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PHOTO BY SHAUNA ROSE HERMEL

Minerals— AI's Hidden Ally

Three trace minerals and one macromineral hold particular relevance to seedstock producers who want to maximize their reproductive potential.

by ***Ed Haag***

Dale ZoBell, Utah State University professor and Extension beef specialist, says today's livestock nutritionists are faced with a dilemma when it comes to researching the role minerals play in the well-being of beef cattle.

"The problem with any mineral study is that there are so many interrelationships," he says. "It is really difficult to attribute a result to a single cause."

He adds that this impediment applies to every aspect of mineral research, including reproduction.

The scarcity of published studies on the effects of supplementation on conception rates in beef cows doesn't mean minerals are any less relevant to the reproductive process. Producers should understand that economizing on the most important of these supplements could affect their bottom line.

This is becoming increasingly evident as a growing number of scientists respond to the challenge and develop research models that effectively isolate the effects of specific minerals on cattle.

Copper, zinc and manganese

Strategic supplementation of three important minerals leads to higher conception rates in artificially inseminated (AIed) beef cows when compared with animals that did not receive mineral supplementation.

An excellent example of this type of research was a two-year study reported in the *Journal of Animal Science* and conducted by a team from Colorado State University led by Jason Ahola, beef Extension specialist at the University of Idaho. It confirmed what was long-suspected by animal nutritionists — that trace minerals copper (Cu), zinc (Zn) and manganese (Mn) played an important part in reproduction.

It also showed, in the second year of the study, that AIed beef cows that were strategically supplemented with National Research Council (NRC)-recommended levels of copper, zinc and manganese during critical reproductive periods had measurably higher pregnancy rates than those that were denied these three trace minerals during an extended period of time. This was particularly true when insemination was administered based on an observed estrus.

"Strategic supplementation is feeding cows minerals around the time of physiological need," Ahola says, adding that this critical period in beef cows is just before calving through rebreeding. "We would start supplementing in January and end it in late June."

The study

As Ahola explains, the study involved the same animals over a two-year period. One hundred and seventy-eight crossbred beef cows participated in the first year of the study. A remaining 148 completed the last year.

Cows were stratified by expected calving date, age, body weight, body condition score (BCS) and liver mineral status and assigned to one of three groups. A control group received no copper, zinc or manganese supplement during the entire 24 months of the study. A second group received 50% organic and 50% inorganic copper, zinc and manganese. A third group received those three minerals in a 100% inorganic form.

All supplemented animals received their minerals through free-choice feeders at recommended NRC concentrations. Strategic supplementation periods lasted 192 days the first year and 216 days the second.

While in Year 1 the pregnancy rates to AI in control cows and supplemented cows were the same, there was a substantially different outcome in Year 2. Ahola notes that on almost all levels, the groups that were fed the trace minerals with their diet had measurably higher pregnancy rates when compared with their control group counterparts.

"In that second year the cows who had not received the three supplemental minerals for over a year had a harder time breeding back to that synchronized AI," he says, adding that the pregnancy rates to AI in both supplemented groups were at least 20 percentage points higher than the control group.

Other factors

ZoBell, who works with seedstock producers on a regular basis, says that it isn't just the individuals who fail to provide any trace mineral supplements to their cows who could be facing mineral-related reproductive problems. Cattle can be receiving some trace minerals but not enough to support their systems during that critical period from late pregnancy through conception.

"You are asking them to produce a calf, to produce milk and then to rebreed," ZoBell says. "Everything has got to be in sync, all their requirements have to be met, or something is going to slip."

He notes that there is a fine line between feeding the appropriate levels of minerals and shorting those animals of the necessary nutrients. ZoBell adds that under-supplemented animals rarely show any overt sign of a mineral deficiency.

"You can walk out into a herd and if they are energy-deficient their condition score is lower," he says, noting the visibility of the deficiency. "With minerals you can't do that."

ZoBell points out that ranchers who think they are feeding their cows adequate levels of minerals may actually be failing to do so. "Every animal is an individual, and there is no guarantee that all cows are going to consume what they require," he says.

Not all cows are equal

This became evident to researchers conducting a supplement intake study at Montana State University. When feeding a total protein, energy and mineral package, they quickly discovered that supplement allotment among the cattle in the study was far from equitable, with the average dry-matter (DM) supplement intake being 33% lower for 3- and 4-year-old cows compared to 8- and 9-year-olds.

It was determined from observations that older, larger animals held a dominant position in the herd hierarchy and were successful in monopolizing the self-feeders. Only by segregating the cows in the herd into separate age groups were they successful in changing the dynamics responsible for the inequitable division of supplements.

Outside of modifying the hierarchy, another issue to emerge from the Montana study was the role that competition at the feeder played in the distribution of supplements. Contradicting intuitive thinking, the research team discovered that a certain amount of competition could actually increase the likelihood of more animals receiving supplements. While too much competition prevented smaller

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Table 1: Least squares means for initial body weight, body condition score, age and liver mineral status of multiparous cows

	Treatments		
Item	**Control**	**ORG[a]**	**ING[b]**
No. of cows	59	60	59
Age, years	5.83	6.17	5.71
Body weight, kg	619.4	616.1	615.3
Body weight, lb.	1,366	1,358	1,356
BCS[c]	5.91	5.97	5.97
Initial liver mineral status:			
Cu, mg/kg of DM	55.1	42.8	66.5
Zn, mg/kg of DM	99.7	98.2	99.2
Mn, mg/kg of DM	7.2	6.7	7.2

[a]ORG = 50% organic and 50% inorganic Cu, Zn and Mn.

[b]ING = 100% inorganic $CuSO_4$, $ZnSO_4$ and $MnSO_4$.

BCS: 1 = emaciated; 9 = obese (Richards et al., 1986).

Table 2: Ingredient composition and laboratory analysis of three trace mineral treatments

	Trace mineral treatments		
Item	**Control**	**ORG[a]**	**ING[b]**
Ca_2PO_4, %	52.0	52.0	52.0
NaCl, %	21.5	21.5	21.5
Dried distillers' grain, %	15.6	15.6	15.6
MgO (52%), %	4.9	4.9	4.9
Soybean oil, %	4.0	4.0	4.0
Se (0.16%), %	1.9	1.9	1.9
Anise-fenugreek dry, %	0.11	0.11	0.11
EDDI[c] (79.6%), %	0.009	0.009	0.009
Chemical analyses:			
Ca, %	10.7	10.7	10.7
P, %	11.4	11.4	11.4
Cu, mg/kg of DM	6.2	1,038.2	1,087.2
Zn, mg/kg of DM	17.1	3,173.1	3,241.0
Mn, mg/kg of DM	15.2	2,921.3	2,895.3

[a]ORG = 50% organic and 50% inorganic Cu, Zn and Mn.

[b]ING = 100% inorganic $CuSO_4$, $ZnSO_4$ and $MnSO_4$.

EDDI = ethylenediamine dihydroiodide.

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animals from feeding, too little competition encouraged animals to fight rather than feed. It was determined that the ideal goal was to size the feeder space so that it encouraged a continual rotation of animals accessing the supplements.

In some circumstances, the researchers found the best way to make sure all animals received their necessary supplementation was to change how they were fed. They noted that cows responded differently to each system used. For example when supplements were hand-fed, there was less variation in intake between cows than there was on self-fed systems.

More is better

The Montana researchers also determined from their study that increasing the target amount of supplements from 2 pounds (lb.) per cow to 5 lb. per cow per day contributed to the likelihood that more cows would consume supplements and the variability between high consumers and low consumers would be narrowed.

This doesn't necessarily mean that the overall cost of supplementation would have to increase. Feeding frequency can be reduced to compensate for the change.

In their final recommendations, the Montana researchers noted that one of the most practical and cost-effective ways to ensure that beef cows will consume mineral supplements as adults is to condition them to consume them as calves.

For heifers and young adult cows that are not already conditioned to consuming supplements, the researchers recommend they be confined to an enclosed area with easy access to supplements for a few days before being released onto the range.

Nutritionist input valuable

Modifying the feeding environment, increasing access and conditioning cows from an early age to consume supplements are effective tools in helping improve the chances that all cows receive their needed supplement levels, but ZoBell is quick to note that there are some environmental conditions that can jeopardize any free-choice supplement feeding strategy.

"If you are in a location with high sodium levels in the water or it is particularly alkaline and you put minerals out, it is hard to get cows to eat them," he says. "Free choice may not be the answer in that case."

ZoBell says one of the best ways a producer can ensure each of his cows is consuming the minerals she needs to support her reproductive system is to spend some time with a qualified nutritionist who can evaluate the operation's supplementation program.

From his own experience interacting with livestock producers, ZoBell says he is always surprised at what they can overlook if they are working without professional input. He cites, as an example, how a seemingly conscientious producer inadvertently under-supplements his animals by feeding all his cows the same level of supplements regardless of size.

"You put a 1,600-pound cow against a 1,200-pound cow; her requirements are higher," he says. "To get her to recycle and do everything she is supposed to do, it is going to take more groceries, including the minerals."

Phosphorous also important

ZoBell adds that one mineral that is likely to be affected by this discrepancy is phosphorous. "It is one of those minerals that is involved in everything from metabolism to reproduction," he says. "Phosphorous is a macromineral, so it is needed in larger quantities than the trace minerals."

Studies that date back to the King Ranch of Texas in the 1930s have shown that a phosphorous deficiency will have a negative effect both on conception and calf survival.

Because levels of this mineral are usually high in grains and low in forage, cheap corn was, until recently, an excellent source of phosphorous for seedstock cattle.

While those who are now feeding distillers' grains (DGs) — also high in phosphorous — may not need to worry about meeting their animals' phosphorous requirements, those on strictly forage-based diets may be facing a phosphorous deficiency and the reproductive problems associated with that deficiency.

"The bottom line is find out the requirements for your herd and then, if deficient, feed minerals to compensate for that deficiency," ZoBell says.

Table 3: Reproductive performance of cows supplemented with different trace mineral treatments[a]

	Treatments		
Item	**Control**	**ORG[a]**	**ING[c]**
Estrous cyclicity[d]	26% (11/43)[i]	28% (13/46)	23% (11/47)
Estrus observed within 72 hours of $PGF_{2\alpha}$ administration	83% (80/96)	77% (78/101)	77% (79/103)
Pregnancy rate to AI (Year 1)[e]	65% (34/52)	67% (36/54)	52% (29/56)
Pregnancy rate to AI (Year 2)[e]	34% (15/44)	57% (26/46)	58% (25/43)
Pregnancy rate of AI if observed in estrus[f]	58% (46/80)	77% (59/77)	65% (49/75)
Pregnancy rate of AI if mass-inseminated[g]	19% (3/16)	13% (3/23)	21% (5/24)
Overall pregnancy rate after 60-day season[h]	89% (85/96)	93% (94/101)	95% (98/103)

[a]Values reported are percentages, with ratios in parentheses.

[b]ORG = 50% organic and 50% inorganic Cu, Zn and Mn.

[c]ING = 100% inorganic $CuSO_4$, $ZnSO_4$ and $MnSO_4$.

[d]Percentage of estrous cyclicity at the beginning of the breeding season was evaluated in Year 2 only via the collection of two blood samples at 10-day intervals. Cows were identified as "cycling" if at least one blood sample had a serum progesterone concentration greater than 1.0 ng/mL, indicating the presence of a functional corpus luteum (CL).

[e]There was a year × treatment interaction ($P<0.02$) for pregnancy to AI, so data could not be pooled across years. For each year, the value includes all cows in the study because all cows were inseminated once (either based on an observation of estrus with 72 hours after $PGF_{2\alpha}$ administration or via mass-insemination at 72 hours after $PGF_{2\alpha}$ administration.

[f]Values reported include only cows observed in estrus within 72 hours of $PGF_{2\alpha}$ administration and inseminated based solely on this observation of behavioral estrus.

[g]Values reported include only cows never observed in estrus and subsequently mass-inseminated at 72 hours of $PGF_{2\alpha}$ administration.

[h]Overall 60-day pregnancy rate includes data from both years 1 and 2.

[i]Number of animals observed per number of animals evaluated.