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LAND & LIVESTOCK

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

In this installment we will work through an example similar to what was done in Part X (May 2012) but put it all together and take into account the information from Part XI (Oct 2012) with regard to formulating a custom supplement package. The examples in Part XI were for determining the needed ingredients of a supplement for a point in time but we know forage quality changes over the course of the year as well as the cow's physiological conditions and thus her nutrient requirements. Taking this into account we'll look at how to determine the monthly nutrient needs of a NE Wyoming cow herd with an average SBW of 1200 pounds when in BCS 5.0; calving season 60 days beginning the first of February; average calf birth weight 100 pounds; peak milk production at 8.5 weeks is 17.5 lb/day; and calves weaned in October. Although we will determine what nutrients are needed for each month of the year providing a different formulation for each month is not realistic. Thus a formulation that will do the best job over the longest period of time will be determined.

Table 1 lists the monthly nutrient contents of the range grasses for this exercise and is in the form of a spreadsheet. Table 2 lists the monthly estimated physiological conditions of the beef cows calving in February, their daily range forage and nutrient consumption amounts, their nutrient requirements, and the amounts of the various ingredients to satisfy nutrient imbalances.

Dr. Diven did not take into account the NEm needs of the cow for activity or cold conditions but they need to be included and are listed in Rows 16 and 17 of Table 2. In Parts VI – X the production year examples started with February the month calving began but in this exercise we are going to start with May the month breeding begins for Feb

calving cows. The reason is that though it is important to have the cows in a BCS of 5 – 6 at time of calving it is more critical for them to be in this condition at time of breeding.

Empty mature body weight (**EMBW)** of the cows of this herd when in a body condition score (BCS) of 7.85 would be **1333 lb**.

TABLE 2 VALUES

Row 6 – EBW: Empty body weight is determined by the following equation:
((BCS – 7.85) x (0.082 x EMBW)) + EMBW

If the cows' average BCS the first of May is 5.5 their EBW would be:
((5.5 – 7.85) x (0.082 x 1333)) + 1333
(-2.35 x 109.3) + 1333
-256.9 + 1333 = **1076 lb**

Row 7 – SBW: With an EBW of 1076 lb SBW would be 1265 lb (EBW ÷ 0.851).

Note: A beef cow's shrunk body weight when in BCS 6.0 is the same as her EMBW. For every full BCS more or less than 6.0 her SBW will be 10% ± her EMBW. Thus if these cows have an EMBW of 1333 lb their SBW when in BCS 5.0 would be 1200 lb (1333 x 0.9).

If the SBW of your cows when in BCS 5.0 is 1100 lb then their EMBW would be 1222 lb (1100 ÷ 0.9).

Row 8 – Wt. Change: The daily amount of EBW in pounds the cows would potentially gain or lose is determined by:
If Mcal balance is positive; divide balance by (1.3665 + (0.33073 x BCS)) x 2.95
If balance is negative; divide balance by the same equation without the 2.95 multiplier

For May the Mcal balance was +8.06 (Row 28 or 34) so the cows should gain weight.
8.06 ÷ ((1.3665 + (0.33073 x 5.5)) x 2.95)
8.06 ÷ ((1.3665 + 1.819) x 2.95)
8.06 ÷ (3.1855 x 2.95)
8.06 ÷ 9.4 = **0.86 lb/day**
0.86 lb/day x 31 days = **27 lb EBW gain for the month of May**

Row 9 – BCS: BCS after initial month is determined by the following equation: Previous month's BCS + ((lb/day weight change x days in previous month) ÷ lb/BCS)
Lb/day weight change from Row 8
See Appendix Table 1 for lb/BCS

At the beginning of May the cows were in a BCS of 5.5 so what would their BCS potentially be the beginning of June?
5.5 + ((0.86 lb/day x 31 days) ÷ 110 lb)
5.5 + (26.7 lb ÷ 110 lb)
5.5 + 0.24 = **5.74**

Row 11 – Dry Forage: Forage consumption on a dry matter basis is estimated by multiplying a factor (Appendix Table 2) by the cow's SBW. The factors used were: 0.027 (May – Jul); 0.023 (Aug & Sep); 0.02 (Oct & Nov); 0.018 (Dec & Jan); and 0.022 (Feb – Apr). These factors are for when degradable intake protein needs are met. For example range forage consumption in May for the Feb calving cows would be 34.1 lb/day (1265 lb x 0.027).

Row 12 – NEm: Mcal of NEm consumed is determined by multiplying pounds of forage consumed by Mcal NEm/lb. If the NEm content of May range forage was 0.73 Mcal/lb (Table 1; Column G: Row 2) and the cow consumed 34.1 lb of the forage she would obtain 24.9 Mcal of NEm (34.1 x 0.73).

Row 13 – Protein: The amount of protein obtained can be determined by multiplying pounds of forage consumed by its %protein content. For May: 34.1 lb forage time 16.5% protein (Table 1; Column G; Row 3) equals 5.63 lb of protein ingested.

Row 14 – DIP: The amount of degradable intake protein consumed can be determined by multiplying pounds of protein consumed by its percent DIP content. For May: 5.63 lb of crude protein was ingested and its DIP content was 72% (Table 1; Column G; Row 4) so the amount of DIP would be 4.05 lb (5.63 x 0.72).

Row 16 – NEm (M): Mcal NEm required for maintenance (M) is calculated by taking the cow's EBW to the 0.75 power which yields its metabolic body weight and multiplying it by 0.04256. If a cow's EBW = 1076 lb her metabolic body weight would be 187.9 lb ($1076^{0.75}$). Thus her NEm (M) requirement would be 8.0 Mcal (187.9 x 0.04256).

Row 17 – NEm (G): An equation to determine Mcal NEm needed for gestation (G) had not been provided in the past but instead a table that gave the amounts required for each of the last five months of gestation based on calf estimated birth weight (e.g. Appendix Table 3 in Part V – Sep 2010). The reason I had not provided an equation before was because they are somewhat complex but with a scientific calculator or a computer spreadsheet program they are not that difficult to use so the one found in Nutrient Requirements for Beef Cattle (1996) follows:

Mcal NEm (G) = $((0.262 \times w) \times (0.4504 - 0.000766 \times t)) \times e^{((0.03233 - 0.0000275 \times t) \times t)} \div 1000$

Where w = calf birth weight in pounds; and
t = days in gestation

Let's go through the equation in a step-by-step manner to determine what the cows' NEm (G) requirement would be for their 6th month of gestation with an estimated calf birth weight of 100 lb. We'll use 173 days for t which would be the middle of the 6th month.

1) 0.262 x 100 lb = **26.2**
2) 0.4504 – (0.000766 x 173 days)
   0.4504 – 0.1325 = **0.318**
3) **26.2** x **0.318** = ***8.33***
4) 0.03233 – (0.0000275 x 173 days)
   0.03233 – 0.00476 = 0.02757
5) 0.02757 x 173 days = 4.77
6) $e^{4.77}$ = ***117.9***
7) ***8.33*** x ***117.9*** = 982 Kcal
8) 982 Kcal ÷ 1000 = **0.98 Mcal**

Row 18 – NEm (L): To determine Mcal NEm for lactation (L) we need to first estimate how many lb/day of milk our cows' will produce on average for each week they are in lactation. We do need to have a fairly good idea as to how much milk they will potentially produce at peak (week 8.5). Appendix Table 5 in Part V (Sep 2010) lists estimated lb/day of milk at peak production based on cow EMBW and male calf weaning weight at 7 months of age. Based on a 1333 lb EMBW for the cows in our example herd and an average male calf weaning weight at 7-months of 570 lb these cows peak milk yield would be 17.5 lb/day.

The equation to estimate weekly milk yield is:
$(W \div (a \times (e^{(0.1176 \times W)}))$
Where W is week in lactation; and
a = a factor for each level of milk production

For the above cows a = 0.1778; for cows with peak milk yields of 11, 24, or 31 lb/day a = 0.2844, 0.1293, or 0.1016, respectively (Nutrient Requirements of Beef Cattle 1996).

For their first month of lactation our cows would yield 14.7 lb of milk per day at the end of the month [Week = 4.34: (30.4 days ÷ 7)]. Let's go through the equation to see how this amount was determined.

1) 0.1176 x 4.34 weeks = 0.5104
2) $e^{0.5104}$ = 1.666
3) (a) 0.1778 x 1.666 = 0.296
4) 4.34 weeks ÷ 0.296 = **14.7 lb/day**

The equation to estimate Mcal NEm (L) required is: lb/day milk x 0.34. Thus, the

amount needed by the cows to produce 14.7 lb of milk would be: 14.7 x 0.34 = **5.0 Mcal**
Note: The Mcal for NEm (L) reported are mid-month values (W = 2.2; 6.5; 10.9; 15.2; 19.5; 23.9; and 28.2 for months 1 – 7, respectively).

Row 19 – Cold and Row 20 – Activity: For Mcal NEm needed for cold conditions and grazing activity see Part VI (Jan 2011); pages 4 & 5; and for cold Appendix Tables 1, 2, and 3; for grazing activity Mcal NEm (M) x 0.5.
Note: Our example herd is located near Buffalo, Wyoming in the NE part of the state.

Row 21 – Total: The summation of the Mcal amounts for NEm (M), NEm (G), NEm (L), NEm (cold), and NEm (activity)

Rows 22, 23, 24, and 25 – Protein (M), (G), (L), and Total: As reported in Part V (Sep 2010) the cow's protein requirements in pounds per day are based on her daily NEm Mcal needs for (M), (G), and (L).
Protein (M) = Mcal NEm (M) x 0.07895
Protein (G) = Mcal NEm (G) x 0.09615
Protein (L) = Mcal NEm (L) x 0.2362
Total = the summation of the amounts for (M), (G), and (L)

Row 26 – DIP: The amount of DIP required is 0.1 x Mcal NEm consumed from the forage. For May: 24.92 Mcal NEm consumed x 0.1 equals 2.49 lb DIP required.

Row 28 – NEm Net: Daily balance for NEm is determined by subtracting total Mcal NEm required (Row 21) from the total amount consumed (Row 12). For May the cows would have consumed **8.06** Mcal/day more than they needed (24.92 – 16.86).

Note: In Part XI nutrient balances were determined by subtracting the amount consumed from the amount required and thus negative balances indicated that the cow had consumed more of the nutrient than she needed. However, this is contrary to how one thinks so instead the amounts needed are subtracted from the amounts consumed.

Row 29 – Protein Net: Daily balance for protein is determined by subtracting total protein required (Row 25) from the total amount consumed (Row 13). For May the cows would have consumed **3.85** lb/day more protein than they required (5.63 – 1.78).

Row 30 – DIP Net: Daily balance for degradable intake protein is determined by subtracting amount consumed (Row 14) from the amount required (Row 26). For May: the balance would be **1.56** lb (4.05 – 2.49).

Degradable Intake Protein (DIP)

Although the first nutrient to satisfy will be DIP we want to first calculate how much weight and resultant change in BCS would potentially occur during the months of May – Oct when a protein supplement is not needed. This is done so that we can determine what the cows' BCS would potentially be at the beginning of the next breeding season. The cows' EBW should increase by 110 pounds during these months and as a result their body condition would increase by one score and they will be at 6.5 the first of Nov.

In the formulating a supplement example in Part XI in which Dr. Diven furnished the ingredients to be used he chose urea as the DIP supplement. He did this to simplify the process as urea contains only nitrogen that is 100% degradable. Protein in other protein supplements is usually not 100% degradable and the supplement may contain other nutrients as well, including NEm that have to be accounted for. If there is a need for additional energy in the cows' diet a protein supplement that also contains energy might supply all that is needed.

Cottonseed meal (CSM) will be the ingredient used to meet the rumen bugs DIP needs. It contains 46.1% crude protein that is 57% degradable resulting in a DIP content of 26.3% [(46.1% * 57%) ÷ 100]. It also contains 0.81 Mcal NEm/lb so some of its DIP will be needed by the rumen microbes to utilize this energy. The remaining amount of DIP will be available to address the shortfall in the range forage.

The DIP deficiency in Nov was 0.24 lb/day (Row 30). Because CSM contains energy we cannot simply divide the 0.24 lb of DIP that is deficient by 0.263 lb (26.3% ÷ 100), the amount of DIP in a pound of the meal, to come up with the amount of CSM needed. We have to subtract the 0.105 lb of DIP (0.81 Mcal x 0.13 – see below note) that will be used by the rumen microbes to digest the 0.81 Mcal/lb of NEm from 0.263 lb. This would leave 0.16 lb of DIP per lb of CSM that will be available to the rumen microbes to replace that deficient in the range grasses. Dividing 0.24 lb by 0.16 lb results in 1.5 lb/day of the CSM that would be needed in Nov (**Row 32**). We would then do the same for Dec – Apr to come up with how many lb/day of the CSM would be needed in those months. Note: CSM amounts are on a dry matter basis; as is basis amounts would be dry matter amounts divided by percent dry matter.
For example: 1.5 lb ÷ 92% = 1.63 lb.

Note: Dr. Diven used a multiplier of 0.1 for the amount of DIP needed per Mcal of NEm and for low to medium NEm content forages that is probably sufficient (See Parts IV and V – May and Sep 2010) but for high NEm content feeds it is probably better to use 0.13 as the multiplier (Simms 2009) to ensure enough DIP is provided the rumen microbes.

The 1.5 lb of CSM provided in Nov would also provide 1.22 Mcal of NEm (1.5 lb x 0.81 Mcal/lb) (**Row 33**). Subtracting this 1.22 Mcal from the 0.42 Mcal needed (Row 28) leaves a surplus of 0.80 Mcal (**Row 34**). This surplus would result in the cows gaining an average of 0.08 lb/day in EBW (Row 8) or about 2.5 pounds for the month (0.08 lb x 30 days) resulting in little change in their BCS. Although the cows would lose some weight Dec – Apr if the only NEm provided when the range forage was deficient in NEm was from the CSM the cows' would potentially be in a BCS of 5.6 the following May. This is why we want to balance for DIP for each month it is deficient if we are using a protein supplement that also contains energy so we can see how that energy would affect their body condition.

The 1.5 lb/day of CSM furnished per cow in Nov would also provide them 0.69 lb of protein (**Row 35**) resulting in a protein balance of 1.79 lb (**Row 36**). The only two months that the range grasses did not provide an adequate amount of protein to the cows were Mar and Apr but the CSM provided enough additional protein to make up for the deficient.

Going through the same procedures for the Mar calving cows we would find that if they are in a BCS of 5.5 at the beginning of the breeding season (Jun) they'll end up in a BCS of 5.6 the following Jun (Data not shown). Although the Feb and Mar calving cows ended up in the same body condition at the beginning of the following breeding season it took a little more of the CSM in order for the Feb calving cows to meet their DIP needs compared to the Mar calving cows (Daily Averages: Feb cows 2.15 lb; Mar cows 2.01 lb – Tables 3 and 4). However, with these average amounts being similar providing 2.08 lb/day of the CSM to both groups Nov – Apr would result in the Feb calving cows being in a 5.6 BCS the beginning of the next breeding season and the Mar ones in a 5.5 BCS.

Net Energy Maintenance (NEm)

With the cows' BCS at the beginning of the next breeding season at 5.5 to 5.6 any additional energy beyond that provided by the cottonseed meal would appear not to be warranted. Although there will be months, such as Dec, in which the cows will not obtain enough NEm to meet their needs, even with the CSM, it is not necessary that they do so. We know the cows will put on weight through late spring and summer when the range grasses contain more energy than they need and as the calves eat more forage and nurse less the cows' energy needs diminish also allowing them to gain weight. This gained weight can then be used as a reservoir when the forage does not contain enough energy to meet their needs. However, we do not want them to drop to too low a condition (< 4.0) so an exercise like this can reveal when this could potentially happen and thus plan accordingly.

If additional energy needs to be provided due to the possibility that the cows will decline to too low a BCS, the amount to provide them can be estimated by taking the difference between the desired BCS and that calculated for a specific period of time. This difference in BCS represents the amount of body weight that the cows will need to gain or not lose. A realistic period of time for them to gain the weight also needs to be decided upon and then the daily Mcal of NEm needed to do this can be determined.

For example, if we find that the cows will be in a BCS of 5.0 at the beginning of the next breeding season but we want them to be at 5.5 at this time how much additional energy do we need to provide them? The difference in EBW between these BCS is 55 pounds (110 lb per BCS) for cows with an EMBW of 1333 pounds. The additional Mcal of NEm needed for the cows to gain 55 pounds would be 490. This amount is determined by use of the weight change equation. In this case the BCS value to use in the equation will be 5.0 the condition the cows are currently in: (1.3665 + ((0.33073 x 5.0)) x 2.95 = 8.91 Mcal/lb; 55 lb x 8.91 Mcal/lb = 490 Mcal. For the cows to gain 55 pounds in a month they would need an additional 16.3 Mcal/day (490 Mcal ÷ 30 days), if over two months 8.15 Mcal/day.

If corn was the energy source (1.0 Mcal NEm/lb) it would take 16.5 lb/day of it for a month or 8.25 lb/day over two months. However, if we know in advance that they could end up in a lower BCS then we want them to be in we could provide extra energy before they lose too much weight. It takes 2.95 times less Mcal to maintain their weight then it takes for them to gain weight. If we know they will be in BCS 5.5 two months prior to calving we can maintain them there for the next two months with an additional 2 – 3 Mcal NEm/day using 2 – 3 lb of corn/day.

Macro-minerals (Table 2)

Phosphorus (P)

The P amounts the cows would obtain from the range forage are listed in **Row 39**. The amounts are determined by multiplying Mcal NEm consumed (Row 12) by lb P/Mcal (Table 1; Column G; Row 19). For May: 24.92 Mcal x 0.003 lb P/Mcal = 0.075 lb P.

Because CSM contains 1.16% P (Appendix Table 3) the amount of P the cows will acquire from it needs to be included in the months it is furnished (**Row 40**). The amount is determined by multiplying the lb/day of the CSM by 1.16%. If the Feb calving cows are fed 1.5 lb/day of the CSM in Nov they will obtain 0.0174 lb of P (1.5 lb x 1.16%).

Total amounts of P ingested by the cows from the range forage and the CSM when it is furnished are listed in **Row 41**.

The required amount of P is determined by multiplying the Mcal of NEm for (M), (G), and (L) by 0.00426, 0.0048, and 0.00272 lb P/Mcal, respectively, and adding the results. For May: (8.00 x 0.00426) + (4.87 x 0.00272) = 0.0341 + 0.0132 = 0.0473 lb P (**Row 42).**

The net balance would be the difference between the amount consumed and that required. For May: 0.0751 – 0.0473 = 0.0278 lb P and for Nov: 0.0042 + 0.0174 – 0.0452 = -0.0236 lb P (**Row 43).**

Dicalcium phosphate (DCP) which contains 19.3% P (Appendix Table 3) will be the ingredient used to provide P when it is deficient in the diet. Dividing the 0.0236 lb P that is deficient in Nov by 19.3% yields 0.1224 lb of the DCP (**Row 44**) that would need to be included in the supplement in Nov to satisfy the rumen bugs P needs.

The average amount of DCP that would need to be provided May – Oct would be 0.0842 lb/day and Nov – Apr it would be 0.1220 lb/day for the Feb calving cows (Table 4). For the Mar calving cows the amounts would be 0.0977 and 0.1172 lb/day, respectively. Both groups could be provided 0.09 and 0.12 lb/day of DCP for the months May – Oct and Nov – Apr, respectively. In doing this there would be some months when the P needs of the cows would not fully be met but it appears not at a problematic level.

Calcium (Ca)

The amounts of Ca the cows' would obtain from the range forage is determined by multiplying Mcal NEm consumed/day (Row 12) by lb Ca/Mcal (Table 1; Row 20). For May: 24.92 Mcal x 0.0068 lb Ca/Mcal = 0.1707 lb Ca (**Row 45**). The DCP would add some Ca to the cows' diet (**Row 46**) as it contains 22%Ca (Appendix Table 3). The total amount of Ca in the cows' diet is listed in **Row 47**.

The required amount of Ca in the cows' diet needs to be at least 1.5 times the amount of P in their diet but should not be more than seven times the amount. Adding the amounts of P obtained from the range forage (Row 39), CSM (Row 40), and DCP (Row 42) and multiplying the total by 1.5 will yield the minimum amount of Ca needed in the diet (**Row 48**). For Nov: 0.0042 + 0.0174 + (-0.0236) = 0.0452 lb P x 1.5 = 0.0678 lb Ca. The amount of Ca in the diet exceeded the amount required for all months but not to the point that the amount was greater than seven times that of P (**Row 49**). For May: 0.1707 lb Ca ÷ 0.0751 lb P = 2.3: 1 ratio.

Magnesium (Mg)

As with P and Ca the amount of Mg the range forage would provide the cows is determined by multiplying Mcal NEm consumed (Row 12) by lb of the mineral/Mcal in this case Mg (Table 1; Row 21). For May: 24.92 Mcal x 0.0019 lb Mg/Mcal = 0.0478 lb Mg (**Row 50**). CSM contains 0.65% Mg so it would add to the amount of Mg consumed by the cows (**Row 51**). Although DCP contains 0.59%Mg it would add only a nominal amount to the diet. Total Mg amounts in the cows' diet from range forage and CSM are listed in **Row 52**.

The required amount of Mg in pounds (**Row 53**) is determined by multiplying Mcal NEm consumed (Row 12) by 0.003 lb Mg/Mcal. For May: 24.92 x 0.003 = 0.0748 lb Mg. The required amount is then subtracted from the total amount consumed to come up with the net balance (**Row 54**). For May: 0.0478 lb consumed – 0.0748 required = -0.027 lb Net. Dividing this 0.027 lb shortfall in Mg by 56.2%, the amount of Mg in magnesium oxide (MgO), results in 0.048 lb of it needed in the supplement (**Row 55**).

Potassium (K)

The amounts of K the range forage would provide are listed in (**Row 56**). For May: 24.92 Mcal (Row 12) x 0.0274 lb K/Mcal

(Table 1; Row 22) = 0.6829 lb K. The CSM contained 1.65% K so would provide some K when it was furnished (**Row 57**). Total amounts of K in the cows' diet from these two sources are listed in **Row 58**.

Required lb/day of K (**Row 59**) is obtained by multiplying Mcal NEm consumed (Row 12) by 0.016 lb K/Mcal. For May: 24.92 x 0.016 = 0.3988 lb K. As a result the net balance (**Row 60**) would be 0.2841 lb. In the months the range forage and CSM do not provide an adequate amount of K to the cows, potassium chloride (KCl) would be the ingredient in the supplement to satisfy this need. KCl contains 50%K so for every amount K was deficient it would require twice that amount in KCl (**Row 61**). For Sep: 0.034 lb ÷ 0.50 = 0.068 lb KCl.

Grass tetany can be of concern, especially in the spring when grass is actively growing. Grass tetany is an imbalance in the amount of K a ruminant consumes compared to the amounts of Ca and Mg in the diet all on an equivalent weight basis; that is the amount of each element corrected for its molecular weight. If the amount of K is not more than 2.2 times the amount of Ca + Mg then grass tetany should not be an issue. K: Ca + Mg ratios are listed in **Row 62** with all being below the 2.2: 1 threshold for tetany.
The ratio is determined by:
(K ÷ 39) ÷ [(Ca ÷ 20) + (Mg ÷ 12.1)]
For May the ratio was 1.2:1:
(0.683 ÷ 39) ÷ [(0.171 ÷ 20) + (0.075 ÷ 12.1)]
0.0175 ÷ (0.0085 + 0.0062)
0.0175 ÷ 0.0147 = 1.2: 1 ratio

Sulfur (S)

The amount of S the range forage would provide is listed in (**Row 63**). For May: 24.92 Mcal (Row 12) x 0.003 lb S/Mcal (Table 1; Row 23) = 0.0751 lb S. The CSM contained 0.42% S so would provide some S when furnished (**Rows 64**). The total amounts of S in the cows' diet from these sources are listed in **Row 65**.

The amount of S required in a cow's diet is 0.15% of dry matter consumed; not on Mcal NEm consumed. For Nov: 27.9 lb forage (Row 11) + 1.5 lb CSM (Row 32) = 29.4 lb dry matter x 0.15%S = 0.044 lb S (**Row 66**). The net S balances are listed in **Row 67**. Sulfur is deficient Dec through Apr and to satisfy this shortfall sodium sulfate ($NaSO_4$) will be the ingredient used in the supplement. $NaSO_4$ contains 9.95% S and dividing the lb of S lacking in the diet by this percentage gives the pounds of $NaSO_4$ needed (**Row 68**). For Dec: 0.0014 lb S needed divided by 9.95% = 0.0143 lb $NaSO_4$.

Sodium (Na)

The amounts of Na the range forage would provide the cows are listed in **Row 69**. For May: 24.92 Mcal (Row 12) x 0.0006 lb Na/Mcal (Table 1; Row 24) = 0.0137 lb Na. KCl and $NaSO_4$ contain 1.0% and 14.3% Na, respectively, and would provide some Na when they are furnished (**Rows 70 and** 71). Total amounts of Na in the diet are listed in **Row 72**.

The amount of Na required in the diet of the cows is determined by multiplying total Mcal NEm consumed by 0.00227 lb Na/Mcal (**Row 73**). For Nov: 15.04 Mcal from forage (Row 12) + 1.22 Mcal from CSM meal (Row 33) = 16.26 Mcal NEm x 0.00227 lb Na/Mcal = 0.0369 lb Na. The cows did not obtain an adequate amount of Na from the range forage and the ingredients in the supplement (**Row 74**) so salt (NaCl) would need to be added to the supplement or provided free choice. If salt is included in the supplement the amount needed would be determined by dividing the Na deficiency (**Row 75**) by 39.3% the amount of Na in salt. For May: 0.0429 lb ÷ 39.3% = 0.1091 lb salt.

Micro-minerals (Table 2)

Because micro-minerals are reported in ppm (mg/kg) the amounts are divided by 2.2 to convert them to mg/lb. For example: The range forage contained 10 mg Cu per kg of dry matter throughout the year (Table 1; Row 11) or 4.54 mg/lb (Table 1; Row 25).

Cobalt (Co)

The range forage was not tested for Co but the Feed Library indicates that range forage contains on average 24 ppm (11 mg/lb) of Co throughout the year. Assuming range forage in NE Wyoming does as well the amounts of Co it provided the cows are listed in **Row 77**.

The required amount of Co in the cows' diet is determined by multiplying total Mcal NEm consumed by *0.2* and dividing by 2.2 (**Row 78**). For Nov: 15.04 Mcal from forage (Row 12) + 1.22 Mcal from CSM (Row 33) = 16.26 Mcal NEm x 0.2 = 3.25 ÷ 2.2 = 1.48 mg Co. If the range forage contained at least 12 ppm Co throughout the year it would have satisfied the needs of the rumen microbes (**Row 79**).
Note: In the Oct 2012 issue the factor was incorrectly stated as 0.02.

Copper (Cu)

The amounts of Cu the range forage would provide the cows are listed in **Row 80** and are determined by multiplying pounds of forage consumed by mg Cu/lb of forage (Table 1: Row 25). For May: 34.1 lb (Row 11) x 4.54 mg Cu/lb = 155 mg Cu. The CSM contained 16 ppm Cu (Appendix Table 3) or 7.3 mg/lb (16 ÷ 2.2), thus it would provide the cows 11 mg Cu in Nov (1.5 lb x 7.3 mg/lb) (**Row 81**). Total daily amounts of Cu ingested by the cows are listed in **Row 82**.

The amount of Cu required is determined by multiplying total Mcal NEm consumed by 16 and dividing by 2.2 (**Row 83**). For Nov: 15.0 Mcal from forage (Row 12) + 1.22 Mcal from CSM (Row 33) = 16.3 Mcal NEm x 16 = 261 ÷ 2.2 = 118 mg Cu. In the months Cu was deficient (**Row 84**), copper sulfate ($CuSO_4$) would be the ingredient in the supplement to meet the shortfall. $CuSO_4$ contains 254,500 mg Cu/kg or 0.2545 kg Cu/kg (254,500 ÷ 1,000,000). Dividing the mg of Cu that is deficient by 0.2545 yields the mg of $CuSO_4$ needed (**Row 85**). For May: 155 mg Cu consumed – 181 mg required = -26 mg; 26 mg ÷ 0.2545 kg = 102 mg $CuSO_4$ needed. $CuSO_4$ contains 12.84% S but the amount it would provide the cows would not be enough to reduce the amount of $NaSO_4$ needed.

Iodine (I)

The range forage was not tested for I and the Feed Library does not list any values for range forage. The required amounts of I are listed in **Row 86** and are determined by multiplying total Mcal NEm consumed by 1.0 and dividing the product by 2.2. For Nov: 16.26 Mcal x 1.0 = 16.26 ÷ 2.2 = 7.39 mg I. To supply I in the diet EDTA will be in the supplement as it contains 803,400 mg I/kg or 0.8034 kg I/kg. For May: 11.3 mg required ÷ 0.8034 = 14.1 mg EDTA needed (**Row 87**).

Iron (Fe)

The range forage provided a significant amount of Fe to the cows throughout the year (**Row 88**). In addition, DCP provided a fair amount of Fe (**Row 89**) with total amounts ingested by the cows listed in **Row 90**). The amount of Fe required equals Mcal NEm consumed x 100 ÷ 2.2 (**Row 91**). For Nov: 16.26 Mcal x 100 ÷ 2.2 = 739 mg Fe. The amount of Fe ingested by the cows' was greater than the required amounts in all months (**Row 92**).

Manganese (Mn)

The amounts of Mn the range forage would provide the cows are listed in **Row 93**. The CSM and DCP also provided the cows with some Mn when furnished (**Rows 94 and 95**, respectively). Total daily amounts of Mn

ingested by the cows from all sources are listed in **Row 96**.

The amount of Mn required equals Mcal NEm consumed x 90 ÷ 2.2 (**Row 97**). For Nov: 16.26 Mcal x 90 ÷ 2.2 = 665 mg Mn. For the months when not enough Mn is supplied by all feed sources to meet the cows' needs (**Row 98**) manganese carbonate ($MnCO_3$) would be included in the supplement. It contains 478,000 mg Mn/kg or 0.478 kg Mn/kg. The amounts of $MnCO_3$ needed are reported in **Row 99**.

Selenium (Se)

As with Co and I the range forage was not tested for Se and the Feed Library does not list any values for range forage. However, CSM contains 0.98 ppm Se (0.445 mg/lb) and the amounts it would provide the cows when furnished are reported in **Row 100**. The required amounts of Se are listed in **Row 101** and the factor to multiply total Mcal NEm consumed by is 0.4 to come up with these amounts. For Nov: 16.26 Mcal x 0.4 ÷ 2.2 = 2.96 mg Se. Even in the months CSM was provided Se was deficient in the cows' diet (**Row 102**). Sodium selenite (Na_2SeO_3) will be the ingredient used to supply Se in their diet. It contains 456,000 mg Se/kg or 0.456 kg Se/kg. The amounts of Na_2SeO_3 needed are listed in **Row 103**.

Zinc (Zn)

The Zn amounts the range forage would provide the cows are reported in **Row 104**. The CSM contains 74 ppm Zn or 33.6 mg/lb and the amounts it would provide the cows are listed in **Row 105**. Total daily amounts of Zn ingested are listed in **Row 106**.

The factor to multiply Mcal NEm consumed by to come up with the amount of Zn required is 90 (**Row 107**). In the months Zn was deficient (**Row 108**) zinc sulfate ($ZnSO_4$) would be the ingredient in the supplement to satisfy this need. $ZnSO_4$ contains 363,600 mg Zn/kg or 0.3636 kg Zn/kg. The mg of $ZnSO_4$ needed are listed in **Row 109**.

Table 3 shows the daily amounts of each supplement ingredient to satisfy the DIP and mineral needs of the March calving cows.

Total lb/day of the May-Oct and Nov-Apr supplements for the Mar cows averaged 99% and 94%, respectively, of that for the Feb cows (**Table 4**). The ingredient amounts for both calving groups are similar enough that providing a supplement that is the average of the amounts for both groups would probably be alright. There would be some months when a mineral could be slightly deficient and other months it would be slightly more than they need but in neither case enough to cause health and production issues.

Although the cows of both groups did not need any supplemental P in May and Jun, K May – Aug, and Cu and Mn in Oct (Tables 2 and 3) the May-Oct supplement would be provided each day for all six months (Table 4). This would be done to minimize the number of different supplemental packages needed. It could be argued that KCl would not need to be included in this supplement as the deficient amounts in Sep and Oct were minimal. In addition, the cows did not need any supplemental S in Nov or Mn Nov – Jan but the Nov-Apr supplement would be fed each day of this six month period, again to minimize the number of custom supplements needed. The cost of providing these minerals when not needed is probably not that great and easier than having numerous supplement formulations. A reason for 45-day breeding seasons! In no case was there too much of a mineral with regard to animal tolerances.

Next issue: Supplement formulas for the same cow herd but with hay being provided in place of rangeland forage Jan – Apr.

Table 1. Forage analysis report for NE Wyoming range grasses.

R/C	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**Nutrient**	**Units**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2	NEm	Mcal/lb	0.50	0.48	0.46	0.50	0.73	0.65	0.65	0.64	0.63	0.58	0.54	0.52
3	Protein	%	6.0	5.5	5.0	6.5	16.5	11.5	11.0	10.5	10.0	10.5	7.0	6.5
4	Degradable	%	63	63	63	65	72	72	72	72	70	68	65	63
5	Calcium	%	0.55	0.40	0.35	0.30	0.50	0.50	0.50	0.65	0.65	0.65	0.65	0.60
6	Phosphorus	%	0.008	0.006	0.005	0.004	0.220	0.160	0.100	0.090	0.070	0.060	0.015	0.010
7	Magnesium	%	0.06	0.05	0.05	0.05	0.14	0.13	0.11	0.11	0.11	0.10	0.08	0.07
8	Potassium	%	0.35	0.30	0.25	0.25	2.00	1.75	1.50	1.30	0.90	0.80	0.50	0.45
9	Sulfur	%	0.11	0.10	0.09	0.09	0.22	0.18	0.17	0.16	0.15	0.15	0.14	0.12
10	Sodium	%	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
11	Copper	mg/kg	10	10	10	10	10	10	10	10	10	10	10	10
12	Iron	mg/kg	380	300	250	230	205	200	250	295	350	420	490	450
13	Manganese	mg/kg	47	43	39	42	47	36	42	49	51	53	55	51
14	Molybdenum	mg/kg	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
15	Zinc	mg/kg	10	10	10	14	18	15	15	14	12	12	11	11
16	Converted to lb/Mcal NEm, or lb/lb or mg/lb of dry matter forage (See Table 1 from Part XI for equations)													
17	Protein	lb/Mcal	0.1200	0.1146	0.1087	0.1300	0.2260	0.1769	0.1692	0.1641	0.1587	0.1810	0.1296	0.1250
18	Degradable	lb/Mcal	0.0756	0.0722	0.0685	0.0845	0.1627	0.1274	0.1218	0.1181	0.1111	0.1231	0.0843	0.0788
19	Phosphorus	lb/Mcal	0.0002	0.0001	0.0001	0.0001	0.0030	0.0025	0.0015	0.0014	0.0011	0.0010	0.0003	0.0002
20	Calcium	lb/Mcal	0.0110	0.0083	0.0076	0.0060	0.0068	0.0077	0.0077	0.0102	0.0103	0.0112	0.0120	0.0115
21	Magnesium	lb/Mcal	0.0012	0.0010	0.0011	0.0010	0.0019	0.0020	0.0017	0.0017	0.0017	0.0017	0.0015	0.0013
22	Potassium	lb/Mcal	0.0070	0.0063	0.0054	0.0060	0.0274	0.0269	0.0231	0.0203	0.0143	0.0138	0.0093	0.0087
23	Sulfur	lb/Mcal	0.0022	0.0021	0.0020	0.0018	0.0030	0.0028	0.0026	0.0025	0.0024	0.0026	0.0026	0.0023
24	Sodium	lb/Mcal	0.0008	0.0008	0.0009	0.0008	0.0006	0.0006	0.0006	0.0006	0.0006	0.0007	0.0007	0.0008
25	Copper	mg/lb	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55
26	Iron	mg/lb	173	136	114	105	93	91	114	134	159	191	223	205
27	Manganese	mg/lb	21.4	19.6	17.7	19.1	21.4	16.4	19.1	22.3	23.2	24.1	25.0	23.2
28	Molybdenum	mg/lb	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
29	Zinc	mg/lb	4.55	4.55	4.55	6.36	8.18	6.82	6.82	6.36	5.45	5.45	5.00	5.00
30	Cu: Mo	≥ 4: 1	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0

Table 2. Monthly physiological conditions of February calving beef cows (1333 lb EMBW; 1200 lb SBW @ BCS 5.0), their daily intake of nutrients from the range forage, their daily nutrient requirements, and the nutrient balances before and after supplementation. ***Note: May of the following year cow EBW = 1090 lb, SBW = 1281 lb, and BCS = 5.63.***

R/C	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1		**Units**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
2		Days	31	30	31	31	30	31	30	31	31	28	31	30
3	**Cow Physiological Conditions**													
4	Gestation	Months					5	6	7	8	9			
5	Lactation	Months	4	5	6	7	8					1	2	3
6	EBW	Pounds	1076	1103	1123	1149	1165	1180	1185	1187	1172	1133	1133	1110
7	SBW	Pounds	1265	1296	1320	1350	1369	1387	1393	1395	1378	1331	1332	1304
8	Wt. Change	lb/day	0.86	0.70	0.82	0.53	0.51	0.15	0.08	-0.48	-1.28	0.01	-0.77	-0.64
9	BCS	1.0 – 9.0	5.50	5.74	5.93	6.16	6.31	6.45	6.50	6.52	6.38	6.02	6.02	5.81
10	**Forage (dry matter basis) and resultant Net Energy maintenance (NEm), Crude Protein, and Degradable Intake Protein (DIP) consumption**													
11	Forage	lb/day	34.1	35.0	35.6	31.0	31.5	27.7	27.9	25.1	24.8	29.3	29.3	28.7
12	NEm	Mcal/day	24.92	22.74	23.17	19.87	19.84	16.09	15.04	13.06	12.40	14.06	13.48	14.34
13	Protein	lb/day	5.63	4.02	3.92	3.26	3.15	2.91	1.95	1.51	1.49	1.61	1.46	1.72
14	DIP	lb/day	4.06	2.90	2.82	2.35	2.20	1.98	1.27	0.95	0.94	1.01	0.92	1.12
15	**Requirements for NEm, Crude Protein and DIP (Note: DIP based on Mcal NEm consumed – Row 12)**													
16	NEm (M)	Mcal/day	8.00	8.14	8.26	8.40	8.49	8.57	8.60	8.61	8.53	8.31	8.31	8.18
17	NEm (G)	Mcal/day					0.51	0.98	1.79	3.14	5.08			
18	NEm (L)	Mcal/day	4.87	3.76	2.76	1.96	1.35					3.22	5.79	5.79
19	Cold	Mcal/day						0.66	0.78	0.54	0.53	0.28		
20	Activity	Mcal/day	4.00	4.07	4.13	4.20	4.24	4.29	4.30	4.30	4.26	4.16	4.16	4.09
21	Total NEm	Mcal/day	16.86	15.97	15.14	14.55	14.59	14.50	15.46	16.60	18.40	15.96	18.26	18.07
22	Protein (M)	lb/day	0.63	0.64	0.65	0.66	0.67	0.68	0.68	0.68	0.67	0.66	0.66	0.65
23	Protein (G)	lb/day					0.05	0.09	0.17	0.30	0.49			
24	Protein (L)	lb/day	1.15	0.89	0.65	0.46	0.32					0.76	1.37	1.37
25	Total Protein	lb/day	1.78	1.53	1.30	1.12	1.04	0.77	0.85	0.98	1.16	1.42	2.02	2.01
26	DIP	lb/day	2.49	2.27	2.32	1.99	1.98	1.61	1.50	1.31	1.24	1.41	1.35	1.43
27	**Net Balances for NEm, Protein, and DIP**													
28	NEm	Mcal/day	8.06	6.77	8.02	5.32	5.25	1.59	-0.42	-3.54	-6.00	-1.90	-4.78	-3.72
29	Protein	lb/day	3.85	2.49	2.62	2.13	2.11	2.14	1.10	0.53	0.33	0.19	-0.56	-0.29
30	DIP	lb/day	1.56	0.62	0.51	0.36	0.22	0.37	-0.24	-0.36	-0.30	-0.39	-0.42	-0.32

R/C	A	B	C	D	E	F	G	H	I	J	K	L	M	N
		Units	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
31	**Amount of Cotton Seed Meal to meet DIP shortfalls and amount of NEm and Protein provided by the CS meal and resultant Net balances**													
32	CS Meal	lb/day							1.50	2.26	1.92	2.48	2.70	2.00
33	NEm	Mcal/day							1.22	1.83	1.56	2.01	2.19	1.62
34	Net	Mcal/day	8.06	6.77	8.02	5.32	5.25	1.59	0.79	-1.70	-4.45	0.11	-2.60	-2.10
35	Protein	lb/day							0.69	1.04	0.89	1.14	1.24	0.92
36	Net	lb/day	3.85	2.49	2.62	2.13	2.11	2.14	1.79	1.57	1.21	1.34	0.68	0.63
37	**Intake amounts of minerals from forage and supplement ingredients, the amounts Required and resultant Net balances, and amount of each ingredient in the supplement to satisfy negative balances: macro minerals in pounds per day and micro minerals in milligrams (mg) per day**													
38	Macro-Minerals:													
39	Phosphorus	Forage	0.0751	0.0560	0.0356	0.0279	0.0220	0.0166	0.0042	0.0025	0.0020	0.0018	0.0015	0.0011
40		CS Meal							0.0174	0.0263	0.0223	0.0288	0.0313	0.0232
41		Total	0.0751	0.0560	0.0356	0.0279	0.0220	0.0166	0.0216	0.0288	0.0243	0.0306	0.0328	0.0244
42		Required	0.0473	0.0449	0.0427	0.0411	0.0423	0.0412	0.0452	0.0518	0.0607	0.0442	0.0512	0.0506
43		Net	0.0278	0.0111	-0.0070	-0.0132	-0.0202	-0.0246	-0.0236	-0.0230	-0.0365	-0.0136	-0.0184	-0.0262
44	Dicalcium phosphate*				0.0364	0.0681	0.1048	0.1273	0.1224	0.1190	0.1889	0.0704	0.0954	0.1359
45	Calcium	Forage	0.1707	0.1749	0.1782	0.2018	0.2047	0.1803	0.1810	0.1507	0.1364	0.1172	0.1025	0.0860
46		DCP*			0.0080	0.0150	0.0231	0.0280	0.0269	0.0262	0.0416	0.0155	0.0210	0.0299
47		Total	0.1707	0.1749	0.1862	0.2168	0.2277	0.2083	0.2079	0.1769	0.1780	0.1327	0.1235	0.1159
48		Required	0.1127	0.0840	0.0640	0.0616	0.0634	0.0618	0.0678	0.0776	0.0911	0.0662	0.0767	0.0759
49	Ca: P Ratios	1.5-7: 1	2.3	3.1	4.4	5.3	5.4	5.1	4.6	3.4	2.9	3.0	2.4	2.3
50	Magnesium	Forage	0.0478	0.0455	0.0392	0.0341	0.0346	0.0277	0.0223	0.0176	0.0149	0.0146	0.0146	0.0143
51		CS Meal							0.0098	0.0147	0.0125	0.0161	0.0175	0.0130
52		Total	0.0478	0.0455	0.0392	0.0341	0.0346	0.0277	0.0321	0.0323	0.0274	0.0308	0.0322	0.0274
53		Required	0.0748	0.0682	0.0695	0.0596	0.0595	0.0483	0.0488	0.0447	0.0419	0.0482	0.0470	0.0479
54		Net	-0.0270	-0.0227	-0.0303	-0.0255	-0.0249	-0.0205	-0.0167	-0.0124	-0.0145	-0.0174	-0.0148	-0.0205
55	Magnesium oxide		0.0480	0.0405	0.0539	0.0453	0.0443	0.0365	0.0297	0.0220	0.0258	0.0310	0.0263	0.0365
56	Potassium	Forage	0.6829	0.6122	0.5347	0.4036	0.2834	0.2219	0.1393	0.1130	0.0868	0.0879	0.0732	0.0717
57		CS Meal							0.0248	0.0374	0.0317	0.0410	0.0445	0.0331
58		Total	0.6829	0.6122	0.5347	0.4036	0.2834	0.2219	0.1641	0.1504	0.1185	0.1288	0.1178	0.1048
59		Required	0.3988	0.3638	0.3707	0.3179	0.3174	0.2574	0.2601	0.2383	0.2233	0.2571	0.2506	0.2554
60		Net	0.2841	0.2484	0.1640	0.0857	-0.0340	-0.0355	-0.0961	-0.0879	-0.1048	-0.1283	-0.1328	-0.1507
61	Potassium chloride (KCl)						0.0680	0.0710	0.1921	0.1758	0.2096	0.2566	0.2657	0.3013
62	K: Ca+Mg	< 2.2: 1	1.19	1.09	0.91	0.66	0.50	0.46	0.46	0.49	0.46	0.62	0.64	0.67

R/C	A	B	C	D	E	F	G	H	I	J	K	L	M	N
		Units	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
63	Sulfur	Forage	0.0751	0.0630	0.0606	0.0497	0.0472	0.0416	0.0390	0.0301	0.0273	0.0293	0.0264	0.0258
64		CS Meal							0.0063	0.0095	0.0081	0.0104	0.0113	0.0084
65		Total	0.0751	0.0630	0.0606	0.0497	0.0472	0.0416	0.0453	0.0396	0.0353	0.0397	0.0377	0.0342
66		Required	0.0512	0.0525	0.0535	0.0466	0.0472	0.0416	0.0440	0.0411	0.0401	0.0477	0.0480	0.0460
67		Net	0.0239	0.0105	0.0071	0.0031	0.0000	0.0000	0.0013	-0.0014	-0.0047	-0.0079	-0.0103	-0.0118
68	Sodium sulfate ($NaSO_4$)									0.0143	0.0476	0.0798	0.1035	0.1186
69	Sodium	Forage	0.0137	0.0140	0.0143	0.0124	0.0126	0.0111	0.0111	0.0100	0.0099	0.0117	0.0117	0.0115
70		KCl					0.0007	0.0007	0.0019	0.0018	0.0021	0.0026	0.0027	0.0030
71		$NaSO_4$								0.0020	0.0068	0.0114	0.0148	0.0169
72		Total	0.0137	0.0140	0.0143	0.0124	0.0133	0.0118	0.0131	0.0138	0.0188	0.0257	0.0291	0.0314
73		Required	0.0566	0.0516	0.0526	0.0451	0.0450	0.0365	0.0369	0.0338	0.0317	0.0365	0.0356	0.0362
74		Net	-0.0429	-0.0376	-0.0383	-0.0327	-0.0318	-0.0247	-0.0238	-0.0200	-0.0129	-0.0108	-0.0064	-0.0048
75		Salt	0.1091	0.0956	0.0974	0.0831	0.0807	0.0628	0.0606	0.0508	0.0327	0.0275	0.0163	0.0123
76	Micro-Minerals:													
77	Cobalt	Forage	3.72	3.82	3.89	3.39	3.43	3.03	3.04	2.74	2.71	3.20	3.20	3.13
78		Required	2.27	2.07	2.11	1.81	1.80	1.46	1.48	1.35	1.27	1.46	1.42	1.45
79		Net	1.46	1.75	1.78	1.58	1.63	1.56	1.56	1.39	1.44	1.73	1.77	1.68
80	Copper	Forage	155	159	162	141	143	126	127	114	113	133	133	130
81		CS Meal							11	16	14	18	20	15
82		Total	155	159	162	141	143	126	138	131	127	151	153	145
83		Required	181	165	169	145	144	117	118	108	101	117	114	116
84		Net	-26	-6	-6	-3	-1	9	19	22	25	34	39	29
85		Copper Sulfate	102	25	25	13	4							
86	Iodine	Required	11.3	10.3	10.5	9.0	9.0	7.3	7.4	6.8	6.3	7.3	7.1	7.3
87		EDTA	14.1	12.9	13.1	11.2	11.2	9.1	9.2	8.4	7.9	9.1	8.9	9.0
88	Iron	Forage	3181	3180	4051	4163	5009	5296	6203	5137	4283	3994	3329	2999
89		DCP			239	446	686	834	801	779	1236	461	624	889
90		Total	3181	3180	4289	4609	5695	6129	7004	5916	5520	4455	3954	3888
91		Required	1133	1034	1053	903	902	731	739	677	634	731	712	726
92		Net	2049	2147	3236	3706	4793	5398	6265	5239	4886	3725	3242	3162
93	Manganese	Forage	729	572	681	691	730	668	696	582	530	573	519	548
94		CSM							18	28	24	30	33	25

R/C	A	B	C	D	E	F	G	H	I	J	K	L	M	N
		Units	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
95		DCP			5	9	14	17	17	16	26	10	13	19
96		Total	729	572	685	701	744	686	731	626	579	613	566	591
97		Required	1020	930	948	813	811	658	665	609	571	657	641	653
98		Net	-290	-358	-262	-112	-67	27	66	17	8	-45	-75	-62
99	Manganese Carbonate		607	748	549	234	141					94	157	131
100	Selenium	CSM							0.7	1.0	0.9	1.1	1.2	0.9
101		Required	4.5	4.1	4.2	3.6	3.6	2.9	3.0	2.7	2.5	2.9	2.9	2.9
102		Net	-4.5	-4.1	-4.2	-3.6	-3.6	-2.9	-2.3	-1.7	-1.6	-1.8	-1.7	-2.0
103	Sodium Selenite		9.9	9.1	9.2	7.9	7.9	6.4	5.0	3.7	3.7	4.0	3.6	4.4
104	Zinc	Forage	279	239	243	198	172	151	139	126	113	133	133	183
105		CS Meal							51	76	65	84	91	67
106		Total	279	239	243	198	172	151	190	202	177	217	224	250
107		Required	1020	930	948	813	811	658	665	609	571	657	641	653
108		Net	-740	-692	-705	-615	-640	-507	-475	-408	-394	-441	-417	-403
109	Zinc Sulfate		2036	1902	1938	1692	1759	1394	1307	1121	1082	1212	1146	1109

Table 3. Daily amounts of each supplement ingredient to satisfy the DIP and mineral needs of the March calving beef cows. ***Note: Jun of the following year cow EBW = 1084 lb, SBW = 1274 lb, and BCS = 5.57.***

Nutrient	Ingredient	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
DIP	CSM (lb)						1.46	2.20	1.88	2.02	2.58	1.95	
Phosphorus	DCP (lb)		0.0518	0.0796	0.0998	0.1137	0.1012	0.0857	0.1403	0.1803	0.0604	0.1356	
Magnesium	MgO (lb)	0.0395	0.0525	0.0439	0.0428	0.0354	0.0288	0.0214	0.0253	0.0252	0.0252	0.0356	0.0473
Potassium	KCl (lb)				0.0658	0.0687	0.1861	0.1706	0.2052	0.2083	0.2543	0.2939	
Sulfur	$NaSO_4$ (lb)							0.0138	0.0466	0.0648	0.0990	0.1157	
Sodium	Salt (lb)	0.0933	0.0948	0.0806	0.0791	0.0618	0.0613	0.0532	0.0400	0.0323	0.0300	0.0288	0.1076
Copper	$CuSO_4$ (mg)	24	25	13	4								101
Iodine	EDTA (mg)	12.6	12.8	10.9	10.9	8.8	8.9	8.2	7.7	7.4	8.5	8.8	13.9
Manganese	$MnCO_3$ (mg)	730	544	224	137					41	159	126	599
Selenium	Na_2SeO_3 (mg)	8.8	9.0	7.7	7.7	6.2	4.9	3.6	3.6	3.2	3.5	4.3	9.8
Zinc	$ZnSO_4$ (mg)	1857	1886	1642	1703	1349	1266	1088	1060	984	1097	1081	2007

Table 4. Daily average amounts of each supplement ingredient to satisfy the degradable intake protein (DIP) and mineral needs of the February and the March calving cows and the average* supplement mixes to be provided all cows for the May-October and November-April periods.

Nutrient	Ingredient	February Cows		March Cows		May-Oct Supplement			Nov-Apr Supplement		
		May-Oct	Nov-Apr	May-Oct	Nov-Apr	Avg.*	Lb/T[2]	% of[3]	Avg.*	Lb/T[2]	% of[3]
DIP	CSM (lb)		2.15		2.01				2.08	1622	81.1
Macro minerals											
Phosphorus	DCP (lb)	0.0842	0.1220	0.0977	0.1172	0.0909	614	30.7	0.1196	93.3	4.66
Magnesium	MgO (lb)	0.0447	0.0286	0.0436	0.0269	0.0442	299	14.9	0.0277	21.6	1.08
Potassium	KCl (lb)	0.0695	0.2335	0.0673	0.2197	0.0684	463	23.1	0.2266	177	8.84
Sulfur	$NaSO_4$ (lb)		0.0727		0.0680				0.0704	54.9	2.74
Sodium	Salt (lb)	0.0881	0.0334	0.0862	0.0409	0.0872	590	29.5	0.0372	29.0	1.45
Micro minerals[1]											
Copper	$CuSO_4$ (mg)	34.1		33.5		33.8	0.503	0.0252			
Iodine	EDTA (mg)	11.9	8.8	11.6	8.2	11.8	0.1754	0.0088	8.5	0.0146	0.0007
Manganese	$MnCO_3$ (mg)	456	127	447	109	451	6.72	0.336	118	0.2027	0.0101
Selenium	Na_2SeO_3 (mg)	8.4	4.1	8.2	3.8	8.3	0.1236	0.0062	4.0	0.0068	0.0003
Zinc	$ZnSO_4$ (mg)	1787	1163	1741	1096	1764	26.3	1.31	1129	1.94	0.0969
	Totals	*0.292 lb*	*2.639 lb*	*0.300 lb*	*2.490 lb*	*0.296 lb*	*2000*	*100*	*2.564 lb*	*2000*	*100*

[1]Micro minerals: To convert mg to lb divide mg by 454,500. For example: $CuSO_4$ May-Oct average = 33.8 mg; 33.8 ÷ 454,500 = 0.0000744 lb

[2]Lb/T = Avg. lb/day of ingredient ÷ Total lb/day of supplement x 2000. For example: DCP May-Oct average = 0.0909 lb/day; Total supplement = 0.296 lb/day; 0.0909 ÷ 0.296 = 0.3071; 0.3071 * 2000 = 614 lb/T.

[3]% of = Lb/T ÷ 2000 x 100. For example: DCP May-Oct average = 614 lb/T; 614 ÷ 2000 = 0.307; 0.307 x 100 = 30.7%

Appendix Table 1: Changes in cow empty body weights for every change in one body condition score (BCS) at Empty Mature Body Weights from 1000 to 2000 pounds.

	Empty Mature Body Weights (EMBW)										
	1000	**1100**	**1200**	**1300**	**1400**	**1500**	**1600**	**1700**	**1800**	**1900**	**2000**
Lb/BCS*	82	90	98	107	115	123	131	139	148	156	164

*****For lb/BCS for EMBW between those listed divide the cows' EMBW by the nearest listed weight less than it and then multiply the product by the lb/BCS for that listed EMBW. For example: 1333 lb ÷ 1300 lb = 1.0254 * 107 lb = 110 lb

Appendix Table 2: Percent of body weight to estimate forage dry matter intake of beef cows in different physiological stages and subjected to different supplementation programs. *(From Table 14-2, D.D. Simms, 2009)*

Forage Type[1]/Conditions	Dry, Gestating	Lactating
Low quality/unsupplemented	1.5	2.0
Low quality/protein supplemented	1.8	2.2
Low quality/energy supplemented	1.5	2.0
Average quality/unsupplemented	2.0	2.3
Average quality/protein supplemented	2.2	2.5
Average quality/energy supplemented	2.0	2.3
High quality	2.5	2.7

[1]Forage Type: Low quality – winter range, crop residues in winter, very low quality hay (e.g. mature bromegrass); Average quality – late summer/early fall range, good grass hay (e.g. late bloom brome), crop residues shortly after harvest; High quality – spring/early summer range, alfalfa hay and corn silage

Appendix Table 3: Composition of ingredients used in the supplements.

	Macro-Minerals (%)						Micro-Minerals (mg/kg)						
Ingredient	**Ca**	**Mg**	**P**	**K**	**Na**	**S**	**Co**	**Cu**	**I**	**Fe**	**Mn**	**Se**	**Zn**
Cottonseed meal (92% dry)[1]	0.20	0.65	1.16	1.65	0.07	0.42	0.53	16		162	27	0.98	74
Dicalcium Phosphate	22.0	0.59	19.3	0.07	0.05	1.14	10	10		14400	300		100
Magnesium Oxide	3.07	56.2									100		
Potassium Chloride	0.05	0.34		50.00	1.00	0.45				600			
Sodium Sulfate					14.27	9.95							
Salt					39.34								
Copper Sulfate						12.80		254500					
Ethylenediamine (EDTA)									803400				
Manganese Carbonate											478000		
Sodium Selenite					26.60							456000	
Zinc Sulfate	0.02					17.68				10	10		363600

[1]Cottonseed meal contains 0.81 Mcal NEm/lb; 46.1% crude protein that is 57.0% degradable = 26.3% DIP; 92% dry – 1.0 lb dry = 1.09 lb as is
[2]Molasses, beet contains 0.81 Mcal NEm/lb; 8.5% crude protein that is 100% degradable; 78% dry – 1.0 lb dry = 1.28 lb as is

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