Basic Cow Nutrition

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Introduction

The cow is our basic production unit and most important employee of the beef enterprise. To get the most out our production unit, let's review the job expectations and responsibilities the cow has to fulfill if she wants to stick around. Our expectations of our bovine employees are to maintain her bodyweight-body condition, deliver a live calf, start the re-breeding process promptly, get pregnant, maintain her pregnancy, and nurse the calf that is already on her side until weaning. That's quite a load of tasks for one cow to accomplish. In order to adequately perform her duties we need to give the cow the tools and resources to do her job. The main tool for her to accomplish her assignment is adequate nutrition. Nutritional management of our cow herds is an on-going and ever evolving process of management decisions.

Proper nutritional status is critical for optimal production efficiency in the beef cow herd. However, beef producers often take a "one size fits all" approach to feeding the cows in the cow herd. This singular approach to nutrient supply for the cow herd can have serious nutritional and economic ramifications. It should be obvious that not all cows have the same nutrient requirements. Nutritional requirements vary with age, breed, sex, body condition, environment, and physiologic status. By acknowledging differences in nutrient requirements that exist in the beef cow herd, management strategies can be implemented to feed beef herds to optimized feed resources and overall production.

So let's address the nutritional equation. On the surface it is fairly simplistic, if we know what the cow's nutrient requirements are and we know what the amount of nutrients that the base forage is supplying then we will know if there is a need for supplementation, and to what extent are supplemental nutrients required. However, the equation is complicated by the fact that cow nutrient requirements change depending upon a number of factors and is further complicated by a forage base that is not static and has daily and seasonal changes. The cow herd's feed requirements amount to 54-75% of the annual maintenance costs for the herd. In Florida, grazed forages comprise the largest and most important feedstuff for the cow. Therefore, utilization of forage through grazing is the most economical feed that is available to the cow herd.

Understanding Nutrient Requirements

Cow nutrient requirements change throughout the year. The requirement of the mature cow for the variety of nutrients is a dynamic situation because the production cycle is not static. At no point in a yearly production cycle does a cow experience only maintenance requirements. We may say that "a cow is just maintaining herself", but if she is a productive member of the herd more than maintenance is occurring on a daily basis. Maintenance is defined as the amount of feed nutrient intake that will result in no net loss or gain from the tissues of the cow's body. In reality, a cow must always be adding or subtracting nutrients from her body tissues. The additive functions to maintenance include; growth, gestation, and lactation. The result of all ongoing functions results in the total nutrient requirements of the cow.

When we consider feeding our cow herd and meeting nutrient requirements there are five considerations that warrant consideration: 1) feed intake, 2) water, 3) energy, 4) protein, and 5) minerals. The amounts of these nutrients that are required by cattle are affected by a number of different factors. The nutrient requirements differ for cows of different ages, level of production, breed, stage of physiology of cattle, terrain, and pest load to list a few considerations. It is important to realize that cattle nutrient requirements change throughout the productive year. Maximal energy/protein requirements occur starting approximately four weeks after

calving when cows reach peak lactation. Minimal energy and protein requirements occur at weaning when the need for nutrients dedicated to lactation ceases. An important consideration for the cow herd is the level of milk production, greater milk production potential increases the energy and protein requirements for lactation and the maintenance requirements during the lactation period.

Feed Intake

Most simply put body weight drives the intake of forages and feedstuffs. Dry matter intake (DMI) is affected by a number of factors including cow body weight, stage of production, forage quality, supplementation level and type, and environmental factors (Table 1 and 3). Cattle of larger frame size and body weight have greater potential to consume forage and feed compared to smaller frame or lighter body weight. If one assumes a cow can consume 2% of her body wieght in dry feed, DMI ranges from 24 lb/d for a 1,200 lb mature cows to 18 lb/d for 900 lb replacement heifers. Therefore, even though absolute amounts of energy and protein may not differ greatly, the concentration of energy and protein in the diets needs to be different among ages of cattle to meet many of their nutrient requirements. Additionally, throughout the production cycle DMI capacity will vary. Lactating cows have greater DMI potential compared to gestating cows. Additionally, thin cows are more likely to consume greater amounts of feedstuffs compared to well-conditioned cows. The energy and protein requirements increase in cows as they approach calving and at peak lactation. Thus, as cows approach calving and lactation the concentration of energy and protein in their diet need to increase to meet requirements associated with maintenance, growth, gestation, and lactation.

Forage DMI is generally limited by forage quality. The greater the forage quality, that is energy and protein concentrations and digestibility, of the base forage the greater potential for increased DMI by cattle. Through DMI cows consume the required energy, protein, fats, vitamins, and minerals required for maintenance and production. There is plenty of literature that demonstrates the DMI potential, total digestible nutrients (TDN), and crude protein requirement differences between cows of different weight during a production cycle. Regardless of the time of year, differences in weight are manifest in differences in DMI.

Water

Water is an important yet overlooked nutrient required by cattle. Water is an important component in many body functions including temperature regulation, growth, reproduction, lactation, and many metabolic functions. Water comes from two sources, feedstuffs and ad libitum consumption. The water requirement is influenced by several factors including pregnancy, lactation, activity, type of diet, level of intake, and environmental temperature. Restriction of water intake below requirement will reduce feed intake which will lower cattle production. Cattle lose water from the body through a number of routes. Sources of water loss include urine, feces, sweat, and by water vapor from the skin and lungs. Urine production depends upon activity level, air temperature, water consumption and other factors. The amount of water loss in the feces depends upon the diet. Water quality is an important consideration to achieve optimal water intake and acceptable cattle performance. Clean water is especially important for young growing cattle, but dirty water can decrease cattle performance and be a potential site of disease for all cattle. Generalized total water intake requirements are indicated in Table 2. Water sources for cattle should be periodically sampled for quality and potential contaminants. Water sources for livestock should also be analyzed whenever significant a change in well levels, water source, or potential contamination occurs.

Energy

Cow energy requirements change throughout the year. The requirement for energy by the mature cow is a dynamic situation because the production cycle is not static. At no point in a yearly production cycle does a cow experience only maintenance energy requirements. We may say that “a cow is just maintaining herself”, but if she is a productive member of the herd more than maintenance is

occurring on a daily basis. Maintenance is defined as the amount of feed energy intake that will result in no net loss or gain of energy from the tissues of the cow's body (NRC, 1996). In reality a cow must always be adding or subtracting energy from her body tissues. The additive functions to maintenance include; growth, gestation, and lactation. The result of all ongoing energetic functions results in the total energy requirement of the cow. There is a hierarchical portioning of energy use in the cow's body. Maintenance energy requirements are met first. Subsequent energy requirements (lactation, gestation, growth) are met with any remaining energy supply. Supplemental energy will be utilized to meet any deficiency in maintenance energy supply, then to meet productive energy requirements.

Maintenance

Interestingly enough the NRC does not consider all maintenance equal. Table 3 presents the energy requirements on a monthly basis of a 1,200 lb cow in good condition. There exist two distinct phases of maintenance requirements (NEm); during the lactation period and during the dry period. About a 20% difference (NRC, 1996) exists between these two periods. This increase in maintenance energy requirement associated with lactation is due to the increased metabolic demand upon body tissues, not the production of milk itself. Additionally, the nominal maintenance energy requirements do not account for any energy expenditure for activity associated with grazing. The difference in maintenance energy requirements for grazing cattle could be from 10 to 50% greater depending upon the grazing conditions and forage availability.

Lactation

The energy of lactation requirement expressed for lactation is a function of milk yield, milk fat %, and milk protein %. The previously mentioned variables change during the lactation cycle, and thus the energy requirement of lactation changes accordingly. In the monthly energy requirements (Table 3) peak lactation energy requirement occurs during the second month postpartum. Identified differences between and within breeds that affect milk yield and milk composition also affect the lactation energy requirement. Unlike other energy requirements, lactation has a rapid onset of demand for energy that is initiated by parturition. Development of mammary tissues occur prepartum, but the majority of the lactation energy requirement is associated with milk production.

Gestation

The energy requirement associated with pregnancy is an underlying energetic demand for 10 out of 12 months during the yearly production cycle. Whereas the energy required for gestation is initially very small, just 0.1% of the maintenance energy during the third month postpartum. In contrast, the gestation energy requirement one month prior to parturition is approximately 56% of the maintenance energy requirement during the same time. The post-weaning period is often referred to as a "maintenance period" for the grazing beef cow. Indeed, gestational requirements at weaning (3% of total energy required) do not equate to the greater energetic demand of lactation (17% of total energy demand), however this is an important energetic supply and demand period. This period is utilized for growth of the products of conception.

Growth

Growth in the case of the mature cow herd can be construed as the recovery of body tissue energy (i.e. bodyweight and body condition) not associated with the products of conception. During a small time period after the cessation of lactation and prior to the accelerated fetal growth, additional energy supplied to the cow can be utilized for growth of body tissues. This growth is utilized to regain lost bodyweight and body condition due to the mobilization of body tissues during lactation. These accreted body tissues will most likely be re-utilized at some point during the production cycle to support maintenance or lactation.

Energy Balance of Grazing Cows

The energy supplied by the forage diet and the energy required by the grazing cow result in the energy balance. A comparison of energy requirements and energy supplied by the

forage will indicate several months in which energy supplied by the grazed forage is deficient to meet maintenance energy requirements. A deficiency in energy supply indicates that either more feed is necessary or greater energy density in the ration is needed. Obviously in many situations the forage energy supply is not sufficient to meet a grazing cow's energy requirements. Accurate prediction of grazing cattle DMI has been and continues to be a challenge to accurately assess. Obviously in production settings large, long-term energy deficiencies are not tolerated. The alternative to additional forage DMI is to provide additional energy in supplemental feeds. To meet the energy deficiency a reasonable approach to supplemental energy can be accomplished with energy dense supplemental feeds. The quantity of supplemental feed will vary depending upon the predicted DMI and energy concentration of the supplemental feedstuff. The amounts of supplemental feed needs to be determined to meet the energy deficit. Given the nature of energy supplementation, factors such as substitution, associative effects, and dietary protein adequacy are likely to have multiple impacts on forage DMI and the resulting energy balance.

Protein

Protein requirements are expressed in Table 3 in terms of crude protein (CP). The CP requirement of cattle is shown in the tables as a percent of the diet dry matter or as pounds per day. Similar to energy, a cow's protein requirements change throughout the year. The requirement for CP is dependent upon the age of the cow, stage of production, and level of production. Protein requirements, like energy are additive during any point in the cow's production cycle.

The CP system as the name implies is a crude measurement of the protein in any feedstuffs. The amount of CP in a feedstuff is a calculation determined by the following equation CP = nitrogen concentration x 6.25. The CP system is the basic description of protein for cattle. However, protein requirements have been further characterized to indicate the amount of protein that is actually available for the cow to metabolize. Cattle protein requirements are meet by two basic sources, the feedstuffs that they consume and the microorganism that populate the rumen. The protein component of feedstuffs can be divided into two basic fractions identified as rumen degradable protein (RDP) and rumen undegradable protein (RUP). The RDP fraction is comprised of the protein fraction of the diet that is digested in the rumen, utilized by rumen microorganisms, and ultimately resulting in bacterial (microbial) protein or passes through the rumen wall as ammonia and is ultimately metabolized in the liver. In the liver, excess nitrogen is metabolized to urea which can be recycled back to the gastrointestinal tract or excreted through the kidney into urine. The RUP fraction in comprised of the protein fraction of the diet that is not digested in the rumen and thereby "escapes or by-passes" the rumen. The RUP protein may then be digested and absorbed in the small intestine. Together the bacterial protein and RUP fraction comprise the metabolizable protein requirement available for the cow to meet her protein requirement.

Maintenance

The general rule of thumb is that forages with a CP concentration of 7% or greater are adequate to meet a mature cow's CP requirements. Research has shown that the bacterial protein fraction of the diet can provide anywhere from 50% to all 100% of the cow's metabolizable protein requirement depending upon the RUP content of the diet. This would imply that forage based diets of sufficient CP concentration can maintain a mature cow during certain phases of the cow's productive cycle.

Lactation

Lactation is most stressful time in the cow production cycle. Milk contains a large concentration of protein. The source of the protein in milk comes either from dietary sources or mobilization of body lean tissue. Mobilization of lean tissue decreases the overall body condition score of the cow. Research indicates that maintenance of body condition score from calving to rebreeding is imperative to ensure acceptable conception rates. Therefore adequate protein from the diet is an important nutritional consideration.

Gestation

The effect of gestation does not greatly affect the cow's protein requirement during the first seven months of gestation. The majority of the protein requirement is associated with placental development and growth. However, during the last two months of gestation, 2/3 of the fetal growth occurs. This fetal growth results in a large demand on maternal protein supply. Thus protein requirements leading up to parturition are largely associated with fetal growth and other products of conception. During this period, the cow will sacrifice body condition to support fetal growth. Additionally, adequate protein status leading up to parturition is essential for the production of adequate high-quality colostrum to support newborn calf health.

Growth

Like energy, protein requirements for mature cattle are associated with the recovery of lean body tissue that was mobilized during the production cycle. Lean tissue mobilization supplies a good deal of protein when it is needed. However, because of differences in efficiency of utilization a greater amount of dietary crude protein in addition to maintenance requirements is needed to replace the mobilized tissue.

Minerals

Calcium is the most abundant mineral in the body and is an important component for bones, teeth, membrane permeability, muscle contraction, and many other metabolic functions. The calcium requirements listed in the tables are converted to dietary calcium requirements assuming a true absorption of 50%. Absorption of calcium is largely determined by the balance of requirement and intake. Skeletal reserves serve as a large repository of calcium that can be utilized to maintain blood concentrations. Phosphorus is generally discussed with calcium because the two minerals function together in bone metabolism. Phosphorus is predominantly associated with bones and teeth, but also functions in cell growth, energy utilization, and membrane formation. Historically, the calcium:phosphorus ratio recommendation was 2:1, however research has indicated that a ratio of between 1:1 and 7:1 resulted in similar performance assuming that the dietary phosphorus requirement was met.

Conclusion

The key concept to remember in feeding the beef cow herd is that cattle need to be fed to meet nutrient requirements for their expected level of performancne. Cows do not have requirements for specific feeds they have requirements for energy and specific nutrients. Energy and other nutrients will first be utilized to meet the cow's maintenance requirements then nutrients and energy will be allocated to productive uses (growth, reproduction, lactation).

Additional Resources

Basic Nutrient Requirements of Beef Cattle. http://edis.ifas.ufl.edu/an190

Florida Cow-calf Management, 2nd ed. Feeding the Cow Herd. http://edis.ifas.ufl.edu/an117

Water Nutrition and Quality Considerations for Cattle. http://edis.ifas.ufl.edu/an195

Table 1. Dry matter intake (DMI) guidelines for beef cows

Forage Type	Gestating Cow	Lactation Cow
Low quality (<52% TDN)	% of Body weight	
Un-supplemented	1.8	2.0
Protein supplemented	1.8	2.2
Energy supplemented[1]	1.5	2.0
Medium quality (52-59% TDN)		
Un-supplemented	2.0	2.3
Protein supplemented	2.2	2.5
Energy supplemented[1]	2.0	2.3
High quality (>59% TDN)		
Un-supplemented	2.5	2.7
Protein supplemented	2.5	2.7
Energy supplemented[2]	2.5	2.7

[1] Above 4 lb of supp, each lb of supp decreases forage consumption by 0.6 lb.
[2] Lb for lb substitution of supplement for forage.

Table 2. Approximate total daily water requirement of beef cows and bulls[1]

	Temperature in Fahrenheit[2]					
	40	50	60	70	80	90
Pregnant cows[3]			*gallons*			
900 lbs	6.7	7.2	8.3	9.7	11.4	13.7
1,100 lbs	6.0	6.5	7.4	8.7	10.4	12.5
Lactating cows						
All weights	11.4	12.6	14.5	16.9	17.9	16.2
Mature bulls						
1,400 lbs	8.0	8.6	9.9	11.7	13.4	19.0
1,600 lbs	8.7	9.4	11.8	12.6	14.5	20.6

[1] Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.
[2] Water intake of a given class of cattle in a specific management system is a function of DMI and temperature. Water intake is constant up to 40° F.
[3] Dry matter intake has a major influence on water intake. Heavier cows are assumed to be in better conditions and thus require less dry matter intake and in turn less water intake.

Table 3. Nutrient requirements of 1,200 lb mature cow.

Mature Weight	Nutrient	Months Since Calving											
		1	2	3	4	5	6	7	8	9	10	11	12
1,200	(10 lbs peak milk)												
	DMI, lb/d	24.4	24.9	26.0	25.6	25.1	24.8	24.2	24.1	24.0	23.9	21.4	24.6
	TDN, %	55.3	56.0	53.7	52.9	52.1	51.5	44.9	45.8	47.1	49.3	52.3	56.2
	NEm, mcal/lb	0.54	0.55	0.51	0.50	0.49	0.48	0.37	0.38	0.41	0.44	0.49	0.55
	CP, %	8.43	8.79	8.13	7.73	7.33	7.00	5.99	6.18	6.50	7.00	7.73	8.78
	Ca, %	0.24	0.25	0.23	0.21	0.20	0.19	0.15	0.15	0.15	0.26	0.25	0.25
	P, %	0.17	0.17	0.16	0.15	0.14	0.14	0.12	0.12	0.12	0.16	0.16	0.16
	TDN, lb/d	13.49	13.94	13.96	13.54	13.08	12.77	10.87	11.04	11.30	11.78	11.19	13.83
	NEm, mcal/d	13.18	13.70	13.29	12.80	12.30	11.90	8.95	9.16	9.84	10.52	10.49	13.53
	CP, lb/d	2.06	2.19	2.11	1.98	1.84	1.74	1.45	1.49	1.56	1.67	1.65	2.16
	Ca, lb/d	0.06	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.04	0.06	0.05	0.06
	P, lb/d	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04
1,200	(20 lbs peak milk)												
	DMI, lb/d	26.8	27.8	28.4	27.4	26.5	25.7	24.2	24.1	24.0	23.9	21.4	24.6
	TDN, %	58.7	59.9	57.6	56.2	54.7	53.4	44.9	45.8	47.1	49.3	52.3	56.2
	NEm, mcal/lb	0.59	0.61	0.57	0.55	0.53	0.51	0.37	0.38	0.41	0.44	0.49	0.55
	CP, %	10.10	10.69	9.92	9.25	8.54	7.92	5.99	6.18	6.50	7.00	7.73	8.78
	Ca, %	0.29	0.31	0.29	0.26	0.24	0.22	0.15	0.15	0.15	0.26	0.25	0.25
	P, %	0.19	0.21	0.19	0.18	0.17	0.15	0.12	0.12	0.12	0.16	0.16	0.16
	TDN, lb/d	15.73	16.65	16.36	15.40	14.50	13.72	10.87	11.04	11.30	11.78	11.19	13.83
	NEm, mcal/d	15.81	16.96	16.19	15.07	14.05	13.11	8.95	9.16	9.84	10.52	10.49	13.53
	CP, lb/d	2.71	2.97	2.82	2.53	2.26	2.04	1.45	1.49	1.56	1.67	1.65	2.16
	Ca, lb/d	0.08	0.09	0.08	0.07	0.06	0.06	0.04	0.04	0.04	0.05	0.06	0.06
	P, lb/d	0.05	0.06	0.05	0.05	0.05	0.04	0.03	0.03	0.03	0.04	0.03	0.04
1,200	(30 lbs peak milk)												
	DMI, lb/d	29.2	30.6	30.8	28.4	27.9	23.7	24.2	21.1	24.0	23.9	21.4	24.6
	TDN, %	61.6	63.2	60.8	59.0	57.0	55.2	44.9	45.8	47.1	49.3	52.3	56.2
	NEm, mcal/lb	0.64	0.66	0.62	0.59	0.56	0.54	0.37	0.38	0.41	0.44	0.49	0.55
	CP, %	11.51	12.25	11.41	10.55	9.61	8.45	5.99	6.18	6.50	7.00	7.73	8.78
	Ca, %	0.34	0.36	.34	0.31	0.27	0.25	0.15	0.15	0.15	0.26	0.25	0.25
	P, %	0.22	0.23	0.22	0.20	0.18	0.17	0.12	0.12	0.12	0.16	0.16	0.16
	TDN, lb/d	17.99	19.34	18.73	17.35	15.90	14.74	10.87	11.04	11.30	11.78	11.19	13.83
	NEm, mcal/d	18.69	20.20	19.10	17.35	15.62	14.42	8.95	9.16	9.84	10.52	10.49	13.53
	CP, lb/d	3.36	3.76	3.51	3.10	2.68	2.34	1.45	1.49	1.56	1.67	1.65	2.16
	Ca, lb/d	0.10	0.11	0.10	0.09	0.08	0.07	0.04	0.04	0.04	0.06	0.05	0.06
	P, lb/d	0.06	0.07	0.07	0.06	0.05	0.05	0.03	0.03	0.03	0.04	0.03	0.04

Adapted from the Nutrient Requirements of Beef Cattle, published by the National Research Council, 2000.