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Does Mineral Supplementation Pay?

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Introduction

The Arizona Veterinary Diagnostic Lab (**AZVDL**) has determined that the primary reason for poor reproductive performance for beef cattle on Arizona rangelands is sub-optimal nutrition. Protein and energy content in the forage at certain times of the year can be lower than what is considered adequate. Trace mineral deficiencies can also be associated with syndromes that may not exhibit classic clinical signs of mineral deficiency but could result in sub-optimal production and reproduction. The AZVDL has done considerable investigation concerning micronutrient deficiencies in range cattle and has detected several trace mineral deficiencies in Arizona range forage, notably selenium, zinc, and copper.

In 1996, Dr. Larry Corah (formerly of Kansas State University, now with NCBA) and Dr. David Dargatz (APHIS) conducted a study (Corah and Dargatz, 1996) assessing trace mineral status with 352 forage samples from 18 states (Arizona not included). The most common element found to be deficient was zinc (deficient in 63.4% of samples), followed by cobalt (48.6%), and selenium (44.3%). Copper was deficient in 14.2% of samples and marginal in 49.7% of samples.

A large area of central Arizona from Roosevelt Lake eastward to the New Mexico border has been reported to be deficient in selenium (Kubota et al., 1967). Additional forage sampling has shown that the selenium deficient belt is much larger than originally thought. With preliminary sampling, it appears that most all of the broken Mogollon Rim country with volcanic derived or granitic soils are selenium deficient. Additionally, many of these areas also appear to be copper deficient. Also, it has long been known that sandy or swampy soils are generally deficient in copper. We suspect that most of the state is deficient in zinc.

Clinical signs of selenium deficiency in cattle include retained placentas, slipped or aborted calves, infertility, stillbirth, persistent diarrhea, mastitis, calf pneumonia, "ill thrift syndrome", immune suppression, neonatal weakness, and "white muscle disease" in calves (Maas, 1983; Corah and Ives, 1991). Additionally, subclinical nutritional deficiencies of selenium may reduce conception rates in beef cattle without producing clinical signs of selenium deficiency. Yamini and Mullaney (1985) reported a positive relationship between abortion and deficiency of selenium and or vitamin E in food animals. Selenium supplementation decreased cow weight loss during the first four weeks following calving (Cohen et al., 1989) and reduced the incidence of metritis (inflammation of the uterus), retained placenta, and cystic ovaries (Harrison et al., 1984). Selenium supplementation during mid-pregnancy for cattle grazing selenium deficient pastures increases colostral and post-suckle serum immunoglobulin G concentrations (Swecker et al., 1995) necessary for calf immunity. Selenium is a trace mineral needed in small amounts (.1 parts per million or 1 mg /kg of forage) and is a component of the enzyme glutathione peroxidase which is involved in protecting cellular membranes from oxidative damage (Radostits et al., 1994).

Conditioned copper deficiencies can occur in animals even when there appears to be adequate copper in the soil and plants. Copper is interfered with by other constituents in the diet, notably sulfur, iron, and molybdenum (Smart et al., 1986; Bremner et al., 1987; Gooneratne et al., 1989). It is well known that excess molybdenum in the diet will result in copper deficiency (Gooneratne et al., 1989; Suttle and Jones, 1989; Ladefoded and Sturup, 1995). We have found high molybdenum levels in range plants from some areas of the state. Infertility, increased disease susceptibility, and sometimes depressed growth rates can occur due to copper deficiency (Corah and Dargatz, 1996; Ward and Spears, 1997).

Subclinical, non-observable symptoms for zinc deficiencies are decreased immunity (Greene et al., 1998; Galyean et al., 1999) and reduced fertility of bulls (Puls, 1994). Additionally, there is some evidence of decreased fertility and abnormal estrous behavior in cows (Puls, 1994). Dairy cattle supplemented with a chelated mineral (zinc methionine) had less spontaneous abortions (Graham et al., 1992) and cattle supplemented with zinc have less foot rot (Puls, 1994).

Although it has been well reported that concentrations of macrominerals such as calcium and phosphorus increase in forage with increased moisture (Daniel and Harper, 1934; Midgley, 1937; Honeycutt et al., 1990; Grings et al., 1996), little is known about the correlation of forage micromineral concentrations to moisture. Radostits et al. (1994) reported that selenium uptake by plants decreased during high moisture periods. We can find several studies detailing the depletion of animal stores of microminerals over time, but there is a scarcity of data (Grings et al., 1996) concerning changes in range forage concentrations by season of year. This is especially true for the desert Southwest.

Some ranchers in Arizona are reluctant to utilize trace mineral supplements. Reasons often stated for the lack of using this management tool are: 1) cattle should be able to obtain what they need from the forage via selection; 2) lack of trace mineral palatability; 3) cost; 4) doesn't really work for improving production; 5) difficulty in dispensing mineral in rugged country; 6) I already put out white salt, what's the difference? or 7) I've never supplemented trace minerals in the past.

One objective of this study was to demonstrate the effectiveness (or lack of effectiveness) of an oral trace mineral supplement in raising trace mineral blood values of copper and selenium in range cattle. Another objective of this study was to see if trace mineral supplementation was economically feasible due to increased conception. Finally, we desired to gather data to identify how trace mineral concentrations varied by season of the year by pasture and among different range forage species.

Animal Requirements

Table 1 lists beef cattle nutrient requirements for trace minerals. Although we still need to do more research in trace mineral nutrition, the values in Table 1 are good guidelines to begin with.

Assessing Trace Mineral Adequacy

Table 2 lists tabular values for assessing the trace mineral status of beef cattle by either forage or animal blood or liver. Trace mineral status in beef cattle herds is commonly assessed in two ways: 1) Compare plant concentrations to animal requirements (e.g., Table 2 vs Table 1); and/or 2) Determine blood or liver trace mineral contents from a sampling of the herd (at least 10 cows). Liver biopsy samples are generally preferred to blood samples, especially for copper and zinc. *Unless cattle are deficient in copper (less than .60 ppm), blood copper is not considered a reliable indicator of trace mineral status.* The difficulty of obtaining liver biopsies are that they usually need be obtained by an experienced veterinarian to prevent infection. For copper samples, serum samples are preferred to whole blood samples. Serum copper levels can be increased by the trauma of obtaining blood. However, low serum copper levels can indicate severe deficiencies of copper stores in the liver. When serum copper levels are low it would indicate that liver stores are mostly depleted. At this time, whole blood selenium is thought to be a fairly good indicator of cow selenium status.

Table 1. Beef Cow Trace Mineral Requirements and Maximum Tolerable Levels in Forage, ppm

Mineral	Growth & Finishing	Gestation	Early Lactation	Max. Tolerable level
Chromium	-----------	-------------	-------------	1.0
Cobalt	.10	.10	.10	10
Copper[1]	10	10	10	100
Iodine	.50	.50	.50	50
Iron[2]	50	50	50	500
Manganese	20	40	40	1000
Molybdenum[3]	-----------	-------------	-------------	5
Nickel	-----------	-------------	-------------	50
Selenium[4]	.1	.1	.1	2
Zinc	30	30	30	500

Above requirements are parts per million (ppm) or mg per kg of feed or forage. Above table adapted from 1996 NRC Requirements of Beef Cattle. One kg = 2.205 lb.; 1 oz. = 28.3 g or 28,375 mg.

[1]Although Arizona is the copper state, many sites are deficient or marginally deficient in copper. Copper absorption can be negatively affected by high levels of molybdenum (if greater than 2 ppm), sulfur (if greater than .25%), and iron (if greater than 400 ppm). Researchers in Canada feel that copper requirements for cows in the last trimester of pregnancy should be increased to 25 ppm. This is because fetal liver copper stores increase at the expense of the maternal liver stores.

[2]Many areas of Arizona are already high in iron so that some nutritional consultants don't even put iron in the mineral supplement.

[3]The ideal copper:molybdenum ratio is 6.0 to 10.0:1. The minimum acceptable ratio is 3.0:1.

[4]Selenium absorption is negatively affected by sulfur over .25%. Recently, allowable dietary selenium intake has been increased to .3 ppm/unit of feed or forage for cattle by FDA.

Table 2. Classification of Liver, Blood, and Forage Samples for Mineral Adequacy, ppm

	Deficient	Marginally Deficient	Required, Minimum	Required, Maximum
Forage				
Copper	below 4	4 to 7	above 7	
Zinc	below 20	20 to 40	above 40	
Selenium[1]	below .1	.1 to .15	.16	.3
Blood				
Copper	below .4	.4 to .59	.60	1.5
Zinc			.8	1.4
Selenium	below .05	.05 to .08	.081	.16
Liver				
Copper			75 to 90	540
Zinc			80 to 90	730
Selenium			.08	.3

All values are expressed as parts per million (ppm) on a dry matter basis for forage, blood, or liver.
Above table adapted from various sources including Corah and Dargatz, 1996; Radostits et al., 1994; Baird-Levalley, 1996; Bagley et al., 1995; Puls., 1994.
[1]Some references consider .1 ppm selenium as adequate.

Materials and Methods

Range site. The study site for this experiment was at the X4 Ranch, a long time cooperator with Arizona Cooperative Extension, located approximately 18 miles northeast of Globe Arizona. The ranch ranges in elevation from approximately 4000 to 5160 feet and lies within the Arizona Interior Chaparral 38-1AZ major land resource area. Vegetation sampling sites were chosen from five upland pastures associated with Cellar-Lampshire -Rock outcrop soils on very shallow and shallow soils and Rock outcrop on granitic hills and mountains. The pastures chosen were grazed at least once each year in a modified Holistic Range Management grazing plan. Average and yearly rainfall data for the years of this study are presented in Table 3.

The understory perennial grassy vegetation predominantly consisted of curly mesquite, sideoats grama, three awn, hairy grama, lovegrass, cane beardgrass, sand dropseed, black grama, vine mesquite, fluff grass, junegrass, and bottlebrush squirreltail, with curly mesquite being the dominant grass. Cool season annual grasses consisted primarily of annual foxtail and red brome. Warm season annual grasses included six weeks grama and six weeks needle grama. Dominant annual forbs included filaree, Indian wheat, aster, and purslane, and dominant perennial forbs were yarrow, sweet clover and globemallow. Half-shrubs consisted predominantly of false mesquite, shrubby buckwheat, and Mormon tea. Shrubs were predominantly turbinella oak, Emory oak, manzanita , mountain mahogany, squawberry, mesquite, catclaw acacia , desert ceanothus, algerita, paloverde, desert agave, cholla, Engelmann prickly pear, hedge hog cactus, beargrass, yucca , crucifixion thorn, jojoba, saguaro cactus, and broom snakeweed. Trees were predominantly juniper and pinyon pine in the uplands and cottonwood, willow, Arizona walnut, and Arizona sycamore along riparian drainages.

Forage Sampling. Forage was sampled from 3 pastures (West, East, and Reveg) on 6 February, 25 April, and 24 May and from 5 pastures (West, East, Reveg, Indian Gardens, and Hudson) on 27 August and 24 November in 1997. In 1998, forage from all 5 pastures was sampled 3 February, 16 April, 20 June, 24 September, and 23 November.

The West pasture forage sampled over 2 years consisted of sideoats grama, curly mesquite, lovegrass, three awn, bottlebrush squirreltail, sand dropseed, hairy grama, cane beardgrass, shrubby buckwheat, filaree, annual red brome, annual foxtail, Indian wheat, and purslane with samples being obtained from a ridge top with a southern and eastern aspect.

The Reveg pasture was the lowest elevation range site (4200 feet) with gentle slopes and had been treated by root plowing and reseeding more than 20 years ago. Since that time, the brushy canopy (primarily mesquite) has reestablished but an understory of lovegrass, three awn, and shrubby buckwheat was present during this study. Annual red brome, annual six weeks grama, and annual six weeks needle grama were also sampled when available.

The East pasture forage samples were obtained from a ridge top with a northern aspect and consisted of sideoats grama, curly mesquite, three awn, bottlebrush squirreltail, hairy grama, junegrass, shrubby buckwheat, globemallow, annual red brome, annual foxtail, filaree, and Indian wheat.

The forage samples from the Indian Gardens pasture were obtained from a ridge with a southern aspect and consisted of sideoats grama, curly mesquite, bottlebrush squirreltail, three awn, sand dropseed, shrubby buckwheat, filaree, globemallow, annual red brome, and Indian wheat.

Forage samples from the Hudson pasture consisted of sideoats grama, curly mesquite, three awn, black grama, bottlebrush squirreltail, shrubby buckwheat, globemallow, sweet clover, filaree, and annual red brome and were obtained from both the east and west aspect of a narrow ridge top.

Grasses were hand clipped to ground level and current year leaders were clipped from the one half shrub sampled (shrubby buckwheat). The dominant grasses present in pastures (sideoats grama, curly mesquite, and/or lovegrass) and the half shrub, shrubby buckwheat, were sampled each sampling period. Other forage species were sampled during sampling periods according to availability and perceived palatability to cattle. For example, filaree was only sampled when it was elevated sufficiently off the ground for a cow to harvest it and annuals were not sampled when they had dried out and were prostrate on the soil surface. Likewise, cool season perennial grasses are somewhat marginal in this southern climate and were not available in sufficient quantity for sampling during all time periods due to moisture constraints.

Forage Analyses. Forage samples were analyzed for sulfur, molybdenum, copper, zinc, and selenium by the AZVDL in Tucson.

Animals. In May 1997, 60 lactating cattle of mostly Brazona breeding were equally and randomly assigned to either a control or treatment group. Cattle were approximately equal in age distribution among the different experimental groups. The treatment group of cattle remained with the majority of the cowherd and had access to an oral trace mineral supplement (Table 2) from mid-June until late August and from early September until mid-September 1997. The control cattle were placed in a different pasture (Indian Gardens) from the rest of the cowherd and did not have access to any type of trace mineral supplement although they did have access to white iodized salt. All cattle were placed together in a common herd (without access to a trace mineral supplement) on 20 Sep. 1997. Cattle remained in a common herd without mineral supplement until late May 1998. At that time, an oral trace mineral supplement was made available to all cattle.

Data Sampling for Cattle. Cattle were weighed, scored for body condition (1 to 9; 9 = fattest; Richards et al., 1986), and checked for pregnancy by rectal palpation on 24 May 1997, 20 Sep. 1997, and on 20 June 1998. Thirteen cows which were missing from the treatment group on 20 Sep. 1997 were also scored for body condition and checked for pregnancy on 11 Oct. 1997. There was 1 cow from the treatment group which did not have data collected after the first initial data collection. During the 20 Sep. 1997 data collection, there were two cows in the control group with missing data. In the 20 June 1998 data collection, one cow in the control group had missing data, respectively.

In all the 1997 data sampling periods for cattle, blood samples were obtained, cooled, and analyzed for whole blood selenium and serum copper by the AZVDL. The 13 samples for copper and selenium obtained on 11 Oct. 1997 were misplaced and never found. Consequently, blood selenium and copper means for treatment and control cattle in the fall of 1997 are for 28 and 16 cows, respectively. We did not obtain blood samples in 1998 due to all cattle having access to the trace mineral supplement for 20 to 30 days.

Pregnancy status for the 20 June 1998 sampling period was only analyzed for those cattle which were pregnant during September or October 1997. We done this to avoid confounding data for lactating vs nonlactating cattle.

Results

Climatic Conditions. As Table 3 shows, there was a difference in the rainfall pattern between 1997 and 1998, particularly in the late winter period. The winter of 1997 to 1998 was classified as a “stronger El Nińo” with a Southern Oscillation Index of -1.67 (Redmond, 1998). This was the strongest El Nińo since the winter of 1982 to 1983 (Redmond, 1998). During an El Nińo winter, the desert Southwest tends to be wetter than usual due to the changing jet stream influenced by warmer than usual water temperatures off the Mexican coast. It will be shown later that the increased winter moisture had an effect upon both macro- and micro-mineral concentrations. However, the effect was not the same for all trace minerals analyzed.

Overall Forage Trace Mineral Concentrations. There did not appear to be a problem of tie-up of either Se or Cu due to Mo (only 5% of forage samples had less than a 6:1 ratio of Cu to Mo) or S (average forage S value of .024%). Concentrations in forage of both Cu and Zn were marginally deficient at 7.0 ± .19 and 20.5 ± .53 ppm, respectively. Selenium in forage was deficient at 0.05 ± .002 ppm.

Seasonal Variation in Forage Trace Mineral Concentrations. There were no differences in forage Se, Cu, or Zn concentrations by year, but levels of Cu and Zn increased ($P < .01$) with increased winter and summer moisture, respectively (Figure 1). Selenium concentrations in forage did not appear to respond dramatically to either El Niño or late summer monsoon rains (Figure 2). The only time period in which Se increased significantly ($P < .001$) was from April to May 1997. There were 1.52 cm of rain recorded in Globe on 21 May and forage samples were collected on 24 May. The increase in Se observed from April to May could have been due to the precipitation which occurred three days prior to forage sampling, sampling error, or to different mechanisms of translocation for Se when compared to other trace minerals. Radostits et al. (1994) reported that Se concentration in forage was lowest during periods of heavy moisture.

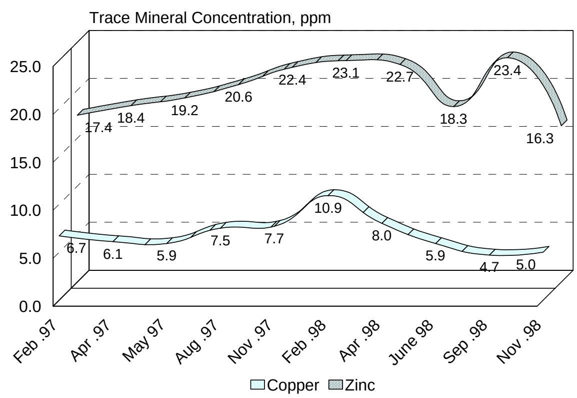


Figure 1. Concentration of copper and zinc in forage across time.

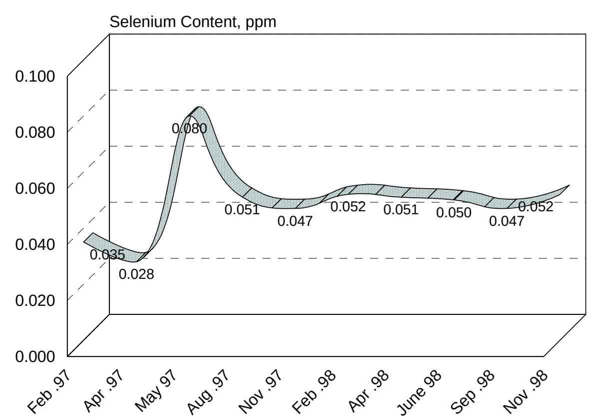
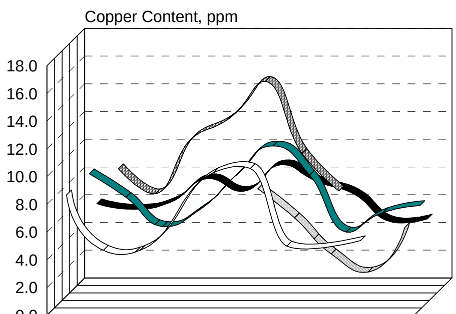


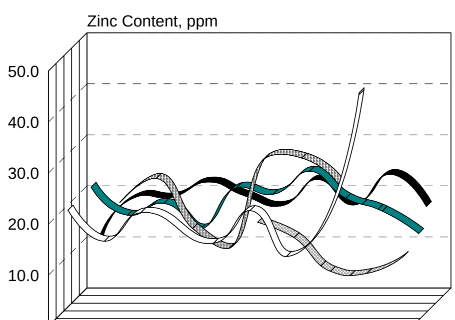
Figure 2. Concentration of selenium in forage across time.

Variation by Season for Different Forage Groups. Figures 3 to 5 show the seasonal variation in trace mineral concentrations by forage group for copper, zinc, and selenium, respectively. Copper concentrations in forbs were greater (*P* < .001) than for all other forage groups, which did not differ (*P* > .10). Zinc concentrations were greater in forbs (*P* < .05) than in shrubs and perennial grasses and tended (*P* < .10) to be greater than that observed for annual grasses. Unlike Cu, translocation of Zn in forbs did not appear to be favored across all seasons. There appeared to be an increase in Zn translocation in forage groups receiving increased moisture during key periods favorable to plant phenology. This was most noticeable with warm season annual grasses during Sept. 1998 (n = 2). The only forage group which exhibited pronounced cyclicity in Se concentrations was forbs. Annual grasses had less (*P* < .05) Se concentrations than did forbs, shrubs, and warm season perennial grasses. Cool season perennial grasses also tended (*P* < .10) to have less Se concentrations than did forbs, shrubs, and warm season perennial grasses.



	Feb .97	Apr .97	May 97	Aug .97	Nov .97	Feb .98	Apr .98	June 98	Sep .98	Nov .98	SD	n	$\bar{X}$
Annual Grasses	8.6	4.6	4.6		10.2	10.5	4.9		5.3		3.0	21	6.8 b
Cool Season Grasses						8.5	6.4	3.8	2.5	5.7	2.4	12	6.0 b
Forbs		9.4	7.6	11.6	13.0	15.7	10.5	7.8			3.6	30	11.3 a
Shrubs	8.5	6.8	4.7	5.9	8.4	10.5	8.4	4.3	5.7	6.2	2.4	39	6.9 b
Warm Season Grasses	5.8	5.4	5.9	7.6	6.7	8.6	7.4	6.5	4.5	4.7	1.9	126	6.2 b

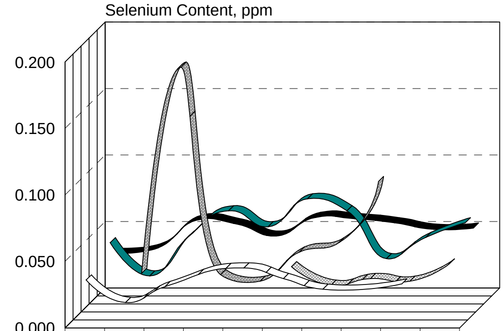
Figure 3. Seasonal variation in copper among forage groups.



	Feb .97	Apr .97	May 97	Aug .97	Nov .97	Feb .98	Apr .98	June 98	Sep .98	Nov .98	SD	n	$\bar{X}$
Annual Grasses	22.5	16.4	22.0		16.0	22.4	13.4		45.5		10.7	21	20.7abc
Cool Season Grasses						18.6	15.6	9.0	8.6	11.9	5.4	12	13.7 c
Forbs		21.0	25.7	15.9	12.0	29.7	29.7	24.6			10.6	30	26.6 a
Shrubs	22.5	17.0	19.3	14.3	22.4	21.1	25.6	20.3	17.8	13.4	6.4	39	19.4 b
Warm Season Grasses	10.8	19.0	19.0	22.0	19.3	17.3	22.5	17.5	23.5	17.2	6.4	125	20.1 b

Figure 4. Seasonal variation in zinc among forage groups.

Cow Weight. There were no differences (*P* > .10) in changes in cow body weight from spring to fall for treated (4.4 ± 6.5 kg) vs control (-7.6 ± 8.6 kg) cows.



	Feb .97	Apr .97	May 97	Aug .97	Nov .97	Feb .98	Apr .98	June 98	Sep .98	Nov .98	SD	n	$\bar{X}$
Annual Grasses	0.035	0.018	0.030		0.044	0.036	0.028		0.032		0.010	21	.029 a
Cool Season Grasses						0.039	0.025	0.030	0.028	0.041	0.011	12	.034 ac
Forbs		0.028	0.183	0.027	0.022	0.044	0.051	0.097			0.055	29	.061 bc
Shrubs	0.045	0.020	0.050	0.069	0.057	0.078	0.069	0.033	0.049	0.060	0.024	39	.056 b
Warm Season Grasses	0.031	0.035	0.056	0.053	0.044	0.058	0.057	0.054	0.049	0.050	0.018	125	.050 b

Figure 5. Seasonal variation in selenium among forage groups.

Trace Mineral Values in Cattle. Prior to the initiation of treatment, there were no differences (*P* > .10) in either blood Se (Figure 6) or serum Cu (Figure 7), though both trace mineral values were marginally deficient. After the 1997 grazing season, Se and Cu levels in both treatment groups were adequate, but treated cows had greater (*P* < .001) blood levels of Se in blood than did control cows (Figure 6). There were no differences (*P* > .10) in serum Cu levels after the grazing season (Figure 7).

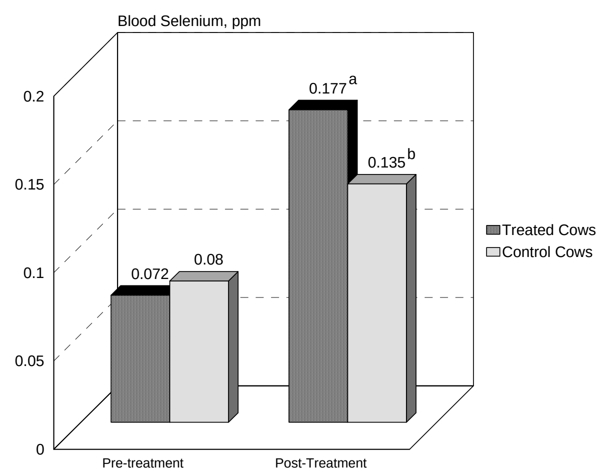


Figure 6. Whole blood selenium levels for cattle before (*P* > .10) and after (*P* < .001) treatment. The post-treatment standard error was .007 and .009 ppm for treated and control cows, respectively.

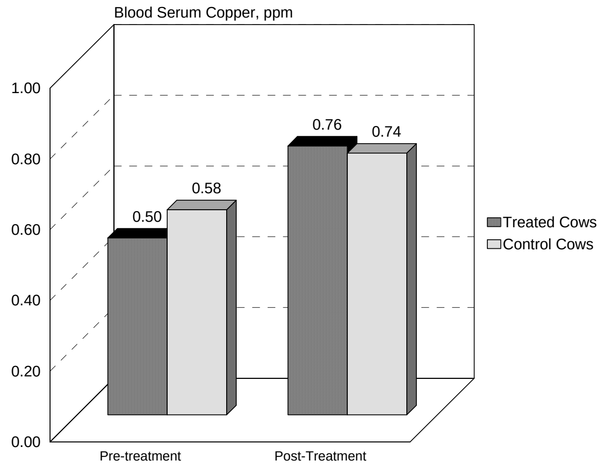


Figure 7. Blood serum copper levels for cattle before and after treatment ($P > .10$).

Pregnancy Status. Pregnancy status did not differ ($P > .10$) between treatment groups in the autumn following the 1997 grazing season, but early breeding season conception (January to April 1998) was greater for treated vs control cattle (14% vs 0%) during the spring following treatment.

Implications

Trace mineral supplementation of cattle deficient in Se may positively affect reproduction. Forbs appear to have greater Cu than do other types of forage. Concentrations of Cu and Zn in forage appear to increase with greater moisture, but this does not appear to be the case for Se.

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Table 3. Precipitation Totals for the X4 Ranch, Inches.													
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Average[1]	1.48	1.31	1.32	0.61	0.31	0.37	2.53	2.78	1.25	1.11	1.02	1.80	15.89
1995	3.30	1.22	1.99	0.46	0.25	0.00	0.05	2.31	2.69	0.00	1.05	T	13.32
1996	0.15	3.47	.76	T	0.01	0.21	2.32	1.00	2.45	0.72	1.12	0.06	12.27
1997[2]	3.25	2.29	0.16	0.23	0.66	0.00	0.18	2.91	0.37	1.24	0.65	2.44	14.38
1998[2]	0.57	4.87	2.19	0.52	0.00	0.00	1.96	2.31	1.38	1.07	1.36	0.95	17.18

[1]Average precipitation data (1894 to 1975) and precipitation data for 1995 to 1998 was obtained from the Globe Arizona weather stations. T = trace amounts of precipitation.

[2]Forage mineral content data for this experiment was collected in 1997 and 1998. The winter of 1997 to 1998 was characterized by a stronger El Nińo year.

Field Notes: Aug. 1997: All pastures have had a little bit of rain and all are green except Indian Gardens. Nov. 1997: Indian Gardens pasture has had some rain and sideoats grama is green. Other pastures are short in forage height. Feb. 1998: Annual grasses and filaree are started, especially annual grasses. Bottlebrush squirreltail is green and growing well under cover of shrubs, Reveg pasture is not doing much yet. Lovegrass is not green and filaree and annual grasses are short in Reveg pasture. Curley mesquite in all pastures is dormant. There is some limited “green-up” of sideoats grama at the base of the plant. Apr. 1998: All pastures are green due to good winter moisture. Cattle are in West and Hudson pastures. East pasture is short in forage height. Jun. 1998: Essentially no rain in about a month. West pasture (grazed early spring) has some green, seen some sideoats grama heading out. Hudson pasture also had some green regrowth, mostly three awn and sideoats grama (short). Annuals are all dried up. Cattle are in East pasture. Abundant bottlebrush squirreltail in sheltered areas in East pasture. Indian Gardens pasture needs grazing, lots of dead plant material with little green growth. Most warm-season grasses are not doing much yet, except for three awn and sideoats grama. Sep. 1998: Hudson pasture is the shortest. All other pastures have good forage growth with good height of seeded out forages. Forage is drying out with some green, but with variation. Range looks good with plenty of excess forage. Nov. 1998: Most of the range has had rain. Forage is mostly dormant with some green at the base of plant except for junegrass. Junegrass is green and growing. There has been good regrowth of grazed plants.

Table 4. Chemical Composition of Mesquital Salt Supplement

Guaranteed Analysis		
Calcium	Not less than	3.5%
Calcium	Not more than	4.5%
Phosphorus	Not less than	5.0%
Salt	Not less than	68.0%
Salt	Not more than	80.0%
Selenium		90 ppm
Copper		1,945 ppm
Manganese		12,521 ppm
Zinc		6,449 ppm

Ingredients:
Salt, Mono and Dicalcium Phosphate, Sodium Selenite, Vegatable Oil, Manganous Sulfate, Zinc Sulfate, Copper Sulfate, Potassium Iodide, Cobalt Sulfate.

Manufactured by: Eagle Milling Company, Inc., P.O. Box 15007, Casa Grande, AZ 85230-5007