Forage Analyses from Cow/Calf Herds in 18 States

Beef

CHAPA

Cow/Calf Health & Productivity Audit

NAHMS

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Background:

Profit, or lack of it, is determined by the balance between revenue from production and culling activities and costs. Achieving the optimum balance between costs and revenues for long term profits requires careful consideration of input cost and impacts on long term revenue production. Feed costs for cow/calf operations accounts for approximately 60-70% of total costs. As producers focus on cost containment to maintain economic viability the nutrition program is prime for consideration. Nutrition also has significant impacts on revenue generation. Inadequate or excessive nutrition can adversely impact reproductive efficiency. Inappropriate nutrient balances, deficiencies, or toxicities can impact animal health. The forage base of an operation usually forms the core of the overall nutrition program. The forage base is composed of animal harvested forage such as pasture and crop residues and mechanically harvested forages that are often used to supplement animals in times of low forage availability for animal harvest. Accordingly, an assessment of nutrient content of mechanically harvested forages allows animal managers and their advisers to make good decisions about supplementation programs.

Experimental Procedures:

In 1993 a sample of cow/calf producers from 18 states (Table 1) was selected to participate in a survey of management procedures and animal health. Producers were selected based on having at least 5 beef cows or heifers and expecting at least 50% of their 1992 calf crop during the months of January through June. Producers participating in the USDA's National Animal Health Monitoring System (NAHMS) Cow/Calf Health and Productivity Audit (CHAPA) were offered the opportunity to have a single forage sample collected and submitted for analysis without cost. Additional samples could be submitted and producers were charged at cost for the analysis. All the samples were collected by state and federal veterinary personnel and mailed to Kansas State University.

In the Nutrition Lab at Kansas State University, these samples were dried to an absolute dry matter content with the samples ground and submitted to a commercial lab (Peterson Labs, Hutchinson, KS) for analysis for: crude protein, acid detergent fiber, phosphorus, copper, cobalt, iron, manganese, molybdenum, and zinc. All analysis at the commercial lab was done utilizing conventional proximate analysis procedures for protein and ADF. Conventional laboratory procedures for phosphorus and all trace mineral analysis used an ICP analyzer system with appropriate internal standards to validate the results.

Upon completion of the analyses, a copy of the results was submitted to Kansas State University for summarization, and a copy of the results was returned to the producer through the federal and state veterinary personnel involved in the collection process. Personnel at Kansas State University evaluated each of the analyses, and in instances where deficiencies or potential problems existed they were brought to the attention of the producers.

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[1] This report is a product of a Cooperative Agreement between Dr. Corah and the USDA:Animal and Plant Health Inspection Service: Veterinary Services, National Animal Health Monitoring System.

Following collection and submission, 352 samples from 327 operators were analyzed and used in the final analysis. The breakdown of sample numbers per state for the 18 cooperating states is shown in Table 1.

Table 1. Forage samples submitted from cow/calf operations by state.

State	Number Samples
Alabama	8
Arkansas	16
California	7
Colorado	17
Florida	4
Georgia	8
Iowa	25
Kansas	28
Kentucky	10
Mississippi	20
Missouri	23
Nebraska	47
New Mexico	9
Oklahoma	19
Tennessee	17
Texas	45
Virginia	11
Wyoming	38
TOTAL:	352

For analysis purposes, the forage codes listed by the submitting veterinarians were combined into 9 forage codes as follows.

A **Alfalfa/Alfalfa Mix**--This breakdown included 39 samples that were coded alfalfa and 19 samples that were classified as alfalfa mix which was predominantly a grass alfalfa mix.

B **Brome**--Eight samples were clearly designated as brome.

C **Bermuda**--In the 36 samples designated as bermuda, 1 of these samples was a bermuda grass (orchard) grass mix.

D **Fescue/Fescue Mix**--This included 12 samples designated as fescue and 10 fescue-clover combination.

E **Sudan/Sudan x Sorghum**--This classification included all of the forage samples coded with sorghum or sudan in their heading. It did include sorghum silage, forage sorghums, baled sorghams, sorghum forage, and straight sorghum and sudan codes.

F **Cereal Forages**--The designation of the 17 cereal forages included those classified as wheat, oats, barley or cereal.

G **Native**--The native section includes 30 samples coded either as native or prairie grass.

H **Grass**--The grass and native headings probably overlap extensively. The grass category no doubt also includes brome, timothy, mixed grasses, and other grass/hay combinations.

I **Silage**--The 9 samples classified as silage were coded predominantly corn silage. (NOTE: Sorghum silage [3 samples] included in sudan/sudan x sorghum category)

J **Other**--The Other classification includes 26 samples with the breakdown as follows: bluestem (1), clover (1), crested wheat (2), bahayla (4), millet (2), timothy (3), crabgrass (1), with the remaining 12 being either uncoded or mixed grass categories.

In addition to a descriptive summary of the proximate forage analyses by forage type, the samples were categorized as deficient, marginal or adequate for the copper, manganese, zinc, and cobalt. Futher, samples were classified as ideal, marginally high or high for molybdenum and iron because of their potential antagonistic role in tying up other trace elements. The specifics of these classifications is shown in Table 2.

Table 2. Classification of Trace Elements Relative to Their Ability to Meet Either Dietary Requirements or Cause an Antagonistic Problem with Other Trace Elements

Trace Minerals	Deficient, ppm	Marginal, ppm	Adequate, ppm
Copper	below 4	4-7	7+
Manganese	below 20	20-40	above 40
Zinc	below 20	20-40	above 40
Cobalt	below .1	---	.1-.25
Selenium	below .1	.1-.15	.15-.3
Copper:Mo Ratio	below 4:1	4-4.5:1	4.5-5:1

Trace Mineral Antagonist	Ideal ppm	Levels Above This Can Cause Copper "Tie-ups" ppm
Iron	50-200	400
Molybdenum	below 1	above 3

* Above this level can cause a copper tie-up.
**Above 1 can cause copper tie-up--ratio of copper to molybdenum should be 4.5 or above.

It is somewhat difficult to classify trace elements because of the interrelationship between the trace elements and also the antagonistic relationship of one element on the other. For example, dietary copper requirements are often reported to be in the range of 4-10 ppm. However, antagonists such as molybdenum, sulfur, iron, and other elements can often cause a copper tie-up resulting in a need for a considerably higher level of copper than is shown in the levels reported in Table 2.

Trace elements such as iron and molybdenum are characteristically antagonists to copper, resulting in reduced copper availability (Table 2). The levels used for iron would indicate that 400 ppm and above can cause reduced utilization of dietary copper. Likewise, levels of molybdenum above 3 ppm can cause problems with copper deficiency. As would logically be expected when both trace elements are present in a diet, there is a synergistic effect in reducing the availability of copper. Thus, when antagonists are present at relatively high levels or a combination of antagonists are present, one of the best ways of monitoring animal status is not through the use of forage samples, but, rather through the use of tissue samples such as liver biopsies.

RESULTS

ALFALFA/ALFALFA MIX

	No.	Nutrient Analysis*, %				Trace Mineral Antagonist			
	Samples	D.M.	Crude Protein	ADF	Phos	Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	69	87.3±.8	16.4±.5	38.9±1	.25±.01	20.2±28.7	11.6	2.1±.2	17.4

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	7.4±.28	51.0±3.4	19.1±.8	0.26±.02	320.9±47.9 (n=54)	5.2:1±.5
Classification						
Adequate, %	46.4	62.3	0	31.9	22.2	47.8
Marginal, %	47.8	30.4	37.7	18.8	24.1	---
Deficient, %	5.8	7.3	62.3	49.3	16.7	52.2
High, %	---	---	---	---	37.0	---

Summary

The proximate analysis results of a 16.4% crude protein and a 38.9% ADF would reflect that either the alfalfa was baled in a fairly mature stage, or reflects the fact that many of the alfalfa samples (19) contained grass mixes which are fairly common in many states.

For the trace elements, the most notable deficiency was zinc with 62.3% of the samples classified as deficient (under 20 ppm). The manganese content of the samples was the most acceptable with 62.3% classified as having adequate manganese.

BROME

	No. Samples	Nutrient Analysis*, % D.M.	Crude Protein	ADF	Phos	Trace Mineral Antagonist Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	8	85.3±1.5	11.1±1.3	43.3±1.4	.26±.02	163.5±52	0	1.8±.6	12.5

*Results are on dry matter basis.

Trace Elements

	Copper ppm	**Manganese ppm**	**Zinc ppm**	**Cobalt ppm**	**Selenium ppb**	**Copper:Mo Ratio ppm**
Mean ± S.E.	5.7±.28	67.7±16.2	13.6±2.4	0.17	146.8±43 (n=6)	4.8:1±1.1
Classification						
Adequate, %	25	50	0	25	16.7	
	50					
Marginal, %	37.5	37.5	12.5	37.5	33.3	---
Deficient, %	37.5	12.5	87.5	37.5	33.3	50
High, %	---	---	---	---	16.7	---

Summary

Only 8 brome samples are represented in the forage analysis. However, as evidenced by the crude protein content (11.1%) and ADF value (43.3%), the brome samples represent hay cut in a fairly early stage of maturity. The most notable deficiency was for the trace element zinc with 87.5% of the samples being classified as deficient. However, only 25% of the samples contained adequate levels of copper and cobalt.

BERMUDA

	No. Samples	Nutrient Analysis*, % D.M.	Crude Protein	ADF	Phos	Trace Mineral Antagonist Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	36	90.5±.5	9.6±.43	39.4±.48	.21±.01	121.8±15	3	.9±.15	5.6

*Results are on dry matter basis.

Trace Elements

	Copper ppm	**Manganese ppm**	**Zinc ppm**	**Cobalt ppm**	**Selenium ppb**	**Copper:Mo Ratio ppm**
Mean ± S.E.	8.5±.6	125.2±15.5	22.4±1.6	0.22	202.9±73.6 (n=33)	14.7:1±1.8
Classification						
Adequate, %	55.6	91.7	2.8	44.4	9.1	80.6
Marginal, %	38.9	2.8	47.2	13.9	18.2	---
Deficient, %	5.6	5.6	50	41.7	63.6	19.4
High, %	---	---	---	---	9.1	---

Summary
A total of 36 bermuda samples were taken and seem to reflect typical bermuda hay which contains 9.6% protein and ADF content of 39.4%. Of all the forage types classified, the bermuda samples had the highest percentage with adequate levels of copper, cobalt and manganese. Also, nearly 50% of the samples had adequate or marginal levels of zinc.

FESCUE

	No. Samples	Nutrient Analysis*, % D.M.	Crude Protein	ADF	Phos	Trace Mineral Antagonist Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	26	88.5±.9	10.9±.6	42.7±.6	.27±.01	99.7±10	0	.99±.2	3.9

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	6.2±.4	122.3±17	17.8±1.5	0.22±.01	63.2±5 (n=23)	11.9:1±2.6
Classification						
Adequate, %	34.6	100	0	46.2	0.0	84.6
Marginal, %	50	0	19.2	7.7	4.4	---
Deficient, %	15.4	0	80.8	46.2	95.6	15.4

Summary
A total of 26 fescue or fescue legume samples were taken. The protein content in these of 10.9% is possibly slightly elevated because a number of samples may have contained a legume. 100% of the samples collected contained adequate quantities of magnesium, however, 80.8% of the samples were classified as deficient in zinc and 65.4% of the samples were classified as marginal or deficient in copper.

SUDAN

	No. Samples	Nutrient Analysis*, % D.M.	Crude Protein	ADF	Phos	Trace Mineral Antagonist Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	27	81.1±2.8	7.9±.6	43.1±1	.21±.02	363.7±86	18.5	1.4±.2	3.7

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	7.5±1.3	57.1±5.7	24.4±4.4	0.33±.03	216.9±25 (n=27)	8.3:1±2
Classification						
Adequate, %	22.2	74.1	7.4	29.6	40.7	74.1
Marginal, %	63	25.9	37.1	7.4	7.4	---
Deficient, %	14.8	0	55.6	63	22.2	25.9
High, %	---	---	---	---	29.6	---

Summary

The 27 sudan/sudan x sorghum/sorghum samples contained fairly typical protein content for this forage classification of 7.9% and an ADF content of 43.1%. 55.6% of these forages were classified as deficient in zinc, and 77.8% of the samples were marginal or deficient in copper. Manganese appeared to be the only trace element where most of the samples (74.1%) were classified as having an adequate level. Another noticeable trend was the fairly high iron content (363.7 ppm) that is typically contained in this forage classification. That is an iron content that could certainly create an antagonistic affect, particularly causing a tie-up of copper.

CEREAL

	No.	Nutrient Analysis*, %				Trace Mineral Antagonist			
	Samples	D.M.	Crude Protein	ADF	Phos	Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	17	87.7±1.3	10±.9	41.2±1.6	.21±.01	148±21	0	1.3±.2	5.9

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	5.5±.9	69.4±14	15.1±1.7	.17±.04	184.5±30 (n-15)	5.4:1±.7
Classification						
Adequate, %	23.5	64.7	0	23.5	26.7	52.9
Marginal, %	41.2	23.5	17.7	35.3	33.3	---
Deficient, %	35.3	11.8	82.4	41.2	20.0	47.1
High, %	---	---	---	---	20.0	---

Summary

Seventeen cereal samples represent fairly typical cereal-type forages. The most notable trace mineral deficiency with these samples was in the area of zinc, where 82.4% of the samples were classified as deficient, and with copper where 76.5% of the samples were classified as deficient.

NATIVE GRASS

	No. Samples	Nutrient Analysis*, % D.M.	Crude Protein	ADF	Phos	Trace Mineral Antagonist Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	30	83.3±3.4	9.1±.8	41.2±1.3	.17±.02	351.8±127	23.3	1.5±.2	6.7

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	6.4±.5	103.6±19	18.3±1.2	0.31±.08	247.6±77 (n=27)	6.9:1±1
Classification						
Adequate, %	33.3	80	0	23.3	18.5	53.3
Marginal, %	50	3.3	36.7	23.3	14.8	---
Deficient, %	16.7	16.7	63.3	53.3	48.2	46.7
High, %	---	---	---	---	16.5	---

Summary

The 30 native grass samples contained an average protein content of 9.1% which is higher than is typically seen with native grass, and would indicate the hay was harvested in a fairly favorable stage of growth (i.e., early). As with many of the forages, zinc was very deficient (63.3% classified as deficient) and 66.7% of the samples were classified as marginal to deficient in copper. In addition, the native grass sample contained a fairly high content of iron (351.8 ppm) which certainly offers a potential of causing antagonistic problems.

GRASS

	No. Samples	Nutrient Analysis*, % D.M.	Crude Protein	ADF	Phos	Trace Mineral Antagonist Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	109	86±1.1	10.3±.4	42.4±.6	.21±.007	209±24	14.7	1.5±.1	10.1

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	6.7±.4	113.1±11.6	19.6±.9	0.26±.02	158.1±25 (n=88)	7.7:1±1.1
Classification						
Adequate, %	32.1	78	3.7	32.1	18.2	51.4
Marginal, %	55.1	20.2	34.9	12.8	21.6	---
Deficient, %	12.8	1.8	61.5	55.1	51.1	48.6
High, %	---	---	---	---	9.1	---

Summary

As was typical with the native grass, 109 grass samples were cut at a fairly ideal stage of maturity based on the protein content of 10.3%. A very high percentage of these samples were deficient in zinc and, likewise, a number of the samples were marginal to deficient in both copper and cobalt.

SILAGE

	No.	Nutrient Analysis*, %				Trace Mineral Antagonist			
	Samples	D.M.	Crude Protein	ADF	Phos	Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	9	33.5±1.8	7.3±.6	35.1±2.6	.22±.02	157.3±29	0	1.5±.3	0

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	5.3±.8	52.1±15.5	18.3±1.7	0.25±.13	153.8±25 (n=8)	5.1:1±1.3
Classification						
Adequate, %	22.2	33.3	0	22.2	50.0	44.4
Marginal, %	55.6	44.4	44.4	44.4	37.5	---
Deficient, %	22.2	22.2	55.6	33.3	12.5	55.6

Summary

The 9 silage samples reflected fairly typical proximate analysis values. The most common trace element deficiency was with zinc (55.6% of the samples).

OTHER

	No.	Nutrient Analysis*, %				Trace Mineral Antagonist			
	Samples	D.M.	Crude Protein	ADF	Phos	Iron, ppm	% with High Levels	Moly, ppm	Above 3 ppm
Mean values ± S.E.	26	85.7±3.4	9.8±.9	42.2±1.7	.24±.04	419.9±238	19.2	1.2±.2	7.7

*Results are on dry matter basis.

Trace Elements

	Copper ppm	Manganese ppm	Zinc ppm	Cobalt ppm	Selenium ppb	Copper:Mo Ratio ppm
Mean ± S.E.	8.9±2.1	140.1±28	29.6±11	0.36±.1	155.5±39 (n=23)	11.7:1±2.1
Classification						
Adequate, %	34.6	88.5	7.7	53.9	17.4	65.4
Marginal, %	42.3	7.7	26.9	15.4	17.4	---
Deficient, %	23.1	3.9	65.4	30.8	52.2	34.6
High, %	---	---	---	---	13	---

OVERALL SUMMARY

Table 3. The Trace Mineral Classification for the 352 Forage Samples

Trace Element	Adequate	Deficient	Marginal	High	Antagonist Levels Marginal	Antagonist Levels Very High
Copper	36%	14.2%	49.7%	---		
Manganese	76%	4.7%	19.3%	---		
Zinc	2.5%	63.4%	34.1%	---		
Cobalt	34.1%	48.6%	17.3%	---		
Selenium (n=305)	19.7%	44.3%	19.3%	16.7%		
Iron	62.8%	8.4%	---	---	17%	11.7%
Molybdenum	42.2%	---	---	---	48.6%	9.2%

SUMMARY

The most notable deficiency in the trace mineral analysis of the forage samples was the fact that only 2.5% of the forage samples contained a level of zinc at or exceeding 30 ppm which is classified as adequate in the diet. In contrast, 76% of the samples were classified as having an adequate content of manganese. Only 14.2% of the samples were classified in the deficient category for copper. However, another 49.7% were in the marginal classification. Equally concerning is 10% of the samples contained levels of iron and molybdenum that would be high enough to cause a copper deficiency because their antagonistic affects on copper availability.

IMPLICATION

The results of this NAHMS survey would indicate that the trace element most commonly deficient in forages in the 18 states sampled was zinc. Copper and cobalt levels were adequate in 36 and 34.1 of the diets respectively. In contrast, manganese levels exceeded 40 ppm in 76% of the samples, and was only deficient (below 20 ppm) in 4.7% of the samples collected. Antagonists such as iron and molybdenum were in the marginal or high classification for 28.7% and 57.8%, respectively, indicating that both of these elements are often present in levels that can cause a reduction in copper availability.

APPENDIX 1 -- Deficiency Symptoms for the Various Key Trace Elements

The following is a description of clinical symptoms associated with key trace element deficiencies.

COPPER

1. General importance--its effect on production traits and animal health.

Copper (Cu) is involved in numerous physiological functions such as: hemoglobin formation, iron absorption and mobilization and connective tissue metabolism--usually via copper's involvement in enzyme function. In fact, one of the major affects of copper deficiency may well be its effect on enzyme systems reducing productivity via alteration of enzymatic activity in the body.

In a number of research studies it's been clearly documented that a copper deficiency can have an effect on fertility. This has been evidenced by a reduction in first service conception rates, altered embryonic survival (in situations of embryo transfer) and a reduction in overall pregnancy rates. The effect on fertility can range from a very limited effect to a very pronounced decrease in first service conception and overall pregnancy rates. It is interesting to note that in a number of studies where copper deficiency has clearly been documented, there often is no impact on fertility or any other reproductive parameter.

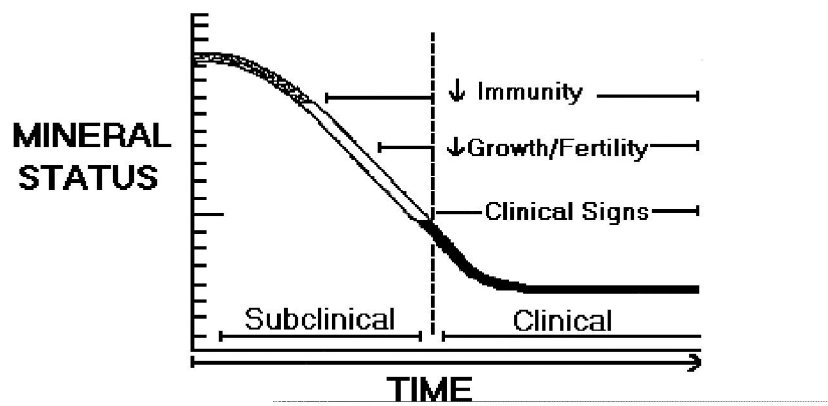
In addition to its effect on fertility, research has shown that there will be an alteration in reproductive behavior, or manner in which cows show estrous activity. Specifically, cows may show normal estrous behavior and then in situations where a severe copper deficiency develops, ovulation does not occur and, subsequently, there is a retardation of future estrous cycles. In addition, there is evidence that copper can cause an alteration in semen quality in males.

Exactly how does copper alter reproductive function in animals? Some excellent research data reported by Phillippo et al., (1987), showed that the effect on reproduction may not relate to a copper deficiency, but rather may relate to the copper deficiency being created by excesses of other trace elements such as molybdenum and sulfur. In their study they showed that the dietary inclusion of molybdenum delayed puberty in yearling beef heifers by 8-12 weeks, reduced conception rates from 68% in cows with no molybdenum included in the diet to 22% when molybdenum was included in the diet. In addition, this research showed that the failure of the cattle to ovulate may have been related to molybdenum's interference rather than a copper deficiency. Specifically, the mode of action in which molybdenum might be causing this is not clearly known. In the heifer studies where puberty was delayed, it was shown that the secretion of the hormone LH (luteinizing hormone) was altered as the pulsatile release of LH was not observed and there was a lower basal level of LH secretion. Further, their studies showed that this altered LH release pattern may have been related to ovarian estradiol production. When estradiol was supplemented, normal LH secretion occurred and the animals did not exhibit altered ovarian function.

One of the effects of copper deficiency that is less well documented but may in fact have its greatest economic consequence on the industry is its impact on immune function in animals. In incidences of copper deficiency, it appears that the immune system is altered in animals making them more susceptible to a variety of diseases. The incidence of scours has increased in calves born to copper deficient dams. Documentation has shown that abomasal ulcers shortly after birth is related to a copper deficiency in the calves. Other studies have reported respiratory problems in copper deficient calves. The mechanism of how the immune system is affected is being studied intensively at a number of locations. Xin et al., (1991) reported that a copper deficiency depleted copper being available for tissue and enzyme activity and resulted in animals having reduced neutrophil bactericidal function. The effects of copper deficiency on immune function, as well as other production traits, is described in the following figure.

FIGURE 1. EFFECTS OF TRACE MINERAL DEFICIENCES ON IMMUNE FUNCTION IN COWS AND CALVES

Source: Wikse, 1992, TAMV Beef Cattle Short Course



2. **Recognizing problems.**

The clinical symptoms of a copper deficiency are extremely varied. From a physical appearance standpoint via the enzyme, polyphenyl oxidase which effects the conversion of L. tyrosine to melanin, there often is an alteration in the hair coats of animals. This may show up simply as a lightening of the hair coat in black or red animals, or may show up as reddish tinge in the case of black animals, which will appear behind the shoulder and on the lower quarter. Another feature is graying of the hair in black animals. On occasion, a copper deficiency may appear as graying of the hair around the eyes creating virtually a "ring". In general, a "rough" hair coat is a common deficiency symptom.

Other symptoms include a general anemic condition, and abnormal bone and ligament development creating an inability of calves to walk or animals more susceptible to foot and leg injuries. On occasion growth rate of animals can be effected.

As previously discussed, one of the clinical signs can be reduced reproductive function, or an effect on immune function.

3. Diagnosis--first step to a solution.

Diagnosis of any trace element deficiency often needs to be based on a number of factors. This can include general clinical symptoms as previously described, data from blood or liver analysis, or information from a forage analysis. If any of the possible clinical symptoms appear, one of the early steps should be analysis of forage for copper levels. When this analysis is made, it's important to also analyze for molybdenum, sulfur and, possibly, iron. The following table illustrates how high levels of molybdenum or iron reduce the level of copper in the liver.

Table 1. Effect of Dietary Mo and Fe on Liver Copper in Growing Heifers

Week	Control*	Fe 500 ppm	Mo 5 ppm
0	128.7	134	127.4
8	48.9	16.3	19.5
16	31.3	5.6	4.8

*Fed basal diet only (Cu=4 ppm)
Source: Phillippo et al., 1987

One of the effective means of confirming a copper deficiency is via liver biopsies which, when performed by a veterinarian with biopsy experience, will cause minimal physical discomfort to the animal or damage to the liver. Serum samples can be used as a general indicator, but diagnosis based on just blood analysis can be misleading. When forage samples contain less than 8-10 ppm copper, they border on being deficient. This especially is a problem when molybdenum levels are in excess of 1-3 ppm, or when the copper to molybdenum ratio falls below 3:1 or 4:1. In some situations we've seen copper molybdenum ratios of 1:5. When liver biopsies are taken, levels below 75-90 ppm (on a dry matter basis) are considered deficient. Serum samples below .6 ppm indicate a potential deficiency may exist.

4. Toxicity.

When levels of copper in the diet exceed 200-800 ppm in cattle, or 115 ppm in calves, a potentially toxic situation may result.

MANGANESE

1. **General importance--its effect on production traits.**

Considerable attention in the livestock industry is focused on trace element deficiencies such as copper, selenium, zinc and other elements. One of the hidden trace elements that may have considerably more influence than we realize is manganese.

Manganese is nutritionally essential to both plants and animals and, unfortunately, is very poorly utilized from the diet by animals with evidence that only 14-18 percent of ingested manganese is actually absorbed.

Like with copper, manganese probably exerts its greatest influence on the animal via its effect on enzyme systems. Research evidence exists that manganese deficiencies can have an impact on suppression of conception rates, delayed estrus in both postpartum females and young prepuberal heifers. In addition, there is excellent evidence that manganese deficiency will cause abortions in animals and deformed calves at birth. There has been evidence that calves, at birth, will "knuckle over" at the fetlock. Other symptoms reported include poor calf growth and loss of hair color in both calves and cows, and an increase in the incidence of cystic ovaries.

The mode of action by which manganese causes this deficiency is not clear other than it appears to be exerting these influences via enzyme systems in which it may be an essential cofactor. There is strong evidence, for example, that the manganese content of ovaries in normal cows was considerably higher than in those with high incidences of cystic ovaries. There is also excellent evidence that manganese, via its effect on enzyme systems, alters the synthesis of gonadal steroids such as estrogen and progesterone in the female. Part of this explanation relates to the role of manganese in altering ovarian luteal metabolism.

2. **Recognizing problems.**

As previously described, altered reproductive efficiency, delayed puberty, abnormal calves at birth and hair color alteration are all symptoms associated with a manganese deficiency.

Unlike the other trace elements that will be discussed, there is not clear evidence at this time that manganese has a direct effect on immune function, as is the case with copper, selenium and zinc.

3. **Diagnosis.**

One of the most effective diagnoses of a manganese deficiency is simply a determination of the manganese content in the diet or forage being fed. A diet is considered deficient if less than 30-40 ppm manganese is present.

Blood (below .005 ppm) and liver (below 9-15 ppm on a dry basis) samples can also be useful indicators of a manganese deficiency. There is evidence of manganese deficiency in herds.

4. **Toxicity.**

Unlike a number of the other trace elements, excess levels of manganese in the diet generally is not toxic.

SELENIUM

1. General importance--its affect on production traits.

Selenium, an important trace element in many areas of the United States, can be both deficient and toxic even within the same state. Any discussion of selenium needs to also include vitamin E. Although vitamin E will not be discussed to any extent in this article, there is excellent evidence that the role of vitamin E in beef cow diets needs to be reevaluated, and it is likely that in the future we will be using higher levels of vitamin E supplementation in a beef cow diet.

One manner in which a selenium deficiency can affect production in a cow herd is an increase in the incidence of early embryonic death. In addition, another common clinical symptom associated with selenium deficiency is an increase in the incidence of retained placentas with evidence in dairy herds of a selenium deficiency increasing incidence of retained placenta from a level of 8-10 percent to 50 percent.

Another effect of a selenium deficiency associated with reproductive functions is an increased incidence of cystic ovaries and an increased incidence of weak or silent heat periods. Finally, evidence exists linking selenium deficiency to weak calves at calving time.

The mode of action under which selenium may effect reproductive function is not clearly defined. It appears to function through its affect on the metabolism of hydrogen peroxide which may alter the synthesis of prostaglandin or its derivatives. This effect could then be associated with its impact on a number of reproductive parameters.

As with copper, there is excellent evidence that a deficiency of selenium will alter the immune system function in animals making them considerably more susceptible to disease problems.

2. Recognizing problems.

As previously discussed, early embryonic death, increased incidence of retained placentas, increased incidence of cystic ovaries and silent heats, coupled with weak calves at the time of birth can be associated with selenium deficiencies.

3. Diagnosis.

One of the most effective ways of determining selenium deficiency is a liver analysis. Liver levels of .8-1.0 ppm on wet weight basis are considered to be adequate and levels below .2 ppm considered to be deficient. As a general indicator of potential selenium deficiencies, whole blood samples can be utilized with .05 ppm and below considered to be deficient.

4. Toxicity.

Unfortunately, selenium is much like copper in that it can be both toxic and deficient with variability occurring even within a state. Diets containing over 80 ppm are considered to be toxic.

Toxic signs include loss of appetite, loss of tail hair, sluffing of hooves and even death.

ZINC

1. General importance--its affect on production traits.

Zinc, as with all of trace elements, is actively involved in enzyme function. The role of zinc in reproductive function appears to be more pronounced on the male side than on the female side. Evidence exists in research studies that zinc deficiency in the bull causes impaired fertility, possibly associated with an alteration in the late stage spermatozoa formation. This impairment of male infertility appears to be associated with the role of zinc as an activator of enzymes involved in steroidogenesis process which results in the secretion of testosterone and related hormones.

In the female, there is some evidence of a decrease in fertility and, for some, indication of abnormal estrous behavior.

There is also research evidence that zinc may play a greater role in the growth of stocker/feedlot cattle, and excellent evidence to indicate zinc plays a role in immune function in stocker and feedlot cattle which may transpose to some affect in the cow, though this has been less well documented.

2. Recognizing problems.

As previously stated, there is documented evidence for altered reproduction in bulls. In addition, some evidence of decreased fertility and abnormal estrous behavior in cows also exists.

3. Diagnosis.

The requirements as listed by the National Research Council (NRC) suggests 30-40 ppm as the recommended dietary level. As with other trace elements, blood can give some indication of a deficiency, however, care needs to be taken in interrupting serum levels. A more accurate determination can be made through either liver biopsies or through forage analysis. Liver tissue samples testing below 80-100 ppm (on a dry matter basis) are considered marginal or deficient.

4. Toxicity.

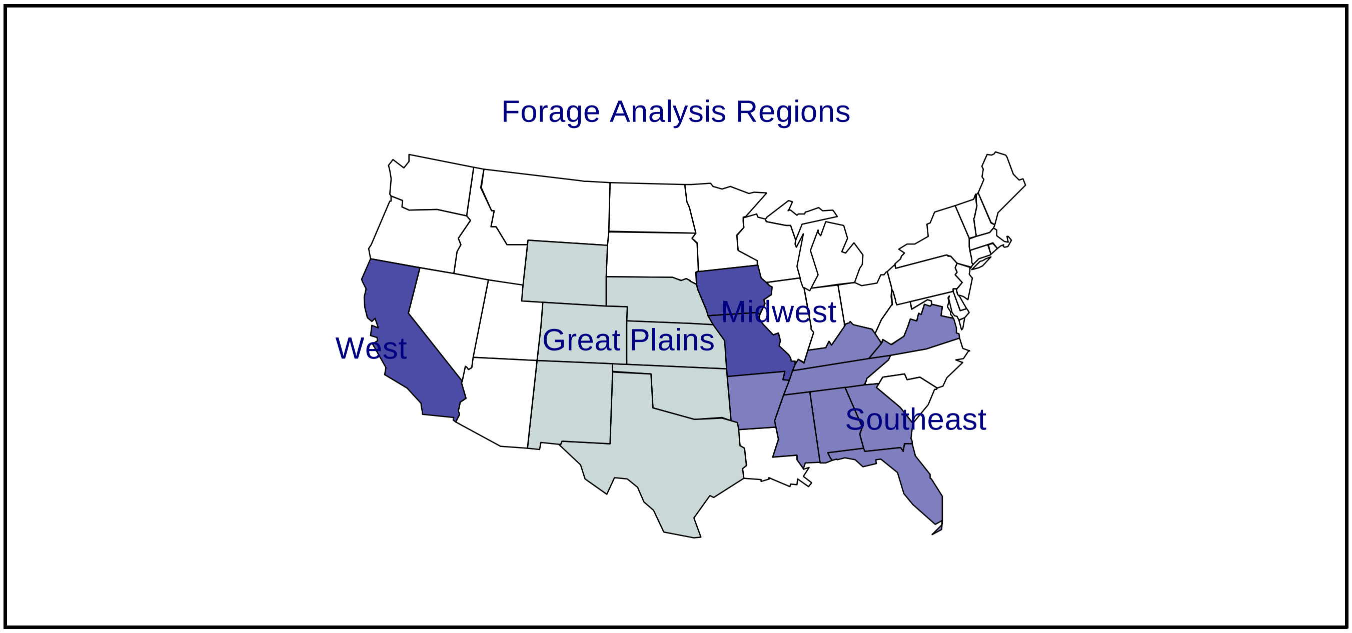
Evidence of zinc toxicity in adult ruminants is relatively uncommon. However, there has been evidence that animals receiving above 500 ppm can show toxic effects.

APPENDIX 2 -- Nutrient Analysis By Region

The following is a breakdown of the various forage types by region.

SUMMARY OF DATA

As a general summary, samples collected in the southeastern part of the United States generally tended to be higher for most trace elements except selenium levels which was lower than in any of the other regions. Copper, zinc and manganese levels tended to be higher in the Southeast area, and levels of antagonists such as molybdenum and iron tended to be lower. Just the reverse was present in the Great Plains and Midwest where fairly high levels of molybdenum and iron were often present and there was a tendency for selenium levels to be considerably higher in these regions, particularly the Great Plains region.



NUTRIENT ANALYSIS BY REGION

Region	Forage	No. Samples	Crude Protein, % D.M.	ADF,% D.M.	Phos,% D.M.	Copper, ppm	Zinc, ppm	Mo, ppm	Iron, ppm	Mang, ppm	Cobalt, ppm	Selenium, ppb	Copper:Mo Ratio, ppm
Southeast	Alfalfa	3	11	40.5	.28	5.1	12.8	2.6	76.1	60.4	.24	98.5	3.6
	Bermuda	10	10.6	39.3	.26	6.3	26.4	1	71	138.9	.23	68.4	12.9
	Fescue	19	10.2	43.3	.26	5.8	18.7	1	99.6	118.6	.22	59.6	12.3
	Sudan	2	7	46.1	.26	6.3	28.1	.9	1026	72.6	.25	130.9	7.4
	Cereal	3	7.2	45.8	.21	6	19.4	1.1	173	54.7	.2	92.3	5.8
	Native	3	9.3	39.3	.29	5.8	25.9	1	365	66.7	.29	373.2	6.7
	Grass	38	10	43.1	.25	6.5	23.7	1.3	179.2	159.3	.24	146.6	8.6
Great Plains	Alfalfa	46	17.3	36.8	.23	7.2	19.1	2.2	168.9	48.3	.24	394.3	4.9
	Bermuda	26	9.1	39.4	.19	9.3	20.9	.87	141.5	119.9	.22	261.5	15.4
	Fescue	4	14.8	38.3	.31	7.4	17.8	.63	119	156	.27	92.6	11.8
	Sudan	24	8	43.1	.2	7.8	24.3	1.2	318.9	56.7	.34	232	8.7
	Cereal	14	10.6	40.2	.21	5.3	14.2	1.3	142.6	72.6	.17	198.8	5.4
	Native	25	9.2	41.6	.15	6.3	17.2	1.4	347.6	91	.25	240.6	7.2
	Grass	49	10.7	40.2	.18	6.5	16.9	1.5	188.2	72.3	.25	175.6	7.8
	Silage	6	6.5	38.9	.2	5.6	16.7	1.6	176.9	34.3	.35	187.8	5.3
Midwest	Alfalfa	19	14.5	44.5	.27	7.5	19.9	1.6	296	57.5	.3	179.7	5.8
	Brome	7	11.6	43.6	.26	6.1	14.3	2	186.1	74.3	.2	168.9	4.8
	Fescue	3	10	44.3	.31	6.7	12.2	1.1	74.1	100.7	.15	63.8	9.8
	Grass	18	10.1	47.8	.22	6.3	15.6	1.7	276.9	91.1	.28	150.7	5.4
	Silage	2	9.1	25.2	.3	4.8	22.2	1	128	46.4	---	135.3	5.8
West (Calif)	Grass	4	10.3	39.3	.19	12.9	29.9	1.6	441.8	271.5	.51	53.5	9.4

Mo = Molybdenum
Mang = Manganese

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