B-1553

Texas Agricultural Extension Service

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Nutrient Composition of Feeds

Ronald J. Gill and Dennis B. Herd*

Forages normally supply protein and digestible energy cheaper than any other feedstuff. Pastures, which cows harvest themselves, are basic to a cow-calf operation. Harvested forages in the form of hay or silage are a more expensive source of nutrients, but normally they are cheaper than concentrate feeds such as grain and protein supplements. Where forage quality is poor (forages lacking in protein and energy) it is necessary to feed limited amounts (0 to 8 pounds) of expensive supplements in order to obtain satisfactory animal performance. A mineral supplement should be available to cattle on a free choice, year-round basis. Protein, energy and vitamin A supplements are normally needed during the winter or drought periods when available forage is often limited in amount as well as quality. Requirements for various nutrients may be found in Extension publication B-1554, "Nutrient Requirements of Beef Cattle."

Mineral Content of Forages

Forages typically contain adequate to high levels of calcium (0.25 to 0.7 percent with 0.3 to 0.5 percent typical) and deficient to adequate levels of phosphorus (0.02 to 0.3 percent with 0.1 to 0.2 percent typical). The calcium content tends to vary among forages, but remains more consistent within a specific forage than phosphorus. The phosphorus content of forages varies greatly due to the soil phosphorus content and the stage of maturity of the plant. Like protein, phosphorus is much higher in leafy young growing plants than in mature stemmy plants. Forages are normally deficient in salt (sodium chloride) and phosphorus and sometimes deficient in magnesium, copper and zinc. Potassium is only deficient in droughty, weathered or leached forages. Problems concerning forages and other minerals are not common in Texas. More detailed information on minerals is available in Extension publication L-2213, "Mineral Recommendations for Pastured Beef Cattle in Texas".

*Extension livestock specialist and Extension beef cattle specialist, The Texas A&M University System.

Vitamin A Content of Forages

Green, growing forages normally contain adequate carotene which yields vitamin A. During dormancy, mature forages are deficient. Because vitamin A supplements are relatively cheap and analytical procedures to check for carotene or vitamin A are expensive, vitamin A supplementation is suggested if there is any doubt about the adequacy of the vitamin. Other vitamins should not be a problem for grazing cattle.

Protein Content of Forages

The protein content of several classes of forage is presented in Figure 1. As a class, the cool season grasses and legumes are highest in protein content followed by the warm season legumes and then the warm season grasses. Within each general class a number of factors influence the exact concentration of protein. Principal of these are the effect of soil type, soil fertility, age and growth rate of the plant. In general, increasing soil fertility (especially nitrogen) and growth rate results in increased protein content. Increasing age with accompanying decreasing growth rate results in reduced protein content.

As a forage class, the cool season grasses and legumes contain protein in excess of the requirement of all classes of beef cattle. Only when they become very mature and dormant are they deficient. Similarly, the warm season legumes contain more than adequate concentrations of crude protein for all classes of beef cattle.

Warm season grasses are commonly deficient in protein. Protein deficiency occurs during the summer and fall when forage growth rate slows down. This can be minimized by maintaining favorable growing conditions (fertility and water). There are areas, like some very alkaline, high pH, blackland soils, where forages do not respond well to nitrogen or phosphorus fertilization. Most warm season grasses will contain adequate protein to meet the protein requirement of cattle during the periods of rapid forage growth.

With the advent of a killing frost, the protein content of warm season grasses drops rapidly below

the requirement of all classes of cattle. This decrease in protein is accentuated by high rainfall and in low-growing forages such as the bermudas.

Energy Content of Forages

The range in digestible energy content observed for various classes of forage is shown in Figure 2. Within each forage class, digestibility and energy value for specific species will lie within a more restricted portion of the range shown. As an example, Coastcross 1 bermudagrass is known to have higher values than Coastal, other things being equal (Table 1).

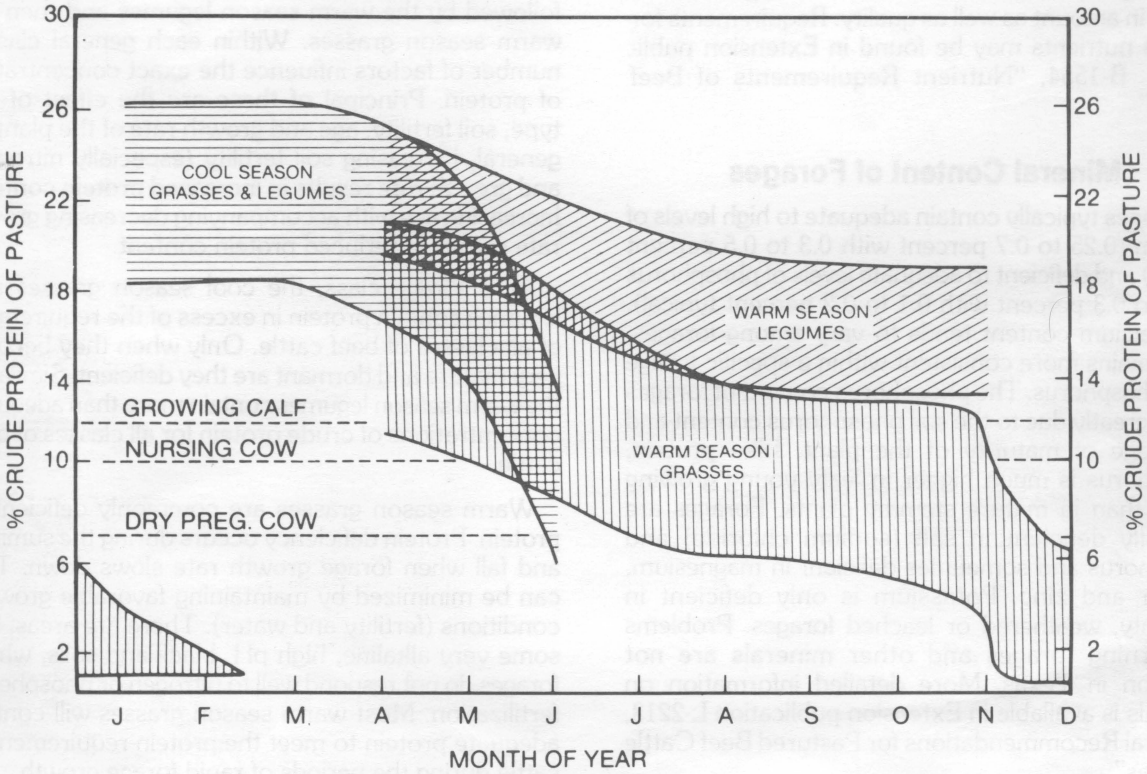
Forages have higher values when they are well fed, young, actively growing, leafy and vegetative. As maturity sets in and growth slows, there is a decline in digestibility. For large yields of protein and energy, plants must receive adequate nutrition from naturally rich soils or from fertilization. Management determines whether forage will be grazed or cut for hay when it is high in quality or later when the feeding value is reduced because of plant maturity.

Forages which maintain higher digestibility at maturity make better standing hay crops. Mature plants make a low quality feed and definitely need supplementation. Feeding value of dormant forage in late winter in the 30-inch plus rainfall areas is quite limited.

The composition of several hay crops analyzed by the Extension Forage Testing Service is reported in Table 1. The values are from producer submitted samples and give some idea of the field situation. Complete information concerning the forage testing service is available through county Extension offices. Study of Table 1 should reveal that there is a tremendous range in the protein content of forages. Because of this and the high cost of protein supplementation, testing for protein is a money-making management tool. A forage's energy content varies, but not to the extent that protein varies. Testing for energy is suggested for more advanced, intensive operations or in cases where there are problems and closer observation may be helpful.

Variation in the nutrient content occurs primarily because of fertilization and stage of maturity. Management determines when crops will be harvested. Young, growing, well-fertilized plants will have the higher values resulting in superior animal performance while mature, poorly fertilized plants will have the low values.

Figure 1. Protein Content of Forages.



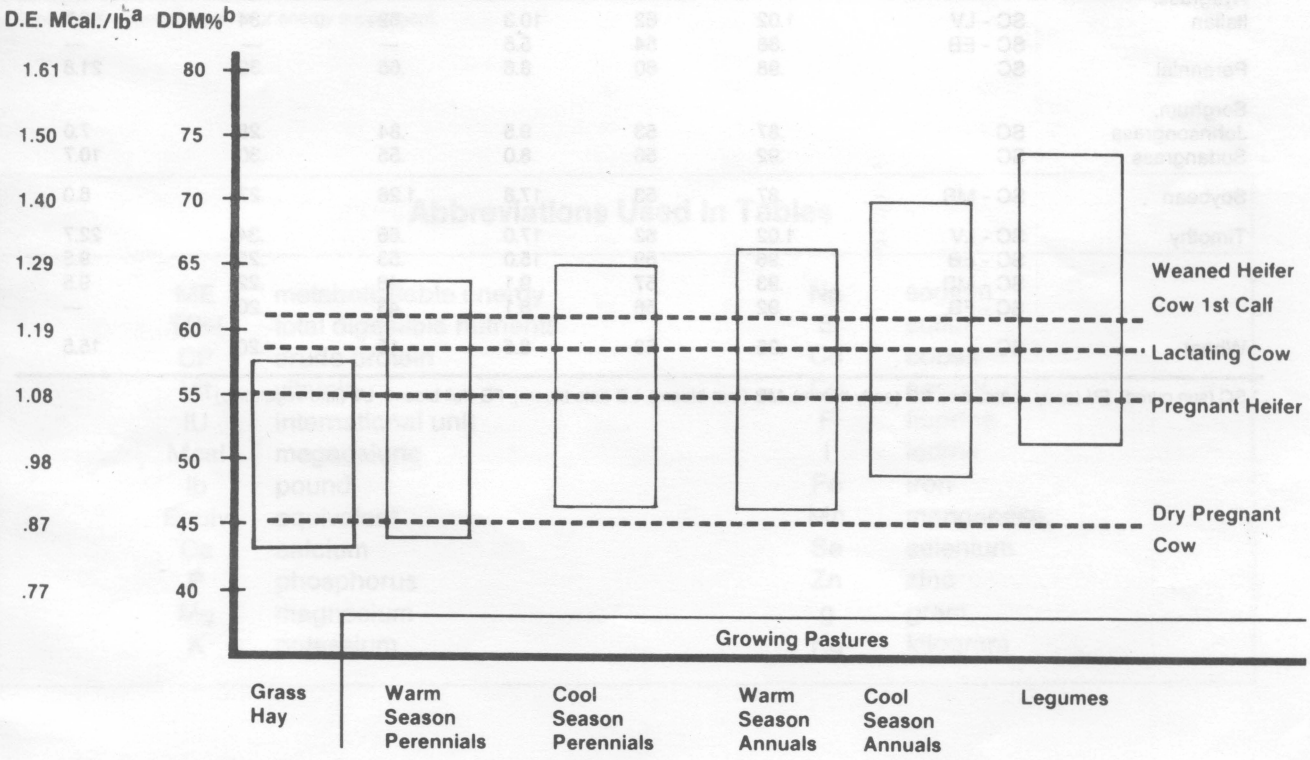
W.C. Ellis, Beef Cattle Short Course, August 1973.

Table 1. General summary of forage analyses performed through the Extension Forage Testing Service[a].

Type Forage	Crude Protein, % Average	Crude Protein, % Range	Digestible Energy, Mcal./lb. Average	Digestible Energy, Mcal./lb. Range
Alfalfa	18	11-26	1.08	0.95-1.23
Coastal bermudagrass	9	3-20	0.92	0.80-1.07
Common bermudagrass	9	4-17	0.91	0.79-0.97
Alicia bermudagrass	9	4-15	0.90	0.80-0.99
Coastcross 1 bermudagrass	11	3-16	1.08	1.06-1.10*
Johnsongrass	7	3-15	0.97	0.91-1.02
Forage sorghum	6	2-13	0.97	0.89-1.06
Sudan & hybrids	7	3-17	0.96	0.81-1.10
Bahiagrass	7	4-12	0.96	0.93-1.00*
Kleingrass	7	2-15	0.93	0.86-0.98
Introduced bluestemgrass	5	2-8	0.92	0.87-1.02
Native prairiegrass	5	4-8	0.85	0.77-0.91
Weeping lovegrass	7	3-14	0.91	0.88-0.96
Misc. legumes, clover vetch, peas	15	10-22		

[a] Data reported on an as-fed basis of approximately 90 percent dry matter, 10 percent moisture.
* Small number of samples analyzed.

Figure 2. Variation in energy content of various forages relative to the requirements of various classes of cattle (values given on a dry matter basis).



[a]Digestible energy as megacalories per pound.
[b]Digestible dry matter.

Feed Ingredient Analysis Tables (Adapted from NRC, 1984).

Forages (Dry Matter Basis)

Feed Name	Description*	ME (Mcal/lb)	TDN (%)	CP (%)	Ca (%)	P (%)	Vit. A Equiv./lb 1000 IU
Alfalfa	SC - EB	.98	60	18.0	1.41	.22	25.5
	SC - MB	.95	58	17.0	1.41	.24	6.0
	SC - LB	.85	52	14.0	1.43	.25	—
	SC - Mature	.82	50	12.9	1.13	.18	2.1
Bermudagrass	SC	.80	49	6.0	.43	.20	18.9
Clover,							
Alsike	SC	.95	58	14.9	1.29	.26	33.9
Crimson	SC	.93	57	18.4	1.40	.22	3.1
Ladino	SC	.98	60	22.0	1.35	.31	15.1
Red	SC	.90	55	16.0	1.53	.25	3.6
Fescue	SC - EV	1.00	61	12.4	.51	.36	—
	SC - EB	.79	48	9.5	.30	.26	—
Lespedeza	SC - EB	.90	55	15.5	1.23	.25	24.9
	SC - MB	.82	50	14.5	—	—	10.0
	SC - FB	.77	47	13.4	—	—	2.3
Oat	SC	.90	55	9.3	.24	.22	5.0
Orchardgrass	SC - EB	1.06	65	15.0	.27	.34	6.8
	SC - LB	.88	54	8.4	.26	.30	3.6
Peanut	SC	.90	55	10.8	1.23	.15	6.3
Ryegrass,							
Italian	SC - LV	1.02	62	10.3	.62	.34	52.7
	SC - EB	.88	54	5.5	—	—	—
Perennial	SC	.98	60	8.6	.65	.32	21.8
Sorghum,							
Johnsongrass	SC	.87	53	9.5	.84	.28	7.0
Sudangrass	SC	.92	56	8.0	.55	.30	10.7
Soybean	SC - MB	.87	53	17.8	1.26	.27	6.0
Timothy	SC - LV	1.02	62	17.0	.66	.34	22.7
	SC - EB	.96	59	15.0	.53	.25	9.5
	SC - MB	.93	57	9.1	.48	.22	9.5
	SC - FB	.92	56	8.1	.43	.20	—
Wheat	SC	.95	58	8.5	.15	.20	15.5

* SC (sun cured), EV (early vegatative), EB (early bloom), MB (mid-bloom), LB (late bloom), FB (full bloom), LV (late vegatative)

Roughages (Dry Matter Basis)

Feed Name	Description	ME (Mcal/lb)	TDN (%)	CP (%)	Ca (%)	P (%)	Vit. A Equiv./lb 1000 IU
Alternate Sources, Roughages							
Almond	Hulls	.90	55	2.1	.23	.11	—
Barley	Straw	.65	.40	4.3	.30	.07	—
Citrus	Dehyd. Pulp	1.35	82	6.7	1.84	.12	—
Corn	Fodder w/ears	1.06	65	8.9	.50	.25	—
	Fod. w/mat. ear	1.13	69	8.0	—	—	—
	Stover	.82	50	6.6	.57	.10	—
	Cobs, ground	.82	50	3.2	.12	.04	—
Cotton	Hulls	.69	42	4.1	.15	.09	—
	Bolls, SC	.72	44	11.0	.90	.12	—
Oat	Hulls	.57	35	3.9	.15	.15	—
	Straw	.74	45	4.4	.24	.06	—
Peanut	Hulls	.36	22	7.8	.26	.07	—
Rice	Hulls	.19	12	3.3	.10	.08	—
	Straw	.67	41	4.3	.21	.08	—
Rye	Straw	.50	31	3.0	.24	.09	—
Sorghum	Fodder	.95	58	7.5	.40	.21	9.4
	Stover	.88	54	5.2	.52	.28	4.1
Soybean	Hulls *	1.05	64	12.1	.49	.21	—
	Straw	.69	42	5.2	1.59	.06	—
Wheat	Straw	.67	41	3.6	.18	.05	—

* Feed may be used as protein or energy supplement.

Abbreviations Used in Tables

ME	metabolizeable energy	Na	sodium
TDN	total digestible nutrients	S	sulfur
CP	crude protein	Co	cobalt
Vit	vitamin	Cu	copper
IU	international unit	F	fluorine
Mcal	megacalorie	I	iodine
lb	pound	Fe	iron
Equiv	equivalent	Mn	manganese
Ca	calcium	Se	selenium
P	phosphorus	Zn	zinc
Mg	magnesium	g	gram
K	potassium	Kg	kilogram

Supplements (Dry Matter Basis)

Feed Name	Description	ME (Mcal/lb)	TDN (%)	CP (%)	Ca (%)	P (%)	Vit. A Equiv./lb 1000 IU
Protein Supplements							
Alfalfa	Meal	1.00	61	18.9	1.52	.25	23.8
Bone	Meal	1.18	72	53.8	11.25	5.39	—
Corn	Gluten meal	1.41	86	46.8	.16	.50	3.2
Cottonseed	Meal, mech. ext.	1.28	78	44.3	.21	1.16	—
	Meal, solv. ext.	1.31	80	45.6	.22	1.21	—
	Whole	1.57	96	23.9	.16	.75	—
Fish	Meal	1.07	59	58.4	4.20	2.40	—
Peanut	Meal, mech. ext.	1.36	83	52.0	.20	.61	—
	Meal, solv. ext	1.26	77	52.3	.29	.68	—
Rapseed	Meal, mech ext.	1.25	76	38.7	.72	1.14	—
	Meal, solv. ext.	1.13	69	40.6	.67	1.04	—
Soybean	Meal, mech. ext.	1.39	85	47.7	.29	.68	—
	Meal, solv. ext.	1.38	84	49.9	.33	.71	—
	Meal, solv. ext., no hull	1.43	87	55.1	.29	.70	—
	Hulls	1.05	64	12.1	.49	.21	—
Energy Supplements							
Barley	Grain	1.38	84	13.5	.05	.38	—
Brewers	Grain, dehy	1.08	66	29.4	.33	.55	—
Citrus	Pulp, dehy	1.34	82	6.7	1.84	.12	—
Corn	Dist. grain *	1.44	88	25.0	.15	.71	—
	Grain, grade	1.47	90	10.1	.02	.35	—
Cottonseed	Whole seed	1.57	96	23.9	.16	.75	—
Fats	Animal	2.90	177	—	—	—	—
Molasses	Sugarcane, dehy	1.18	72	5.8	1.00	.11	—
Oats	Grain	1.26	77	13.3	.07	.38	—
	Groats	1.54	94	17.7	.08	.48	—
Sorghum	Grain	1.38	84	10.1	.04	.34	—
Triticale	Grain	1.38	84	17.6	.06	.33	—
Wheat	Grain	1.44	88	16.0	.04	.42	—
Yeast, Brewers	dehy	1.29	79	46.9	.13	1.49	—

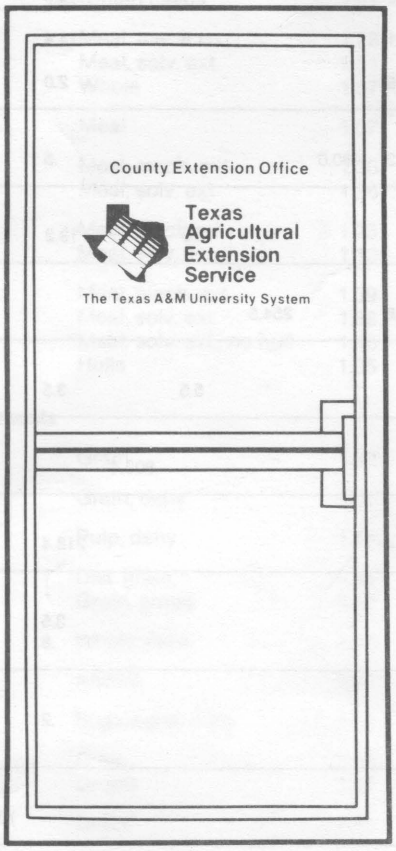
* Feed may be used as protein or energy supplement.
mech ext — mechanical extracted
solv. ext. — solvent extracted

Composition of Mineral Supplements for Beef Cattle*

(Adapted from NRC, 1984).

Feed name	(CA) (%)	(Cl) (%)	(Mg) (%)	(P) (%)	(K) (%)	(Na) (%)	(S) (%)	(Co) (g/kg)	(Cu) (g/kg)	(F) (g/kg)	(I) (g/kg)	(Fe) (g/kg)	(Mn) (g/kg)	(Se) (g/kg)	(Zn) (g/kg)
BONE															
charcoal	30.1		.6	14.1	.2										
meal, steamed	31.5		.6	14.2	.2	.4	.2					.8			.3
CALCIUM															
carbonate (limestone)	39.4		.1		.1	.1						.3	.3		
phosphate, monobasic (Monocalcium phosphate)	16.4		.6	21.6	.1	.1	1.2			2.1		15.8	.4		.1
phosphate, dibasic (Dicalcium phosphate)	22.0		.6	19.3	.1	.1	1.1			1.8		14.4	.3		.1
sulfate (Gypsum)	25.9		2.6				23.5					2.0			
COBALT															
carbonate							.2	460.0				.5			
COLLOIDAL															
clay	17.2		.4	9.1		.1				15.0		19.2			
COPPER (CUPRIC)															
sulfate							12.8		254.5						
CURACAO															
phosphate	34.3		.8	14.1		.2				5.5		3.5			
ETHYLENEDIAMINE															
dihydroiodide											803.4				
IRON (FERROUS)															
sulfate							12.4					218.4			
LIMESTONE															
limestone	34.0		2.1		.1	.1						3.5			
magnesium	22.3	.1	10.0		.4							.8			
MAGNESIUM															
carbonate			30.8									.2			
oxide MgO	3.1		56.2										.1		
MANGANESE															
oxide MnO													774.5		
OYSTERSHELL															
ground (flour)	38.0		.3	.1	.1	.2						2.9	.1		
PHOSPHATE															
defluorinated	32.0		.4	18.0	.1	4.9				1.8		6.7	.2		.1
POTASSIUM															
bicarbonated					39.1										
chloride	.1	47.3	.1		50.5	1.0	.2					.6			
iodide					21.0						681.7				
SODIUM															
bicarbonate						27.0									
chloride		60.7			39.3										
phosphate, monobasic				22.5		16.7									
selenite						26.6								456.0	
sulfate						14.3	10.0								
tripolyphosphate				25.0		31.0									
ZINC															
oxide															780.0
sulfate							17.7		.1			1.0	.1		363.6

*Mineral compositions of feed grade mineral supplements vary by source, mining site, and manufacturer. Use manufacturer's analysis when available.



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