

## ARSBC 2012: Herd Fertility Nutrition

# Nutrition and Reproduction

Energy, protein go hand in hand for reproductive benefits.

by Kasey Miller, associate editor

‘R’eproduction is the single most important factor associated with economic success of the cow-calf producer,” said Scott Lake, assistant professor of animal science at the University of Wyoming. He explained how nutrition directly affects reproduction to nearly 350 participants at the Applied Reproductive Strategies in Beef Cattle (ARSBC) symposium in Sioux Falls, S.D.

It is important for the calving interval to be every 365 days, not just within every calving season, Lake said. The longer the postpartum anestrous period, the more likely a cow is to get culled. Generally, he added, 2- and 3-year-olds are the most likely to fall out because their continued growth demands more nutrients. The magic number is for a cow to conceive a calf 83 days after calving, and the biggest reason why cows don’t hit that number is inadequate nutrition.

If cows or first-calf heifers have a body condition score (BCS) of 5 or 6 at calving, the postpartum anestrous period shortens dramatically to 50-60 days, Lake observed. Conception rates also increase to 85%-90%.

Additionally, nutrition during pregnancy affects the calves *in utero*, he noted. Calves

can weigh 40 more pounds (lb.) at weaning if the cow is in BCS 5-6. Granted, he said, milk production can be a factor to a degree, but nutrition of the cow greatly affects the calf’s potential.

“Cows need to be in the condition we want them in by the time they calve,” Lake emphasized. It is much harder to put on weight after calving.

“Most cases of protein, mineral and vitamin deficiencies are confounded with energy,” he said. It is very difficult to rank importance of energy and protein because of this.

As long as crude protein (CP) and total digestible nutrient (TDN) requirements are met, he explained, it doesn’t matter the source, as long as it is of good quality. Inadequate protein intake can result in reduced pregnancy rates in cows whose diets contain equal energy.

He warned that protein-supplement effects are dependent upon the environment and the cow’s age. Protein also needs corresponding energy to work properly. Protein and energy go hand in hand.

He urged producers to slow down and



PHOTOS BY TROY SMITH

► The biggest reason cows fail to conceive within 83 days of calving — the magic number to maintain a 365-day calving interval — is inadequate nutrition, explained Scott Lake.

feed cattle correctly. He concluded it doesn’t matter the quality of semen for breeding or technician, reproduction won’t work without proper nutrition.

Lake spoke during Tuesday’s session focused on herd fertility and nutrition. Visit [www.appliedreprostrategies.com/2012/SiouxFalls/newsroom.html](http://www.appliedreprostrategies.com/2012/SiouxFalls/newsroom.html) to listen to his presentation and to view the accompanying PowerPoint and proceedings paper.



► To calculate mineral needs, Cody Wright advised producers to first figure out the animals’ requirements and then determine mineral content of primary sources such as forage, feeds, supplements and water.

## Mineral Mystery

SDSU professor explains the mystery of minerals and their effect on reproduction.

by Kasey Miller, associate editor

‘M’inerals are essential for the proper function of numerous physiological processes. From a production perspective, proper mineral nutrition is critical for metabolic function, health and reproduction. Unfortunately, mineral nutrition is one of the most complicated and least understood components of nutrition,” Cody Wright, a South Dakota State University animal science professor, explained to nearly 350 participants of the Applied Reproductive Strategies in Beef Cattle (ARSBC) symposium in Sioux Falls, S.D., Dec. 3-4, 2012.

Wright explained that the biggest challenge of feeding minerals is their concentration and availability in feed. For instance, mineral availability in grazed forages can vary simply by soil type. When he was with extension, he said some of the most-asked questions from producers were about mineral availability in feeds or supplements. Most often, they found that the formulation of minerals was fine, but the cow didn’t intake enough of it, eating, for example, 1 ounce (oz.) instead of the formulated 3 oz.

Required macro-minerals for reproduction

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## Mineral Mystery CONTINUED FROM PAGE 140

include calcium, phosphorus (the two largest requirements), magnesium, potassium, sulfur, chlorine and sodium. Trace, or micro-, minerals include cobalt, iodine, manganese, zinc, copper, iron and selenium.

Trace minerals are needed in parts per million (ppm), but can drastically affect animal performance and function. To put

parts per million into perspective, Wright noted that 1 ppm is the equivalent of 1 inch within 15.8 miles. However, these small components definitely make a large impact in an animal, he added.

### Calcium (Ca)

Calcium is most well-known for being a

component of bones, as 99% of the body's calcium is found in the skeleton, but it also plays a large part in reproduction. Wright said calcium is closely tied to sperm motility and ability to enter the egg. The physiological changes in the reproduction cycle change the requirements of calcium. It is important to have enough calcium during the breeding season especially.

In most circumstances, he said, very little

**Table 1: Nutrient requirements of beef cows (1,000-lb. mature weight)<sup>a</sup>**

	Months since calving											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>10-lb. peak milk production:</b>												
Ca, %	0.24	0.24	0.23	0.22	0.20	0.19	0.15	0.15	0.15	0.24	0.24	0.24
P, %	0.17	0.17	0.16	0.15	0.14	0.14	0.11	0.11	0.11	0.15	0.15	0.15
<b>20-lb. peak milk production:</b>												
Ca, %	0.30	0.32	0.30	0.27	0.24	0.22	0.15	0.15	0.15	0.24	0.24	0.24
P, %	0.20	0.21	0.19	0.18	0.17	0.15	0.11	0.11	0.11	0.15	0.15	0.15
<b>30-lb. peak milk production:</b>												
Ca, %	0.35	0.38	0.35	0.32	0.28	0.25	0.15	0.15	0.15	0.24	0.24	0.24
P, %	0.22	0.24	0.22	0.21	0.19	0.17	0.11	0.11	0.11	0.15	0.15	0.15

<sup>a</sup>Adapted from *Nutrient Requirements of Beef Cattle* (National Research Council, 2000).

**Table 2: Nutrient requirements of beef cows (1,200-lb. mature weight)<sup>a</sup>**

	Months since calving											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>10-lb. peak milk production:</b>												
Ca, %	0.24	0.25	0.23	0.21	0.20	0.19	0.15	0.15	0.15	0.26	0.25	0.25
P, %	0.17	0.17	0.16	0.15	0.14	0.14	0.12	0.12	0.12	0.16	0.16	0.16
<b>20-lb. peak milk production:</b>												
Ca, %	0.29	0.31	0.29	0.26	0.24	0.22	0.15	0.15	0.15	0.26	0.25	0.25
P, %	0.19	0.21	0.19	0.18	0.17	0.15	0.12	0.12	0.12	0.16	0.16	0.16
<b>30-lb. peak milk production:</b>												
Ca, %	0.34	0.36	0.34	0.31	0.27	0.25	0.15	0.15	0.15	0.26	0.25	0.25
P, %	0.22	0.23	0.22	0.20	0.18	0.17	0.12	0.12	0.12	0.16	0.16	0.16

<sup>a</sup>Adapted from *Nutrient Requirements of Beef Cattle* (National Research Council, 2000).

**Table 3: Nutrient requirements of beef cows (1,400-lb. mature weight)<sup>a</sup>**

	Months since calving											
	1	2	3	4	5	6	7	8	9	10	11	12
<b>10-lb. peak milk production:</b>												
Ca, %	0.23	0.25	0.23	0.21	0.20	0.19	0.16	0.16	0.16	0.27	0.26	0.26
P, %	0.17	0.17	0.16	0.15	0.15	0.14	0.12	0.12	0.12	0.17	0.17	0.17
<b>20-lb. peak milk production:</b>												
Ca, %	0.28	0.30	0.28	0.26	0.24	0.22	0.16	0.16	0.16	0.27	0.26	0.26
P, %	0.19	0.20	0.19	0.18	0.17	0.16	0.12	0.12	0.12	0.17	0.17	0.17
<b>30-lb. peak milk production:</b>												
Ca, %	0.33	0.35	0.32	0.30	0.27	0.24	0.16	0.16	0.16	0.27	0.26	0.26
P, %	0.22	0.23	0.21	0.20	0.18	0.17	0.12	0.12	0.12	0.17	0.17	0.17

<sup>a</sup>Adapted from *Nutrient Requirements of Beef Cattle* (National Research Council, 2000).

supplemental calcium is necessary for cattle grazing early in the growing season. As forages mature, though, supplemental calcium may be needed. However, the ratio of calcium to phosphorus should be maintained between 1½:1 and 7:1 to avoid an imbalance.

### Phosphorus (P)

Phosphorus is the second-most-abundant mineral in the body, with 80% in the bones and teeth.

“It is also an essential component of DNA and RNA, phospholipids, and has a key role in a host of metabolic processes. Given the importance of phosphorus to so many physiological processes, it is not surprising that it can impact reproduction,” he said.

Many studies have resulted in conflicting data on the effect of phosphorus in reproduction. One study showed higher pregnancy rates with supplemented phosphorus; another showed no change in pregnancy rates but increased weaning weights of supplemented dams’ calves. Another study showed no response to phosphorus supplementation during normal years, but did see response in drought years. Clearly, he observed, there is still much research to be done.

Distillers’ grains are a good source of

phosphorus, so he recommended working with an extension agent to evaluate whether using distillers’ grain could significantly reduce supplementation costs.

### Copper (Cu)

Copper is tied to enzyme systems. A copper deficiency can result in delayed or depressed estrus, he explained.

The biggest problem with copper is the negative effects of interactions with sulfur and molybdenum (Mo). The combination of sulfur and molybdenum in the rumen forms thiomolybdates, which then form insoluble complexes with copper, thereby reducing its absorption.

Because of this, Wright shared that recent thoughts in the scientific community actually blame copper deficiency problems on molybdenum. Molybdenum binds copper molecules and makes them unusable and even pulls stored copper from the body.

“Given the relatively high concentrations of molybdenum in feeds and forages and the amount of high-sulfate water and feeds, i.e. distillers’ coproducts, copper deficiency is arguably the most common mineral concern in the Upper Great Plains,” Wright clarified.

He did say that copper supplementation can solve the problem.

### Iodine (I)

Iodine plays a vital part in thyroid hormones. Iodine deficiency impairs thyroid function and can result in goiter and suppressed estrus. Iodine deficiency can also lead to infertility, sterility, and poor conception rates in females, and decreased libido and semen quality in males.

Wright explained that cover crops like turnips and radishes have become popular feed for ruminants, but these cover crops can also contain compounds called goitrogens, which interfere with thyroid hormone production. He recommended making sure that iodine is in the diet to counteract these goitrogens, which can be solved with iodized salt.

### Manganese (Mn)

Manganese is among the least well-researched trace minerals. It is linked to the function of the corpus luteum and the synthesis of cholesterol and sex hormones. He said that a deficiency in manganese can result in reduced or irregular estrus, reduced conception rates, and abortions and stillbirths. Manganese deprivation has also been shown to restrict testicular growth in rams.

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**Table 4: Requirements and maximum tolerable concentrations of minerals in beef cow diets**

Mineral	Unit	Gestation <sup>a</sup>	Early lactation <sup>a</sup>	Maximum tolerable concentration <sup>b</sup>
Calcium	%	Refer to Tables 1-3, page 142		1.5
Chromium	ppm (mg/kg)	---	---	100 <sup>c</sup>
Cobalt	ppm (mg/kg)	0.10	0.10	25
Copper	ppm (mg/kg)	10	10	40
Iodine	ppm (mg/kg)	0.50	0.50	50
Iron	ppm (mg/kg)	50	50	500
Magnesium	%	0.12	0.20	0.6
Manganese	ppm (mg/kg)	40	40	2,000 <sup>d</sup>
Molybdenum	ppm (mg/kg)	---	---	5-10 <sup>e</sup>
Phosphorus	%	Refer to Tables 1-3, page 142		0.7
Potassium	%	0.60	0.70	2
Selenium	ppm (mg/kg)	0.10	0.10	5
Sodium	%	0.06-0.08	0.10	--- <sup>f</sup>
Sulfur	%	0.15	0.15	0.3 or 0.5 <sup>g</sup>
Zinc	ppm (mg/kg)	30	30	500

<sup>a</sup>Adapted from *Nutrient Requirements of Beef Cattle* (National Research Council, 2000).

<sup>b</sup>Adapted from *Mineral Tolerance of Animals* (National Research Council, 2005).

<sup>c</sup>When chromic oxide (Cr<sub>2</sub>O<sub>3</sub>) is fed, the maximum tolerable concentration is 3,000 ppm.

<sup>d</sup>If fed adequate concentrations of dietary iron.

<sup>e</sup>For copper-adequate cattle.

<sup>f</sup>Ruminants can consume 0.016 oz. salt (NaCl) per 1 lb. body weight.

<sup>g</sup>To prevent polioencephalomalacia (PEM), the maximum tolerable sulfur concentration is 0.3% for cattle consuming at 85% or more of their diet as concentrate and 0.5% for cattle consuming at least 40% forage in their diet. Dietary sulfur concentrations below the maximum tolerable concentrations may have adverse effects on copper absorption.

## Mineral Mystery CONTINUED FROM PAGE 143

Not much research has been done on supplemental requirements, but he said supplementing to meet the 40-ppm requirement is generally the best management practice.

### Selenium (Se)

Selenium is a component of several enzyme systems and serves as an antioxidant. Selenium deficiency can cause reduced immune function, reduced semen viability, retained placenta, cystic ovaries, endometritis, and white muscle disease.

This mineral can be challenging in that certain areas have an abundance of selenium to the point of toxicity, but other areas are deficient.

“Selenium supplementation should be based on the amount of selenium in the basal dietary ingredients. In some areas, supplementation will result in beneficial responses; in others it may be the straw that breaks the camel’s back relative to toxicity. Given the narrow window between the requirement and toxicity, feed analysis and careful formulation is as essential for selenium nutrition as for any other mineral,” he warned.

### Zinc (Zn)

Zinc is the most pervasive of the trace minerals; it is an integral component of more than 300 enzymes and is associated with many biological processes. Gene expression is an important process in which zinc is required, so zinc should not be underestimated, Wright noted.

Deficiencies can reduce growth, fertility and disease resistance. More specifically

in males, reduced testicular development, semen quality and libido are side effects of zinc deficiencies. He added that zinc supplementation has been shown to increase ejaculate volume, sperm concentration, percent live sperm and percent motility in bulls. While zinc supplementation is important, especially for a bull battery, he warned against wasting money by supplementing beyond the requirements.

### Inorganic vs. organic

The source of each mineral can have a dramatic impact on supplement effectiveness. In general, he said, inorganic sources are the most cost-effective means of supplying minerals to beef cattle. However, not all inorganic sources are created equal. Research suggests that sulfate and chloride forms of various minerals are the most bioavailable, followed by carbonates and oxides as the least. Copper oxide is the exception, though. He reported that copper oxide needles, administered as a bolus, are effective in delivering copper to cattle on forage-based diets.

Organic mineral sources are another option. He said positive responses to organic supplementation are most likely during stressful periods in the production cycle or when mineral antagonists (sulfur, molybdenum, iron or aluminum) are present in large amounts. Organic sources are more costly, and thus should be warranted by increased animal performance.

### Supplementation

To begin supplementing minerals, Wright recommended figuring out the animals’

requirements (which differ by production stage) and determining mineral content in primary sources such as forage, feeds, supplements and even water. Wright advised producers not to rely on book values for feedstuffs as there is too much variability across a region to rely on them.

“It’s a really worthwhile investment to do some testing to understand what those animals’ [unmet] requirements really are,” he asserted.

Knowing which supplements are needed most and which are available is integral, because too many minerals can produce toxicity and some minerals can interact adversely (such as copper and molybdenum), he warned. To avoid these issues, he recommended consulting professionals to help with mineral supplementation and analysis.

“Developing the most cost-effective mineral program is certainly not a formula that can be applied to every farm and ranch around the country. Producers should carefully evaluate their production system, its resources, level of production and production constraints to develop the most cost-effective program for their operation. Keep in mind that more expensive mineral supplements do not always correlate with increased production or performance,” he concluded.

Wright spoke during Tuesday’s session focused on herd fertility and nutrition. Visit [www.appliedreprostrategies.com/2012/SiouxFalls/newsroom.html](http://www.appliedreprostrategies.com/2012/SiouxFalls/newsroom.html) to listen to his presentation and view the accompanying PowerPoint and proceedings paper.





# Implications of Fetal Programming

A dam's nutrition has a direct correlation to her progeny's performance.

by Kasey Miller, associate editor

**T**he consequences of nutrient restriction must be considered not only for the individual animal performance, but also for the developing fetus," Rick Funston, associate professor and beef reproductive physiologist from the University of Nebraska West Central Research and Extension Center, North Platte, told participants of the Applied Reproductive Strategies in Beef Cattle (ARSBC) symposium in Sioux Falls, S.D.

There is no doubt that feed is the single greatest cost in beef production, he explained. He and his research team wanted to see if management practices could reduce the need for harvested forages and thereby decrease production costs. The challenge, he explained, is that dormant forages don't meet dietary requirements.

**Management of cows before calving affects the performance of calves before they are even born.**

Funston looked at how early-weaning calves or supplementing the mothers during gestation affected the performance of progeny, both as replacement females and feeder steers. He said pregnancy rates when rebreeding both groups of cows were the same, though the early-weaned calf was lighter by about 100 pounds (lb.) live weight, and 60 lb. carcass weight. He said it was most profitable to wean later and supplement the cow.

A similar study looked at the effect of dam supplementation on heifer and steer calves in a low-input system. There was no effect of supplementation at pregnancy, but there was a higher percentage of calves weaned on supplemented cows.

There was no difference among heifer calves in age at puberty and percentage cycling, but the heifers of supplemented



► Calves of supplemented cows performed better in all aspects except feed efficiency, noted Rick Funston. The calves that were born to unsupplemented mothers adapted to using fewer nutrients, but, consequently, suffered in performance.

cows had higher fertility rates. Management was only different before the calves were born.

"These calves are influenced in performance before they are ever born," Funston explained.

In steers, those born to unsupplemented dams graded lower than those born to supplemented dams. He reiterated that management of cows before calving affects the performance of calves before they are even born.

Overall, he said, calves of supplemented cows performed better in all aspects except feed efficiency. The calves that were born to unsupplemented mothers adapted to using fewer nutrients, but, consequently, suffered in performance.

Funston concluded that maternal nutrition influences fetal organ development, muscle development, postnatal calf performance, carcass characteristics and reproduction. He urged producers to manage their resources during gestation to improve calf performance and health later on.

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**Fig. 1: Effects of maternal nutrition on bovine fetal skeletal muscle development**

