

Stocker/Backgrounder Nutrition

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Lesson 4

Introduction

Successful rearing of cattle from weaning to a range of weights between 700 to 1000 lb (the process we all know and refer to as backgrounding) requires a keen knowledge and application of nutrition. This lesson is the first in a series of lessons that will introduce basic concepts for a cow-calf operator or current backgrounder to learn and/or hone their skills in nutrition and management of stockers and backgrounders. Stocker is mainly referred to as calves that are placed on grass or winter annuals for rearing from a light weight of 300 to 400 lb to as much as 1000 lb. If the same process is conducted in a drylot, as happens to be the case in northern regions of the country, then it is called backgrounding. Regardless of how this growing phase is conducted, the reader is strongly encouraged to evaluate this process in an objective manner while applying economic principles dictated in Lesson 5, because it is ultimately the economics of cattle prices and feed costs that will determine whether the process is successful or not.

The objectives of this lesson are:

1. to outline nutrient requirements of growing cattle
2. to describe the feeding value of forages, commodities and alternative feeds suitable to meet these requirements
3. to provide a simple method to balance a ration
4. to briefly discuss use of feed additives and growth promoting agents which may enhance performance in the growing phase

Nutrient Requirements

Nutrient requirements of growing cattle are dependent on sex, weight and rate of gain. A thorough description of nutrients, nutrient requirements, and tables of requirements are provided by NRC (1996; Nutrient Requirements of Beef Cattle 7th Ed.) available for sale or to read free on line at <http://www.nap.edu/catalog/9791.html>. Requirements listed in the book, or those in Table 1, apply to growing cattle, fed in a drylot, with no environmental stress. Therefore, these tables must be considered only as guidelines to formulate diets. Diets will need to be formulated using nutrient content of local feeds, and adjusted for weather and other factors.

Nutrient requirements are listed in terms of megacalories (**Mcal**) of net energy for maintenance (**NE_m**) or gain (**NE_g**), or grams (**g**) of metabolizable protein (**MP**), calcium (**Ca**) or phosphorus (**P**) for steers or heifers of various body weights (**BW**) at various expected average daily gains (**ADG**; Table 1).

Energy

The concept of net energy is best illustrated as the proportion of energy that is readily available to sustain body function (NE_m) or that which remains after accounting for energy sustain body function and can readily be utilized for gain (NE_g). This concept is new to most cow-calf producers, although it has been utilized by feed companies and nutrition consultants for a long time while formulating and feeding feedlot diets. Simply stated, an animal cannot use energy for growth until it has consumed sufficient energy for maintenance, and net energy is intended to represent the final transformation of energy required to sustain life or growth. The following explanation of the net energy system is provided merely to illustrate this concept, and familiarize the reader with terminology they may encounter in tables or discussions with nutritionists.

Table 1. Nutrient requirements of growing cattle (NRC, 1996)

	Body weight, lb					
	500	600	700	800	900	1000
Maintenance requirements						
NE_m^a Mcal/day	4.5	5.16	5.79	6.4	6.99	7.57
Metabolizable protein, g/day	222	255	286	316	345	374
Calcium, g/day	7	8.4	9.8	11.2	12.6	14
Phosphorus, g/day	5.3	6.4	7.5	8.5	9.6	10.7
Growth requirements						
	Net energy for gain ^b , Mcal/day					
Average daily gain						
0.5 lb/day	0.58	0.66	0.74	0.82	0.9	0.97
1.0 lb/day	1.23	1.42	1.59	1.76	1.92	2.08
1.5 lb/day	1.93	2.21	2.48	2.74	2.99	3.24
2.0 lb/day	2.64	3.03	3.4	3.76	4.11	4.44
2.5 lb/day	3.37	3.87	4.34	4.8	5.24	5.68
	Metabolizable protein, g/day					
Average daily gain						
0.5 lb/day	72	74	75	74	70	66
1.0 lb/day	141	142	145	142	132	123
1.5 lb/day	207	209	212	207	192	177
2.0 lb/day	273	275	278	270	249	229
2.5 lb/day	337	339	342	331	305	279
	Calcium, g/day					
Average daily gain						
0.5 lb/day	6.2	5.9	5.5	5.2	4.9	4.6
1.0 lb/day	12.1	11.4	10.6	9.9	9.3	8.6
1.5 lb/day	17.9	16.7	15.5	14.5	13.4	12.4
2.0 lb/day	23.5	21.9	20.3	18.8	17.4	16
2.5 lb/day	29.1	27	25	23.1	21.3	19.5
	Phosphorus, g/day					
Average daily gain						
0.5 lb/day	2.5	2.4	2.2	2.1	2	1.8
1.0 lb/day	4.9	4.6	4.3	4	3.7	3.5
1.5 lb/day	7.2	6.7	6.3	5.8	5.4	5
2.0 lb/day	9.5	8.8	8.2	7.6	7	6.5

respectively. A rather old, but useful method of measuring energy (total digestible nutrients, **TDN**) is commonly used to express energy requirements of beef cows. It is a simple measurement expressed as a percentage of the feed mass. Simply stated this measurement is a hybrid between DE and ME because it contains an adjustment for energy losses due to urinary excretion of nitrogen, but it does not adjust for gas losses. When required, TDN can be transformed to DE or ME by multiplying TDN (%) by 2 or 1.63, respectively. Thus, if a diet was formulated to contain 55% TDN (typical of a beef cow diet), this diet would contain 1.1 Mcal DE or .9 Mcal ME/lb DM (dry matter).

Transformations of ME are necessary to sustain maintenance of body function or production processes (lactation, pregnancy, growth). The efficiency with which ME is transformed into NE_m or NE_g is quite different. Because maintenance is a body-sustaining function, transformation of ME to NE_m is one of the most efficient (from 50% to 65%) while that of ME to NE_g is one of the least efficient processes (from 30% to 47%). Two quite complex formulas are used to estimate NE_m or NE_g from ME. Suffice to say that an alternative, simple approach is to utilize efficiencies of transformation from ME to each NE to arrive at quick estimates of their NE content. Also, it is important to understand that efficiencies of transformation are not additive—transforming ME to NE_m at 60% does not mean that transforming ME to NE_g has to be 40%.

When applying the net energy system, dietary energy concentration and intake are important factors in determining rate of growth:

For example: a 68% corn silage, 23% corn grain, 9% protein supplement diet containing 0.84 Mcal NE_m /lb is fed to 700 lb steers. Intake is calculated from NRC equations to be 16.0 lb dry matter (DM).

- NE_m intake is 13.4 Mcal/day
- DM intake is 16.0 lb/day
- NE_m required is $.0426 \cdot (700)^{.75} = 5.8$ Mcal/day
- Steer needs to eat $5.8 \text{ Mcal} / .84 \text{ Mcal/lb} = 6.9$ lb DM for daily maintenance
- This leaves $16.0 - 6.9 = 9.1$ lb DM for gain
- NE_g intake is $9.1 \cdot .55 = 5.0$ Mcal NE_g /d
- This is sufficient for 2.84 lb ADG

Protein

Protein requirements are now based on the MP system to take into consideration the differences in rates of digestion and utilization of various protein sources (Table 1; NRC, 1996), and to account for requirements of rumen bacteria and those of the animal. This is a major change over the currently established system of describing protein requirements as CP. However, describing protein requirements in terms of CP creates some of the same concerns as describing energy requirements as GE—differences in the supply of a readily available fraction such as MP or NE are not recognized, and make it difficult to evaluate difference between diets. For example a corn grain-based diet (>75%) is likely to contain sufficient amounts of rumen-undegradable protein (**UIP**), but perhaps be deficient in rumen-degradable protein (**DIP**). Although this diet may supply sufficient amounts of MP, it may be lacking DIP for rumen function, which will lead to lower digestibility of the diet. In contrast, a corn silage-based diet (> 75%) is likely to contain sufficient amounts of DIP, but may be lacking sufficient MP for growth. The challenge is that expressing protein requirements in terms of MP forces users to have a previous knowledge of diets they wish to use so that they can determine the equivalent CP value to formulate diets, because most feedstuffs have protein reported as CP. A quick and simple method to transform MP requirements listed in Table 1 to CP requirements is to divide

MP by 0.67; however, the limitations of using this figure are obvious; it assumes that DIP and UIP average 80% and 20%, respectively (this is not the case in all diets), and it assumes that these fractions are supplied in sufficient amounts to meet DIP and MP requirements.

In an effort to assess MP supply of diets of growing cattle, NRC (1996) utilized two different rates of crude protein utilization; one for bacteria-derived CP, originally obtained from the amount of DIP in the diet, and the other for digestibility of rumen-undegraded CP. Bacteria-derived CP is expected to be 80% true protein and 80% digestible in the small intestine. Undegraded CP reaching the small intestine is expected to be 80% digestible. Therefore, for an estimate of CP required to meet requirements of growing cattle, the reader is encouraged to know and understand the undegradable intake protein UIP and DIP fractions of diets to be used. Table 2 provides examples of various feeds, their UIP and DIP fractions, and the factor required to transform MP to CP.

Table 2. Examples of degradable (DIP) and undegradable (UIP) protein fractions of various feeds and the factor used to convert metabolizable to crude protein requirements ^a

Example feed	DIP, %	UIP, %	Factor
Theoretical max UIP	0	100	80.0
	10	90	78.4
Blood meal	20	80	76.8
Feather meal	30	70	75.2
Corn gluten meal	40	60	73.6
Corn grain	50	50	72.0
Cottonseed meal	60	40	70.4
Corn silage	63	37	69.9
Soybean meal	70	30	68.8
Grass hay	77	23	67.7
Alfalfa	80	20	67.2
Fescue	90	10	65.6
Urea	100	0	64.0

^a NRC, 1996.

For example, when evaluating a diet (12.8% CP; 69.5% DIP and 30.5% UIP) for steers (from 550 to 990 lb) on grass pastures (95% of the diet DM; 11% CP and 70% DIP) supplemented with cottonseed meal (5% of the diet DM; 46% CP and 60% DIP), the MP or CP intake required for 2.2 lb/day gain would be 605 g MP/day or 879 g CP/day. Considering forage intake in this example to be 2.3% of the BW supplemented with 1 lb cottonseed meal DM for a total intake of 19.6 lb would yield CP intake of 1,138 g/head/day. This figure would indicate that the supplement would be sufficient to meet requirements for gain of 2.2 lb/head/day (assuming energy requirements are met). Therefore, when formulating supplements for growing cattle, nutritionists and students are encouraged to thoroughly research and understand the DIP and UIP fractions, and energy content of forages and supplement ingredients.

Vitamin and Minerals

Calcium and P requirements are listed in Table 1, and those of other minerals and vitamins are listed in Table 3. Again, these values are provided as guidelines to balance and maintain diets within these concentrations. In most cases, meeting the Ca and P requirement with common backgrounding diets or on pasture is not very difficult. However, producers must evaluate their trace mineral package with regards to meeting requirements of copper, manganese, zinc, and selenium. Often times, supplies of these minerals are taken for granted. Similarly, producers must carefully watch excess concentrations of sulfate in diets and water, to prevent concerns with toxic concentrations of sulfur that may result in reduced rumen function.

Table 3. Mineral and vitamin requirements and maximum tolerable amounts (NRC, 1996)

Mineral or vitamin	Unit	Requirement	Maximum
Cobalt (Co)	mg/kg	0.1	10
Copper (Cu)	mg/kg	10	100
Iodine (I)	mg/kg	0.5	50
Iron (Fe)	mg/kg	50	1000
Magnesium (Mg)	%	0.1	0.4
Manganese (Mn)	mg/kg	20	1000
Potassium (K)	%	0.6	3
Selenium (Se)	mg/kg	0.1	2
Sodium (Na)	%	0.07	
Sulfur (S)	%	0.15	0.4
Zinc (Zn)	mg/kg	30	500
Vitamin A	IU/kg	2200	
Vitamin D	IU/kg	275	
Vitamin E	IU/kg	7.5	

Nutrient Value of Feeds

When attempting to formulate diets for growing cattle, the list of feed ingredients that come close to meeting requirements is definitely much shorter than one that would be used to formulate diets for beef cows. The reason is that cows are mostly fed at maintenance levels, and thus require relatively little energy, while growing cattle must be provided sufficient energy at a relatively lower intake to meet requirements for growth. Listed in Table 4 are nutrient contents of various feeds that may be readily available on the farm or ranch. For a more comprehensive list, the reader is referred to NRC (1996) or Stock et al. (1995).

Producers utilizing corn-based diets, whether including corn processing products or not, to background calves will recognize that meeting energy requirements is not that difficult. However, because of the greater proportion of UIP, meeting DIP requirements creates a challenge that will likely require the use of high-protein, high-DIP supplements such as urea, soybean meal, canola meal or sunflower meal. Producers balancing diets for backgrounding

cattle using small grain cereals will recognize that meeting energy and protein requirements will be easier.

Corn processing co-products tend to be high in both energy and protein, but, as indicated, protein tends to degrade slowly in the rumen. Therefore, utilization of urea- or other oilseed-based supplements will compensate for this.

Small grain cereals and their co-products are slightly lower in energy, relative to corn, but have higher protein and of higher rumen degradability. Because of this, their use in backgrounding diets is widespread. One area of concern, however, is the fact that small grains must be processed (broken or cracked) to facilitate digestion, but excessive grinding can cause extremely fast fermentation rates that can lead to rumen acidosis. When feeding backgrounding diets with increasingly high energy content, dietary changes must be made gradually to permit adaptation of rumen micro-flora to the increasing starch content of the diets. This is especially true of diets formulated with small grains or small grain co-products.

Oilseeds tend to have relatively high energy, and are high in protein. Their degradability in the rumen tends to be high; thus, they compensate for lower rumen degradability observed in corn products. Soybean meal has the highest protein concentration, and therefore is the most expensive protein source in Table 4. However, sunflower and canola meal offer good alternatives, especially when the base diet (forage and grain) is comprised of hay and small grains.

A co-product of oilseed processing, soyhulls, is an excellent energy, and moderate protein source. Its use in feeding growing cattle, and for adapting cattle to high-grain diets is widespread because, in spite of being a fiber source, its rate and extent of digestion are sufficiently high to yield energy concentration comparable to that of some corn processing co-products. Soyhulls are used as a “filler” in many commercial feed supplements; therefore, their cost may be prohibitive in certain cases.

Beet processing co-products are intermediate to low in energy content, and low in protein content. However, due to the type of fiber they contain, they also are quite benign to rumen function, and thus compatible with corn silage, corn grain or small grains and their co-products.

Corn and corn co-products tend to be low in Ca. Thus, when feeding diets based on corn grain or corn processing co-products, producers will need to utilize Ca-containing supplements such as limestone. Also, some co-products of the corn milling industry may have high concentrations of sulfur, which can disrupt rumen function. When utilizing these co-products, it is advisable to obtain S concentration of the individual ingredients and water before formulating diets.

Additionally, a review of the values for each of the nutrients listed indicates that there is a great degree of variation in nutrient composition of each of feeds, especially co-products. This is critical as formulating diets without determining the concentration of nutrients supplied by feeds to be fed will affect performance. Thus, producers are strongly encouraged to sample their forage and grain supply, and have samples of co-products they wish to use analyzed for DM, CP, and fiber fractions (acid, ADF, and neutral detergent fiber, NDF). A list of local laboratories is provided in the appendix of this lesson.

Table 4. Nutrient value of selected feed ingredients ^a

Feed	DM	NE _m	NE _g	TDN	CP	UIP	Ca	P	Mg	K	S	Na	Cu	Mn	Zn	Se
	%	Mcal/lb	Mcal/lb	%	%	%	%	%	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg
Forage																
Corn silage	35	0.77	0.49	72	8	25	0.38	0.31	0.18	1.14	0.12	0.01	4	24	18	NA
Corn stalks	83	0.41	0.16	48	6	30	0.57	0.1	0.4	1.45	0.17	0.07	5	136	NA	NA
Hay	85	0.52	0.26	55	12	15	0.26	0.27	0.09	2.32	0.2	0.02	10	70	NA	NA
Corn processing																
Distillers solubles	26	1.01	0.7	90	24	20	0.17	1.45	0.65	1.8	0.4	0.25	89	80	92	0.36
Corn	88	1.01	0.7	90	9	60	0.02	0.31	0.13	0.37	0.14	0.02	3	6	16	0.14
Corn gluten feed, dry	90	0.88	0.59	80	20	22	0.04	0.67	0.36	0.64	0.23	1.05	52	26	72	0.30
Corn gluten feed, wet	45	0.88	0.59	80	18	20	0.04	0.67	0.36	0.64	0.23	1.05	52	26	72	0.30
Distillers grains, dry	90	0.96	0.66	86	30	60	0.02	0.49	0.18	0.44	0.33	0.57	58	25	98	0.42
Distillers grains, wet	35	1.47	1.07	126	30	60	0.02	0.49	0.18	0.44	0.33	0.57	58	25	98	0.42
Small grains																
Barley	88	0.96	0.66	86	13	20	0.05	0.38	0.15	0.47	0.17	0.03	9	18	19	0.22
Barley malting	89	0.8	0.51	74	19	20	0.21	0.55	0.2	0.37	NA	0.09	6	20	NA	NA
Grain screenings	90	0.74	0.46	70	14	20	0.48	0.43	0.14	0.75	0.15	0.02	NA	NA	NA	NA
Wheat midds	90	0.92	0.62	83	17	20	0.16	1.01	0.18	0.58	0.22	0.1	NA	33	NA	0.68
Oilseed																
Soybean hulls	90	0.88	0.59	80	12	30	0.59	0.17	0.22	1.27	0.09	0.01	18	11	24	0.14
Soybean meal	88	0.97	0.67	87	48	30	0.29	0.71	0.28	1.98	0.37	0.03	24	35	66	0.11
Sunflower meal	90	0.65	0.39	64	39	20	0.39	1.06	0.75	1.06	0.33	0.03	4	20	105	2.30
Canola meal	90	0.77	0.49	72	42	25	0.64	0.97	0.6	1.36	1.25	0.03	8	56	72	NA
Beet processing																
Beet pulp, dry	90	0.77	0.49	72	9	30	0.72	0.2	0.28	0.22	0.22	0.2	14	38	1	0.12
Beet pulp, wet	25	0.77	0.49	72	9	30	0.72	0.2	0.28	0.22	0.22	0.2	14	38	1	0.12
Beet tailings	18	0.67	0.4	65	9	25	2.35	0.27	1.07	5.74	0.57	0.54	NA	NA	NA	NA

^a Please see text for nutrient definitions.

Formulating Backgrounding Diets

Knowledge of nutrient requirements and nutrient value of feedstuffs is necessary before formulating diets. Because of the need to understand the net energy system, and the new method of expressing protein requirements, there simply is not an easy way to formulate diets for growing cattle without the use of a computer. Weeks are spent in college classes to teach students how to formulate rations. We are trying to do it in one lesson. Particularly if you do not have formulating experience, this task can be complicated and a bit tricky. If you have no interest in formulating your rations by hand, the following section will be of limited use to you. If you do have the interest, be patient and it may take reading this section several times before it makes complete sense. On the other hand, growing cattle require energy in excess of that required to maintain body weight; therefore, formulating growing diets is made simple because the choice of feeds and the ratio in which they need to be fed is limited. Adaptations to a formula proposed by Goodrich and Meiske (1971) to account for greater weights and gains expected by modern cattle types were made to express energy requirements based on TDN; a more user-friendly, single-unit measurement. These, and adaptations proposed by NRC (1996) to list MP requirements as CP, as well as requirements for Ca and P are listed in Table 5. Amounts required are listed in pounds to facilitate on-farm application. However, it is necessary to have a prior knowledge of the potential diet to determine DMI based on a prediction equation that uses energy or one that uses DM concentration.

An equation to predict DMI based on DM concentration of the ration (%) and BW (lb) was developed by Goodrich and Meiske (1971):

$$\text{DMI, lb/day} = 0.0157\text{BW} + 0.2774\text{DM} - 0.0021\text{DM}^2 - 2.38$$

Determining approximate DM content of resulting diets is not difficult. Most backgrounding diets require maximizing high-energy forage use. In most places, the highest energy forage available is either corn or small grain silages (oatlage). Grass and or grass-legume haylages seldom contain more than 62% TDN. Thus, most backgrounding diets contain from 20% to 50% corn or other cereal grains on a DM basis. The lower the energy concentration of the base forage the more corn, other small grains or high-energy co-products that is required to provide sufficient energy in the ration for growth rates beyond 1.0 lb/day. Thus, DM concentrations of backgrounding diets fluctuate between 45% and 75%. Applying the DM equation to this range of DM values for a 700-lb steer gaining from .5 to 2.5 lb/day (Table 5) led to determinations of nutrient concentrations (Table 6) producers can use as targets to formulate backgrounding diets.

Table 5. Nutrient requirements of growing cattle expressed as total amounts per day for various rates of gain (ADG)

ADG	Body weight, lb					
	500	600	700	800	900	1000
Total digestible nutrients ^a , lb/day						
0.5 lb/day	6.64	7.41	8.14	8.84	9.53	10.19
1.0 lb/day	7.83	8.76	9.66	10.53	11.37	12.18
1.5 lb/day	9.01	10.12	11.19	12.21	13.21	14.18
2.0 lb/day	10.20	11.48	12.71	13.90	15.05	16.17
2.5 lb/day	11.38	12.84	14.24	15.59	16.89	18.16
Crude protein, lb/day						
0.5 lb/day	0.97	1.08	1.19	1.28	1.37	1.45
1.0 lb/day	1.19	1.31	1.42	1.51	1.57	1.64
1.5 lb/day	1.41	1.53	1.64	1.72	1.77	1.81
2.0 lb/day	1.63	1.74	1.86	1.93	1.95	1.98
2.5 lb/day	1.84	1.95	2.07	2.13	2.14	2.15
Calcium, g/day						
0.5 lb/day	13.2	14.3	15.3	16.4	17.5	18.6
1.0 lb/day	19.1	19.8	20.4	21.1	21.9	22.6
1.5 lb/day	24.9	25.1	25.3	25.7	26	26.4
2.0 lb/day	30.5	30.3	30.1	30.0	30.0	30.0
2.5 lb/day	36.1	35.4	34.8	34.3	33.9	33.5
Phosphorus, g/day						
0.5 lb/day	7.8	8.8	9.7	10.6	11.6	12.5
1.0 lb/day	10.2	11.0	11.8	12.5	13.3	14.2
1.5 lb/day	12.5	13.1	13.8	14.3	15.0	15.7
2.0 lb/day	14.8	15.2	15.7	16.1	16.6	17.2
2.5 lb/day	17.0	17.3	17.6	17.8	18.2	18.6

^a Adjusted from Goodrich and Meiske (1971).

Table 6. Nutrient requirements of a 700-lb steer for various rates of gain (ADG) expressed as percentage of the diet dry matter (DM) when DM content of the diet varied from 45% to 75%

ADG	Diet dry matter content						
	45%	50%	55%	60%	65%	70%	75%
Total digestible nutrients							
0.5 lb/day	48%	47%	46%	46%	46%	46%	46%
1.0 lb/day	57%	56%	55%	55%	54%	54%	55%
1.5 lb/day	66%	65%	64%	63%	63%	63%	64%
2.0 lb/day	75%	74%	73%	72%	72%	72%	72%
2.5 lb/day	85%	83%	81%	80%	80%	80%	81%
Crude protein							
0.5 lb/day	7.1%	6.9%	6.8%	6.7%	6.7%	6.7%	6.7%
1.0 lb/day	8.4%	8.2%	8.1%	8.0%	8.0%	8.0%	8.1%
1.5 lb/day	9.7%	9.5%	9.4%	9.3%	9.2%	9.2%	9.3%
2.0 lb/day	11.0%	10.8%	10.6%	10.5%	10.4%	10.5%	10.5%
2.5 lb/day	12.3%	12.0%	11.8%	11.7%	11.6%	11.7%	11.7%
Calcium							
0.5 lb/day	0.20%	0.20%	0.19%	0.19%	0.19%	0.19%	0.19%
1.0 lb/day	0.27%	0.26%	0.26%	0.25%	0.25%	0.25%	0.26%
1.5 lb/day	0.33%	0.32%	0.32%	0.32%	0.31%	0.31%	0.32%
2.0 lb/day	0.39%	0.39%	0.38%	0.38%	0.37%	0.37%	0.38%
2.5 lb/day	0.46%	0.45%	0.44%	0.43%	0.43%	0.43%	0.44%
Phosphorus							
0.5 lb/day	0.13%	0.12%	0.12%	0.12%	0.12%	0.12%	0.12%
1.0 lb/day	0.15%	0.15%	0.15%	0.15%	0.15%	0.15%	0.15%
1.5 lb/day	0.18%	0.18%	0.17%	0.17%	0.17%	0.17%	0.17%
2.0 lb/day	0.21%	0.20%	0.20%	0.20%	0.19%	0.20%	0.20%
2.5 lb/day	0.23%	0.23%	0.22%	0.22%	0.22%	0.22%	0.22%

^a Adjusted from Goodrich and Meiske (1971).

Thus, when formulating a backgrounding diet for 2.5 lb/day gain using corn silage and corn (67% DM), a diet containing 80% TDN, 11.7% CP, .43% Ca, and .22% P would be required. A relatively simple method exists to formulate diets for beef cows that can be applied, albeit with some limitations, to formulating backgrounding diets—the substitution method. The substitution method has one chief advantage in addition to its simplicity: it maximizes forage use. However,

its main disadvantages and major limitations, especially when attempting to use it to formulate backgrounding diets are, that 1) using a moderate energy feed to substitute a low-energy forage will result in substitution values greater than the intended DMI, and 2) when selecting a protein feed to balance CP, the energy content of the protein source must be at least as high as the energy content of the energy feedstuff it is substituting. Also, although this method maximizes forage use, it does not guarantee least cost, because the choice of energy or protein feeds determines ultimate cost. For example, using soybean meal instead of a supplement balanced with urea and other protein sources may yield diets of higher cost.

The substitution method.

The following steps describe this method in detail:

1. Determine the amount of TDN and CP needed for the projected weight and gain during the backgrounding period.

700 lb steers gaining 2.5 lb/d require 14.24 lb TDN and 2.07 lb CP (from Table 5, Pg 10)

2. Determine what the base forage will be. Keep in mind that too low an energy content will likely cause excessive grain to be used or lead to erroneous answers. At this time, it would be appropriate to consider an energy and a protein feed to substitute for forage. Remember that the energy feed should be sufficiently high in energy relative to the base forage, and that the protein feed should have similar or greater energy content than the energy feed.

	DM, %	TDN, %	CP, %	Price, \$/ton	\$/lb
Corn silage	35.0	72.0	8.0	22.00	.011
Corn grain	88.0	90.0	9.0	65.00	.0325
Soybean meal	88.0	88.0	48.0	175.00	.0875

3. Estimate DMI using the formula provided in this lesson or a suitable alternative. A 50% DM content was assumed as it is likely corn in excess of 25% of the diet DM will be used.

$$\text{DMI, lb/day} = 0.0157\text{BW} + 0.2774\text{DM} - 0.0021\text{DM}^2 - 2.38$$

$$\text{DMI, lb/day} = 0.0157*700 + 0.2774*50 - 0.0021*50^2 - 2.38$$

$$\text{DMI, lb/day} = 17.23$$

4. Calculate the amount of TDN provided if the diet contained only forage.

	DMI, lb/day	TDN, %	TDN, lb/day
Corn silage	17.23	72.0	12.40

5. Compare the amount of TDN supplied with the TDN required. If there is a deficit, proceed to correct it using the substitution method.

	Supplied TDN, lb/day	Required TDN, lb/day	Difference TDN, lb/day
Corn silage	12.40	14.24	-1.83

6. Calculate the amount of energy the energy feed you selected in (2) would provide over the energy of the forage.

	Corn TDN	Corn silage TDN	Difference TDN
TDN difference	0.90	0.72	0.18

7. Divide the deficit in (5) by the amount you determined in (6). This is the amount of energy feed that the diet needs to provide energy requirements as determined in (1).

Deficit	<u>1.83</u>
TDN difference	0.18
 Corn, lb/day	 10.19

8. Subtract the amount in (7) from DMI estimated in (3). This is the maximum amount of forage that the diet can contain, and still supply energy when fed with the energy feed in (7).

$$\text{Corn silage} = 17.23 - 10.19 = 7.04 \text{ lb/day}$$

9. Calculate total DMI, and intakes of TDN and CP using the values obtained for the energy feed (7) and forage (8). Make sure that TDN is balanced, and determine if there is a protein shortage.

	DM, lb/day	TDN, lb/day	CP, lb/day
Corn silage	7.04	.07	.56
Corn grain	.19	9.17	.92
Total	17.23	14.24	1.48
 Required	 17.23	 14.24	 2.07
Difference	0.00	0.00	-0.59

10. If a protein shortage exists, calculate the amount of protein the protein feed you selected in (2) would provide over the protein of the energy feed.

	Soybean meal CP	Corn CP	Difference CP
CP difference	0.48	0.09	0.39

11. Divide the deficit in (9) by the amount you determined in (10). This is the amount of protein feed that the diet needs to provide protein requirements as determined in (1).

Deficit	<u>0.59</u>
CP difference	0.39
 Soybean meal, lb/day	 1.51

12. Subtract the amount in (11) from the amount of energy feed estimated in (7). This is the new total for the energy feed, which must be reduced to permit protein supplementation.

$$\text{Corn} = 10.19 - 1.51 = 8.68 \text{ lb/day}$$

13. Calculate total DMI, and intakes of TDN and CP using the values obtained for the protein feed (11), energy feed (12) and forage (8). Make sure that TDN and CP are balanced. Determine nutrient content of the resulting diet by dividing TDN or CP totals by DMI.

	DM, lb/day	TDN, lb/day	CP, lb/day
Corn silage	7.04	5.07	.56
Corn grain	8.68	7.81	.78
Soybean meal	1.51	1.33	.72
Total	17.23	14.20	2.06
Required	17.23	14.24	2.07
Difference	0.00	-0.03	-0.01
Nutrient content, %		82.4	11.6

This diet would be considered balanced even though there is a 0.03 lb TDN and a .01 lb CP shortage. Differences in TDN or CP values for the balance from those required could be within 1% to 2% without any impact on performance.

14. Determine amounts and percentages to be fed, and cost. Divide the amount of each feed by their respective DM content. Then, divide the total DMI by lb to feed/day to obtain DM content of the diet (54.4%). Multiply resulting values by feed price (\$/lb).

	DM, lb/day	DM, %	lb to feed/day	Diet, %	Cost, \$
Corn silage	7.04	35.0	20.11	63.5	0.22
Corn grain	8.68	88.0	9.86	31.1	0.32
Soybean meal	1.51	88.0	1.72	5.4	0.15
Total, unit/day	17.23		31.69		0.69

15. Determine projected performance and cost of gain. Diet was balanced to support 2.5 lb/day with DMI of 17.23 lb/day. Thus, divide lb DMI by ADG to obtain feed-to-gain ratio. Then, daily feed cost by ADG to obtain feed cost of gain.

Projected performance	
ADG, lb/day	2.50
DMI, lb/day	17.23
Feed-to-gain, lb/lb	6.89
Feed cost, \$/day	0.69
Feed cost, \$/lb	0.02
Feed cost, \$/lb gain	0.28

Once the diet is balanced to provide energy and protein, it is important to turn our attention to mineral supply of this diet to determine potential deficits or over-supply of minerals. Especially when formulating using co-products of any kind, it is important to determine what the final concentration of potentially detrimental concentrations of minerals such as sulfur, molybdenum, or iron. Potential deficits encountered when calculating mineral supply from the base diet can

be corrected by incorporating a mineral pre-mix. However, choosing this mineral mix needs to be based on mineral needs, rather than just relying on any mineral mix that may either not meet needs or provide excesses. Transformations and calculations required to obtain mineral supply from the diet, and sequentially determining the appropriateness of a mineral mix are quite complex, but provided below as a reference. Producers are strongly encouraged to work with their nutritionist to choose the appropriate mineral mix for their operations.

1. List total DMI and convert to grams by dividing by 0.002205.

DMI, lb/day	Factor	DMI, g/day
17.23	0.002205	7814

2. Multiply the total DMI in (1) by macro-mineral requirement (those listed as percentage in Table 3). This is the actual macro-mineral requirement in grams/day.

Mineral	Unit	Requirement	Requirement, g/day
Magnesium	%	0.10%	7.8
Potassium	%	0.60%	46.9
Sodium	%	0.15%	11.7
Sulfur	%	0.07%	5.5

3. List intakes of each feed ingredient (DM), and convert to grams by dividing by 0.002205. These values will be used to determine macro-mineral intake (those listed as percentages in Table 4, Pg 8).

	DM, lb/day	Factor	DMI, g/day
Corn silage	7.04	0.002205	3193
Corn grain	8.68	0.002205	3937
Soybean meal	1.51	0.002205	685
Total	17.23	0.002205	7814

4. Multiply the DMI in grams by macro-mineral content of each feed ingredient (those listed as percentages in Table 4). Total results for each macro-mineral.

	Corn silage	Corn	Soybean meal	Total
DMI, lb/day	7.04	8.68	1.51	17.23
DMI, g/day	3193	3937	685	7814
	Corn silage, %	Corn, %	Soybean meal, %	Total, g/day
Magnesium	0.18%	0.13%	0.28%	12.8
Potassium	1.14%	0.37%	1.98%	64.5
Sodium	0.01%	0.02%	0.03%	1.3
Sulfur	0.12%	0.14%	0.37%	11.9

5. Subtract mineral requirement listed in grams (2) from macro-mineral supplied by the diet (4). Any values showing a negative sign are considered to be deficient.

	Total, g/day	Required, g/day	Difference, g/day
Magnesium	12.8	7.8	5.0
Potassium	64.5	46.9	17.6
Sodium	1.3	5.5	-4.2
Sulfur	11.9	11.7	0.2

6. List total DMI and convert to kilograms by dividing by 2.205.

DMI, lb/day	Factor	DMI, kg/day
17.23	2.205	7.8

7. Multiply the total DMI in (6) by each micro-mineral requirement (those listed as mg/kg in Table 3, Pg 6). This is the actual micro-mineral requirement in mg/day.

Mineral	Unit	Requirement	Requirement, mg/day
Copper	mg/kg	10	78.1
Manganese	mg/kg	20	156.3
Zinc	mg/kg	30	234.4
Selenium	mg/kg	0.1	0.8

8. List intakes of each feed ingredient (DM), and convert to kg by dividing by 2.205. These values will be used to determine mineral intake for trace mineral intake (those listed as mg/kg in Table 4, Pg 8).

	DM, lb/day	Factor	DMI, kg/day
Corn silage	7.04	2.205	3.19
Corn grain	8.68	2.205	3.94
Soybean meal	1.51	2.205	0.68
Total	17.23	2.205	7.81

9. Multiply the DMI in kilograms by trace mineral content of each feed ingredient (those listed as percentages in Table 4). Tally results for each trace mineral.

	Corn silage	Corn	Soybean meal	Total			
DMI, lb/day	7.04	8.68	1.51	17.23			
DMI, kg/day	3.19	3.94	0.68	7.81			
	Corn silage, mg/kg	Corn silage, mg/day	Corn, mg/kg	Corn, mg/day	Soybean meal, mg/kg	Soybean meal, mg/day	Total, mg/day
Copper	4	13	3	10	24	16	40
Manganese	24	75	6	24	35	24	123
Zinc	18	57	16	63	66	45	165
Selenium	0	0	0.14	1	0.11	0	0.63

10. Subtract mineral requirement listed in mg/day (7) from trace mineral supplied by the diet (9). Any values showing a negative sign are considered to be deficient.

	Total, mg/day	Required, mg/day	Difference, mg/day
Copper	40	78.1	-38.5
Manganese	123	156.3	-33.7
Zinc	165	234.4	-69.7
Selenium	0.63	0.78	-0.15

11. A mineral mix fed at 0.5% of the diet DM is to be considered to supply minerals in deficit listed in (10). Divide DMI by 2.205 as done in (6). Multiply this value by 1,000,000 to obtain intake in mg/day.

DMI, lb/day	Factor	DMI, g/day	Intake, mg/day	Intake	Mineral intake, mg/day
17.23	2.205	7.81	7814059	0.50%	39070

12. List all trace mineral differences in mg/d from (10), but eliminate the negative sign. Also, list the mineral content and units it is expressed in from the mineral mix tag. Then, multiply the intake value in mg from (11) by the mineral content of each mineral in the mix (Example, for Copper, multiply 39,070 X 0.0003 to obtain a mineral mix supply of 11.7 mg/day). Then, subtract mineral intake from mix from difference to determine whether intake of mineral mix will help alleviate the deficit or provide an excess.

Mineral	Difference, mg/day	Mineral mix	Intake	Difference, mg/day
Copper	38.5	0.030%	11.7	-26.76
Manganese	33.7	0.200%	78.1	44.48
Zinc	69.7	0.350%	136.7	67.02
Selenium	0.15	0.005%	2.0	1.80

For copper, even after consuming approximately 1 oz of mineral mix/day, there will still be a deficit (26 mg/day). All other minerals with the exception of selenium will be provided in sufficient amounts by the mineral mix to alleviate deficits. If choosing to feed this mineral mix, selenium may be provided at 1.80 mg/day more than required. This could be an area of concern; therefore, a mineral mix not containing as much selenium, and containing more copper is required to balance this diet. A similar approach may be used when balancing vitamin requirements.

Feed Additives and Growth Promoting Agents

Once the decision is made to background calves, and diets are formulated and balanced, producers need to make an important decision: whether they will be including feed additives or utilizing growth promoting implants. From almost any economic angle one studies this issue it is impossible not to consider at least some level of enhancement from the use of feed additives or growth promoting agents, or both. The main reasons for this are that effects of feed additives and growth promoting are additive. In other words, increases in gain from use of implants are added to enhancements in feed efficiency from use of feed additives. Additionally, effects of these compounds on gain and feed efficiency are well documented with cattle consuming diets of various energy and protein densities, and their impact is well understood. Thirdly, effects of these compounds result in gain and feed efficiency enhancements that are reaped by the producer backgrounding cattle with little negative impact to the feedlot segment.

Feed additives available for backgrounding are ionophores such as monensin sodium (Rumensin) or lasalocid (Bovatec), and bambamycin (Gainpro). In cattle fed backgrounding type diets, both ionophores have a positive on gain and feed efficiency (DiCostanzo et al., 1996). At lower doses (17 to 20 g Rumensin or Bovatec/ton), Rumensin appeared to have a greater impact on gain and efficiency than Bovatec. However, at the higher doses (29 g/ton for Rumensin or 24 g/ton for Bovatec), gains were similar, but cattle fed Bovatec converted feed to gain more efficiently. Thus, at low inclusion rates, Rumensin may be the ionophore of choice, but at higher inclusion rates, Bovatec may have an advantage. On pasture cattle gain response to feeding ionophores or bambamycin was similar, but better than cattle not fed any additive. At daily feed additive costs of less than \$0.03/day (\$3.60 for 120 days), improvements in feed efficiency result in lower feed requirements (400 lb to 500 lb of feed savings for 300 lb gain), and lower feed costs (\$10/head) for a net return of \$6.40/head or \$2.77 return/\$1 invested.

Implants have been tested extensively; a partial list of most commonly used implants to be used during the backgrounding phase is listed in Table 7 with details on hormone content and manufacturer. Generally, the response to implanting cattle is at least as good as that reported for using feed additives provided the diet is balanced, and access to feed is uncompromised by crowding, poor bunk design or management. Thus, the choice to use an implant is really dependent on determining the length of the backgrounding period, and how comfortable a producer is with the various implanting guns. Of the implants listed in Table 7, Compudose and Encore are the only ones approved to deliver hormone payouts beyond 150 days. All other implants listed in Table 7 will be good for at least 60 days.

Table 7. Approved implants that may be incorporated into a backgrounding or stocker program

Name	Label	Hormonal compound ^a , mg					Manufacturer
		TBA	T	E	P	Z	
Component	ES			20	200		Vetlife ^b
Component	EH		200	20			Vetlife ^b
Component	TEIS	80		16			Vetlife ^b
Component	TEIH	80		8			Vetlife ^b
Component	TEG	40		8			Vetlife ^b
Compudose				25.7			Vetlife
Encore				43.9			Vetlife
Ralgro						36	Schering-Plough
Revalor	IS	80		16			Intervet
Revalor	IH	80		8			Intervet
Revalor	G	40		8			Intervet
Synovex	S			20	200		Fort Dodge
Synovex	H		200	20			Fort Dodge

^a TBA = trenbolone acetate; T = testosterone; E = estrogen in the form of estradiol or estradiol benzoate; P = progesterone; Z = zeranol.

^b Also available with 29 mg tylosin tartrate (antibiotic) for enhanced implanting.

Summary

Profitability during backgrounding depends on three factors, purchase and sale price, and proper feeding management. Feeding management starts with proper nutrition. Nutrition of growing cattle is a complex topic; however, some strategies to simplify it are contained in this lesson. Of all the nutrients a producer needs to worry about, energy and protein are perhaps the most important. Diets of backgrounding cattle should look nothing like those of beef cows because their protein and energy requirements are much higher. Thus, it is important to consider this before deciding to add weight to weaned calves before selling or moving them to a feedlot. Mineral nutrition is also quite complex, and must be evaluated carefully, especially in areas where potential excesses or deficiencies exist. Once diets are formulated for energy and protein, producers are encouraged to spend extra time evaluating what mineral intake these diets provide, and work with a qualified nutritionist to reduce or eliminate excesses or deficiencies in mineral nutrition.

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Appendix and Additional Reading

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Lesson 3

Nutrition Quiz

1. According to Table 1. list four nutrients that a producer wishing to background must concern themselves with providing.
2. What nutrient is the most critical to support adequate rates of gain?
3. TDN is replacing what two methods of expressing energy requirements?
4. At a TDN concentration of 80% what average daily gain would be expected?
5. If a diet is formulated to supply 12.5% crude protein, based on what you learned about the new system of expressing protein requirements, would you be completely sure this diet is fully balanced? (A Yes or a No is sufficient here).
6. What grain or co-product would most likely complement a backgrounding diet that must be based on hay? (realizing that energy is needed)
7. What are the potential concerns with utilizing dry milling co-products?

8. What are the potential concerns with feeding small grains?

9. What are the main disadvantages of the substitution method?

10. What is the expected return on investment from supplementing ionophores in backgrounding diets?

Name _____ Phone _____

Address _____

Fax Optional) _____ Email _____

Nutrition Supplemental Reading

1. Nutrition and Management Considerations for Preconditioning Home Raised Beef Calves
2. Implanting Beef Cattle