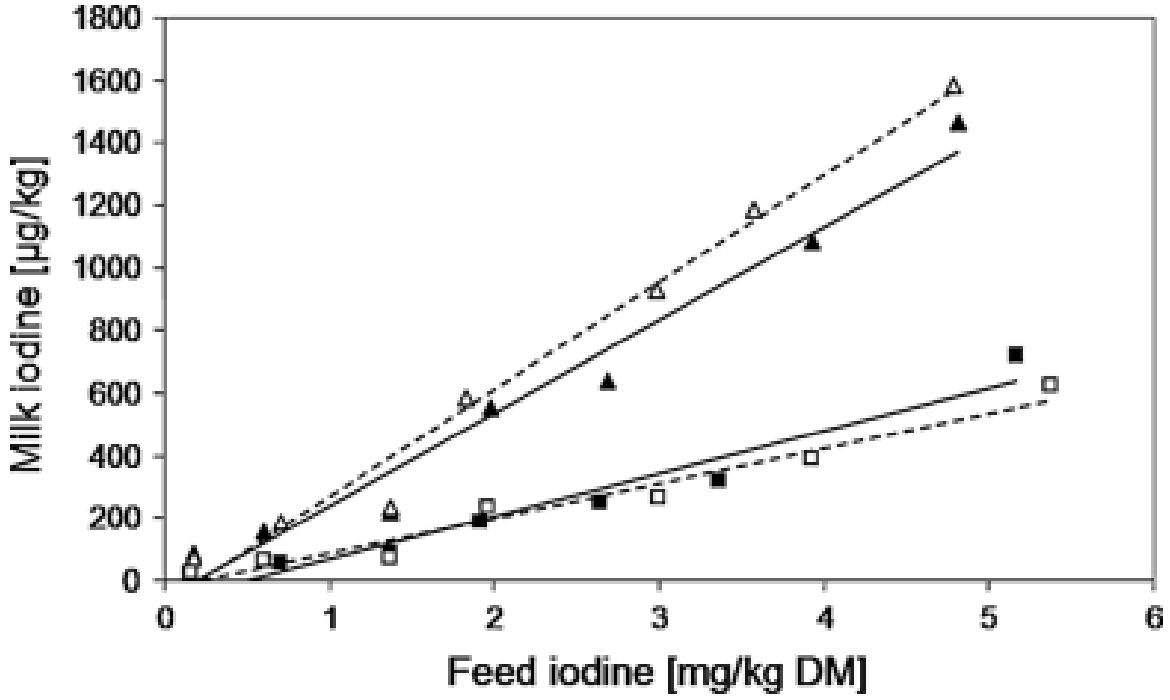
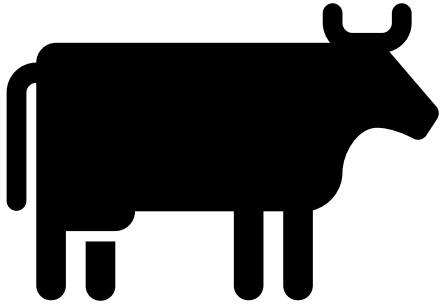


Fig. 2 Dependence of the milk iodine concentration on the kind of iodine supplementation in diets without and with iodine antagonists via RSM ($n = 8$, *filled triangle*, DDGS/iodide; *open triangle*, DDGS/iodate; *filled square*, RSM/iodide; *open circle*, RSM/iodate). *DDGS* distillers dried grains with solubles; *RSM* rapeseed meal [50, 51]

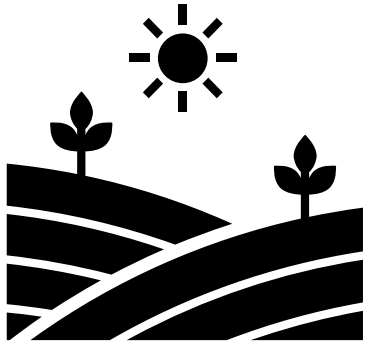
Flachowsky *et al*, 2014

RESPONSE TO MINERAL PROVISION

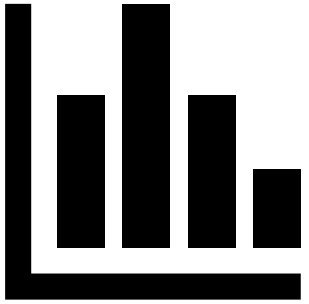
DCAD is a classic example of response: changing mineral provision, outside of requirement to enhance cow production.



Animal



Environment



Evidence

ZINC; SOME EXAMPLES OF RESPONSE

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Inconsistent reports of improved growth rate in cattle.

Linked to protein response, with optimisation of protein, energy balance.

Increased N retention has been demonstrated with increased Zn in diet

Weiss & Hansen, 2024

Zinc, has been reported to reduce pathogens associated with digital dermatitis

Evidence also for hoof strength and structure associated with other forms of lameness

Wenner *et al*, 2022

Early evidence that Zn may improve meat tenderness

Schulte *et al*, 2023

FINAL THOUGHTS…

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1. Mineral nutrition is complex!

2. Getting the balance right, to optimise the system is critical for animal health and performance.

3. We need to think long term when thinking about balancing diets, but ensure resilience during critical times in the production cycle.

4. Research is always evolving in mineral nutrition, knowledge is increasing in feeding the high performing dairy cow and will continue to evolve.

Thankyou

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Nuffield Farming Scholarship: Mineral Advice in Ruminants are we getting it right?