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Low Cost Cow/Calf Program: The School – Part X

In this issue of the late Dr. Dick Diven's (Agri-Concepts, Inc.) information we will look at the micro-minerals (iron, manganese, zinc, and copper) needs of the cow through the production year and determine the amount she would obtain from the rangeland grasses, smooth bromegrass hay, and 30% protein supplement. Micro-minerals are reported in mg/kg which is equivalent to ppm.

THE COW HERD

The cows have an average shrunk body weight (SBW) of 1200 pounds when in body condition score (BCS) 5.0. Thus their empty body weight (EBW) is 1021 pounds (1200 lb * 0.851). Calving season is 60 days; average calf birth weight 100 pounds; peak milk production at week 9 is 17.5 lb/day; calves weaned at eight months.

The production year scenarios looked at in the previous installments were for a cow calving the first of Feb, Mar, Apr, May, or Jun with the provision of a 30% protein supplement when degradable intake protein (DIP) was insufficient. In addition, the same production scenarios were looked at but with the provision of smooth bromegrass hay instead of native range forage for the last month of gestation and the first three months of lactation if these occurred during the winter and early spring months.

Range Grass Iron (Fe) Content

The Fe content of grass can be somewhat variable depending on soil type and growing conditions. However, as grasses mature and go dormant their Fe content concentrates but as they undergo weathering it appears to decline. The Fe content of grasses from the five Johnson County, Wyoming ranches was highest in late fall and lowest in late spring (Table 1). There is no listing of the Fe content for range forage in the Feed Library.

Beef Cow Iron Needs

Dr. Diven indicated that the Fe requirement by all classes of cattle is the same; **100** ppm (parts per million) per Mcal of forage NEm consumed. Table 1 lists the amounts of Fe the reference beef cow would obtain from the range grass and how much she would require.

The National Research Council ([NRC] 1996) suggests that all classes of beef cattle require 50 ppm Fe in their diet with the maximum tolerable limit at 1000 ppm. Although the 50 ppm may appear to be half that suggested by Dr. Diven it is actually about the same. On average the amount Dr. Diven suggested is 1.15 times more than the NRC amount for the reference beef cow used in the exercises. Dr. Diven bases his recommended amount on Mcal of NEm consumed, whereas the NRC on the amount on dry matter consumed.

Note: ppm is also expressed as milligrams per kilogram (mg/kg) by some laboratories and publications. An mg is $1/1000^{th}$ of a gram (g) and a kg is 1000 g, so an mg is $1/1{,}000{,}000^{th}$ of a kg. Also a kg is equivalent to 2.2 pounds. Instead of reporting micro-mineral amounts as ppm they will be reported as mg/kg hereafter.

Let's look at an example for both methods to see how they compare with regard to their recommended amounts of Fe. If the forage a cow eats contains 0.48 Mcal NEm/lb and she eats 26.4 pounds of it she would consume 12.7 Mcal NEm (0.48 * 26.4). Thus, Dr. Diven would recommend 1270 mg/kg Mcal Fe/day (12.7 * 100). However, this 1270 mg/kg needs to be divided by 2.2 to obtain the actual amount consumed which would be 577 mg. The reason for dividing by 2.2 will be shown in the next paragraph when the actual amount of Fe is consumed determined. The NRC recommendation would be 666 mg (26.4 lb ÷ 2.2 = 12 kg; 12 kg * 50 mg/kg = 600 mg). Thus, the amount recommended by Dr. Diven is actually less than the NRC's.

Dr. Diven reports consumption of micro-minerals on mg/kg Mcal NEm. He divides the micro-mineral content of the forage by its Mcal/lb NEm content, the same as he does for macro-minerals and protein. He then multiplies the product by total Mcal NEm consumed. Thus total Fe consumption by a cow eating forage with 300 mg/kg Fe and 0.48 Mcal/lb NEm would be 7938 mg/kg Mcal: (300 ÷ 0.48 = 625; 625 * 12.7 Mcal = 7938. However, this amount is 2.2 times more Fe than the actual amount that would be consumed. Multiplying pounds of forage consumed by the Fe concentration in the forage yields the actual amount. For the above example it would be 3600 mg [26.4 lb x 136.4 mg/lb (300 mg/kg ÷ 2.2)]. Note: Dividing 7938 mg/kg Mcal by 2.2 equals 3608 mg. Consumption of all micro-minerals will be determined by multiplying pounds of forage consumed by mg/lb of the micro-mineral. In addition, the amount of a micro-mineral the cow would obtain from a supplement is determined in this manner and as a result the amounts can then be added.

Iron content of the range grasses was sufficient throughout the year (Table 1). The lowest amount was 94 mg/kg from a mid-May sample and the highest 1103 mg/kg from a late Oct sample. The 30% protein supplement did not contain any Fe but the dicalcium phosphate provided when phosphorus was deficient (Part VIII Sep 2011) contained 14,400 mg/kg Fe. This additional amount of dietary Fe did not result in the total amount exceeding the toxic level of 1000 mg/kg as suggested by the NRC. However, the NRC (1980) also reported that dietary Fe levels as low as 250 mg/kg has caused copper depletion in cattle. Thus, provision of copper above what would be required otherwise could be needed. This will be discussed in the copper segment of this installment.

Table 1: Range grass iron (Fe) content, amount consumed from the grass and dicalcium phosphate supplement, and amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct.

Month	lb/day grass	mg/kg grass	mg/day Consumed			mg/day Required[4]	Balance
			Grass[2]	DiCal[3]	Total		
Feb	26.4	300	3600	687	4288	710	3579
Mar	26.4	250	3000	869	3869	699	3170
Apr	26.4	230	2760	1180	3940	685	3255
May[1]	*32.4*	205	3019	0	3019	1075	1944
Jun	32.4	200	2945	0	2945	957	1988
Jul	32.4	250	3682	382	4064	957	3107
Aug	27.6	295	3701	610	4311	803	3508
Sep	27.6	350	4391	878	5269	790	4479
Oct	24.0	420	4582	1021	5603	633	4970
Nov	21.6	490	4811	1137	5947	606	5341
Dec	21.6	450	4418	1303	5721	598	5123
Jan	21.6	380	3731	1522	5253	589	4664

[1]*Beginning of breeding period (approximately 83 days after calving)*
[2]Fe consumed from range grass = (lb/day grass ÷ 2.2) * mg/kg grass
Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 300 = 3600 mg/day
[3]Fe consumed from dicalcium phosphate = (lb DiCal ÷ 2.2) * 14,400 mg/kg
Ex. Feb: (Appendix Table 1) 0.105 ÷ 2.2 = 0.04773 kg; 04773 * 14,400 = 687 mg/day
[4]Fe required = (Mcal NEm consumed from grass & protein supplement * 100 mg/kg Mcal) ÷ 2.2
Ex. Feb: (Appendix Table 1) 15.6 * 100 = 1561; 1561 ÷ 2.2 = 710 mg/day

If the cow was fed smooth bromegrass hay in lieu of native range forage she would have obtained an adequate amount of Fe to meet her needs but no more (Table 2). Smooth bromegrass hay for the hay trials contained an average of 60 mg/kg Fe.

Because the range grasses and the smooth bromegrass hay contained an adequate amount of Fe to meet the needs of the beef cow, when she calved would appear not to matter with regard to Fe.

Range Grass Manganese (Mn) Content

Manganese content of the range grasses was fairly consistent throughout the year (Table 3). As with Fe there is no listing of the Mn content for range forage in the Feed Library.

Beef Cow Manganese Needs

The Mn requirement of cattle as proposed by Dr. Diven is **90** mg/kg per Mcal of forage NEm consumed. Dr. Diven also indicated that it is the least toxic mineral to ruminant animals due to their ability to excrete the excess through their feces. Table 3 lists the amounts of Mn the reference beef cow would obtain from the range grass and her monthly requirement.

The suggested Mn requirement as put forth by the NRC (1996) is 20 mg/kg for growing and finishing cattle and 40 mg/kg for gestating and lactating cows. The maximum tolerable limit is stated to be 1000 mg/kg. As with Fe, the recommended Mn amounts by Dr. Diven and the NRC are similar with Dr. Diven's recommendation averaging 1.25 times more.

Table 2: Range grass or smooth bromegrass hay iron (Fe) content, amount consumed from the grass or hay, and the dicalcium phosphate supplement, and amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct.

Mon	lb/day forage	mg/kg		mg/day Consumed				mg/day Required[4]	Balance
		Grass	Hay	Grass[2]	Hay[2]	DiCal[3]	Total		
Feb	26.4		60		720		720	720	0
Mar	26.4		60		720		720	720	0
Apr	26.4		60		720		720	720	0
May[1]	32.4	205		3019			3019	1075	1944
Jun	32.4	200		2945			2945	957	1988
Jul	32.4	250		3682		425	4107	957	3150
Aug	27.6	295		3701		643	4344	803	3541
Sep	27.6	350		4391		909	5300	790	4510
Oct	24.0	420		4582		1048	5630	633	4997
Nov	18.0	490		4009		1574	5583	442	5142
Dec	18.0	450		3682		1759	5441	425	5016
Jan	21.6		60		720	584	1173	589	584

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Fe consumed from range grass or smooth bromegrass hay = (lb/day forage ÷ 2.2) * mg/kg forage
Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 60 = 720 mg/day

[3]Fe consumed from dicalcium phosphate = (lb DiCal ÷ 2.2) * 14,400 ppm
Ex. Jul: (Appendix Table 2) 0.065 ÷ 2.2 = 0.0295 kg; 0.0295 * 14,400 = 425 mg/day

[4]Fe required = Mcal NEm consumed (forage & protein supplement * 100 ppm Mcal) ÷ 2.2
Ex. Feb: (Appendix Table 2) 15.8 Mcal * 100 = 1580; 1580 ÷ 2.2 = 720 mg/day

The range grasses did not provide an adequate amount of Mn for the cow, except in Oct and possibly Nov (Table 3). The 30% protein supplement did not contain any Mn but the dicalcium phosphate (DiCal) and magnesium oxide (MgO: Part IX Feb 2012) supplements contained 300 and 100 mg/kg, respectively. Dividing lb/day of these two supplements by 2.2 equates to kg/day then multiplying kg/day by mg/kg Mn results in the mg/day of Mn the cow would obtain from each supplement.

Even with the additional Mn from the DiCal and MgO the cow's Mn requirement was not satisfied. Thus a Mn supplement would need to be included in the custom mineral mix. The amount to include is determined by dividing the amount of Mn lacking in the diet (Table 3: Balance column) by the mg/kg Mn in the supplement. For example: If manganese carbonate ($MnCO_3$) which contains 478,000 mg/kg Mn is used, 220 mg/day would need to be provided each cow in Feb (105 mg/day ÷ 478,000 mg/kg = 0.00022 kg; 0.00022 kg * 1,000,000 = 220 mg).

When the cow calved did affect the amount of $MnCO_3$ that would need to be included in the custom mineral mix. For each month calving was delayed between Feb and June an average of 1.25 g less $MnCO_3$ would be needed (86 g/yr Feb calving vs. 81 g/yr Jun calving).

The Mn content of late bloom/mature smooth bromegrass hay from the hay trials ranged from 30 to 54 mg/kg with an average of 44 mg/kg and would not have been sufficient to meet the needs of the cow (Table 4). The Mn amount listed in the Feed Library (NRC 1996) for mid-bloom and mature smooth brome-

grass hay was 40 and 73 mg/kg, respectively. No value was listed for late bloom smooth bromegrass hay but it's probably around 55 mg/kg. Thus late bloom to mature smooth bromegrass hay potentially could provide an adequate amount of Mn, especially if raised from an area with more available Mn in the soil then NE Wyoming.

Later calving had little effect on the amount of $MnCO_3$ that would need to be included in the custom mineral supplement for cows fed smooth bromegrass hay in lieu of range forage.

Table 3: Range grass manganese (Mn) content, amount consumed from the grass, and the dicalcium phosphate (DiCal) and magnesium oxide (MgO) supplements, amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct; and the amount of supplemental manganese carbonate($MnCO_3$) needed to meet the cow's manganese needs.

Mon	lb/day grass	mg/kg grass	mg/day Consumed				mg/day Required[5]	Balance	mg/day[6] $MnCO_3$
			Grass[2]	DiCal[3]	MgO[4]	Total			
Feb	26.4	43	516	14.3	2.7	533	638	-105	222
Mar	26.4	39	468	18.1	2.6	489	629	-140	294
Apr	26.4	42	504	24.6	2.5	531	616	-85	178
May[1]	*32.4*	47	692		2.1	694	968	-274	572
Jun	32.4	36	530		1.7	532	862	-330	690
Jul	32.4	42	619	8.0	2.2	629	862	-233	487
Aug	27.6	49	615	12.7	1.8	629	723	-94	195
Sep	27.6	51	640	18.3	1.7	660	711	-51	108
Oct	24.0	53	578	21.3	1.4	601	569	32	
Nov	21.6	55	540	23.7	1.8	565	545	20	
Dec	21.6	51	501	27.1	1.9	530	538	-8	17
Jan	21.6	47	461	31.7	2.0	495	530	-35	73

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Mn consumed from range grass = (lb/day grass ÷ 2.2) * mg/kg grass

Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 43 = 516 mg/day

[3]Mn consumed from dicalcium phosphate = (lb DiCal ÷ 2.2) * 300 mg/kg

Ex. Feb: (Appendix Table 1) 0.105 ÷ 2.2 = 0.04773 kg; 0.04773 * 300 = 14.3 mg/day

[4]Mn consumed from magnesium oxide (MgO) = (lb MgO ÷ 2.2) * 100 mg/kg

Ex. Feb: (Appendix Table 1) 0.0587 ÷ 2.2 = 0.02668 kg; 0.02668 * 100 = 2.7 mg/day

[5]Mn required = Mcal NEm consumed (range grass & protein supplement * 90 mg/kg Mcal) ÷ 2.2

Ex. Feb: (Appendix Table 1) 15.6 * 90 = 1404; 1404 ÷ 2.2 = 638 mg/day

[6]$MnCO_3$ (Manganese carbonate contains 478,000 mg/kg Mn): (Negative balances ÷ 478,000) * 1,000,000 = mg/day

Ex. Feb: 105 ÷ 478,000 = 0.00022; 0.00022 * 1,000,000 = 222 mg $MnCO_3$

Range Grass Zinc (Zn) Content

Zinc content of the range grasses was fairly consistent throughout the year (Table 5).

Beef Cow Zinc Needs

The Zn requirement of cattle as proposed by Dr. Diven is **90** mg/kg per Mcal NEm of forage consumed. Table 5 lists the amounts of Zn the reference beef cow would obtain from the range grass and her monthly requirement.

The NRC (1996) suggested Zn requirement is 30 mg/kg for all classes of beef cattle with the maximum tolerable limit at 500 mg/kg. This recommended amount by the NRC is 60% of that recommended by Dr. Diven.

Table 4: Range grass or smooth bromegrass hay manganese (Mn) content, amount consumed from the grass or hay, and the dicalcium phosphate (DiCal) and magnesium oxide (MgO) supplements, amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct; and the amount of supplemental manganese carbonate ($MnCO_3$) needed to meet the cow's manganese needs.

Mon	lb/day forage	mg/kg forage	mg/day Consumed				mg/day Required[5]	Balance	mg/day[6] $MnCO_3$
			Forage[2]	DiCal[3]	MgO[4]	Total			
Feb	26.4	45	540		0.43	540	646	-106	222
Mar	26.4	45	540		0.43	540	646	-106	222
Apr	26.4	45	540		0.43	540	646	-106	222
May[1]	*32.4*	47	692		2.07	694	968	-273	572
Jun	32.4	36	530		1.70	532	862	-330	690
Jul	32.4	42	619	8.9	2.23	630	862	-232	485
Aug	27.6	49	615	13.4	1.83	630	723	-93	194
Sep	27.6	51	640	18.9	1.76	661	711	-51	106
Oct	24.0	53	578	21.8	1.44	601	569	32	
Nov	21.6	55	450	32.8	1.19	484	398	86	
Dec	21.6	51	417	36.6	1.25	455	383	72	
Jan	21.6	45	442	12.2	0.35	454	530	-76	159

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Mn consumed from range grass or smooth bromegrass hay = (lb/day grass ÷ 2.2) * mg/kg forage
Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 45 = 540 mg/day

[3]Mn consumed from dicalcium phosphate = (lb DiCal ÷ 2.2) * 300 mg/kg
Ex. Jul: (Appendix Table 2) 0.065 ÷ 2.2 = 0.0295 kg; 0.0295 * 300 = 8.9 mg/day

[4]Mn consumed from magnesium oxide (MgO) = (lb MgO ÷ 2.2) * 100 mg/kg
Ex. Feb: (Appendix Table 2) 0.0094 ÷ 2.2 = 0.00427 kg; 0.00427 * 100 = 0.43 mg/day

[5]Mn required = Mcal NEm consumed (range grass & protein supplement * 90 mg/kg Mcal) ÷ 2.2
Ex. Feb: (Appendix Table 2) 15.8 * 90 = 1422; 1422 ÷ 2.2 = 646 mg/day

[6]$MnCO_3$ (Manganese carbonate contains 478,000 mg/kg Mn): (Negative balances ÷ 478,000) * 1,000,000 = mg/day
Ex. Feb: 106 ÷ 478,000 = 0.00022; 0.00022 * 1,000,000 = 222 mg $MnCO_3$

The range grasses did not contain an adequate amount of Zn to meet the cow's needs in any month of the year (Table 5). The 30% protein supplement contained 490 mg/kg Zn and as a result in the months it was provided the cow her Zn needs were met, except in Apr if she calved in Feb, Mar, or Apr (Table 5). The DiCal contained 100 mg/kg Zn but the amounts provided to off-set phosphorus deficiency in the range grasses was not enough to satisfy the cow's Zn needs. Thus the inclusion of a Zn supplement in the custom mineral mix would be needed to ensure that the cow's Zn requirement is met.

Zinc sulfate ($ZnSO_4$) is what will be included in the custom mineral mix.

Zinc sulfate contains 363,600 mg/kg Zn. It also contains 17.68% sulfur, 10 mg/kg iron and 10 mg/kg manganese. However, these amounts are minute and thus inconsequential and we will not concern ourselves with them. The amount of $ZnSO_4$ to include in the custom mineral mix is determined by dividing the amount of Zn lacking in the diet (Table 5: Balance column) by the mg/kg Zn in the $ZnSO_4$. For example: 1930 mg/day would need to be provided each cow in May (702 mg/day ÷ 363,600 mg/kg = 0.00193 kg; 0.00193 kg * 1,000,000 = 1930 mg).

Table 5: Range grass zinc (Zn) content, amount consumed from the grass, the 30% protein and dicalcium phosphate supplements, amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct; and the amount of supplemental zinc sulfate ($ZnSO_4$) needed to meet the cow's zinc needs.

Mon	lb/day grass	mg/kg grass	mg/day Consumed				mg/day Required[5]	Balance	mg/day[6] $ZnSO_4$
			Grass[2]	Protein[3]	DiCal[4]	Total			
Feb	26.4	10	120	646	4.8	772	638	134	
Mar	26.4	10	120	714	6.0	840	629	210	
Apr	26.4	14	168	410	8.2	586	616	-30	83
May[1]	*32.4*	18	265			265	968	-702	1932
Jun	32.4	15	221			221	862	-641	1762
Jul	32.4	15	221		2.7	224	862	-638	1755
Aug	27.6	14	176		4.2	180	723	-543	1493
Sep	27.6	12	151		6.1	157	711	-555	1526
Oct	24.0	12	131		7.1	138	569	-431	1187
Nov	21.6	11	108	368	7.9	484	545	-62	170
Dec	21.6	11	108	422	9.0	539	538	1	
Jan	21.6	10	98	476	10.6	584	530	54	

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Zn consumed from range grass (lb/day grass ÷ 2.2) * mg/kg grass
Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 kg * 10 = 120 mg/day

[3]Zn consumed from 30% protein supplement = (lb protein ÷ 2.2) * 490 mg/kg
Ex. Feb: (Appendix Table 1) 2.9 ÷ 2.2 = 1.32 kg; 1.32 * 490 = 646 mg/day

[4]Zn consumed from dicalcium phosphate = (lb DiCal ÷ 2.2) * 100 mg/kg
Ex. Feb: (Appendix Table 1) 0.105 ÷ 2.2 = 0.04773 kg; 0.04773 * 100 = 4.8 mg/day

[5]Zn required = Mcal NEm consumed (range grass & protein supplement * 90 mg/kg Mcal) ÷ 2.2
Ex. Feb: (Appendix Table 1) 15.6 * 90 = 1404; 1404 ÷ 2.2 = 638 mg/day

[6]$ZnSO_4$ (Zinc sulfate contains 363,600 mg/kg Zn): (Negative balances ÷ 363,600) * 1,000,000 = mg/day
Ex. Apr: 30 ÷ 363,600 = 0.000083; 0.000083 * 1,000,000 = 83 mg $ZnSO_4$

What month the cow calved in had little effect on the amount of $ZnSO_4$ needed in the custom mineral mix, except if she calved in Jun in which an additional 55 g per year would be needed. However, if the protein supplement was provided in Nov and Dec for this cow the amount of $ZnSO_4$ needed would be similar to that needed if she calved Feb – May.

The Zn content of late bloom/mature smooth bromegrass hay from the hay trials averaged 18 mg/kg and this amount would not be sufficient to meet the cow's needs (Table 6). The Zn amount listed in the Feed Library (NRC 1996) for mid-bloom and mature smooth bromegrass hay was 24 and 30 mg/kg, respectively. However, these amounts would still not provide the cow with an adequate amount of Zn.

The Feb calving cow fed smooth bromegrass hay in lieu of grazing native range would require the greatest amount of $ZnCO_4$ in the custom mineral supplement. The reason is that the 30% protein supplement was not provided her whereas it was if she calved in a later month.

Range Grass Copper (Cu) Content

The copper content of the range grasses was similar among the ranches and throughout the year at an average of 10 ppm (Table 7). The Feed Library does not list a Cu amount for range forage.

Table 6: Range grass or smooth bromegrass hay zinc (Zn) content, amount consumed from the grass or hay, and the 30% protein and dicalcium phosphate supplements, amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct; and amount of supplemental zinc sulfate ($ZnSO_4$) needed to meet the cow's zinc needs.

Mon	lb/day forage	mg/kg forage	mg/day Consumed				mg/day Required[5]	Balance	mg/day[6] $ZnSO_4$
			Forage[2]	Protein[3]	DiCal[4]	Total			
Feb	26.4	18	216			216	646	-430	1183
Mar	26.4	18	216			216	646	-430	1183
Apr	26.4	18	216			216	646	-430	1183
May[1]	*32.4*	18	265			265	968	-702	1932
Jun	32.4	15	221			221	862	-641	1762
Jul	32.4	15	221		3.0	224	862	-638	1754
Aug	27.6	14	176		4.5	180	723	-543	1492
Sep	27.6	12	151		6.3	157	711	-554	1525
Oct	24.0	12	131		7.3	138	569	-431	1186
Nov	21.6	11	90		10.9	101	398	-297	816
Dec	21.6	11	90		12.2	102	383	-281	772
Jan	21.6	18	177		4.1	181	530	-349	961

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Zn consumed from range grass or smooth bromegrass hay = (lb/day grass ÷ 2.2) * mg/kg forage
Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 18 = 216 mg/day

[3]Zn consumed from 30% protein supplement = (lb protein ÷ 2.2) * 490 mg/kg
Note: No protein supplement provided Feb calving cows but was if calving was later

[4]Zn consumed from dicalcium phosphate = (lb DiCal ÷ 2.2) * 100 mg/kg
Ex. Jul: (Appendix Table 2) 0.065 ÷ 2.2 = 0.0295 kg; 0.0295 * 100 = 3.0 mg/day

[5]Zn required = Mcal NEm consumed (range grass & protein supplement * 90 mg/kg Mcal) ÷ 2.2
Ex. Feb: (Appendix Table 2) 15.8 * 90 = 1422; 1422 ÷ 2.2 = 646 mg/day

[6]$ZnSO_4$ (Zinc sulfate contains 363,600 mg/kg Zn): (Negative balances ÷ 363,600) * 1,000,000 = mg/day
Ex. Feb: 430 ÷ 363,600 = 0.000118; 0.000118 * 1,000,000 = 1183 mg $ZnSO_4$

Beef Cow Copper Needs

Dr. Diven indicated that the Cu requirement of cattle is **16** mg/kg per Mcal of forage NEm consumed. Table 7 lists the amounts of Cu the reference beef cow would obtain from the range grass and her monthly requirement.

The NRC suggested that the Cu requirement of all classes of beef cattle is 10 mg/kg and the maximum tolerable limit 100 mg/kg. The required amounts of Cu recommended by Dr. Diven and the NRC are about the same.

The range grasses contained an adequate amount of Cu to meet the cow's needs, except May through Sep when the grasses contained more than 0.62 Mcal/lb NEm (Table 7). The 30% protein supplement contained 140 mg/kg Cu and the DiCal 10 mg/kg Cu. The additional amount from the 30% protein supplement would have probably helped offset any negative effects Fe may have had on Cu utilization but the amount from the DiCal would have been inconsequential.

The inclusion of a Cu supplement in the custom mineral mix would be needed during the late spring and summer months to ensure that the cow obtained an adequate amount of Cu in her diet. Copper sulfate ($CuSO_4$) that contains 254,500 mg/kg Cu will be added to the custom mineral mix during the months there was a shortfall in the range grasses as the protein supplement was not needed then.

Copper sulfate also contains 12.84% sulfur but as with $ZnSO_4$ this amount results in a very minute amount of additional sulfur in the diet and should be of no consequences. The amount of $CuSO_4$ to include in the custom mineral mix is determined the same way as the other micro-mineral supplements. Divide the amount of Cu lacking in the diet (Table 7: Balance column) by the mg/kg Cu in the $CuSO_4$. For example: 98 mg/day would need to be provided each cow in May (25 mg/day ÷ 254,500 mg/kg = 0.000098 kg).

The amount of $CuSO_4$ needed in the custom mineral mix on an annual basis was the same regardless of what month the cow calved in.

Table 7: Range grass copper (Cu) content, amount consumed from the grass and the 30% protein supplement, amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct; and the amount of supplemental copper sulfate ($CuSO_4$) needed to meet the cow's copper needs.

Mon	lb/day grass	mg/kg grass	mg/day Consumed			mg/day Required[4]	Balance	mg/day[5] $CuSO_4$
			Grass[2]	Protein[3]	Total			
Feb	26.4	10	120	185	305	114	192	
Mar	26.4	10	120	204	324	112	213	
Apr	26.4	10	120	117	238	110	128	
May[1]	*32.4*	10	147		147	172	-25	98
Jun	32.4	10	147		147	153	-6	23
Jul	32.4	10	147		148	153	-6	22
Aug	27.6	10	125		126	128	-3	10
Sep	27.6	10	125		126	126	0	
Oct	24.0	10	109		110	101	9	
Nov	21.6	10	98	105	204	97	107	
Dec	21.6	10	98	120	220	96	124	
Jan	21.6	10	98	136	235	94	141	

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Cu consumed from range grass (lb/day grass ÷ 2.2) * mg/kg grass
Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 10 = 120 mg/day

[3]Cu consumed from 30% protein supplement = (lb protein ÷ 2.2) * 140 mg/kg
Ex. Feb: (Appendix Table 1) 2.9 ÷ 2.2 = 1.32 kg; 1.32 * 140 = 185 mg/day

[4]Cu required = Mcal NEm consumed (range grass & protein supplement * 16 mg/kg Mcal) ÷ 2.2
Ex. Feb: (Appendix Table 1) 15.6 * 16 = 250; 250 ÷ 2.2 = 114 mg/day

[5]$CuSO_4$ (Copper sulfate contains 254,500 mg/kg Cu): (Negative balances ÷ 254,500) * 1,000,000 = mg/day
Ex. May: 25 ÷ 254,500 = 0.000098; 0.000098 kg * 1,000,000 = 98 mg $CuSO_4$

As noted in the discussion on iron (Fe) if it is greater than 250 mg/kg in the forage it potentially could tie up Cu. As a result additional Cu may need to be provided in the animal's diet. Average Fe levels of the range grasses, especially during the dormant season, were high enough to be of concern, especially when dicalcium phosphate was supplemented. However, grass Cu levels of 10 mg/kg in addition to the amount of Cu in the 30% protein supplement were probably enough that additional dietary Cu may not be needed.

Molybdenum (Mo) content of forage is the major concern with regard to Cu availability to the animal as it can interfere with Cu absorption. In addition, if dietary sulfur (S) is high it can exacerbate the effect of Mo on Cu

absorption. It is recommended that the Cu: Mo ration be less than 4: 1. If higher than this additional Cu in the diet would be needed.

The range grasses and smooth bromegrass hay contained little to no measurable Mo. In addition, S content of the grasses and hay was not high (see Part IX, Feb 2012). Thus, additional dietary Cu due to forage Fe, S, and Mo contents should not be needed in this region of NE Wyoming. However, there are always exceptions and thus forages should be tested for their mineral content, especially if deficiency symptoms appear in the livestock. Drinking water should also be tested, especially for sulfates as this can be a source of dietary S to the cow and if too high can cause problems with Cu availability.

If smooth bromegrass hay was fed the cow in place of her grazing native range about three times more $CuSO_4$ (13.3 g vs. 4.7 g) would need to have been included in the custom mineral mix for the year (Tables 7 and 8). This was primarily due to the 30% protein supplement not being furnished Feb calving cows but also because the smooth bromegrass hay contained an average of 2 mg/kg less Cu compared to the range grasses. However, because hay fed cows that calved later were furnished the protein supplement the total annual amount of $CuSO_4$ needed declined by a little over 2 g for every month calving was delayed but still more than cows grazing native range year round.

Table 8: Range grass or smooth bromegrass hay copper (Cu) content, amount consumed from the grass or hay and the 30% protein supplement, amount required by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb, calf weaned in Oct; and amount of supplemental copper sulfate ($CuSO_4$) needed to meet the cow's zinc needs.

Mon	lb/day forage	mg/kg forage	mg/day Consumed			mg/day Required[4]	Balance	mg/day[5] $CuSO_4$
			Forage[2]	Protein[3]	Total			
Feb	26.4	8	96		96	115	-19	75
Mar	26.4	8	96		96	115	-19	75
Apr	26.4	8	96		96	115	-19	75
May[1]	*32.4*	10	147		147	172	-25	97
Jun	32.4	10	147		147	153	-6	23
Jul	32.4	10	147		147	153	-6	22
Aug	27.6	10	125		125	128	-3	10
Sep	27.6	10	125		125	126	0	
Oct	24.0	10	109		109	101	9	
Nov	21.6	10	82		82	71	12	
Dec	21.6	10	82		82	68	15	
Jan	21.6	8	79		79	94	-15	60

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Cu consumed from range grass or smooth bromegrass hay = (lb/day grass ÷ 2.2) * mg/kg forage

Ex. Feb: 26.4 ÷ 2.2 = 12 kg; 12 * 8 = 96 mg/day

[3]Cu consumed from 30% protein supplement = (lb protein ÷ 2.2) * 140 mg/kg

Note: No protein supplement provided Feb calving cows but was if calving was later

[4]Cu required = Mcal NEm consumed (range grass & protein supplement * 16 mg/kg Mcal) ÷ 2.2

Ex. Feb: (Appendix Table 2) 15.8 * 16 = 253; 253 ÷ 2.2 = 115 mg/day

[5]$CuSO_4$ (Copper sulfate contains 254,500 mg/kg Cu): (Negative balances ÷ 254,500) * 1,000,000 = mg/day

Ex. Feb: 19 ÷ 254,500 = 0.000075; 0.000075 * 1,000,000 = 75 mg $CuSO_4$

Cobalt (Co), Iodine (I), and Selenium (Se)

The range grasses from the five ranches in Johnson County and the smooth bromegrass hay from the hay trials were not analyzed for their cobalt, iodine, and selenium contents. Some laboratories are able to analyze for these but it is expensive. The Feed Library did not list amounts for I and Se in range forage or smooth bromegrass hay but did indicate that these forages contain 0.24 and 0.58 mg/kg Co, respectively. For range forage the amount was for all seasons of the year. Dr. Diven also did not list any amounts for these three micro-minerals in range forage for his example in Section 14 of the class notebook.

The 30% protein supplement contained 24.0 and 2.0 mg/kg I and Se, respectively, and the Feed Library had dicalcium phosphate with 10 mg/kg Co. In reviewing the contents of other commercial protein supplements it was found they too contain I and Se and some also contain Co.

Dr. Diven specified that the Co, I, and Se requirements of beef cattle was 0.2, 1.0, and 0.4 mg/kg for every Mcal NEm consumed and the NRC (1996) suggested it was 0.1, 0.5, and 0.1 mg/kg dry matter, respectively. As has been demonstrated with the other micro-minerals these recommended amounts by Dr. Diven and the NRC are similar, except for Se in which Dr. Diven's recommendation was 2.3 times as much. The NRC also stated that the maximum tolerable levels of Co, I, and Se for beef cattle was 10, 50, and 2.0 mg/kg, respectively.

Cattle do not actually have a Co requirement but their rumen microorganisms do as they use it in the formation of vitamin B_{12}. Cattle do require vitamin B_{12} so an adequate amount of Co in their diet is needed to meet the rumen microbe's requirements.

Going through the same monthly analyses as done for the other nutrients it was found that the Co requirement of the cow was met (1.5 mg/day) assuming the range grasses contained 0.24 mg/kg Co (2.9 mg/day consumed). As a result the amount furnished by the DiCal would not have been needed but would not have caused any harm (0.7 mg/day more). Although the 30% protein supplement used in these exercises did not contain any Co other protein supplements contain 3 mg/kg. Based on this amount and the recommended daily feeding level of the supplement the cow would obtain an additional mg of Co. Even with this additional mg the cow should not obtain too much Co as the toxic level for our example cow would be 120 mg/day.

If it is assumed that the range grasses and smooth bromegrass hay do not contain any I than it will need to be supplemented. In the months that the 30% protein supplement is provided the cow her I requirement is satisfied (≈ 7 mg/day). In those months that the protein supplement is not provided then the provision of iodized salt should be furnished. Based on an average daily consumption of 0.1 lb/day of salt by the cow the salt would need to contain 130 to 150 mg/kg I to ensure that she obtained an adequate amount of I.

The protein supplement provided an adequate amount of Se (2.0 mg/day) when it was furnished if the required amount is based on the NRC recommendation. The amount of Se in other protein supplements reviewed would also provide an adequate amount to the cow. Due to Wyoming soils being notoriously high in Se recommending a Se supplement may not be wise. In addition, if it is suspected that the soils of a ranch are high in Se then it might be best to not provide a protein supplement that contains Se. However, if Se is deficient, then a supplement would be warranted.

Appendix Table 1: Daily amounts of range grass, and the 30% protein, dicalcium phosphate and magnesium oxide supplements consumed by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb; calf weaned in Oct, the Net Energy maintenance (NEm) content of the grass, and amounts of NEm consumed from the range grass and protein supplement.

Mon	Grass (lb/day)	NEm (Mcal/lb)	Protein (lb/day)	Mcal NEm Consumed			DiCal (lb/day)	MgO (lb/day)
				Grass[2]	Protein[3]	Total		
Feb	26.4	0.48	2.9	12.7	2.9	15.6	0.11	0.009
Mar	26.4	0.46	3.2	12.1	3.2	15.3	0.13	0.009
Apr	26.4	0.50	1.9	13.2	1.9	15.1	0.18	0.009
May[1]	32.4	0.73		23.7		23.7		0.046
Jun	32.4	0.65		21.1		21.1		0.038
Jul	32.4	0.65		21.1		21.1	0.06	0.049
Aug	27.6	0.64		17.7		17.7	0.09	0.040
Sep	27.6	0.63		17.4		17.4	0.13	0.039
Oct	24.0	0.58		13.9		13.9	0.16	0.032
Nov	21.6	0.54	1.7	11.7	1.7	13.4	0.17	0.026
Dec	21.6	0.52	1.9	11.2	1.9	13.1	0.20	0.028
Jan	21.6	0.50	2.2	10.8	2.2	13.0	0.23	0.008

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Mcal NEm consumed from the range grasses = lb/day of grass * Mcal NEm/lb

Ex. Feb: 26.4 lb * 0.48 Mcal/lb = 12.7 Mcal

[3]Mcal NEm consumed from the 30% protein supplement = lb/day of protein * 1.02 Mcal NEm/lb

Ex. Feb: 2.9 lb * 1.0 Mcal/lb = 2.9 Mcal

Appendix Table 2: Daily amounts of range grass or smooth bromegrass hay (forage), and the dicalcium phosphate and magnesium oxide supplements consumed by a 1200 lb shrunk body weight cow; body condition score 5.5 at calving in Feb; calf weaned in Oct, the Net Energy maintenance (NEm) contents of the grass and hay, and the amounts NEm consumed from the range grass or smooth bromegrass hay.

Mon	Grass (lb/day)	Hay (lb/day)	NEm (Mcal/lb)		Mcal NEm Consumed[2]		DiCal (lb/day)	MgO (lb/day)
			Grass	Hay	Grass	Hay		
Feb		26.4		0.60		15.8		0.009
Mar		26.4		0.60		15.8		0.009
Apr		26.4		0.60		15.8		0.009
May[1]	32.4		0.73		23.7			0.046
Jun	32.4		0.65		21.1			0.038
Jul	32.4		0.65		21.1		0.07	0.049
Aug	27.6		0.64		17.7		0.10	0.040
Sep	27.6		0.63		17.4		0.14	0.039
Oct	24.0		0.58		13.9		0.16	0.032
Nov	18.0		0.54		9.7		0.24	0.026
Dec	18.0		0.52		9.4		0.27	0.028
Jan		21.6		0.60		13.0	0.09	0.008

[1]*Beginning of breeding period (approximately 83 days after calving)*

[2]Mcal NEm consumed from the range grass of smooth bromegrass hay = lb/day of forage * Mcal NEm/lb

Ex. Feb: 26.4 lb * 0.60 Mcal/lb = 15.8 Mcal

Next Installment

In the next installment we will cover the information in the last section (# 14) of Dr. Diven's "Low cost cow/calf program: The school" notebook titled "Samples, Labs, Feed Stores". In addition, we will work through an example similar to what has been done but putting it all together and taking into account the information Dr. Diven provided in section 14 with regard to formulating a custom mineral package.

References

[NRC] National Research Council. 1996 (Update 2000). Nutrient Requirements of Beef Cattle (7th revised edition). Washington, DC, USA: National Academy Press. 234 p.
Note: Appendix Table 1 – Feed Library pp. 192 – 203.

[NRC] National Research Council. 1980. Nutrient Requirements of Beef Cattle (6th revised edition). Washington, DC, USA: National Academy Press.

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Glen Whipple, Director, University of Wyoming Extension, University of Wyoming, Laramie, Wyoming 82071.