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NUTRITIONAL CONSIDERATIONS AND LIMITATIONS WITH GRAZING

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Pastures have long been a major source of nutrients for ruminants. However, the dairy industry moved away from grazing in the 50's, whereas beef and sheep have continually used pastures as a primary source of nutrients. Dairy producers are moving back to using pastures as a major source of nutrients. Economics to a large extent are the driving force for the movement back to grazing systems as a method to harvest forage. In general, pasture as with all other forages does not provide all the needed nutrients to obtain the most profitable animal performance, and concentrate supplementation should compliment the forage.

PASTURE NUTRIENT QUALITY

Pasture availability and quality are the two most important factors in maximizing the amount of nutrients obtained from pastures. Pasture that is well managed in an intensive grazing system will usually be high in quality. In Table 1 are average nutrient composition values for several types and mixtures of high quality pastures. These are average values and should be used as a guide for providing additional nutrients. Nutrient composition as well as pasture availability will change during the growing season and is influenced by climate, pasture management and pasture species, and numerous other factors. In general, pastures containing some legumes are higher in nutrient value which will likely mean more pasture intake. This suggests that some pasture sampling and forage testing are needed to monitor nutrient composition and changes within a season and between seasons. The seasonal affect on nutrient composition is illustrated in Table 1 with columns titled spring, summer, and fall. For most grasses and grass/legume mixtures, the protein and energy content are highest in spring and fall and lowest during the summer. Grasses generally are higher in fiber and have lower DMI than legumes. The fiber content is usually higher in the summer. Some variation in mineral content also exists during a grazing season suggesting the need for period analyses for mineral composition.

NUTRITIONAL CONSIDERATIONS

The performance of dairy, beef, and sheep is determined by the nutrient content of the pasture, and in turn, the actual nutrient intake from the pasture and the additional nutrients that are provided to meet the nutrient requirement of that species. The nutrient requirements or NRC publications are still the scientific base used to develop feeding programs for pasture feeding

systems. The same basic nutritional principles apply to a grazing system as to stored feeding systems. The major difference is that accurate information on nutrient composition and intake does not exist compared with a nongrazing system. In addition, we do not understand the utilization of the various pastures by grazing ruminants is not we understood as well as the nutrient utilization with stored forages. For example, the net energy of lactation (NEL) and TDN values in Table 1 are estimated from the fiber content of the pasture, similarly to what is usually done with stored forages. In reality, a high producing dairy cow will not likely obtain as much energy from the pasture as estimated from the NEL value and, consequently, low milk yields and body condition are sometimes observed in the field with high producing cows. With proper supplemental feeding it may be possible to have the cow obtain closer to the "book value" of estimated energy.

LIMITATIONS FOR DAIRY

In Table 2 are presented calculated intakes of various nutrients from pastures when fed grass pasture (column 1) in the spring for 2 different production levels (75 and 50 lb. of milk) and for one age of growing heifer. For comparison, a column headed deficient (-) or excess (+) illustrates the specific nutrient status if high quality pasture is the only forage and which nutrients need to be supplemented.

To illustrate, we will go through the example for a 1300 lb. Holstein cow that is expected to produce 50 lb. of milk (Table 2). First, the expected dry matter intake (DMI) is needed if pasture is the only forage. Generally, if pasture is the only forage, a lactating cow will consume about 3.0% of body weight or 39 lb. pasture DMI ($1300 \text{ lb.} \times 3.0\% \text{ BW} = 39 \text{ lb. DMI}$). This is about 200 lb. of pasture on a wet basis and is likely the point where rumen fill may limit further intake. The estimated intake of all nutrients (column 2) is calculated by multiplying the estimated DMI times the nutrient content (column 1). For example, $39 \text{ lb. pasture DMI} \times 22\% \text{ CP} = 8.6 \text{ lb. CP intake/day}$. The estimated nutrient intake of several nutrients from only pasture (column 2) can be compared to the estimated nutrients needed to produce 50 lb. of milk (column 3) and excesses or deficiencies are shown in column 4. The total protein intake is more than adequate, however the amount of undegradable intake protein (UIP) or bypass protein is marginal because the protein in most pastures is highly degradable in the rumen. The NDF intake is somewhat high which may limit DMI because of a rumen bulk or fill factor. The major limiting nutrient is energy. The 2 Mcal of net energy intake short of needs calculates to about 6 lb. less milk or 44 lb instead of 50 lb. This is consistent with research and producer experiences that well-managed, high quality pastures should provide sufficient nutrients to maintain about 40 to 50 pounds of milk with little or no supplemental nutrients. The nonstructural carbohydrate (NSC), which is high in grains such as

corn and is the major source of energy, is low in relation to needs. Providing 10 lb. of shelled corn (1 lb grain to 5 lb milk) will provide about 7 lb. of NSC and adequate energy to allow for 50 lb. milk and some gain in body condition. When supplementing grain, pasture intake will decline with the grain substituting for pasture. However, total DMI should be about 43 lb. with about 33 pasture DM and 10 lb. from grain.

Similar comparisons can be made for a cow producing 75 lb. of milk (columns 5 and 6). In addition to energy, the amount of UIP is low because of the high rumen degradability and solubility of the protein in pastures. Most minerals are deficient. For 75 lb. of milk, we can calculate that 15 to 18 lb. of grain (1 lb. grain to about 4.5 lb. of milk) containing some undegradable protein is needed to maintain this production level. In this example, 46 lb. DMI is the expected intake, 28 lb. from pasture and 18 lb. from grain. The intake is similar to data from Penn State research with cows of a similar production level. More supplemental energy or grain may be required to maintain or improve body condition. All minerals except K need to be supplemented with high producing cows.

Two additional points are important related to increasing energy intake from feeding grain. First, cows require more energy associated with the increased activity during grazing. Generally, 3 to 4 lb. of grain may be needed to supply the energy needed for grazing activity. Second, the highly degradable protein in pasture is usually excreted in urine and requires energy for this metabolic process. The energy required for this nitrogen excretion may be from 3 to 5 lb. of milk per day. Providing extra energy from grain to improve the nitrogen utilization in the rumen decreases the excretion in the urine, and will usually improve milk production. These two factors suggest that a basal amount of supplemental energy from grain is needed for all lactating cows.

For reference, seven example rations are shown in Table 3 for the cow producing 75 lb. of milk. These are examples using the average spring pasture composition which was used in the calculations in Table 2. In all rations (Table 3), 17.4 lb. of grain DM is fed which is about 1 lb. of grain to 4.3 lb. of milk. In all rations supplemental rumen by pass protein was provided from animal protein, corn distillers or roasted/cooked soybeans. Shelled corn was the major energy source. In four examples, additional forage has been included. Many dairy farmers who have adopted a grazing system feed varying amounts of additional forage. When the quantity of available pasture is limited, particularly during summer, dairy producers will need to feed additional forage. Some dairy producers decide to feed supplemental forage in an attempt to obtain higher milk production and improve body condition. Often supplemental forage is fed with the expectation of "maintaining" milk fat test. Feeding some additional forage as a replacement for some of the pasture offers more "control" over the feeding program than pasture alone. Frequently, a combination of grass/hay crop silage and corn silage is fed with grain as a "partial" total mixed ration and appears to work well and

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may be a better way to feed grain than the twice daily slug feeding. Many dairy producers feed small amounts of dry hay. Hay will likely decrease the fast rate of passage that normally exists on pastures and add some needed fiber to high quality pastures. Good nutritional advice is needed to balance the total ration when additional forages are fed.

For the growing heifer expected to gain 1.6 to 1.8 lb/day (columns 7 and 8 in Table 2), the primary nutrients needed are some rumen by pass protein and perhaps a few minerals. High quality, well managed pasture provides a good opportunity to raise heifers at a low cost.

With a grass-based pasture, minerals are often deficient compared to the nutrient requirements. Phosphorus, calcium, magnesium, copper, zinc and selenium along with salt are often deficient in pastures compared to the needs of the lactating cows. Thus, forage testing is frequently needed and supplemental minerals are required. Wherever possible supplemental minerals should be provided in the concentrate mix rather than free-choice to ensure adequate intake for each cow. In particular, supplemental magnesium can reduce the risk of grass tetany with spring pastures. Concentration of minerals in the grain mix needs to be adjusted accordingly if the amount of grain fed is reduced.

CONSIDERATIONS FOR BEEF AND SHEEP

Calculations of nutrient intake compared to nutrient needs, similar to the calculations with dairy, are in Tables 4 and 5. The assumption is that high quality pasture is available in quantities to maximize DMI. In general, high quality pasture is calculated to meet the nutrient needs of lactating and rapidly growing beef and sheep. Although total protein intake appears adequate, the high rumen degradability of the protein in pasture suggests that small amounts of rumen by-pass protein and/or energy (grain) to maximize utilization of the pasture protein may be needed with early lactation and rapidly growing animals. This is similar to the high producing dairy cow. Trace mineral salt is needed free-choice to provide amounts of these nutrients.

SUMMARY

High quality pastures available in adequate amounts in a well managed intensive grazing system provide high quantities of needed nutrients. With dairy cattle, additional amounts of most nutrients are needed to meet the requirements for high milk production, reproduction, and optimum animal health. With beef and sheep, lesser amounts of nutrients are needed. Working with a qualified nutritionist is necessary to maintain a nutritionally balanced feeding program for maximum profitability.

TABLE 1. AVERAGE NUTRIENT COMPOSITION FOR PASTURE

Nutrient	PASTURE														
	Grass			Legume			Mixed Mostly Grass			Mixed Mostly Legumes			Sor-Sud Past; 40 inches	Brassicacs	Small Grain Pasture
	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall			
DM %	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	22.0	18.0	20.0
CP, %	21.0	19.0	22.0	25.0	22.0	25.0	22.0	21.0	23.0	23.0	21.0	24.0	14.0	25.0	18.0
UIP, % of CP	18.0	30.0	26.0	18.0	20.0	18.0	18.0	27.0	24.0	18.0	23.0	21.0	38.0	31.0	24.0
Sol. P, % of CP	50.0	30.0	40.0	37.0	30.0	46.0	46.0	30.0	42.0	40.0	30.0	44.0	32.0	34.0	67.0
ADF, %	26.0	33.0	28.0	25.0	30.0	26.0	26.0	32.0	27.0	25.0	31.0	27.0	41.0	28.0	40.0
NDF, %	48.0	54.0	50.0	36.0	41.0	36.0	46.0	50.0	46.0	45.0	43.0	43.0	62.0	30.0	59.0
TDN, %	70.0	64.0	68.0	71.0	66.0	69.0	70.0	66.0	74.0	70.0	66.0	70.0	63.0	80.0	65.0
NE,Mcal/lb	.76	.72	.76	.75	.70	.75	.75	.71	.76	.75	.70	.75	.65	.80	.58
NSC, %	18	15	18	23	20	23	19	16	19	21	18	21	12	28	16
Ca, %	.70	.70	.80	1.30	1.30	1.50	.90	.90	1.00	1.10	1.00	1.30	.50	1.61	0.57
P, %	.31	.31	.33	.30	.30	.33	.31	.31	.33	.30	.30	.33	.30	0.34	0.32
Mg, %	.14	.17	.20	.19	.21	.24	.15	.19	.21	.17	.19	.22	.30	.30	0.20
K, %	3.20	2.10	2.75	3.50	3.00	3.30	3.30	2.40	2.95	3.30	2.70	3.10	2.60	2.78	2.85
S, %	.16	.19	.22	.20	.23	.26	.17	.20	.23	.18	.21	.24	.12	.29	0.25
Mn, ppm	80	80	80	56	56	56	73	73	73	62	62	62	68	52	63
Cu, ppm	5	6	7	7	8	9	7	8	9	7	8	9	9	17	8
Zn, ppm	26	26	26	26	26	26	26	26	26	26	26	26	34	36	29
Fe, ppm	146	146	146	194	194	194	205	205	205	186	186	186	268	93	345
Vit A, IU/lb	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000	40000	340000		300000
Vit D, IU/lb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vit E, IU/lb	250	250	250	250	250	250	250	250	250	250	250	250	204	0	25
Fat, %	4.9	4.9	4.9	4.3	4.3	4.3	4.7	4.7	4.7	4.5	4.5	4.5	3.1	4.2	3.6
Ash, %	10.0	10.0	11.0	12.0	11.0	12.0	11.0	11.0	12.0	12.0	12.0	14.0	9.8	10	8.3

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TABLE 2. ILLUSTRATION OF ESTIMATED NUTRIENT EXCESSES AND DEFICIENCIES FOR DAIRY CATTLE

Nutrient			<i>Lactating cow (50 lb)</i>		<i>Lactating cow (75 lb)</i>		<i>Growing heifer (12 mo)</i>	
	(1)	(2)	(3) ^d	(4)	(5) ^d	(6)	(7) ^d	(8)
	<i>Grass pasture in spring</i>	<i>Est. nutrient intake (lb/d)^a from pasture</i>	<i>Est. nutrient needed/da to produce 50 lb milk</i>	<i>Deficiency or excess (- or +)</i>	<i>Est. nutrient needed/da to produce 75 lb milk</i>	<i>Deficiency or excess (- or +)</i>	<i>Est. nutrient needed/day</i>	<i>Deficiency or excess (- or +)</i>
DMI, lb		39	43	-	46	-	14	
DM %	20							
CP	22%	8.5	5.0	+	8.0	+	3.0	+
UIP	4.4 (20%) ^b	1.7	1.7	OK	2.9	-	.60	-
Sol. P	11.0 (50%) ^c	4.3	2.5	+	2.7	+	1.50	+
ADF	26%	10.1	10.5	OK	10.0	OK	3.5	+
NDF	46%	17.9	14.3	+	14.4	+	6.5	+
NEL	.75 Mcal/lb	29.2 Mcal	31	-	36	-	10.0 (TDN)	+
NSC	18%	7.0	13	-	16	-	2.5	+
Ca	.70%	.27	.25	OK	.34	-	.10	OK
P	.31%	.12	.17	-	.22	-	.04	-
Mg	.14%	.055	.10	-	.12	-	.02	-
K	3.2%	1.25	.41	+	.48	+	.40	+
S	.16%	.06	.08	-	.10	-	.02	-

^a Assume DMI of 3% BW if pasture is only forage (1300 lb BW)

^b Amount of CP as % of total protein that is undegradable in the rumen.

^c Amount of CP as % of total protein that is soluble

^d Estimated nutrient intake per day (lb. or Mcal)

TABLE 3. EXAMPLE SUPPLEMENTAL RATIONS FOR GRAZING DAIRY COWS AVERAGING 75 LB MILK.

Ingredient	Ration						
	1	2	3	4	5	6	7
Lb. dry matter/day							
Forage:							
Pasture (Spr.), estimated DMI	28.3	28.3	24.8	28.3	24.8	21.3	21.5
	(grass)	(grass)	(grass)	(grass/legume)	(grass/legume)	(grass/legume)	(grass/legume)
Corn silage	—	—	—	—	—	3.4	6.8
Legume hay crop silage	—	—	—	—	—	3.6	—
Legume hay	—	—	3.5	—	3.5	—	—
Grain Ration Ingredients:							
Shelled corn	13.5	12.3	13.6	13.2	13.2	13.8	13.1
Animal Protein	.4	—	.35	—	—	.4	.6
Corn distillers	—	1.5	—	1.5	1.5	—	—
Roasted soybeans	1.8	1.8	1.8	1.3	1.3	1.8	1.8
Molasses	.55	.55	.56	.56	.56	.56	.56
Monosodium P04	.25	.27	.25	.25	.25	.22	.21
Limestone	.40	.45	.37	.12	.13	.14	.17
Magnesium oxide	.11	.12	.11	.11	.11	.10	.10
Dynamate	—	—	—	—	—	.03	.04
Trace mineral mix	.06	.06	.06	.06	.06	.06	.06
Salt	.20	.20	.20	.20	.20	.20	.20
Selenium premix (.06)	.02	.02	.02	.02	.02	.02	.02
	17.4	17.4	17.4	17.4	17.4	17.4	17.4
Total DMI./day (estimated)	45.7	45.7	45.7	45.7	45.7	45.7	45.7
Estimated Nutrient Composition (Total Ration = Forage + Grain mix):							
Protein, % DM							
Total	18.3	18.4	18.0	19.0	18.6	17.9	17.6
UIP	5.6	5.6	5.6	5.7	5.7	5.7	5.7
Soluble protein	7.5	7.6	7.1	6.3	6.0	6.0	5.7
ADF, % DM	18.4	19.1	19.2	21.5	22.0	21.5	20.8
NDF, % DM	33.4	35.1	33.5	34.0	34.3	33.3	33.3
NE _L , Mcal/lb.	.78	.78	.77	.78	.77	.76	.77
NSC, % DM	33	31	33	33	33	35	36
Fat, % DM	3.8	3.9	3.8	3.8	3.7	3.8	3.8
Ca, % DM	.85	.85	.85	.85	.85	.85	.85
P, % DM	.45	.45	.45	.45	.45	.45	.45
Mg, % DM	.30	.30	.30	.30	.30	.30	.30
K, % DM	1.50	1.50	1.50	2.10	2.00	1.90	1.80
S, % DM	.20	.21	.20	.20	.20	.20	.20
Mn, ppm	80	85	80	70	70	70	70
Cu, ppm	13	13	13	13	13	13	13
Zn, ppm	100	96	97	97	95	98	100
Se, ppm	.30	.30	.30	.03	.30	.30	.30

TABLE 4. ILLUSTRATION OF ESTIMATED NUTRIENT EXCESSES AND DEFICIENCIES FOR BEEF.

Nutrient	(1) Grass Pasture in spring	Early lactation (22/lb milk)			Growing (700 lb)		
		(2) Est. nutrient intake/da (lb./da)	(3) Est. nutrients needed/da (lb./da)	(4) Deficiency or excess - or +	(5) Est. nutrient intake/da (lb./da)	(6) Est. nutrients needed/da (lb./da)	(7) Deficiency or excess (- or +)
DMI, lb.		23			15		
CP, %	20	4.6	2.7	+	3.0	1.5	OK
TDN, %	75	17.3	15.0	+	11.2	10.6	+
Ca, %	.70	.16	.08	+	.11	.06	+
P, %	31	.07	.06	+	.045	.035	+
Mg, %	.14	.03	.023	+	.02	.015	+
K, %	3.2	.73	.151	+	.48	.09	+
S, %	.16	.03	.023	+	.024	.015	+

TABLE 5. ILLUSTRATION OF ESTIMATED NUTRIENT EXCESSES AND DEFICIENCIES FOR SHEEP.

Nutrient	(1) Grass Pasture in spring (lb./da)	Early lactation (175/lb)			Growing (88 lb)		
		(2) Est. nutrient intake/da (lb./da)	(3) Est. nutrients needed/da (lb./da)	(4) Deficiency or excess + or -	(5) Est. nutrient intake/da (lb./da)	(6) Est. nutrient needed/da (lb./da)	(7) Deficiency or excess (- or +)
DMI, lb.		6.6			3.35		
CP, %	20	1.3	.96	+	.67	.51	+
TDN, %	75	4.9	4.3	+	2.5	1.15	+
Ca, %	.70	.04	.02	+	.023	.019	+
P, %	.31	.02	.02	+	.010	.010	+