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

In this issue we will cover Dr. Diven's discussion on dietary energy, how it is determined, plant components that supply it, how stage of production affects a cow's needs along with her size and condition, and how that available from range plants varies through the year and what that means for management.

Energy
What is energy? From Webster's 9th New Collegiate Dictionary it is 1: vigorous exertion of power; 2: the capacity of acting or being active; 3: the capacity for doing work; and 4: usable power (as heat or electricity). For livestock producers the energy they are concerned with will be that found in the food their animals eat that keeps them alive, produces growth, offspring, and milk. The source of energy obtained by livestock from forages and grains is light energy from the sun that plants absorbed and turned into chemical energy (starches and sugars). The amount of energy a food contains is determined by the amount of heat it gives off when burned. The unit of measurement used is called the calorie. A calorie is the amount of heat energy it takes to raise the temperature of one gram of water from 16.5° to 17.5° C (61.7° to 63.5° F). Apparently it takes a bit more heat energy to raise the temperature of cold water one degree C and possibly less when water is hot. The gram is a metric weight measurement and there are 28.4 grams to an ounce. In human nutrition the calorie is the unit used to quantify how much energy a foodstuff contains and how much is needed in the diet. For livestock the kilo calorie (Kcal = 1000 calories), and the mega calorie (Mcal = 1,000 Kcal or 1,000,000 calories) are what are used with Kcal for poultry, swine and sheep, and Mcal for cattle and horses.

An animal is not able to use all the energy in a food (dietary gross energy) towards keeping it alive, for growth, or reproduction. Some is lost in the feces, called fecal energy (FE) which is essentially the indigestible portion of the food and what is left is called Digestible Energy (DE). Not all of DE is available to the animal either as some is lost as urinary energy (UE) and in ruminant animals such as cattle and sheep as gaseous energy (GE), primarily methane, from the rumen during microbial fermentation. Microbial fermentation also releases heat that though useful in helping maintain body temperature of cold-stressed animals, it too is an energy loss although accounted for in GE. What is left is called Metabolizable Energy (ME) that is portioned into heat energy (HE) and net energy (NE). Heat energy here is what is generated by all the chemical reactions within the animal that occur in keeping it alive. Net energy is the amount left that goes towards the animal for maintenance, growth, and reproduction.

Dr. Diven exclaims that NE is the business part of dietary gross energy and is the form that can be manipulated by the livestock producer (think ration balancing). A portion of NE is expended to maintain the animal and is called Net Energy for maintenance (NEm) with the remaining portion, if there is any, used for body weight gain or lactation. For feeder cattle on high concentrate diets the portion of NE available for gain is termed NEg and for dairy cows on rations designed to increase milk production this portion is termed NE_L. However, for beef cattle on forage diets these terms are not used (National Academy of Sciences, 1996) but a cow's NEm needs are divided into that for maintenance – NEm (M), gestation – NEm (G), and lactation – NEm (L), and changes in body condition score is described by the term NEΔ. In simpler terms a pregnant cow needs more and more NEm as the calf within her grows, especially during the last trimester, and even more during lactation compared to when she is dry and in her first months of pregnancy. In addition, if she needs to increase her body condition she will need even more NEm.

Many ranchers are familiar with the term TDN, acronym for Total Digestible Nutrients, as a measurement of a feed's energy content and have had livestock rations balanced on this along with crude protein. However, balancing rations based on TDN is not advised if concentrate feeds are to be used in the ration as TDN values tend to be under-predicted for concentrates. NEm does a better job of predicting the usable energy content of all feeds, forages and grains.

Both TDN and NEm are determined from the Acid Detergent Fiber (ADF) content of a feed thus if ADF content is requested in a forage analysis the lab can provide both NEm and TDN contents of the sample. Another reason Dr. Diven focuses on using NEm for ration balancing even if only forages (pasture and hay) are to be used is the relationship between NEm and protein and minerals to be discussed in future installments of this series.

Converting Feed to Calories

Before we delve deeper into the NEm needs of a beef cow and how it is determined let's look at the components of feeds and forages that supply energy to the animal. Plants, as all living things, consist of cells. Plant cells have a primary and secondary cell wall and a cell center called the lumen. In young growing plants the cell walls of leaves and stems are thin consisting entirely of cellulose and the cell lumen is large containing protein and sugars. As the plant matures the cell walls thicken and the cell lumen shrinks resulting in less protein and the sugars are converted to cellulose. This is why mature forages do not contain as much protein as young plants.

Cellulose is made up of subunits of sugar linked together to form long chains. Animals are not able to digest cellulose as the connecting bonds cannot be broken by regular digestion processes. However, these bonds can be broken by microorganisms (bacteria, protozoa, fungi) through fermentation. The first compartment of a ruminant animal's (cattle, sheep, deer, etc.) stomach is the rumen where the microorganisms are housed in a symbiotic relationship (benefit to both) with the host animal. Fermentation of cellulose results in short chain fatty acids as well as methane gas. These short chain fatty acids are the primary energy source for the ruminant animal, as sugar is to humans and other monogastric animals, but the ruminant animal receives what is left after the microbe's needs are satisfied.

Grains (seeds) and roots of plants primarily contain starch and though ruminant animals can digest this and the sugars found in young plant leaves, they first must pass through the rumen and are subject to being fermented by the rumen microbes before the animal has the opportunity to digest them directly. However, the starch and sugars fermented by the rumen microbes is converted to fatty acids of which both the microbes and the host animal use for their energy needs.

Another component of plants we're all familiar with is lignin, the substance that allows plants to stand upright. Although important for plants it is not a desirable substance for animal or microbe nutrition as it is not digestible and can interfere with the breakdown and use of cellulose and protein. As plants mature their lignin content increases and some of it forms chemical linkages with cellulose rendering it un-fermentable. Thus, young, growing plants high in sugar and cellulose but low in lignin have a high NEm value, whereas mature and dormant plants that are void of sugar and highly lignified have a low NEm value. The NEm value of a feed and forage is based on the ability of the microorganisms to convert it to fatty acids. Highly fermentable plant material does not remain in the rumen long allowing the animal to consume more of it. Thus it is advisable to ensure the animal has an adequate amount of grazable forage available so that it remains satiated. However, highly lignified forages remain in the rumen for an exorbitant amount of time and the animal will not graze because it is full. In extreme cases this can actually result in an animal starving on a full belly.

> For example, an 1100 lb empty mature body weight (EMBW – defined on page 6) cow will consume 20 Mcal of NEm per day grazing pre-bloom alfalfa that contains 0.65 Mcal of NEm per pound of dry matter, whereas she will consume only 3.5 Mcal NEm from wheat straw that contains 0.3 Mcal NEm/lb (Galyean and Hubbert, 1993). Thus, how many pounds of dry matter does the cow consume of these forages?
>
> *20 Mcal NEm/day divided by 0.65 Mcal NEm/lb dry matter = 31 lb of pre-bloom alfalfa; whereas,*
> *3.5 Mcal/day divided by 0.3 Mcal/lb = 12 lb of wheat straw.*

There is, however, a limit as to how much forage a cow will be able to consume regardless of how high the NEm content is. As Dr. Diven points out, chemical mechanisms in the brain ensue to limit appetite at high dietary energy density but this is higher than that contained in forages.

The Mcal of NEm that mature cattle will consume from forages is based upon 65% of their EMBW. Following is the equation used to determine this (Galyean & Hubbert, 1993):

$$\text{Mcal NEm consumed from forage} = (0.65 * EMBW)^{0.75} * (0.144598 * NEm + 0.206865 * NEm^2 - 0.036915)$$

Although the equation may appear daunting using a calculator or better yet a spreadsheet software program will make the task much easier. However, Appendix Table 1 is provided at the end of this newsletter that shows how many Mcal NEm will be consumed by cows of different sizes from forages of different NEm levels. This info along with a cow's NEm requirements is needed in order to ensure her needs are being met by the available forage and if not how much NEm needs to be supplemented. At the end of this newsletter we will do an exercise demonstrating this but additional information is first needed before we can.

Let's figure how many Mcal NEm/day a 1200 lb EMBW cow will consume from mature smooth bromegrass hay that contains 0.52 Mcal NEm/lb of dry matter and how many pounds of hay this is. We'll first determine the values for the two parts of the equation and then multiply these values for the answer.

*0.65 * 1200 lb = 780;*
$780^{0.75}$ *= 147.6 (with 780 showing on your calculator press* y^x *then .75 then equal)*

*0.144598 * 0.52 Mcal = 0.0752;*
*0.206865 ** (0.52^2) *= 0.206865 * 0.2704 = 0.0559;*
0.0752 + 0.0559 – 0.036915 = 0.0942

*147.6 * 0.0942 = 13.9 Mcal/day*

13.9 Mcal/day divided by 0.52 Mcal/lb = 26.7 lb dry matter and if the hay contains 10% moisture the actual daily amount consumed would be about 30 lb (26.7 ÷ 0.9).

Conventional View of Nutritionists and Ranchers

Dr. Diven states that a cow must use dietary NEm first for maintenance, then for gestation and finally for lactation. If there is any leftover she will deposit it as fat. Figure 1 below shows how dietary NEm may be distributed throughout the year with the values used being daily averages for each month. If the cow's body condition score (BCS) is to be maintained throughout the year, as the chart depicts, NEm from range pasture forage alone will probably be insufficient to satisfy her daily requirements. Thus the rancher will need to do something to rectify this problem. Dr. Diven points out that there are three management tools and combinations thereof he/she can use: 1) Provide an energy source to supplement the forage energy; 2) Maximize the ability of the cow to store energy as fat that can serve as a source of energy during periods of dietary deficiency; and 3) wean the calf early.

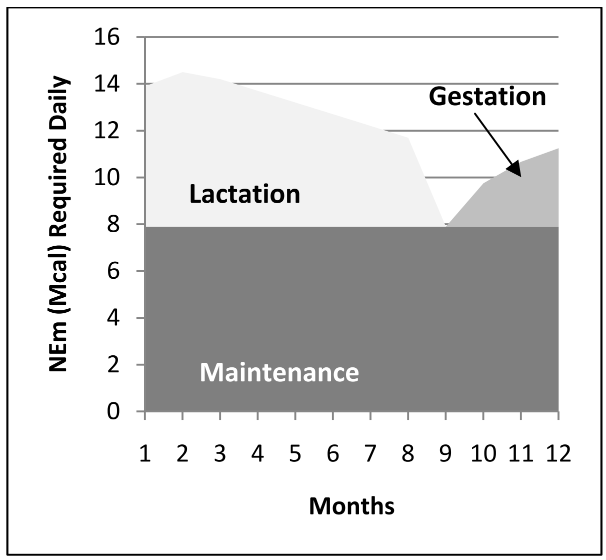

Figure 1: Accumulated NEm required for maintenance, gestation, and lactation when BCS is maintained.

Rangeland and irrigated pasture forages generally begin growth by early May in NE Wyoming and finish growing by late June/early July. Through the rest of the summer the grasses mature and even go semi-dormant but with the onset of cooler temperatures in the fall there may be some new growth if there is sufficient moisture. However, by November the grasses will have gone dormant and throughout the remaining fall and winter will be subjected to weathering reducing their nutrient content. What this means to the livestock producer is that pasture forage is highest in quality including NEm during early growth (May) and declines as the grasses mature and go dormant.

Dr. Diven provides a graph showing average monthly NEm from range forage samples collected over several years from cooperating ranches of his program. Instead of showing the values from these ranches NEm values in Figure 2 below are averages from five ranches in Johnson County, Wyoming between 2002 and 2004. For those who have taken Dr. Diven's Low Cost Cow/calf Program school and have their notebook they will see that the graph values on page 7 of Chapter 4 (Energy) are similar to the Johnson County values.

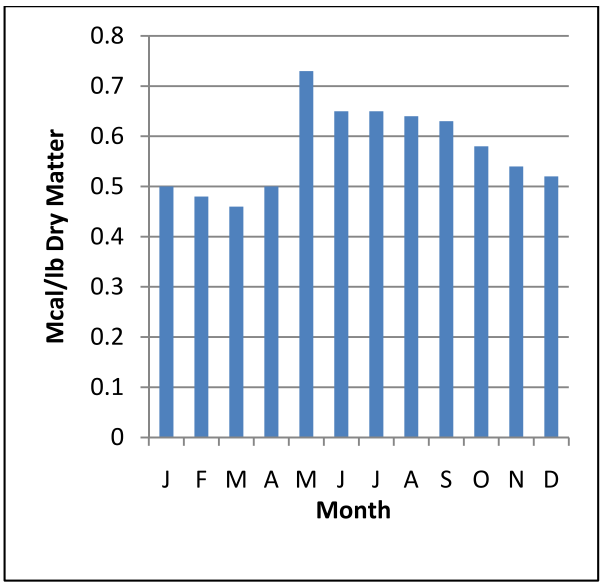

Figure 2: Net Energy maintenance (NEm) of range forage from five Johnson County, Wyoming ranches 2002 – 2004.

The periods of highest nutrient demand for the dam are the last trimester of pregnancy and the early months of lactation. If ranchers are to take advantage of what their pastures provide their livestock in nutrients, they should attempt to match livestock nutrient demand with nutrient availability.

At the end of Chapter 4 there are two charts, one on a clear sheet that reflects the average monthly NEm required by a reproducing cow that maintains its BCS throughout the year, calves on the first day of month 1 and the calf is weaned at 7 months of age; the other on white paper that suggests the average quantity of NEm available from the forage for each month of the year based on forage samples collected from the cooperating ranches. He has the school participants place the NEm REQUIRED chart (clear sheet) over the NEm AVAILABILITY chart and rotate it so that month 1 (month of calving) corresponds with the month you currently begin calving in. For the months in which the line representing requirements extends beyond the availability line the cow is short on energy. Conversely, when the availability line extends beyond the requirement line the forage is providing more energy than needed. Dr. Diven asks "What can be done to the cow's physiological requirements in order to better compliment the forage?" He does not provide an answer but what he is trying to show is that for some ranches moving the calving season from winter to spring may be a viable option or at least have them recognize that the provision of supplemental energy may be warranted.

Although our office can make clear sheet copies they cannot be emailed and even for mailed hardcopies large envelopes would have to be used which is costly. So instead a single chart at the end of this newsletter showing the NEm required by a cow calving either the first of February, March, April, or May and the amount available is provided. You can see from this chart how moving the calving season from winter to mid-spring more closely matches the cow's NEm needs from the range forage. This will also be demonstrated with protein in a future edition.

The amount of Mcal of NEm for Maintenance (M), Gestation (G), and Lactation (L) a cow requires are shown in Appendix Tables 2, 3, and 4, respectively.

The NEm (M) amount is determined by taking the cow's empty body weight (EBW) to the 0.75 power (metabolic weight) and multiplying it by 0.04255919.

Before we move on let's define body weight terms.

EBW (empty body weight) is the body weight of the animal minus gastrointestinal contents. It is 0.891 * SBW (shrunk body weight). Thus, if a cow weighs 1200 lb after standing overnight without feed and water (4% shrink) her EBW would be 1069 lb (0.891 * 1200 lb).

EMBW (empty mature body weight) is the EBW of a cow that has reached its maximum muscular weight and any additional weight gain is fat only.

When EBW = EMBW the cow is at a BCS of 7.85. Thus, EBW is calculated from a cow's potential EMBW and its current BCS.

*((BCS – 7.85) * 0.082 * EMBW) + EMBW = EBW*

For example if a cow's potential EMBW is estimated to be 1250 lb and she is in a BCS 6 her EBW will be 1060 lb.

*((6 – 7.85) * 0.082 * 1250) + 1250 = 1060*
*(-1.85 * 0.082 * 1250) + 1250 = 1060*
*(-0.1517 * 1250) + 1250 = 1060*
-190 + 1250 = 1060

So, how does the rancher determine what his/her cows weigh? Two ways come to mind, 1) weight of cull cows or 2) if access to a scale weigh them. The best time to obtain weights would be in the fall after weaning and the cows have had some time to regain condition if needed. If the cows' weights are not shrunk weights the weights should be multiplied by 0.96 to obtain SBW. This value should be multiplied by 0.891 to obtain their EBW. The EBW can be used in Appendix Table 2 to obtain needed NEm (M) amount.

The NEm (G) amount needed is based on what the potential weight of the calf will be at birth and for just the last 60 days of gestation. NEm (M) is figured to be sufficient to provide for gestation prior to this. I'll forgo the equation used to calculate this as it is complicated.

The NEm (L) amount needed depends upon level of milk produced and its fat content. Dr. Diven provides equations (Clutter and Nielsen, 1987) to determine how many pounds of milk a cow will produce depending on whether she is a high, medium, or low producer and what day of lactation she is in. From the amount of milk produced with an estimated fat content of 5.5% an equation is given to determine how many Mcal of NEm she requires for lactation. However, Appendix Table 4 provides this information so I'll forgo listing the equations to calculate daily pounds of milk and resultant Mcal NEm (L) required.

For those who have attended one of Dr. Diven's schools you will see that the values in Appendix Table 4 average about 1 Mcal less than what is listed in the school notebook. I recalculated the values based on a milk fat content of 4% instead of 5.5%. In Nutrient Requirements of Beef Cattle: Seventh Revised Edition: Update 2000 the authors indicated that average fat content of beef cow milk is 4%. Apparently, prior to this it was believed that fat content of beef cow milk averaged 5.5% as Dr. Diven cites the 1984 (Sixth Revised Edition) of this publication as to where he obtained the equation to calculate NEm (L) from pounds of milk produced.

SOLUTIONS

Energy Management

Dr. Diven has the school participants do an exercise at the end of this chapter determining the total NEm required by a cow for each month of the year and if there is enough from range forage to meet her requirements.

Total amount of NEm required by a cow each month is the sum of the amounts she needs for maintenance, gestation, and lactation.

Let's go through an example. Our cow EMBW is 1175 lb and she is in a BCS of 6 throughout the year. Thus, this cow's EBW is 1000 lb. She calves on March 1st and the calf's birth weight is 100 lb. Her level of milk production is medium (19 lb/day peak). Calf is weaned by November 1st.

Dr. Diven does not have the class figure what a cow's actual weight is from its EBW but if its EBW is 1000 lb what would its actual weight be? This is important because ranchers estimate their cows' weight based on weighing them during pregnancy check/fall vaccinations or from cull cow weights.

To determine this divide 1000 by 0.891 to obtain her SBW and then divide the product by 0.96 to obtain actual body weight. So, let's do the math: 1000/0.891 = 1122/0.96 = 1169 lb. Almost its EMBW which would make sense if she is in a BCS of 6.

OK, let's determine her monthly requirement. We'll need to use Appendix Tables 2, 3, and 4 to determine this.

To determine the daily amount of NEm (M) needed by this cow for each month of the year go to Appendix Table 2. Go down the EMBW column to 1175 and then over to the value under BCS 6.0. This value should be 7.6. *Note: EBW's are listed below the Mcal values so a cow's actual weight can be calculated.*

In Table 1 below 7.6 is entered into the Maintenance column for each month. This value remains the same because the cow does not change in her BCS through the year.

Table 1: NEm Requirement in Mcal

Month	Days	Main.	Gest.	Lact.	Total
Jan	31	7.6	3.5		344
Feb	28	7.6	4.2		330
Mar	31	7.6		6.0	422
Apr	30	7.6		6.6	426
May	31	7.6		6.3	431
Jun	30	7.6		5.8	402
Jul	31	7.6		5.3	400
Aug	31	7.6		4.8	384
Sep	30	7.6		4.3	357
Oct	31	7.6		3.8	353
Nov	30	7.6			228
Dec	31	7.6	2.3		307

To determine daily amount of NEm (G) needed by this cow for her last trimester of pregnancy go to Appendix Table 3. Go across the top column (Calf Birth Weight) to 100. The amounts in this column are what are entered in Table 1's Gestation column for the appropriate months, in this case Dec – Feb.

To determine the daily amount of NEm (L) needed by this cow go to Appendix Table 4. Go across the top column (Level Milk Production) to Medium (19 lb/day). Values in this column are what are entered in Table 1's Lactation column for the appropriate months, in this case Mar – Oct. Note: Peak lactation for a cow is at 8 to 9 weeks postpartum and then it declines.

Add the NEm amounts for (M), (G), and (L) for each month and multiply the total by the number of days in that month to obtain total Mcal needed by this cow for each month.

For Jan: 7.6 + 3.5 + 0.0 = 11.1 Mcal/day * 31 days = 344 Mcal;
For Apr: 7.6 + 0.0 + 6.6 = 14.2 Mcal/day * 30 days = 426 Mcal

Is There Enough To Do the Job?

Now we need to determine if the range forage will supply enough energy to meet this cow's needs. For the Available column in Table 2 below we will use the average values from the five Johnson County Ranches (Figure 2).

To determine Mcal of NEm "Available" from the range forage go to Appendix Table 1. Go across the top of the table to the column where Cow EMBW = 1175 pounds. Go down this column until you come to the value associated with the NEm Mcal/lb value (furthest left column) for the month of interest. For January the NEm Mcal/lb value is 0.50 and thus, the daily amount of Mcal of NEm this cow would consume from the forage would be 12.7. Take this value and multiply it by the number of days in the month to come up with the total amount of Mcal NEm the cow would consume. For January it would be 12.7 * 31 = 394 Mcal. NEm Mcal/lb for the other 11 months:
Feb – 0.48, Mar – 0.46, Apr – 0.50, May – 0.73, Jun – 0.65, Jul – 0.65, Aug – 0.64, Sep – 0.63, Oct – 0.58, Nov – 0.54, and Dec – 0.52. Thus, Mcal of NEm Available = Feb – 11.7, Mar – 10.7, Apr – 12.7, May – 26.0, Jun – 21.0, Jul – 21.0, Aug – 20.4, Sep – 19.8, Oct – 17.0, Nov – 15.1, and Dec – 13.7. These values are then multiplied by the number of days of the respective month.

Table 2: NEm Balance (Mcal)

Month	Days	Required	Available	Balance
Jan	31	344	394	50
Feb	28	330	326	(4)
Mar	31	422	331	(91)
Apr	30	426	380	(46)
May	31	431	807	376
Jun	30	402	630	228
Jul	31	400	651	251
Aug	31	384	633	249
Sep	30	357	595	242
Oct	31	353	526	173
Nov	30	228	443	215
Dec	31	307	425	118

From Table 1 (NEm Requirement) transfer the values from its "Total" column to the column headed "Required" in Table 2. Then subtract the NEm "Required" amount from the NEm "Available" amount to arrive at a balance.

Does the range forage produce enough energy to get through the year? Except for the months of Feb, Mar, and Apr it does.

Take Home Message

Plants are the source of energy to herbivores and in the case of ruminant animals the microbes they host in their rumen. Cellulose is the main constituent of plant leaves and stems that provides energy to the ruminant. However, cellulose cannot be digested through regular digestive processes it must be fermented to break the bonds connecting the sub-units of sugar. This is what the microbe's do converting the cellulose to volatile fatty acids the source of energy for both the microbes and ruminant animal.

All energy from foodstuffs is not available to the animal for maintenance, growth, and reproduction. Some is lost in feces, urine, gas and heat. The portion remaining the animal is able to use to maintain its life is termed Net Energy maintenance.

Cows require increasing amounts of NEm based on their body size and condition. In addition, they require more for gestation, especially during the last trimester, and for lactation. Balancing their needs with that supplied by the range forage is paramount in reducing supplemental feeding costs.

In the next issue we will cover Dr. Diven's discussions on dietary energy as it relates to weight gain or loss (BCS) and how to manipulate a cow's BCS to better match her needs to that supplied by the range forage.

Appendix Table 1: NEm consumption (Mcal[1]) relative to cow empty mature body weight (EMBW) and NEm content of forage and feeds in Mcal per pound dry matter.

Cow EMBW in Pounds[2]

NEm	900	970	1035	1105	1175	1250	1315	1380	1455
0.30	3.0	3.2	3.3	3.5	3.6	3.8	4.0	4.1	4.3
0.31	3.3	3.5	3.7	3.9	4.0	4.2	4.4	4.6	4.7
0.32	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2
0.33	4.0	4.2	4.4	4.6	4.8	5.1	5.3	5.5	5.7
0.34	4.3	4.6	4.8	5.0	5.3	5.5	5.7	5.9	6.2
0.35	4.6	4.9	5.2	5.4	5.7	5.9	6.2	6.4	6.7
0.36	5.0	5.3	5.5	5.8	6.1	6.4	6.6	6.9	7.1
0.37	5.3	5.7	5.9	6.2	6.5	6.8	7.1	7.4	7.7
0.38	5.7	6.0	6.3	6.7	7.0	7.3	7.6	7.9	8.2
0.39	6.1	6.4	6.7	7.1	7.4	7.7	8.1	8.4	8.7
0.40	6.4	6.8	7.1	7.5	7.9	8.2	8.5	8.9	9.2
0.41	6.8	7.2	7.5	7.9	8.3	8.7	9.0	9.4	9.7
0.42	7.2	7.6	8.0	8.4	8.8	9.2	9.5	9.9	10.3
0.43	7.6	8.0	8.4	8.8	9.2	9.7	10.1	10.4	10.8
0.44	7.9	8.4	8.8	9.3	9.7	10.1	10.6	11.0	11.4
0.45	8.3	8.8	9.3	9.7	10.2	10.6	11.1	11.5	11.9
0.46	8.7	9.2	9.7	10.2	10.7	11.2	11.6	12.0	12.5
0.47	9.1	9.7	10.1	10.7	11.2	11.7	12.1	12.6	13.1
0.48	9.5	10.1	10.6	11.1	11.7	12.2	12.7	13.2	13.7
0.49	9.9	10.5	11.0	11.6	12.2	12.7	13.2	13.7	14.2
0.50	10.4	11.0	11.5	12.1	12.7	13.2	13.8	14.3	14.8
0.51	10.8	11.4	12.0	12.6	13.2	13.8	14.3	14.9	15.4
0.52	11.2	11.9	12.4	13.1	13.7	14.3	14.9	15.5	16.1
0.53	11.6	12.3	12.9	13.6	14.2	14.9	15.5	16.1	16.7
0.54	12.1	12.8	13.4	14.1	14.8	15.4	16.1	16.7	17.3
0.55	12.5	13.3	13.9	14.6	15.3	16.0	16.6	17.3	17.9
0.56	13.0	13.7	14.4	15.1	15.8	16.6	17.2	17.9	18.6
0.57	13.4	14.2	14.9	15.6	16.4	17.1	17.8	18.5	19.2
0.58	13.9	14.7	15.4	16.2	17.0	17.7	18.4	19.1	19.9
0.59	14.3	15.2	15.9	16.7	17.5	18.3	19.1	19.8	20.5
0.60	14.8	15.7	16.4	17.3	18.1	18.9	19.7	20.4	21.2
0.61	15.3	16.2	16.9	17.8	18.7	19.5	20.3	21.1	21.9
0.62	15.7	16.7	17.5	18.4	19.2	20.1	20.9	21.7	22.5
0.63	16.2	17.2	18.0	18.9	19.8	20.7	21.6	22.4	23.2
0.64	16.7	17.7	18.5	19.5	20.4	21.3	22.2	23.0	23.9
0.65	17.2	18.2	19.1	20.1	21.0	22.0	22.9	23.7	24.6
0.66	17.7	18.7	19.6	20.6	21.6	22.6	23.5	24.4	25.3
0.67	18.2	19.3	20.2	21.2	22.2	23.2	24.2	25.1	26.0
0.68	18.7	19.8	20.7	21.8	22.8	23.9	24.9	25.8	26.8
0.69	19.2	20.3	21.3	22.4	23.5	24.5	25.5	26.5	27.5

Appendix Table 1: Continued.

	Cow EMBW in Pounds								
NEm	**900**	**970**	**1035**	**1105**	**1175**	**1250**	**1315**	**1380**	**1455**
0.70	19.7	20.9	21.9	23.0	24.1	25.2	26.2	27.2	28.2
0.71	20.2	21.4	22.5	23.6	24.7	25.8	26.9	27.9	29.0
0.72	20.8	22.0	23.0	24.2	25.4	26.5	27.6	28.6	29.7
0.73	21.3	22.5	23.6	24.8	26.0	27.2	28.3	29.4	30.5
0.74	21.8	23.1	24.2	25.5	26.7	27.9	29.0	30.1	31.2
0.75	22.4	23.7	24.8	26.1	27.3	28.6	29.7	30.8	32.0
0.76	22.9	24.2	25.4	26.7	28.0	29.3	30.5	31.6	32.8
0.77	23.5	24.8	26.0	27.4	28.7	30.0	31.2	32.3	33.6
0.78	24.0	25.4	26.6	28.0	29.3	30.7	31.9	33.1	34.4
0.79	24.6	26.0	27.3	28.7	30.0	31.4	32.7	33.9	35.2
0.80	25.1	26.6	27.9	29.3	30.7	32.1	33.4	34.7	36.0
0.81	25.7	27.2	28.5	30.0	31.4	32.8	34.2	35.4	36.8
0.82	26.3	27.8	29.2	30.6	32.1	33.6	34.9	36.2	37.6
0.83	26.8	28.4	29.8	31.3	32.8	34.3	35.7	37.0	38.4
0.84	27.4	29.0	30.5	32.0	33.5	35.0	36.5	37.8	39.3
0.85	28.0	29.7	31.1	32.7	34.3	35.8	37.3	38.6	40.1
0.86	28.6	30.3	31.8	33.4	35.0	36.5	38.1	39.5	41.0
0.87	29.2	30.9	32.4	34.1	35.7	37.3	38.8	40.3	41.8
0.88	29.8	31.6	33.1	34.8	36.4	38.1	39.6	41.1	42.7
0.89	30.4	32.2	33.8	35.5	37.2	38.9	40.5	42.0	43.6
0.90	31.0	32.9	34.4	36.2	37.9	39.6	41.3	42.8	44.4
0.91	31.7	33.5	35.1	36.9	38.7	40.4	42.1	43.7	45.3
0.92	32.3	34.2	35.8	37.7	39.5	41.2	42.9	44.5	46.2
0.93	32.9	34.8	36.5	38.4	40.2	42.0	43.8	45.4	47.1
0.94	33.5	35.5	37.2	39.1	41.0	42.8	44.6	46.2	48.0
0.95	34.2	36.2	37.9	39.9	41.8	43.6	45.4	47.1	48.9
0.96	34.8	36.9	38.6	40.6	42.6	44.5	46.3	48.0	49.8
0.97	35.5	37.5	39.4	41.4	43.3	45.3	47.2	48.9	50.8
0.98	36.1	38.2	40.1	42.1	44.1	46.1	48.0	49.8	51.7
0.99	36.8	38.9	40.8	42.9	44.9	47.0	48.9	50.7	52.7

[1]*Mcal NEm consumed =* $(0.65 * EMBW)^{0.75} * (0.144598 * NEm + 0.206865 * NEm^2 – 0.036915$
Example: EMBW of cow =1315 lb and NEm of the forage = 0.60 Mcal/lb.
$0.65 * 1315 = 854.75$; $854.75^{0.75} = 158.1$; $0.144598 * 0.60 = 0.0867588$;
$0.206865 * 0.60^2 = 0.206865 * 0.36 = 0.0744714$;
*0.0867588 + 0.0744714 – 0.036915 = 0.1243152; 158.1 * 0.1243152 = 19.7 Mcal*

[2]*Cow weights: To estimate a cow's actual weight from EMBW her body condition score needs to be determined, then her empty body weight (EBW) can be calculated, then her actual weight. EBW = ((BCS-7.85) * 0.082 * EMBW) + EMBW; actual weight = EBW/0.96. If her EMBW = 1315 and she is in a BCS = 6.0 her EBW = ((6.0-7.85) * 0.082 * 1315) + 1315 = 1116; and her actual weight = 1116/0.96 = 1162 pounds.*

Appendix Table 2: NEm requirements in Mcal per day for maintenance [NEm (M)[1]] of mature beef cows (≥ 48 months of age) based on Body Condition Score (BCS) and Empty Mature Body Weight (EMBW) in pounds. ***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**
900	4.8	5.0	5.3	5.5	5.7	6.0	6.2	6.4	6.6
	542	*579*	*616*	*653*	*690*	*727*	*764*	*801*	*838*
970	5.1	5.3	5.6	5.8	6.1	6.3	6.5	6.8	7.0
	585	*625*	*665*	*705*	*744*	*784*	*824*	*864*	*904*
1035	5.3	5.6	5.8	6.1	6.4	6.6	6.9	7.1	7.4
	623	*666*	*708*	*751*	*793*	*836*	*878*	*920*	*963*
1105	5.6	5.9	6.1	6.4	6.7	7.0	7.2	7.5	7.7
	666	*711*	*757*	*802*	*848*	*893*	*938*	*984*	*1029*
1175	5.8	6.1	6.4	6.7	7.0	7.3	7.6	7.8	8.1
	709	*757*	*805*	*854*	*902*	*950*	*998*	*1047*	*1095*
1250	6.1	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5
	752	*803*	*854*	*905*	*956*	*1007*	*1059*	*1110*	*1161*
1315	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.8
	793	*847*	*901*	*955*	*1009*	*1063*	*1117*	*1171*	*1225*
1380	6.6	6.9	7.3	7.6	7.9	8.2	8.5	8.8	9.1
	833	*889*	*946*	*1003*	*1059*	*1116*	*1173*	*1229*	*1286*
1455	6.8	7.2	7.5	7.9	8.2	8.5	8.9	9.2	9.5
	875	*935*	*995*	*1054*	*1114*	*1173*	*1233*	*1292*	*1352*

*[1]NEm (M) = 0.04255919 * $EBW^{0.75}$; EBW = ((BCS – 7.85) * 0.082 * EMBW) + EMBW*
Example: EMBW = 1250; BCS = 5.5;
*EBW = ((5.5 – 7.85) * 0.082 * 1250) + 1250 = (-2.35 * 0.082 * 1250) + 1250 = (-0.1927 * 1250) + 1250 = -240 + 1250 = 1009 lb*
*NEm (M) = 0.042555919 * $1009^{.0.75}$ = 0.042555919 * 179.0 = 7.6 Mcal*

Notes:
EMBW of a cow is calculated from her hip height in inches
*EMBW = (Hip height * 37.35) – 765.2*
A cow's hip height = 53.9 inches, thus her EMBW =
*(53.9 * 37.35) – 765.2 = 2013.2.2 – 765.2 = 1248 lb.*

In addition, a cow's frame score is also calculated from her hip height
*Frame score = (0.5413 * hip height) – 23.134*
*Frame score for the above cow = (0.5413 * 53.9) – 23.134 = 29.176 – 23.134 = 6.0*

Appendix Table 3: NEm requirements in Mcal per day for the last trimester of gestation (NEm (G)) for calf birth weights.

	Calf Birth Weight (lb)								
Days Pregnant	**60**	**65**	**70**	**75**	**80**	**85**	**90**	**95**	**100**
220	1.4	1.5	1.6	1.7	1.9	2.0	2.1	2.2	2.3
250	2.1	2.3	2.4	2.6	2.8	2.9	3.1	3.3	3.5
280	2.5	2.7	2.9	3.1	3.4	3.6	3.8	4.0	4.2

Appendix Table 4: NEm requirements in Mcal per day for lactation (NEm (L)) for three levels of milk production.

Postpartum		**Level Milk Production (Peak lb/day)**		
Month	**Days**	**High (21)**	**Medium (19)**	**Low (16)**
1	15	6.1	6.0	4.7
2	45	7.1	6.6	5.3
3	75	7.1	6.3	5.0
4	105	6.6	5.8	4.5
5	135	6.1	5.3	3.9
6	165	5.7	4.8	3.3
7	195	5.2	4.3	2.8
8	225	4.7	3.8	2.2

Note: Using the medium level (19 lb/day) peak milk production Mcal/day values for NEm (L) would be recommended. This would ensure enough Mcal of NEm are being provided for lactation.

References

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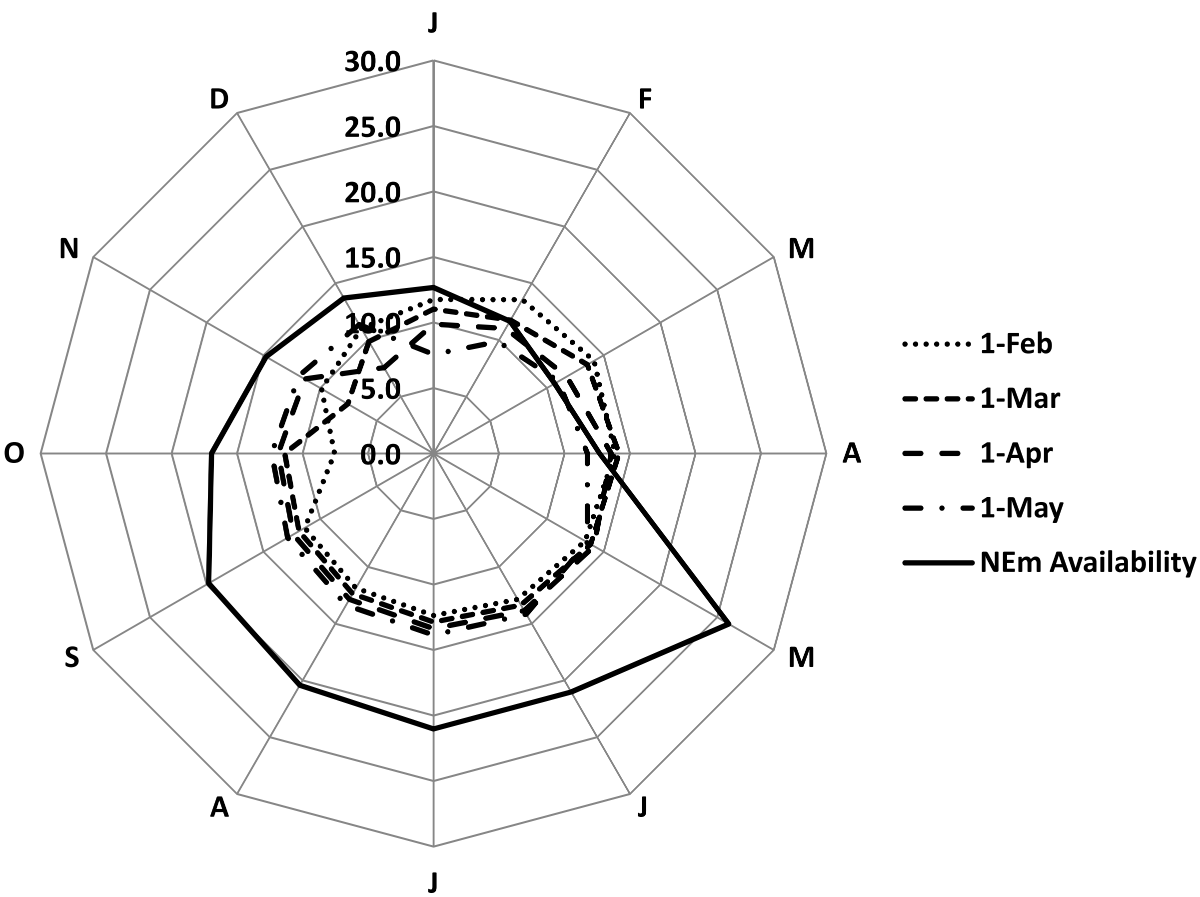
NEm (Mcal/day) required for an 1180 lb EMBW cow in BCS 6 throughout the year of medium milking ability (19 lb/day) that calved a 100 lb calf on either the first of February, March, April, or May with the calf weaned in either November, December, January, or February and the availability of (potentially consumed).



Except for the months of February and March and possibly April if calving occurred in February and March, it appears that the cow will obtain her needed amounts of NEm from the range forage. Dormant grass generally contains an adequate amount of energy to meet the needs of a non-lactating cow but until May when new growth occurs its energy content is mediocre in meeting her NEm needs, especially if she is in lactation. We will see in a future edition that this is even more of an issue with regard to protein.