Chemical Composition of Native Grasses in Central Oklahoma From 1947 to 1962

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Like other states in the Southern Great Plains, Oklahoma depends on cattle for its principal source of agricultural income. Oklahoma has some 44 million acres of which approximately one-half is native range grass (pasture). Cattle subsist year-long on these native pastures, supplemented with high-protein feed during the fall and winter months. A most important question to the cattleman is how much to feed and what should the supplement contain to balance the nutritive deficiencies of the available grasses.

The nutrient composition of native grass varies widely between summer and winter seasons. Nearly all the growth of native grasses occurs from April to August. The maximum growth of Bluestem, for example, occurring from April through July. Drastic changes occur in crude protein, fiber mineral content (Ca, P and carotene) as the plant approaches maturity. More information is needed concerning the extent of these changes within the plants in order to understand them better and ultimately to be able to supplement them most efficiently.

This publication reports a summary of results of chemical composition data obtained through monthly samples of native grasses taken from ranges in north central Oklahoma over a 15-year period from 1947-1962. Although these data represent only one area, the trends may be useful to other areas with similar grasses and conditions.

Research reported herein was conducted under Oklahoma Station projects no. 726 and 1138.

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Experimental Procedure

Monthly grass samples were taken at the Lake Carl Blackwell Experimental range located 12 miles west of Stillwater. The samples were pulled by hand from the same parts of the plant each time. Four native "tall" grasses were sampled: Big Bluestem *(Andropogon gerardi, A. furcatus);* Little Bluestem *(Andropogon scoparius);* Indiangrass *(Sorghastrum nutans);* and Switchgrass *(Panicum virgatum).* These grasses predominate in the eastern one-half of Oklahoma. The tall grasses are characterized by their vigorous growth during late spring and early summer, provided that rainfall is ample. They tend to mature and produce seed in mid-July to early August, and become dormant and stemmy during the early fall.

The grasses were analyzed, using accepted techniques, for their content of dry matter, ash, crude protein, ether extract (fat), crude fiber, calcium, phosphorus and carotene (precursor of Vitamin A). Chemical analysis of the samples collected monthly were determined and the results were averaged for each season (spring, summer, fall and winter). Due to differences in moisture content of the samples taken, the results are expressed on a dry matter basis, however, the percent dry matter present originally is also shown.

The important seasonal trends in chemical content are shown in Table 1. By using these data an estimate of the nutrient intake can be obtained and used as a guide for supplementation.

The maintenance level shown in the figures for crude protein, phosphorus, calcium and carotene are based on the requirements of a 1,000 pound pregnant beef cow for maintenance of body weight and is expressed as a percent of the diet.

Results and Discussion

Perhaps the most meaningful data to the average rancher are the values for crude protein, crude fiber and phosphorus. These are not only three of the most critical items needed by beef cattle, but also the ones which indicate most clearly the nutritive value of the forage. Crude fiber also indicates the quality of the grass.

Crude Protein

The seasonal changes in crude protein content are shown in Figure 1. Note the low protein content as the tall grasses became dormant and weathered during the winter. This crude protein content dropped markedly for all species studied, reaching a low of 2 to 3 percent in late winter (March).

Table 1. Chemical Composition of Four Native Range Grasses. (Average content of each constituent on a monthly and seasonal basis for the period 1947-1962.)

GRASS	SPRING				SUMMER			FALL				WINTER					YEAR
	APR	MAY	JUN	AVG	JUL	AUG	AVG	SEPT	OCT	NOV	AVG	DEC	JAN	FEB	MAR	AVG	AVG
								PERCENT DRY MATTER									
BIG BLUE STEM	92.9	38.5	44.2	44.4	45.4	55.2	50.1	59.0	64.5	80.8	64.5	94.6	93.3	93.8	96.2	93.9	57.4
LITTLE BLUE STEM	92.0	48.4	50.3	51.7	51.8	60.0	55.7	63.0	67.2	79.7	67.2	94.5	93.6	94.2	95.9	94.1	62.0
INDIAN GRASS	92.4	46.5	47.2	49.3	48.1	54.7	51.3	58.4	65.4	83.6	65.0	94.1	93.5	93.3	95.9	93.9	59.2
SWITCH GRASS	93.2	42.5	40.3	44.0	47.9	56.1	51.9	62.7	68.8	81.4	67.9	94.2	93.3	93.0	96.1	93.8	59.1
AVERAGE	92.6	44.0	45.5	47.3	48.3	56.5	52.2	60.8	66.5	81.4	66.2	94.4	93.4	93.6	96.0	93.9	59.4
								PERCENT CRUDE PROTEIN									
BIG BLUE STEM	3.34	11.23	9.06	9.58	6.57	5.21	5.94	4.43	4.02	2.59	3.83	3.41	2.76	2.67	1.87	2.79	5.62
LITTLE BLUE STEM	2.89	9.69	7.34	8.05	6.02	4.87	5.49	3.99	4.02	2.76	3.70	2.65	2.57	2.92	1.72	2.57	5.06
INDIAN GRASS	3.12	8.66	6.91	7.40	5.77	4.86	5.34	3.69	3.60	2.27	3.31	2.19	2.25	2.17	1.83	2.16	4.68
SWITCH GRASS	2.29	10.48	8.05	8.68	5.79	4.74	5.30	3.85	3.52	2.58	3.42	2.27	2.38	2.32	2.38	2.34	5.03
AVERAGE	2.91	10.01	7.84	8.43	6.04	4.92	5.52	3.99	3.79	2.55	3.57	2.63	2.49	2.52	1.95	2.46	5.10
								PERCENT CRUDE FIBER									
BIG BLUE STEM	38.81	29.85	31.37	31.29	32.91	34.21	33.52	34.86	36.19	39.41	36.45	36.92	37.97	35.01	42.56	37.69	34.56
LITTLE BLUE STEM	39.31	31.26	32.20	32.37	31.73	34.18	32.88	35.66	34.71	37.35	35.72	36.99	37.82	35.41	43.08	37.82	34.39
INDIAN GRASS	39.51	31.14	32.27	32.36	33.36	35.28	34.26	36.03	36.04	39.18	36.80	40.03	38.39	38.76	44.24	39.77	35.43
SWITCH GRASS	42.27	30.52	33.07	32.65	34.45	35.64	35.01	35.49	36.26	38.30	36.45	38.33	39.62	39.64	42.89	39.72	35.60
AVERAGE	39.97	30.69	32.23	32.17	33.11	34.83	33.91	35.51	35.80	38.56	36.36	38.07	38.45	37.21	43.19	38.75	35.00

Table 1. Continued.

GRASS	SPRING APR	MAY	JUN	AVG	SUMMER JUL	AUG	AVG	FALL SEPT	OCT	NOV	AVG	WINTER DEC	JAN	FEB	MAR	AVG	YEAR AVG
PERCENT PHOSPHORUS																	
BIG BLUE STEM	0.044	0.140	0.102	0.115	0.101	0.084	0.093	0.084	0.072	0.035	0.068	0.047	0.072	0.039	0.015	0.050	0.083
LITTLE BLUE STEM	0.033	0.112	0.079	0.090	0.086	0.070	0.079	0.062	0.056	0.035	0.053	0.037	0.073	0.030	0.038	0.049	0.069
INDIAN GRASS	0.043	0.118	0.080	0.094	0.083	0.081	0.082	0.071	0.064	0.030	0.058	0.030	0.115	0.033	0.045	0.065	0.075
SWITCH GRASS	0.031	0.139	0.109	0.117	0.095	0.083	0.089	0.069	0.058	0.037	0.058	0.034	0.114	0.038	0.021	0.063	0.081
AVERAGE	0.038	0.127	0.092	0.104	0.091	0.080	0.086	0.071	0.063	0.034	0.059	0.037	0.093	0.035	0.029	0.057	0.077
PERCENT CALCIUM																	
BIG BLUE STEM	0.339	0.304	0.316	0.312	0.349	0.299	0.325	0.313	0.338	0.265	0.311	0.330	0.372	0.333	0.236	0.335	0.319
LITTLE BLUE STEM	0.229	0.313	0.326	0.312	0.381	0.345	0.364	0.247	0.265	0.218	0.247	0.246	0.332	0.246	0.149	0.266	0.299
INDIAN GRASS	0.290	0.320	0.311	0.313	0.371	0.324	0.349	0.295	0.334	0.252	0.299	0.273	0.318	0.258	0.187	0.275	0.313
SWITCH GRASS	0.293	0.259	0.252	0.259	0.294	0.265	0.280	0.277	0.326	0.278	0.295	0.340	0.351	0.342	0.252	0.333	0.288
AVERAGE	0.288	0.299	0.301	0.299	0.349	0.308	0.330	0.283	0.316	0.253	0.288	0.297	0.343	0.294	0.206	0.302	0.305
PERCENT FAT																	
BIG BLUE STEM	1.58	2.88	2.47	2.59	2.58	2.52	2.55	1.90	1.92	2.23	1.99	2.26	2.14	1.85	1.39	2.00	2.30
LITTLE BLUE STEM	1.13	2.30	2.27	2.18	2.38	2.19	2.29	1.82	1.96	2.28	1.98	2.07	2.00	1.98	1.41	1.93	2.12
INDIAN GRASS	1.06	2.51	2.46	2.36	2.78	2.45	2.62	1.91	1.96	2.39	2.04	1.93	2.31	1.77	1.27	1.94	2.28
SWITCH GRASS	0.91	2.62	2.47	2.41	2.40	2.36	2.38	1.94	1.84	1.93	1.90	1.89	2.29	2.84	1.33	2.16	2.20
AVERAGE	1.17	2.58	2.42	2.39	2.53	2.38	2.46	1.89	1.92	2.21	1.98	2.04	2.18	2.11	1.35	2.01	2.22

Table 1. Continued.

GRASS	SPRING				SUMMER			FALL				WINTER					YEAR
	APR	MAY	JUN	AVG	JUL	AUG	AVG	SEPT	OCT	NOV	AVG	DEC	JAN	FEB	MAR	AVG	AVG
								PERCENT ASH									
BIG BLUE STEM	6.91	7.38	6.53	6.95	6.66	6.30	6.49	6.04	5.82	4.75	5.65	6.41	5.55	5.90	4.06	5.67	6.20
LITTLE BLUE STEM	6.84	7.29	7.00	7.12	7.43	6.61	7.05	5.28	5.56	5.39	5.41	5.11	6.02	5.84	4.33	5.54	6.30
INDIAN GRASS	7.73	7.73	7.62	7.68	7.62	7.34	7.49	6.64	6.39	6.54	6.52	5.76	6.41	6.56	5.12	6.12	7.01
SWITCH GRASS	4.80	6.62	6.23	6.29	5.97	5.63	5.81	5.48	5.93	5.34	5.61	5.42	4.89	5.62	4.61	5.17	5.76
AVERAGE	6.57	7.25	6.85	7.01	6.92	6.47	6.71	5.86	5.93	5.50	5.80	5.68	5.72	5.98	4.53	5.62	6.32
								PERCENT NITROGEN-FREE EXTRACT									
BIG BLUE STEM	49.37	48.70	50.27	49.44	51.27	51.53	51.39	52.77	51.25	51.04	51.80	50.99	52.07	55.41	50.14	52.20	51.19
LITTLE BLUE STEM	49.85	49.46	51.00	50.16	52.43	51.90	52.18	53.25	53.76	52.23	53.19	53.18	51.66	53.86	49.48	52.25	52.06
INDIAN GRASS	48.60	50.05	50.52	50.13	50.46	49.74	50.13	51.72	51.12	49.63	50.99	50.10	50.47	50.65	47.56	49.99	50.39
SWITCH GRASS	49.75	49.75	49.92	49.83	51.39	51.36	51.38	53.26	52.44	51.86	52.62	52.09	50.73	49.06	48.80	50.48	51.30
AVERAGE	49.39	49.49	50.43	49.89	51.39	51.13	51.27	52.75	52.14	51.19	52.15	51.59	51.23	52.24	48.99	51.23	51.24
								CAROTENE, MICROGRAMS PER GRAM									
BIG BLUE STEM	0.7	190.0	218.4	185.5	163.9	89.2	126.6	51.0	24.6	4.7	33.7	0.8	0.3	0.3	0.0	0.5	102.1
LITTLE BLUE STEM	1.0	173.0	190.8	165.1	141.8	73.8	107.8	37.2	21.6	3.6	25.2	0.8	0.2	0.2	0.0	0.4	86.9
INDIAN GRASS	0.5	157.9	172.7	150.0	157.3	93.4	124.1	35.9	19.2	2.4	23.5	1.3	0.3	0.5	0.0	0.7	87.2
SWITCH GRASS	0.2	178.4	200.4	171.9	116.3	69.4	91.9	37.4	15.3	3.9	23.0	0.7	0.9	0.3	0.0	0.7	82.7
AVERAGE	0.6	174.8	195.6	168.1	145.2	81.4	112.7	40.4	20.2	3.6	26.3	0.9	0.4	0.3	0.0	0.6	89.7

A sharp increase occurred in late spring and early summer as the plants grew rapidly, reaching a peak in May and June with values approaching 8 to 10 percent. It then fell off rapidly in July and August as the plant matured. Further declines were apparent in September to December as the plant weathered and nutrients leached out from the fall and early winter rains. Assuming it takes a six percent crude protein level for maintenance of the beef cow, it is evident that the samples taken contain inadequate amounts for nearly three-fourths of the year. The beef cow, by selective grazing, may consume forage which is higher in protein than hand-picked samples. However, evidence to support this viewpoint is scanty. By late October the content of 3.6 to 4.3 percent would be considered so low as to warrant additional protein feed such as range cubes or oil meals.

Crude Fiber

The pattern for crude fiber shows an inverse trend to crude protein (see Figure 2). This inverse trend is due to the fact that crude fiber is lowest in the young, growing plant. Rumen bacteria can break down the fibrous portions of the plant and release some energy from the cellulose. However, the higher the fiber content, the lower the digestibility of the forage.

The crude fiber analysis alone does not tell the complete story because of the influence of lignin, a complex organic substance similar

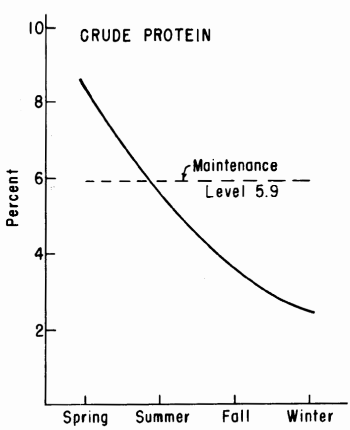

Figure 1. Crude Protein.

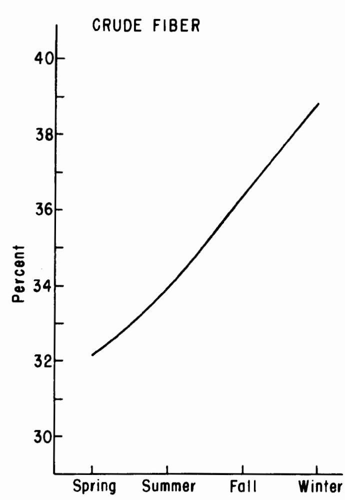

Figure 2. Crude Fiber.

Table 2. Temperature, Rainfall for Lake Carl Blackwell area and Rainfall for Stillwater, Oklahoma Area. (Average on a monthly and seasonal basis for the period 1947-1962.)

	SPRING				SUMMER			FALL				WINTER				
	APR	MAY	JUNE	AVG	JULY	AUG	AVG	SEPT	OCT	NOV	AVG	DEC	JAN	FEB	MAR	AVG
TEMPERATURE, F STILLWATER	66.4	68.6	77.7	72.8	82.0	81.3	81.6	74.0	62.6	47.0	63.7	41.7	34.5	46.0	47.7	40.9
RAINFALL, INCHES LAKE CARL BLACKWELL	3.28	6.16	3.84	4.91	4.06	2.53	3.33	3.04	3.11	1.05	2.61	1.02	0.61	1.19	0.92	0.92
RAINFALL, INCHES STILLWATER	2.61	5.91	4.49	5.06	4.65	2.49	3.62	3.27	3.36	1.30	2.85	1.31	0.39	1.23	1.34	0.99

to cellulose. As the plant approaches maturity and starts to set seed lignin begins to build up quite rapidly in the stemmy portions. It is practically indigestible by bacteria and the host animal and tends to coat the outer structures of the forage preventing maximum bacterial action.

The trends in crude fiber shown in the graph are inversely related to its utilization. Studies have shown that less digestible forages remain in the reticulorumen of the animal for a longer period than those readily digested. Hence, the rate of passage of poor quality forage is slower and the animal consumes less feed per 24-hour period. In turn, this lowers the intake of available energy and results in poor utilization of the mature and weathered forage.

Phosphorus

Another important consideration to the rancher is the phosphorus content of the forage (see Figure 3). All species of tall native grass drop exceedingly low in phosphorus after maturity. Fall and winter rains leach this soluble mineral from the plant.

Note in Table 1 that during the later spring (May-June) the phosphorus content climbs to .08-.14 percent with some variation among the species. However, by August, this level has declined to .07-.084 and by

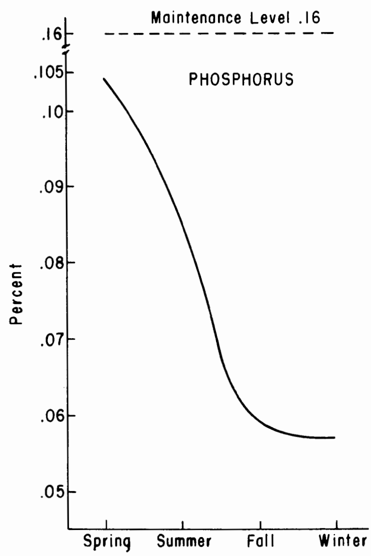

Figure 3. Phosphorus.

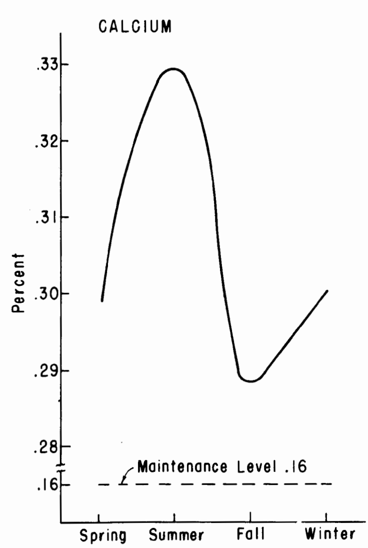

Figure 4. Calcium.

November it is down to .03-.037 percent. If a minimum level of .16 percent phosphorus is assumed, then the available mineral in the grasses is inadequate and supplementation must be furnished throughout the year. This is especially critical in the eastern half of Oklahoma where more rainfall causes a higher degree of leaching. As a minimum mineral mixture containing at least 5 percent phosphorus should be provided cattle during the fall, winter and early spring months.

Fortunately, most protein supplements used to winter beef cows on the range are quite good feed sources of phosphorus. This tends to partially overcome phosphorus deficiency.

Calcium

Calcium is less effected by species of grass, stage of maturity and seasons than phosphorus. Likely, about half of the calcium in the plant is available to the animal. Thus, if levels above .16 percent are adequate in the diet, the calcium content of the plants should be ample throughout the year.

Most mineral supplements used to alleviate a phosphorus deficiency are also rich in calcium. Excess levels of calcium are not only unnecessary, but may actually depress the availability and utilization of phosphorus. (Figure 4)

Carotene

Carotene is an important nutrient because it is converted by the animal into Vitamin A. It drops to insignificant levels after the grasses mature. However, this has become less of a problem because dry, stabilized forms of Vitamin A are now on the market and included in most winter supplements. They will make good any deficiency at a total cost of less than 50 cents per cow for the winter feeding period. Thus, the problem of low carotene levels in the native grass from September to March becomes less significant. (Figure 5)

Dry Matter

The dry matter varies about 2-fold during the year, as shown in Figure 6. The nutrient intake is directly proportioned to the dry matter, hence, it becomes important for the rancher to be able to estimate the dry matter at any time. An estimate of the dry matter, for any season, can readily be made using Figure 6.

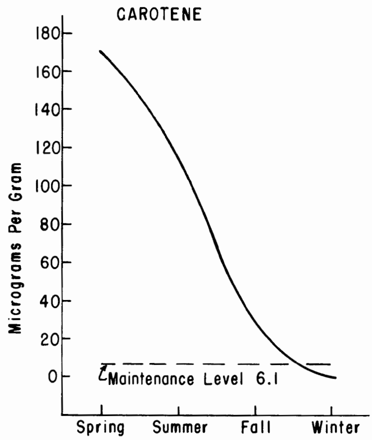

Figure 5. Carotene.

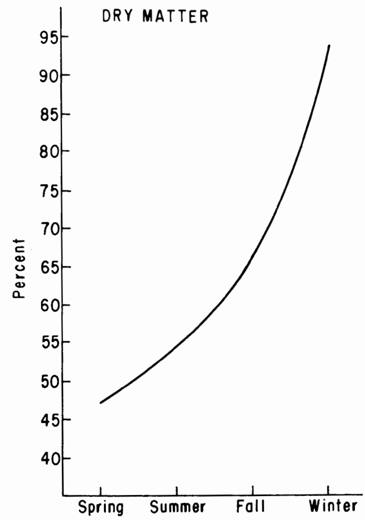

Figure 6. Dry Matter.

Other Nutrients

Nutrients in the native grass, such as those contained in the nitrogen-free-extract (sugars, starches, celluloses and hemicelluloses), tends to show little difference, percentagewise, throughout the year. (Figure 7). Although the percent fat varies widely, (Figure 8), it is not a limiting factor in the animals diet. The percent ash, (Figure 9), also, is not as critical as the actual phosphorus and calcium contents because of reasons pointed out previously.

While there are some variations in the chemical content of different species of native grass, trends observed season by season, for the items studied are remarkably consistent for all species. The short grasses in western Oklahoma are generally higher in crude protein and phosphorus and lower in crude fiber during the winter months.

A significant development during the past two decades has been the advent of private, commercial and state testing laboratories whose services are available to ranchers. While an analysis may be desirable, ranchers should keep in mind the natural variation that can be expected from sample to sample. Further, it is unlikely that any human sampling technique can approximate closely what the cow actually consumes. Thus, spurious results may be obtained and these may lead to serious over or underfeeding of supplement.

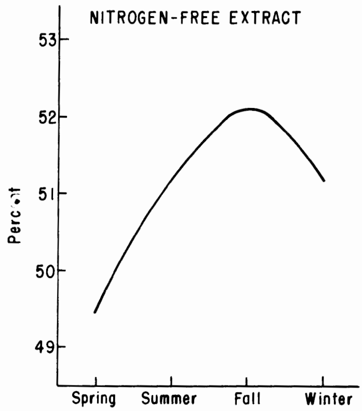

Figure 7. Nitrogen-Free Extract.

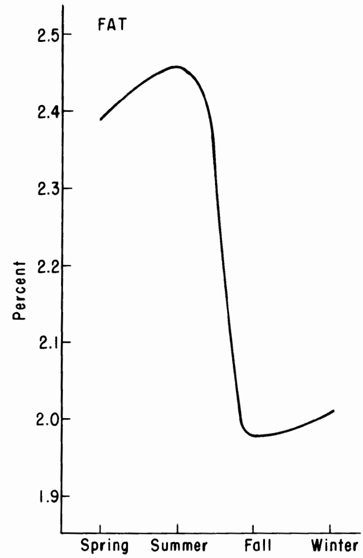

Figure 8. Fat.

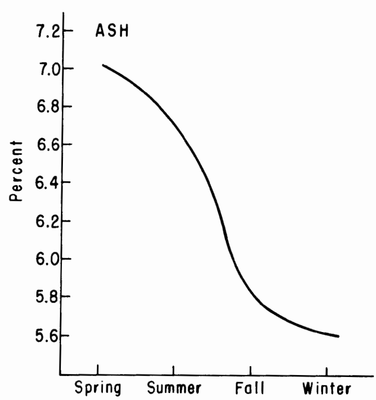

Figure 9. Ash.

For most parts of central Oklahoma, the rancher might be better advised to study carefully the results of this 15-year study and make adjustments for dry and wet years rather than place too much reliance on a few samples of forage which he might have analyzed.

Summary

Monthly samples from each of four species of predominant native tall grasses (Big Bluestem, Little Bluestem, Indian and Switchgrass) obtained during a 15-year period, were chemically analyzed. The major constituents important to the nutrition of beef cattle subsisting year-long on native range were determined. While some variation existed among the species studied, the seasonal trends showed that crude protein, crude fiber, and phosphorus were the most variable during certain periods of the year.

Generally, the changes in fat (ether extract), nitrogen-free-extract, and calcium were less marked, and were believed to be of less nutritional significance. Carotene, which became nearly devoid in the mature and weathered forage, fell to inadequate levels in the ration of the grazing beef cow. However, it was pointed out that the rancher can fortify feed supplement at low cost and avoid the possibility of a deficiency.

An estimate of dry matter consumption, as influenced by stage of maturity of the plant, will help the rancher estimate the nutrient intake of grazing cattle, and supplement accordingly.