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

In this issue we will present Dr. Dick Diven's (Agri-Concepts, Inc.) discussion on protein for the animal with regard to a cow's requirements with respect to maintenance, gestation, and lactation.

REQUIREMENTS

Recall from Part IV (May 2010) that there are two sources of protein for the ruminant animal: Microbial – body protein of rumen bacteria and protozoa that pass from the rumen into the abomasum and on into the intestine and digested; and escape (aka Undegradable Intake Protein) – plant protein that is not degraded by the rumen microorganisms but is washed down the digestive tract to the abomasum and intestines and directly utilized by the animal. Protein requirements for the animal are stated as net protein available to the tissues. For microbial and escape proteins to become "net protein" they must be digested and absorbed. Protein digestibility and absorption is affected by other nutrients, physiological state of the animal, weather conditions, and in the case of escape protein its chemical characteristics. Net available protein varies from 54% to 81% efficiency; that is the percent of dietary protein that is absorbed as amino acids. However, for foraging cattle their protein needs can be calculated with an average value of 65% net availability (NRC 1996). As a result protein requirements presented in Dr. Diven's information have been corrected to show gross dietary values and can be determined by multiplying each energy value by a constant.

Maintenance

The first requirement for protein as for energy is maintenance. We learned in Part II (February 2010) that NEm (M) is related directly to empty body weight (EBW), actually metabolic body weight which is EBW to the ¾ power. As indicated in Part II there is a definite amount of energy required to maintain one pound of live weight and likewise there is a definite amount of protein needed as well. For every pound of metabolic body weight for the mature animal 0.00336 pound of protein is needed. (Note: young, growing cattle have a different requirement that will be presented later). Because the amount of protein and energy for maintenance needed by the animal are related to its body weight the amounts required are related. Thus, for every Mcal of NEm (M) required by the cow she needs 0.07895 pounds of protein.

Before we can determine the pounds of protein a cow needs for maintenance we need to know how much NEm (M) she requires. This was covered in Part II but we'll go over it again. Mcal of NEm (M) needed is determined by multiplying the cow's metabolic body weight by 0.04256. Appendix Table 1 provides the amount of NEm (M) needed by cows with empty mature body weights (EMBW) from 1000 to 1500 lb and body condition scores (BCS) from 3.0 to 7.0. Appendix Table 2 provides the amount of protein that will be needed. What you need to determine is what the average weight of your cows are and their BCS. Cow cull weights can be used to estimate herd average weight if you don't have access to a scale.

Shrunk weights are generally recommended as EBW can then be estimated; it is 0.851 * shrunk body weight (SBW). Thus, if a cow weighs 1200 lb after an overnight shrink her EBW would be 1021 lb (0.851 * 1200 lb). Going to Appendix Table 1 this EBW could be for a cow with an EMBW of 1100 lb @ BCS 7.0 to one with an EMBW of 1200 lb @ BCS 6.0. (*Note: In Part II 0.851 was erroneously stated as 0.891)*

Let's say that the above cow was in BCS 6.0 so her EMBW would be 1200 lb, thus her NEm (M) needs would be 7.67 Mcal/day (Appendix Table 1). Her protein requirement for maintenance would then be 7.67 Mcal * 0.07895 = 0.61 lb (Appendix Table 2).

Gestation

Dr. Diven points out that both NEm and protein required for gestation (G) increases rapidly during the last trimester of pregnancy (weeks 28 – 40) (Figures 1 and 2). The curves are very similar and thus pounds of protein the cow needs for gestation can be estimated by multiplying Mcal NEm (G) by 0.09615. This equation does underestimate the amount of protein needed during the last couple of weeks of pregnancy but only slightly (Figure 2). However, it also accounts for differences in needs due to calf birth weight. *Note: For those of you that attended Dr. Diven's school you'll note that the above factor is slightly greater than what is used in the notebook (0.095).* This is due to newer information on the NEm (G) and protein needs of a beef cow.

Figures 1 and 2 are for a cow whose calf's birth weight is 85 pounds. Appendix Tables 3 and 4 lists the Mcal NEm (G) and pounds protein required by a cow during her last trimester of pregnancy (averages for months 7, 8, and 9) for calf birth weights from 60 to 100 pounds in 5 pound increments.

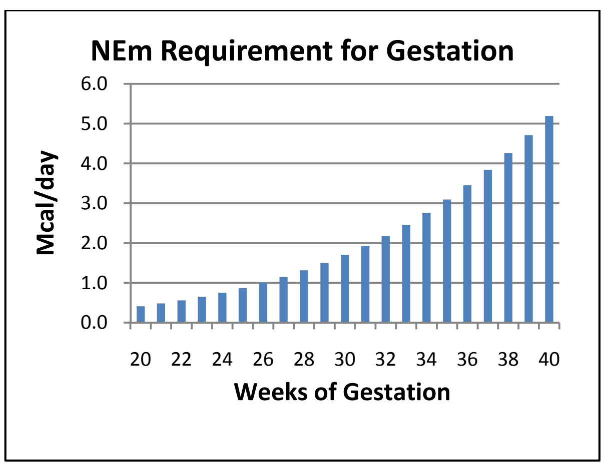

Figure 1: Mcal NEm required daily for gestation (G) during the last five months of pregnancy (85 pound birth weight calf).

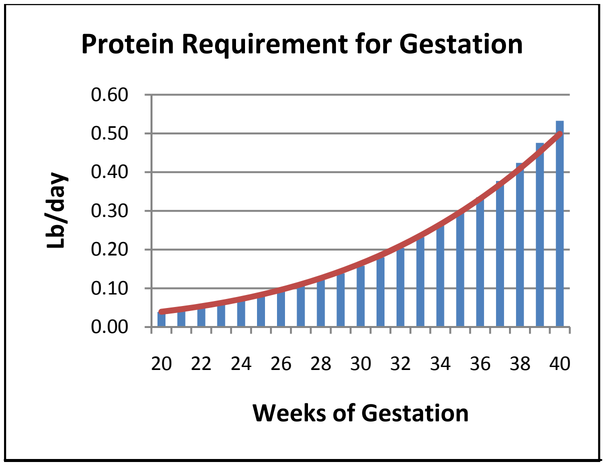

Figure 2: Protein requirement (lb/day) for gestation during the last five months of pregnancy. Note: Bars based on an equation from 'Nutrient requirements of beef cattle'. 1996 (Update 2000), National Academy Press, Washington, D.C. Line above bars is the product of Mcal NEm (G) * 0.09615.

Lactation

As indicated in Part II, the fat content of milk determines the amount of NEm (L) a cow requires. As with maintenance and gestation there is a direct relationship between Mcal NEm for lactation (L) needed and pounds of protein required. The relationship is for every Mcal for NEm (L) 0.2362 pounds of protein is required by the cow for milk production. Dr. Diven used information from the 6th Revised Edition (1984) of "Nutrient Requirements of Beef Cattle" to determine NEm requirements for lactation. However, from the 7th Revised Edition (1996) of this publication the amount of NEm needed is less, thus the NEm (L) and resulted protein values presented here will be lower than those found in Dr. Diven's school notebook.

Beef cow milk averages 4.0% milk fat, 3.4% protein, and 0.33 Mcal/lb of Net Energy. Peak milk production generally occurs by the 9th week post-partum. Dr. Diven used equations from Clutter and Nielsen (1987) to estimate daily milk production for High, Medium, and Low milking cows as was reported in Part II. Peak milk production for High, Medium, and Low milking cows was calculated to be 21, 19, and 16 pounds per day. However, newer information reported in the 7th Revised Edition of "Nutrient Requirements of Beef Cattle" lists peak milk for four production levels: 31, 24, 17.5, and 11 pounds per day. I believe the 17.5 and 11 pounds per day values are more applicable for range beef cows.

PROBLEM – Meeting Cow Protein Needs

Since net protein for the animal is a function of net energy the two can be managed together. Let's go through a production year and determine the monthly net energy and net protein requirements of a beef cow. We will need to establish an average weight of our cow, the birth weight of her calf, and her milking level. For now we will not worry about what month of the year she calves in or the quality of the available forage.

We were able to weigh the cow at weaning after an overnight shrink. She weighed 1186 pounds and was in a BCS of 5.5. *Note: See Table 1 in Part I (Dec 2009 issue) for descriptions of how a cow appears at each BCS 1.0 – 9.0.* Multiplying her SBW of 1186 pounds by 0.851 gives us her EBW which equals 1009 pounds. From Appendix Table 1 we can determine her EMBW and resultant NEm (M) requirement. Going over to the BCS column 5.5 and then down to EBW 1009 we find she will require 7.62 Mcal of NEm (M) each day of the year to maintain her body weight and condition under thermo-neutral conditions, i.e. comfortable temperatures, dry conditions with little to no wind, plus level terrain to traverse. Obviously not realistic but we need to start simple and work into the more complex. Now if we go to the left along this row of NEm (M) values to the EMBW column we find that this weight is 1250 pounds. We will need this weight to determine her consumption of net energy and resultant degradable intake protein.

First, however, what would her daily net protein requirement be? Multiplying 7.62 Mcal by 0.07542 we come up with a daily net protein requirement of 0.57 lb. This value can also be determined from Appendix Table 2 by going down to 1250 in the EMBW column and then over to the 5.5 BCS column. That info is needed but she does us no good if she does not bear a calf. So we need to determine how much additional energy and protein she requires for gestation and lactation.

The expected birth weight of her calf based on previous year's calf weights is 85 pounds (if not already done, it would be a good idea to weigh a few newborn calves each year). Although growth and development of the calf during the cow's first six months of pregnancy takes net energy and protein the amounts are small and generally the diet to satisfy her maintenance and lactation needs suffices. However, as pointed out in the gestation section once she enters her third trimester of pregnancy (months 7 – 9) net energy and protein demands increase dramatically and need to be accounted for.

In Appendix Table 3 we find that during the 7th month (weeks 29-32) of gestation this cow will need an additional 1.83 Mcal/day of NEm. And from Appendix Table 4 we find she will also need 0.18 lb/day more protein (1.83 Mcal * 0.09615). For the 8th month she will require an additional 2.94 Mcal NEm and 0.28 lb protein each day, and for the 9th month 4.5 Mcal NEm and 0.43 lb protein. Thus for the 7th month of gestation (Month 10 in Table 1) our cow will need a total of 9.45 Mcal NEm for maintenance and gestation and 0.78 lb protein. I'll forgo gestation months 8 and 9 but the values for these are displayed in Table 1. In addition, values for gestation months five (weeks 21 – 24) and six (weeks 25 – 28) are also included for your information as it could be argued that they should be included, especially the sixth month.

Establishing a beef cow's milking level is not an easy task; just ask any cowboy who has participated in a wild cow milking contest. Even the most gentle of beef cows will probably not be that cooperative in the attempt to milk them. Appendix Table 5 provides an estimate of beef cow milking ability based on their weight and the weaning weight of their male calves. I recommend using the 17.5 lb/day peak milking level as this most likely will be adequate for most beef breeds. However, if you know your cows produce more or less milk use the NEm and protein values from the appropriate level.

Appendix Table 6 lists the average daily Mcal NEm and pounds protein required for each month of lactation for cows of three peak milking levels. Using values for a cow with a peak milk level of 17.5 lb/day we find that this cow will need an additional 3.10 Mcal NEm and 0.32 lb protein each day during her first month of lactation. Thus, total NEm and protein needs for this month are 10.72 Mcal and 0.89 lb/day, respectively (Table 1).

We now know what the monthly NEm and protein needs of the cow are for a production year (Table 1). What we don't know is if our rangeland forage will provide her with a sufficient amount of NEm and dietary protein to meet these needs, and if not, how much we need to provide with a supplement.

Table 2 lists monthly estimates of Mcal/lb of NEm, percent crude protein, and percent of crude protein that is degradable for Northeastern Wyoming rangeland grasses. From these three quality constituents the pounds of degradable intake protein (DIP) per Mcal of NEm can be determined. Why is this important? In Part IV (May 2010) we learned that the rumen microbes energy and protein requirements need to be satisfied so that they in turn can provide the cow with microbial protein to help meet her net protein needs.

Table 1: Daily Mcal NEm and pounds net protein required by a 1250 pound EMBW beef cow in BCS 5.5 at weaning, calf birth weight 85 pounds, peak milk 17.5 lb/day.

	Maintenance (M)		Gestation (G)		Lactation (L)		Total	
Month	NEm	Protein[1]	NEm	Protein[2]	NEm	Protein[3]	NEm	Protein
1	7.62	0.60			3.10	0.73	10.72	1.33
2	7.62	0.60			5.70	1.35	13.32	1.95
3	7.62	0.60			5.76	1.36	13.38	1.96
4	7.62	0.60			4.86	1.15	12.48	1.75
5	7.62	0.60			3.75	0.89	11.37	1.49
6	7.62	0.60			2.76	0.65	10.38	1.25
7	7.62	0.60			1.95	0.46	9.54	1.06
8	7.62	0.60	0.61	0.06			8.23	0.66
9	7.62	0.60	1.08	0.10			8.70	0.70
10	7.62	0.60	1.83	0.18			9.45	0.78
11	7.62	0.60	2.94	0.28			10.56	0.88
12	7.62	0.60	4.50	0.43			12.12	1.03

[1]Protein for Maintenance: Mcal NEm (M) * 0.07895
[2]Protein for Gestation: Mcal NEm (G) * 0.09615
[3]Protein for Lactation: Mcal NEm (L) * 0.2362

Microbial growth is maximized when the energy and protein levels in the rumen are in balance. The optimum amount of DIP is between 7.5% and 13% for low to high NEm forage (0.45 – 0.62 Mcal/lb) of the amount of NEm. Thus, for every Mcal of NEm the cow consumes she needs to also consume from 0.075 to 0.13 lb of DIP (Sims, D.D. 2009). Table 2 also lists the Mcal of NEm and pounds of DIP the cow would consume from the rangeland forage and the pounds of DIP required based on the amount of NEm consumed. To simplify determining the amount of DIP required Dr. Diven multiplies Mcal of NEm consumed by 0.10 for all forages (average of 7.5%-13%). Although this will over estimate amount of DIP needed for low NEm forage and under estimate that for high it is not of a magnitude to be of concern.

Comparing the pounds of DIP available (Table 2) to the 1250 lb EMBW cow with pounds of net protein required (Table 1) it would appear that her protein needs are being met, except in Feb, Mar, and Apr (Note: Month 1 in Table 1 would be March in Table 2 for a March calving cow). Possibly they are but because rumen microbe protein needs are not being met, except May – September the amount of protein supplied to the animal might be insufficient. In addition, if the protein needs of the microbes are not met they will not be able to fully utilize the available NEm consumed by the cow. Thus, the amount of energy they furnish to the cow in the way of volatile fatty acids will be less possibly resulting in her NEm needs not being satisfied. However, if the protein needs of the rumen microbes are met then most likely those of the cow will also be met, except in forage diets very low in NEm and crude protein. In the school Dr. Diven uses urea to satisfy the rumen microbe protein needs as an example because it is 100% degradable in the rumen. Crude protein content of urea is 288%. Thus, providing 0.13 lb of urea would make up for the 0.38 lb DIP deficiency in Jan (Table 2) ((0.38/288)*100).

Table 2: Relating Net Energy maintenance (NEm) utilization to Degradable Intake Protein (DIP) availability for a 1250 pound Empty Mature Body Weight (EMBW) beef cow.

	Forage Content				From Rangeland Forage per Day			
Mon	NEm Mcal/lb	%CP[1] in diet	%DIP[2]	DIP lb/Mcal[3]	Mcal NEm Consumed[4]	Lb DIP Available[5]	Lb DIP Required[6]	DIP ±[7]
Jan	0.50	6.0	60	0.072	13.3	0.95	1.33	-0.38
Feb	0.48	5.5	60	0.069	12.2	0.84	1.22	-0.38
Mar	0.46	4.0	60	0.052	11.2	0.58	1.12	-0.53
Apr	0.50	6.5	65	0.085	13.3	1.12	1.33	-0.21
May	0.73	16.5	84	0.190	27.2	5.17	2.72	+2.45
Jun	0.65	11.5	80	0.142	22.0	3.11	2.20	+0.91
Jul	0.65	11.0	78	0.132	22.0	2.90	2.20	+0.70
Aug	0.64	10.0	72	0.113	21.4	2.40	2.14	+0.27
Sep	0.63	9.0	70	0.100	20.7	2.07	2.07	0.00
Oct	0.58	8.0	68	0.094	17.7	1.66	1.77	-0.11
Nov	0.54	7.0	65	0.084	15.4	1.30	1.54	-0.24
Dec	0.52	6.5	60	0.075	14.3	1.08	1.43	-0.35

[1]%CP (Crude protein) in diet generally averages 1% to 2% higher than laboratory analysis, thus 1.5% has been added to the laboratory averages. (Difference does not apply to NEm)
[2]%DIP (Degradable Intake Protein): Percent of crude protein that is degradable in the rumen
[3]DIP lb/Mcal NEm: ((%CP/100) * (%DIP/100))/Mcal NEm/lb
For Jan: ((6.0%/100) * (60%/100))/0.50 lb; 0.06 * 0.60 = 0.036; 0.036/0.50 = 0.072
[4]Mcal NEm Consumed = $(0.65 * \text{EMBW})^{.75}$ * ((0.144598 * NEm Mcal/lb) + (0.206865 * NEm Mcal/lb^2) – 0.036915)
Example for a 1250 lb EMBW cow: $(0.65 * 1250)^{.75} = 152.2$
For Jan: 152.2 * ((0.144598 * 0.50) + (0.206865 * 0.50^2) – 0.036915) =
152.2 * (0.0723 + 0.0517 – 0.036915) = 152.2 * 0.0871 = 13.3 Mcal
[5]Lb DIP Available: Lb DIP/Mcal * Mcal NEm Consumed
For Jan: 0.072 * 13.3 = 0.95 lb
[6]Lb DIP Required: Mcal NEm Consumed * 0.10
For Jan: 13.3 * 0.10 = 1.33 lb
[7]DIP ±: Lb DIP Available – Required.
For Jan: 0.95 – 1.33 = -0.38 lb (Amount needed to be provided by a DIP supplement)

Because alfalfa hay is readily available in this area let's look at using it to satisfy the DIP needs of the rumen microbes instead of urea. Good quality alfalfa hay contains at least 17% crude protein and 0.58 Mcal NEm/lb. The presence of NEm complicates calculating how many pounds of alfalfa hay is needed as we cannot simply divide pounds of DIP needed by 17% to get the pounds required to meet the rumen microbe protein needs as this could still result in a deficiency. The reason is that some of the DIP in the alfalfa will need to be utilized by the microbes in their digestion of the available NEm from the alfalfa hay. Thus, more alfalfa hay will need to be provided than just the amount needed to address the DIP deficiency from rangeland forage.

To calculate pounds of alfalfa hay needed to make up for the DIP deficiency from the rangeland forage we first need to determine how many pounds of DIP there is per Mcal NEm in the alfalfa. If the alfalfa hay contains 0.58 Mcal NEm/lb, 17% CP with 77% degradable its lb DIP/Mcal NEm = 0.226
(17% * 77% DIP) / 0.58 Mcal/lb = 0.226

Then multiply lb DIP/Mcal NEm by Mcal NEm to obtain pounds of DIP available to the microbes per pound of hay:
0.226 lb DIP/Mcal * 0.58 Mcal = 0.1311 lb DIP

Next multiply Mcal NEm/lb by 0.10 to obtain pounds of DIP required by the microbes to digest one pound of the hay:
0.58 Mcal/lb * 0.10 = 0.058 lb DIP

Subtract lb DIP required from that available to obtain the amount of excess DIP the microbes can use to effectively digest the rangeland forage, i.e. make up the deficiency:
0.1311 lb – 0.058 lb = 0.0731 lb

Divide lb deficient by lb in excess to obtain pounds of alfalfa hay needed:
0.38 ÷ 0.0731 = 5.2 lb alfalfa hay

Thus, for Jan and Feb 5.2 lb/day of the alfalfa hay would satisfy the rumen microbe DIP needs allowing them to fully utilize all the available energy in the hay and the rangeland forage. Dividing the pounds deficient for each month this occurs (Table 2) by pounds excess DIP (0.0731) the following amounts of alfalfa hay would need to be provided: Mar – 7.3 lb; Apr – 2.9 lb; Oct – 1.5 lb; Nov – 3.3 lb; and Dec – 4.8 lb. This is why Dr. Diven used urea to make up for any deficiencies in DIP as he did not need to account for additional Mcal NEm in the diet. However, if there is a NEm deficiency, using alfalfa hay or similar supplement could meet this need whereas use of urea would not.

There could be situations where even after supplying a supplement that meets DIP needs of the rumen microbes net protein needs of the cow still fall short. However, before we know if this is the case we need to determine how much escape protein the cow is obtaining from the rangeland forage. Remember, the ruminant animal obtains protein from both microbial and escape. If the cow's net protein needs are not being met with these two sources then the provision of a dietary escape protein supplement would be necessary.

On average the crude protein content of grasses is 20% undegradable and thus escapes digestion in the rumen and is absorbed directly by the animal. Table 3 displays total dietary net protein from microbial and escape proteins that the 1250 lb EMBW cow would consume from the rangeland forage and urea as the DIP supplement. The Table also shows the cow's monthly net protein requirement and the protein balance (difference between net protein consumed and that required). Except for April, the cow consumed enough net protein to meet her needs. Thus, for April the provision of an escape protein supplement would be needed. Dr. Diven uses brewers dried grains in the notebook example but let's see what happens when alfalfa hay is used as the DIP supplement instead of urea.

Table 4 provides the Mcal of NEm and pounds of DIP and escape protein the cow would consume from the alfalfa hay supplement. These values are then combined with those for the rangeland forage (Tables 2 and 3) and are presented in Table 5. April was the month of concern as when urea was used as the DIP supplement the total amount of net protein available to the cow was less than her required amount (Table 3). Using alfalfa hay as the DIP supplement instead of urea her net protein needs in April were satisfied. Thus, an additional protein supplement would not need to be provided.

Table 3: Total net protein (DIP and escape) available to the 1250 pound EMBW beef cow (March calving; 85 lb birth weight; 17.5 lb/day peak milk) and her required amount.

Mon	Escape lb/Mcal[1]	Mcal NEm Consumed[2]	Lb DIP [3]	Lb Escape Protein[4]	Lb Net Protein[5]	Lb Protein Required[6]	Protein Balance
Jan	0.024	13.3	1.33	0.32	1.65	0.88	+0.77
Feb	0.023	12.2	1.22	0.28	1.50	1.03	+0.47
Mar	0.017	11.2	1.12	0.19	1.31	1.33	-0.02
Apr	0.026	13.3	1.33	0.34	1.67	1.95	**-0.28**
May	0.045	27.2	5.17	1.23	6.40	1.96	+4.44
Jun	0.035	22.0	3.11	0.78	3.89	1.75	+2.14
Jul	0.034	22.0	2.90	0.74	3.64	1.49	+2.15
Aug	0.031	21.4	2.40	0.67	3.07	1.25	+1.82
Sep	0.029	20.7	2.07	0.59	2.66	1.06	+1.60
Oct	0.028	17.7	1.66	0.49	2.15	0.66	+1.49
Nov	0.026	15.4	1.30	0.40	1.70	0.70	+1.00
Dec	0.025	14.3	1.08	0.36	1.44	0.78	+0.66

[1]Escape protein lb/Mcal NEm: ((%CP/100) * (20%/100))/Mcal NEm/lb

For Jan: ((6.0%/100) * (20%/100))/0.50 lb; (0.06 * 0.20)/.50 = 0.012/0.50 = 0.024

[2]Mcal NEm Consumed from Table 2

[3]Lb DIP from rangeland forage and urea as the DIP supplement (Oct – Apr)

[4]Lb Escape Protein: Escape lb/Mcal * Mcal NEm Consumed

For Jan: 0.024 * 13.3 = 0.32 lb

[5]Lb Net Protein: DIP + Escape Protein

[6]Lb Protein Required: From Table 1

Table 4: Net Energy maintenance (NEm) and protein (Degradable Intake Protein and Escape) available for a 1250 pound Empty Mature Body Weight (EMBW) beef cow from alfalfa hay (0.58 Mcal NEm/lb; 17% crude protein w/77% degradable; 23% escape).

Mon	Lb Dry Matter[1]	Mcal NEm Consumed[2]	Lb DIP Available[3]	Lb DIP Required[4]	Lb Escape Protein[5]	Lb Net Protein[6]
Jan	5.2	3.0	0.68	0.30	0.18	0.86
Feb	5.2	3.0	0.68	0.30	0.18	0.86
Mar	7.3	4.2	0.95	0.42	0.25	1.20
Apr	2.9	1.7	0.38	0.17	0.10	0.48
Oct	1.5	0.9	0.20	0.09	0.05	0.25
Nov	3.3	1.9	0.43	0.19	0.11	0.54
Dec	4.8	2.8	0.63	0.28	0.16	0.79

[1]Lb Dry Matter: Amount of alfalfa hay needed to satisfy rumen microbe protein needs

[2]Mcal NEm Consumed: Lb Dry Matter * 0.58 Mcal/lb

[3]Lb DIP Available: Mcal NEm Consumed * 0.226; (0.17 * 0.77)/0.58 Mcal/lb

[4]Lb DIP Required: Mcal NEm Consumed * 0.10

[5]Lb Escape Protein: Mcal NEm Consumed * 0.0586; (0.17 * 0.20)/0.58 Mcal/lb

[6]Lb Net Protein: DIP Available + Escape Protein

Table 5: Total pounds of net protein (DIP and escape) available to the 1250 pound EMBW beef cow (March calving; 85 lb birth weight; 17.5 lb/day peak milk) from the rangeland forage and alfalfa hay supplement and her required amount.

Mon	Mcal NEm Consumed[1]	Lb DIP Available[2]	Lb Escape Protein[3]	Lb Net Protein[4]	Lb Protein Required[5]	Protein Balance
Jan	16.3	1.63	0.50	2.13	0.88	+1.25
Feb	15.2	1.52	0.46	1.98	1.03	+0.95
Mar	15.4	1.53	0.44	1.97	1.33	+0.64
Apr	15.0	1.50	0.44	1.94	1.95	-0.01
May	27.2	5.17	1.23	6.40	1.96	+4.44
Jun	22.0	3.11	0.78	3.89	1.75	+2.14
Jul	22.0	2.90	0.74	3.64	1.49	+2.15
Aug	21.4	2.40	0.67	3.07	1.25	+1.82
Sep	20.7	2.07	0.59	2.66	1.06	+1.60
Oct	18.6	1.86	0.54	2.40	0.66	+1.74
Nov	17.3	1.73	0.51	2.24	0.70	+1.54
Dec	17.1	1.71	0.52	2.23	0.78	+1.45

[1]Mcal NEm Consumed from rangeland forage and alfalfa hay (Tables 2 and 4)
[2]Lb DIP Available from rangeland forage and alfalfa hay (Tables 2 and 4)
[3]Lb Escape Protein from rangeland forage and alfalfa hay (Tables 3 and 4)
[4]Lb Net Protein: DIP Available + Escape Protein
[5]Lb Protein Required: From Table 1

Let's look at another scenario, May calving. How much alfalfa hay would need to be furnished if the calving date was moved from March to May? The same amount! If you recall from Table 2 the DIP deficiencies were a result of the quality of the rangeland forage and the resultant amount of NEm and protein the cow could obtain based on her EMBW. The cow's production stage had no influence on this. The provision of a DIP supplement whether it be urea, alfalfa hay or some other feed was to satisfy the protein needs of the rumen microbes. Once this was accomplished it was then determined if the cow's protein needs were being met (based on her size and stage of production) and if not, how much more protein would need to be supplied.

Although the amount of escape protein from the alfalfa hay resultant in the cow's net protein needs being satisfied for April, it barely did so. Recall that protein requirements for the cow were determined under thermo-neutral conditions, level terrain, and a BCS of 5.5 for the entire year. If we want the cow to be able to gain body condition so she can withstand sub-zero temperatures under windy conditions and also able to negotiate rough terrain she will require additional protein as well as NEm to do so. This goes back to what was presented in Part III (April 2010) with regard to changes in body condition. We will look further at this in the next part before we move on to the discussion on meeting the cow's mineral needs.

Appendix Table 1: NEm requirements (Mcal/day) for Maintenance of mature beef cows (≥ 48 months of age) based on Body Condition Score (BCS) and pounds Empty Mature Body Weight (EMBW). ***Note: Empty Body Weight (EBW) in pounds below Mcal NEm for each BCS by EMBW.***

Body Condition Score

EMBW	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
1000	5.17	5.44	5.69	5.95	6.20	6.45	6.69	6.93	7.17
	602	*643*	*684*	*725*	*766*	*807*	*848*	*889*	*930*
1050	5.37	5.64	5.91	6.17	6.43	6.69	6.94	7.19	7.44
	632	*675*	*719*	*762*	*805*	*848*	*891*	*934*	*977*
1100	5.56	5.84	6.12	6.39	6.66	6.92	7.19	7.44	7.70
	663	*708*	*753*	*798*	*843*	*888*	*933*	*978*	*1023*
1150	5.75	6.04	6.32	6.61	6.88	7.16	7.43	7.70	7.96
	693	*740*	*787*	*834*	*881*	*928*	*976*	*1023*	*1070*
1200	5.93	6.23	6.53	6.82	7.11	7.39	7.67	7.95	8.22
	723	*772*	*821*	*870*	*920*	*969*	*1018*	*1067*	*1116*
1250	6.12	6.43	6.73	7.03	7.33	7.62	7.91	8.19	8.48
	753	*804*	*855*	*907*	*958*	*1009*	*1060*	*1112*	*1163*
1300	6.30	6.62	6.93	7.24	7.55	7.85	8.14	8.44	8.73
	783	*836*	*890*	*943*	*996*	*1049*	*1103*	*1156*	*1209*
1350	6.48	6.81	7.13	7.45	7.76	8.07	8.38	8.68	8.98
	813	*868*	*924*	*979*	*1035*	*1090*	*1145*	*1201*	*1256*
1400	6.66	7.00	7.33	7.66	7.98	8.30	8.61	8.92	9.23
	843	*901*	*958*	*1015*	*1073*	*1130*	*1188*	*1245*	*1302*
1450	6.84	7.18	7.52	7.86	8.19	8.52	8.84	9.16	9.47
	873	*933*	*992*	*1052*	*1111*	*1171*	*1230*	*1289*	*1349*
1500	7.01	7.37	7.72	8.06	8.40	8.74	9.07	9.39	9.72
	903	*965*	*1026*	*1088*	*1149*	*1211*	*1272*	*1334*	*1395*

Appendix Table 2: Net protein requirements (lb/day) for Maintenance of mature beef cows based on their NEm (M) requirements (Appendix Table 1) by Empty Mature Body Weight (EMBW) and Body Condition Score. ***Pounds Protein = Mcal NEm (M) * 0.07895.***

Body Condition Score

EMBW	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
1000	0.41	0.43	0.45	0.47	0.49	0.51	0.53	0.55	0.57
1050	0.42	0.45	0.47	0.49	0.51	0.53	0.55	0.57	0.59
1100	0.44	0.46	0.48	0.50	0.53	0.55	0.57	0.59	0.61
1150	0.45	0.48	0.50	0.52	0.54	0.57	0.59	0.61	0.63
1200	0.47	0.49	0.52	0.54	0.56	0.58	0.61	0.63	0.65
1250	0.48	0.51	0.53	0.56	0.58	0.60	0.62	0.65	0.67
1300	0.50	0.52	0.55	0.57	0.60	0.62	0.64	0.67	0.69
1350	0.51	0.54	0.56	0.59	0.61	0.64	0.66	0.69	0.71
1400	0.53	0.55	0.58	0.60	0.63	0.65	0.68	0.70	0.73
1450	0.54	0.57	0.59	0.62	0.65	0.67	0.70	0.72	0.75
1500	0.55	0.58	0.61	0.64	0.66	0.69	0.72	0.74	0.77

Appendix Table 3: NEm requirements (Mcal/day) for the last five months of Gestation for calf birth weights of from 60 to 100 pounds.

Weeks (Mon) Pregnant	Calf Birth Weight (lb) 60	65	70	75	80	85	90	95	100
21-24 (5)	0.43	0.47	0.50	0.54	0.57	0.61	0.65	0.68	0.72
25-28 (6)	0.76	0.83	0.89	0.95	1.02	1.08	1.15	1.21	1.27
29-32 (7)	1.29	1.40	1.50	1.61	1.72	1.83	1.93	2.04	2.15
33-36 (8)	2.07	2.25	2.42	2.59	2.77	2.94	3.11	3.29	3.46
37-40 (9)	3.18	3.44	3.71	3.97	4.23	4.50	4.76	5.03	5.29

Note: Values in this table for last three months differ slightly from those of Appendix Table 3, Part II (Feb. 2010) as they are averages of the weeks for each of the final three months instead of for the last day of the month. In addition, newer information indicates the cow requires more NEm for gestation.

Appendix Table 4: Net protein requirements (lb/day) for the last five months of Gestation for calf birth weights of from 60 to 100 pounds. *Pounds Protein = Mcal NEm (G) * 0.09615.*

Weeks Pregnant	Calf Birth Weight (lb) 60	65	70	75	80	85	90	95	100
21-24	0.04	0.04	0.05	0.05	0.06	0.06	0.06	0.07	0.07
25-28	0.07	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.12
29-32	0.12	0.13	0.14	0.16	0.17	0.18	0.19	0.20	0.21
33-36	0.20	0.22	0.23	0.25	0.27	0.28	0.30	0.32	0.33
37-40	0.31	0.33	0.36	0.38	0.41	0.43	0.46	0.48	0.51

Appendix Table 5: Estimated peak milk production based on mature cow size (EMBW) and male calf weaning weight in pounds at 7 months of age. (Adapted from Feeding the Beef Cowherd *for Maximum Profit*, Danny D. Sims, 2009, SMS Publishing, Amarillo, TX)

Cow Weight (lb)	Peak Milk (lb per day) 10	15	20	25	30
1000	440	465	495	---	---
1100	460	485	515	545	570
1200	480	510	540	565	590
1300	500	530	560	585	615
1400	520	550	580	605	635
1500	540	570	600	625	655

Appendix Table 6: Monthly milk production, NEm and net protein requirements for Lactation at three levels of peak milk production (lb/day @ week 9). *Pounds Protein = Mcal NEm (G) * 0.2362.*

	Milk Production (lb/day)			NEm (L) Mcal/day)			Net Protein (lb/day)		
Month	**24.0 lb**	**17.5 lb**	**11.0 lb**	**24.0 lb**	**17.5 lb**	**11.0 lb**	**24.0 lb**	**17.5 lb**	**11.0 lb**
1	12.5	9.1	5.7	4.26	3.10	1.94	1.01	0.73	0.46
2	23.0	16.8	10.5	7.84	5.70	3.56	1.85	1.35	0.84
3	23.3	16.9	10.6	7.92	5.76	3.60	1.87	1.36	0.85
4	19.6	14.3	8.9	6.68	4.86	3.04	1.58	1.15	0.72
5	15.2	11.0	6.9	5.16	3.75	2.35	1.22	0.89	0.55
6	11.1	8.1	5.1	3.79	2.76	1.72	0.90	0.65	0.41
7	7.9	5.7	3.6	2.69	1.95	1.22	0.63	0.46	0.29
8	5.5	4.0	2.5	1.88	1.37	0.85	0.44	0.32	0.20

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