Summary

Samples of forage which cows grazed were collected monthly at the Jornada Experimental Range for chemical analysis.

Samples of 11 perennial grasses were analyzed, three of them only once but five of them seven or more times. The composition of most samples followed the generally expected trend of changes with stage of maturity, that is, protein and phosphorus decreased but fiber and lignin increased as the plants matured. The variation in composition among species of perennial grasses was small. If these grasses were the only plants available for grazing, supplemental protein and phosphorus should be provided to livestock when the grass is dormant. Since many forbs were consumed, supplemental protein was apparently not required.

Sixweeks grama was the only annual grass eaten, and its composition was similar to that of the perennial grasses.

Ten perennial and six annual forbs were eaten by the cows, mostly during the dormant season of the grass, although leatherweed croton, woolly paperflower and russianthistle were eaten during most of the year. Generally the forbs were high in ash, high in protein even in advanced stages of maturity, high in fat, relatively low in fiber, and quite variable in acid-detergent lignin. Some were low in lignin at all stages of maturity. Others had high lignin levels only when mature. Both groups of forbs were high in calcium and relatively high in phosphorus when compared to grasses. Certain species contained high levels of fat (ether extract). This fat may be of value to livestock, or it may consist of unavailable materials, such as essential oils. Apparently forbs furnished much of the nutrients consumed by grazing cattle during dormant periods of the grasses.

Seven different shrub species were grazed, generally when other plants were in short supply. Five of these were eaten only once, but soaptree yucca was consumed frequently when few other green plants were available. The protein content was higher in yucca leaves than in all except a few samples of grasses; but the lignin content of yucca leaves was also higher.

The calcium content of the plants was considered to be adequate, but the phosphorus content of grasses was low except when the plants were green. All other minerals were present in amounts considered adequate for grazing livestock.

Chemical composition of the plants consumed by cows indicate the need, or lack of need, for supplemental nutrients during the dormant season, depending upon the plant species available for grazing. Because of the variety of species available on the Jornada Range, there apparently was no protein deficiency. The protein content of hand-plucked composite samples representing the diet of grazing cows equalled or exceeded requirements in all months except February. There was enough good quality forage, primarily forbs and browse, available to supplement protein deficiencies found in grasses, even though the winter-spring period was quite dry.

Contents

Chemical Composition of Forage Species Grazed by Cattle on an Arid New Mexico Range

A. B. Nelson, C. H. Herbel, and H. M. Jackson[1]

Range beef cattle performance depends greatly upon the level of nutrients in the forage consumed. Chemical composition indicates the nutritive value of plants, although the composition varies because of such factors as stage of plant maturity.

Watkins (13) reported chemical composition of several grasses on the New Mexico State University ranch (20 miles north of Las Cruces), by month of harvest, which reflected stage of maturity. Samples of grasses were clipped at specified heights above the ground in exclosures which prevented grazing by livestock. The protein, phosphorus, calcium, and carotene contents of the grasses were highest from July to October, which was the season of highest rainfall. These were the only months in which the levels of protein, phosphorus, and carotene were considered adequate. However, the plants whose composition was reported were not the only plants available to grazing livestock, and selectivity for certain plant parts may have resulted in higher nutritive content of the diet than suggested by composition of the herbage. The nutrient content of many forbs and browse plants may have complemented that of the grasses and prevented potential nutrient deficiencies.

Watkins (12) has determined the calcium and phosphorus contents of clipped samples of several range forages from each of 31 counties of New Mexico. Samples were collected after the plants were mature, and the composition data were used as the basis for determining the calcium and phosphorus deficiency areas of New Mexico. This study and others (6, 7, 8, 9, 13) have indicated a need for supplemental phosphorus in most areas of New Mexico, on the assumption that 0.093 percent of forage phosphorus, or 8.5 grams daily, is the minimum winter requirement for 1,000-pound breeding cows, and 0.113 percent of phosphorus, or 12.5 grams daily, for the summer. A calcium re-

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quirement of 0.227 percent of the forage, or 18 grams daily, was suggested.

In a later report, Watkins and Repp (14) gave the chemical composition of samples of important grasses clipped at 10 locations in New Mexico on 24 collection dates over a three-year period. Grass containing as much as 6 percent protein, 1 percent ether extract, 0.22 percent in calcium, 0.11 percent phosphorus, and no more than 32 percent crude fiber was considered to be good quality forage. The greatest deficiency was in phosphorus, which was adequate for breeding cows only during the most active growing season of late summer. The protein values decreased during the winter dormancy, but only occasionally were levels extremely low. Calcium was generally in plentiful supply except in three locations in the western part of the state. The range in crude fiber content (27 to 36 percent) indicated a wide variation in the quality of the grasses as a livestock feed. During the growing season, the carotene values were usually quite high. Some species, such as blue grama, contained little or no carotene during the dormant season. Black grama contained carotene at nearly all sampling times.

The studies cited above indicate the usefulness of chemical composition of forages as a basis for making decisions concerning nutritional adequacy of such forages.

Objective

The objective of the study reported here was to determine the chemical composition of forage grazed by cattle on the Jornada Experimental Range.

Procedure

Samples of forage were collected on the Jornada Experimental Range, 25 miles north of Las Cruces, New Mexico. The climate is typical of the arid phase of the semidesert grassland. Precipitation varies extremely, sunshine is abundant, the range between day and night temperature is wide, and humidity is relatively low. The 1915-1964 average annual precipitation is 9 inches and the average growing season (July-September) precipitation is 5 inches. The precipitation during the test (1962-63) was nearly 140 percent of the 1915-64 average, with double the average for the summer of 1962 (10 inches). The precipitation was nearly average in the fall of 1962, but below average for the winter of 1962-63. The average maximum temperature for January is 55.6°F and for July 94.7°. The average minimum temperature for January is 22.4°F and for July 64.2°.

The major plant species are burrograss (*Scleropogon brevifolius* Phil.), mesa dropseed (*Sporobolus flexuosus* (Thurb.) Rydb.), black grama (*Bouteloua eriopoda* (Torr.) Torr.), broom snakeweed (*Gutierrezia sarothrae* (Pursh) Britt. & Rusby), leatherweed croton (*Croton corymbulosus* Engelm.), and soaptree yucca (*Yucca elata* Engelm). Data on soil type and average basal cover of the plant species by soil type in each of the two pastures used are given in table 1.

Samples for chemical analysis were collected from March, 1962, through February, 1963. Two men observed test cows grazing, and selected plants or plant parts similar to those consumed by the cattle (4, 5). Test cows

Table 1. Average basal cover (1961-1964) by soil types for pastures 10 and 11 in units of 0.01 percent

Species	A		B	C	D		E		F
	Soil Type and Pasture*								
	10	11	10	11	10	11	10	11	11
Perennial Grasses									
Aristida longiseta	0.1	1.5	4.3	4.7	2.4	1.9	0.1	0.1	1.6
Bouteloua eriopoda	1.7	1.9	0.9	0.7	1.8	9.3	3.9	2.9	25.6
Hilaria mutica	24.4	7.7	13.9	6.4	1.4	4.2	--	0.4	0.3
Scleropogon brevifolius	137.7	68.6	63.4	66.0	22.0	10.0	0.2	1.3	0.2
Sporobolus airoides	1.6	0.7	1.6	--	5.1	0.2	0.3	0.2	0.6
S. flexuosus	0.7	1.2	5.4	0.1	4.7	6.3	8.6	16.9	12.8
Others	2.7	3.4	3.9	4.8	3.7	6.1	0.2	1.0	3.8
Annual Grasses									
Bouteloua barbata	0.1	--	0.3	--	1.0	T	0.5	1.7	0.5
Perennial Forbs									
Croton corymbulosus	0.2	1.3	1.0	1.0	2.1	0.8	2.6	0.9	1.6
Lesquerella fendleri	T	0.1	0.1	--	--	--	--	0.2	--
Perezia nana	1.0	1.1	0.7	0.3	0.1	0.1	--	0.1	0.1
Psilostrophe tagetinae	0.1	--	--	0.1	0.1	0.2	0.6	0.4	0.4
Sphaeralcea subhastata	0.3	0.2	0.2	0.1	0.3	0.4	0.3	--	--
Others	0.5	1.9	0.8	1.9	1.9	2.1	2.1	2.0	1.4
Annual Forbs									
Corispermum nitidum	--	--	--	--	0.6	--	1.5	0.6	--
Dithyrea wislizeni	--	--	--	--	--	T	T	0.4	T
Iva dealbata	--	0.1	0.6	--	0.1	0.2	--	--	--
Salsola kali	0.6	0.5	1.7	5.0	1.3	3.5	2.3	2.3	5.5
Others	0.4	1.5	0.5	0.8	1.0	0.8	1.6	3.0	2.3
Shrubs									
Ephedra trifurca	--	1.2	1.8	--	0.6	0.1	0.1	0.4	0.1
Gutierrezia sarothrae	0.8	0.5	0.8	0.2	2.7	4.5	4.3	4.5	4.5
Yucca elata	--	--	--	--	2.8	0.4	1.5	3.3	0.6
Others	--	0.2	6.1	--	1.5	1.3	1.1	3.6	4.4

*Soil descriptions:

A. Reakor clay loam, 0 to 1% slopes. This is a moderately deep to deep, light-colored, calcareous soil that has a silty surface and moderately fine-textured, slowly permeable subsoil. Moderate to strong lime (calcium carbonate) zones usually occur at depths of 20 in. and below. It occurs in the lower parts of the Jornada basin and receives some flood water during severe thunderstorms.

B. Dona Ana complex, 0 to 3% slopes. The principal soils of this mapping unit are deep and calcareous with medium-textured surfaces over weakly developed, moderately fine-textured, slowly permeable subsoils. Prominent horizons of calcium carbonate accumulations occur below 25 in. The landscape is traversed by a series of erosional escarpments which range in height from 6 in. to 7 ft. In many places at the foot of the escarpments accumulations of sand have formed a narrow, sandy ridge, varying from a few inches to several feet thick over fine underlying material.

C. Headquarters—Jal Association, 0 to 3% slopes. This is a deep to moderately deep soil with a medium-textured surface over well-developed, clayey, slowly permeable subsoil. Strong lime zones occur below 26 in.

D. Jal—Headquarters Association, 1 to 3% slopes. This is a deep to moderately deep, light-colored, calcareous soil with sandy surface over weakly developed, moderately permeable, sandy clay loam subsoil. A prominent lime zone usually occurs below 20 in. Surface soils were wind-shifted in many places.

E. Sonoita loamy fine sand, 1 to 3% slopes. This soil is deep with moderately sandy surfaces over reddish, moderately permeable, sandy clay loam subsoils. Accumulations of lime are frequent at depths below 16 to 20 in. The surface is very susceptible to wind erosion.

F. Cacique loamy fine sand, 1 to 3% slopes. These are mostly moderately deep soils with moderately sandy textured surfaces, with permeable subsoils. The soils are underlaid with discontinuous layers of indurated caliche. In many places, due to rodent activity, caliche fragments have been mixed throughout the soil profile.

of both Hereford and Santa Gertrudis breeds were selected at random from a herd of 15 cows of each breed grazing the range. They were marked with white paint and observed continuously for a 24-hour period once every four weeks. Another cow of each breed was observed once every four weeks during daylight hours only. The samples were collected on the basis of daylight grazing selection by the test cattle, but observations of nighttime grazing indicated no notable change in species selected between daylight and nighttime grazing.

The forage samples were identified according to species, stage of maturity (2), and date of collection. They were not identified as to breed of cow. Samples of a species at the same stage of maturity and collected in the same month were combined. During each observation period, additional samples of each plant species were collected in the proportions estimated being consumed by the cow, and were combined to form a composite sample representing the diet consumed on that day. All samples were dried before analysis.

The months in which each species was grazed are listed in table 2. In many instances, samples of certain species were collected at the same stage of maturity in successive months. Some of these samples were combined before analysis, and this is indicated in the table. A few samples were not large enough for analysis and were discarded; however, the months when the species was consumed are indicated in the table.

The dry matter, ash, protein, and ether extract contents of the samples were determined by the usual A.O.A.C. methods (1). Acid-detergent fiber and lignin were determined by the method of Van Soest (11). Determinations for calcium, phosphorus, potassium, magnesium, manganese, iron, boron, copper, zinc, aluminum, strontium, molybdenum, cobalt, sodium, silica, and barium were by spectrographic analysis conducted by the Ohio Agricultural Research and Development Center, Wooster, Ohio.

Results and Discussion

Chemical composition of the dry matter of the various species is given in table 3. The data for each species are listed according to collection date within these categories: perennial grasses, annual grasses, perennial forbs, annual forbs, and browse.

Expected Trends for Grasses

The trend for chemical composition of grasses to change with stage of maturity varies with the chemical constituent and with plant species. In general, the protein content of plants, particularly grasses, is high when they are young and growing rapidly, but decreases as they mature. Only young grass contains adequate protein to meet the requirement for many classes of livestock. The protein content of mature and weathered grass is usually too low to meet animal requirements, so that grazing cattle and sheep need supplemental protein in many instances.

Phosphorus and carotene (from which animals make vitamin A) changes with advancing maturity are similar to those for protein; contents are high in young grass, but they de-

Table 2. Months when cows were observed grazing different species

Group and Species	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Perennial Grasses												
Red threeawn	z	x	x	x	y	y	x	xx	x	x	--	--
Sideoats grama	--	--	--	--	--	--	--	--	--	--	x	--
Black grama	x	x	y	x	y	y	x	x	y	x	x	x
Tobosa	--	--	--	--	x	x	x	x	--	--	--	--
Ear muhly	--	--	--	--	--	--	y	x	--	--	--	--
Vine mesquite	--	--	--	--	--	z	--	--	--	x	--	--
Burrograss	x	--	--	--	y	x	x	y	x	x	x	x
Alkali sacaton	y	x	x	--	--	--	xx	x	x	x	x	--
Sand dropseed	x	--	--	--	--	--	--	--	x	--	x	--
Mesa dropseed	x	y	x	x	x	y	x	x	x	x	x	x
Fluffgrass	--	--	--	--	--	--	--	x	--	x	x	--
Annual Grasses												
Sixweeks grama	x	--	--	--	--	z	--	--	--	--	--	x
Perennial Forbs												
Bahia	--	--	--	--	--	--	--	xx	--	--	--	--
Desert baileya	--	--	--	--	--	--	x	x	--	--	--	--
Chamaesarcha	--	--	x	--	--	--	--	--	--	--	--	--
Leatherweed croton	--	z	x	z	z	y	x	x	x	x	--	--
Bladderpod	--	--	--	x	--	--	--	--	--	--	x	--
Plains blackfoot	--	--	x	--	--	--	--	--	--	x	--	--
Desert holly	--	--	--	--	--	--	--	--	--	--	x	--
Woolly paperflower	--	--	--	x	x	z	z	y	x	x	x	y
Globemallow	--	z	--	--	--	x	--	--	--	--	--	--
Rocky mountain zinnia	--	--	--	--	--	y	xx	x	x	--	--	--
Annual forbs												
Tickseed	x	--	--	--	--	--	x	--	--	x	--	--
Spectaclepod	x	--	--	--	--	--	--	--	x	x	x	x
Annual snakeweed	z	--	--	--	--	--	--	--	x	x	--	--
Sumpweed	--	--	--	x	--	--	--	x	--	x	--	--
Western stickleaf	x	z	--	--	--	--	--	--	--	--	--	--
Russianthistle	--	--	--	x	--	y	x	xx	x	x	x	x
Shrubs												
Fourwing saltbush	--	--	--	--	--	--	x	--	--	--	--	--
Torrey mormontea	--	--	--	--	--	--	--	--	--	x	--	--
Longleaf mormontea	--	--	--	--	--	--	--	--	--	x	--	--
Tarbush	--	--	--	--	--	--	--	--	x	x	--	--
Broom snakeweed	x	--	--	--	--	--	--	--	--	--	--	--
Honey mesquite beans	--	--	--	--	--	--	--	--	--	x	--	--
Soaptree yucca leaves	--	--	--	z	--	--	--	--	x	x	x	x

x = Eaten and analyzed.

xx = Two samples within the month.

y = Eaten but sample was combined with sample for adjoining month.

z = Eaten but sample was too small for chemical analysis.

Table 3. Chemical composition of forages grazed by cows at the Jornada Experimental

Group, Species, Common Name, and Stage of Maturity	Month and Year of Collection	Protein	Ether extract	Acid detergent fiber	Acid detergent lignin
		percent			
Perennial grasses					
Aristida longiseta (red threeawn)					
Early leaf	April, 1962	8.2	1.1	48.7	6.5
Mature	May, 1962		2.4	53.7	6.4
Mature	June-July, 1962	7.0	1.1	53.1	6.6
Mature	Aug.-Sept., 1962	10.4	2.8	42.4	5.5
Mature	Oct., 1962	7.3	1.7	49.1	6.7
Overripe	Oct., 1962	6.9	2.1	48.0	6.5
Dormant	Nov., 1962	5.0	1.4	53.7	7.6
Dormant	Dec., 1962	3.7	1.4	53.1	7.0
Bouteloua curtipendula (sideoats grama)					
Dormant	Jan., 1963	3.7	1.9	49.6	7.1
Bouteloua eriopoda (black grama)					
Early leaf	Mar., 1962	4.9	1.3	46.8	7.8
Dormant	April-May, 1962	5.2	0.9	47.4	8.0
Immature	June-July, 1962	6.4	0.8	49.2	7.4
Mature	Aug.-Sept., 1962	5.8	1.6	44.1	7.0
Mature	Oct., 1962	6.7	1.7	47.8	8.4
Dormant	Nov.-Dec., 1962	4.6	1.4	46.9	7.2
Dormant	Jan., 1963	5.4	1.4	46.6	8.5
Dormant	Feb., 1963	5.0	2.0	46.0	7.8
Hilaria mutica (tobosa)					
Mature	July, 1962	8.6	1.3	47.2	6.8
Overripe	Aug., 1962	10.2	2.2	42.0	6.2
Mature	Sept., 1962	9.2	2.0	43.2	6.8
Dough	Oct., 1962	7.9	2.0	48.6	8.5
Dormant	Feb., 1963	4.8	1.2	50.3	9.3
Muhlenbergia arenacea (ear muhly)					
Mature	Oct., 1962	9.0	1.2	46.3	9.0
Panicum obtusum (vine mesquite)					
Dormant	Dec., 1962	7.4	1.3	51.1	7.9

* Less than 0.20 percent potassium

** Less than 0.06 percent magnesium

Range

Composition of Dry Matter

Ash	Calcium	Phosphorus	Potassium	Magnesium	Manganese	Iron	Boron	Copper	Zinc	Aluminum	Strontium	Molybdenum	Cobalt	Sodium	Silicon	Barium
---------percent----------					---------------mg/kg---------------									- percent -		mg/kg
14.0	0.56	0.12	0.39	0.04	79	868	3	16	16	730	30	2.7	0.50	0.01	0.66	31
12.8																
8.0	0.26	0.15	0.75	0.05	69	281	8	17	13	349	30	0.7	0.46	0.01	0.32	25
8.8	0.49	0.16	0.96	0.09	60	336	4	17	22	344	33	1.0	0.45	0.01	0.49	31
8.9	0.44	0.16	0.52	0.07	64	490	2	13	25	460	24	1.3	0.59	0.01	0.40	36
15.4	0.51	0.11	0.33	0.08	59	349	7	17	14	427	42	1.3	0.51	0.01	0.51	43
10.6	0.36	0.10	0.28	0.04	81	123	4	15	12	204	32	0.5	0.58	0.01	0.47	48
12.4	0.48	0.08	*	0.04	51	468	3	16	16	449	31	1.3	0.59	0.01	0.86	38
6.3	0.25	0.06	0.24	**	50	362	2	26	26	349	21	0.9	0.62	0.01	0.26	12
7.7	0.28	0.07	0.32	0.07	44	276	3	17	19	403	23	0.9	0.56	0.01	0.34	21
8.9	0.21	0.07	0.38	**	44	192	3	23	18	326	23	0.5	0.47	0.01	0.36	21
8.6	0.30	0.11	0.53	0.08	42	162	17	26	17	254	40	0.7	0.58	0.01	0.25	16
7.9	0.32	0.12	0.86	0.09	30	177	18	21	19	249	29	1.0	0.70	0.01	0.23	30
6.7	0.26	0.10	0.69	0.06	24	201	7	26	23	295	23	0.6	0.48	0.01	0.26	23
7.0	0.27	0.08	0.47	0.04	38	153	5	23	21	244	26	0.6	0.60	0.01	0.34	24
6.5	0.24	0.09	0.41	0.06	39	118	4	17	19	178	21	0.5	0.62	0.01	0.26	21
7.0	0.23	0.09	0.46	0.06	40	149	6	21	21	252	26	1.0	0.68	0.01	0.33	19
8.5	0.38	0.19	1.20	0.08	54	117	4	15	22	186	26	0.9	0.62	0.01	0.33	13
9.2																
8.2	0.39	0.16	0.28	0.07	66	168	3	16	19	245	24	0.6	0.68	0.01	0.28	14
9.9	0.36	0.12	0.75	0.07	73	216	4	10	18	343	28	0.7	0.57	0.01	0.36	19
8.6	0.36	0.07	0.41	0.04	68	159	9	14	13	264	28	0.9	0.62	0.01	0.52	14
11.5	0.47	0.15	0.72	0.06	42	619	3	10	22	600	25	1.7	0.70	0.01	0.52	22
9.0	0.43	0.10	0.25	0.07	40	477	2	22	26	462	19	1.2	0.69	0.01	0.81	13

Table 3 (continued)

Group, Species, Common Name, and Stage of Maturity	Month and Year of Collection	Protein	Ether extract	Acid detergent fiber	Acid detergent lignin
		------------- percent -------------			
Scleropogon brevifolius (burrograss)					
Dormant	Mar., 1962	7.8	1.3	46.3	8.2
Mature	July-Aug., 1962	11.8	2.3	44.2	6.5
Mature	Sept.-Oct., 1962	9.8	2.6	45.0	6.8
Dormant	Nov., 1962	7.1	3.5	46.3	8.3
Dormant	Dec., 1962	7.7	2.0	44.9	7.9
Dormant	Jan., 1963	7.6		52.4	8.8
Dormant	Feb., 1963	7.4	2.0	49.2	8.9
Sporobolus airoides (alkali sacaton)					
Early leaf	Mar.-April, 1962	8.2	1.2	47.3	8.3
Immature	May, 1962	6.4	0.9	48.3	7.9
Mature	Sept., 1962	6.1	1.5	46.1	7.8
Overripe	Sept., 1962	8.1	2.4	42.7	7.4
Mature	Oct., 1962	8.7	1.9	43.8	8.1
Dormant	Nov., 1962	6.8	1.8	48.1	10.2
Dormant	Dec., 1962	4.2	1.6	51.8	7.9
Dormant	Jan., 1963	4.2	2.2	54.4	9.4
Sporobolus cryptandrus (sand dropseed)					
Early leaf	Mar., 1962	3.8	0.9	54.8	8.7
Dormant	Nov., 1962	4.8	1.0	54.6	10.0
Dormant	Jan., 1963	4.6	0.8	55.0	8.2
Sporobolus flexuosus (mesa dropseed)					
Early leaf	Mar.-April, 1962	4.8	0.7	54.2	9.0
Immature	May, 1962	7.3	2.0	49.7	6.9
Immature	June, 1962	7.3	0.9	48.7	7.4
Pre-bloom	July-Aug., 1962	7.2	1.1	46.0	6.8
Overripe	Sept., 1962	9.2	1.3	46.0	7.6
Mature	Oct., 1962	7.6	0.4	52.0	8.2
Dormant	Nov., 1962	6.5	1.0	49.5	7.7
Dormant	Dec., 1962	4.4	1.0	54.3	8.0
Dormant	Jan., 1963	5.8	2.2	53.2	8.0
Dormant	Feb., 1963	5.0	0.9	47.7	9.2

*** Less than 0.01 percent sodium

Composition of Dry Matter																
Ash	Calcium	Phosphorus	Potassium	Magnesium	Manganese	Iron	Boron	Copper	Zinc	Aluminum	Strontium	Molybdenum	Cobalt	Sodium	Silicon	Barium
percent					mg/kg									percent		mg/kg
16.2	0.61	0.09	0.25	0.07	103	840	5	35	25	897	21	4.4	0.61	0.01	0.76	25
10.0	0.52	0.17	1.16	0.13	51	900	10	34	34	640	34	2.0	0.52	0.01	0.48	25
15.3	0.51	0.13	0.51	0.10	68	725	5	18	25	808	23	3.2	0.68	***	0.52	25
11.8	0.35	0.08	0.37	0.07	71	501	4	18	19	616	23	1.4	0.49	0.01	0.47	20
11.1	0.33	0.10	0.31	0.07	71	363	4	28	23	489	25	1.1	0.58	0.01	0.44	23
9.6																
9.0	0.33	0.08	0.27	0.06	58	442	7	19	19	569	23	1.4	0.44	0.01	0.45	25
6.1	0.33	0.11	1.01	0.12	35	498	4	30	24	614	21	1.5	0.53	0.01	0.42	10
6.4	0.28	0.08	0.97	0.11	39	306	4	23	20	422	23	0.8	0.53	0.01	0.32	13
9.5	0.38	0.17	1.60	0.19	29	259	3	28	29	291	35	1.3	0.59	0.01	0.38	13
6.5																
11.1	0.56	0.16	1.28	0.23	40	470	4	26	36	519	27	2.2	0.53	0.01	0.39	15
7.1	0.29	0.06	1.07	0.20	29	268	3	30	23	357	21	1.0	0.49	0.02	0.28	18
7.8	0.28	0.07	0.41	0.11	20	133	3	15	15	211	22	0.4	0.44	0.01	0.30	15
4.7	0.26	0.04	0.35	0.11	23	164	3	13	13	220	24	0.6	0.47	0.01	0.42	11
4.5	0.13	0.04	0.26	0.06	26	196	2	27	20	337	19	0.4	0.41	0.01	0.27	13
5.5	0.21	0.08	0.63	0.10	28	217	3	17	27	354	21	0.6	0.65	0.01	0.26	11
3.9	0.17	0.07	0.33	0.07	18	66	3	13	17	107	19	0.3	0.47	0.01	0.16	11
6.1	0.25	0.06	0.49	0.09	27	436	2	23	19	560	20	1.3	0.47	0.01	0.47	13
7.6	0.34	0.10	0.91	0.15	32	329	10	19	19	460	23	1.3	0.68	0.01	0.35	11
6.6	0.45	0.08	0.99	0.18	30	406	9	21	16	546	31	1.9	0.56	0.01	0.41	10
8.5	0.41	0.14	1.65	0.18	27	206	8	23	23	310	32	1.0	0.62	0.01	0.29	10
7.0	0.26	0.13	0.89	0.13	37	184	4	20	22	324	24	0.7	0.47	0.01	0.29	12
5.7	0.22	0.14	0.74	0.11	30	200	4	19	23	314	21	1.6	0.96	0.01	0.30	14
6.0	0.26	0.07	0.35	0.09	33	230	3	17	19	331	22	0.7	0.41	0.01	0.34	14
5.2	0.19	0.09	0.37	0.08	25	185	3	14	19	320	22	0.7	0.49	0.01	0.25	14
5.0	0.16	0.07	0.36	0.08	26	100	4	17	16	211	23	0.5	0.38	0.01	0.21	10

Table 3 (continued)

Group, Species, Common Name, and Stage of Maturity	Month and Year of Collection	Protein	Ether extract	Acid detergent fiber	Acid detergent lignin
		------------	percent	------------	
Tridens pulchellus (fluffgrass)					
Mature	Oct., 1962			50.0	6.4
Dormant	Nov., 1962	5.1	2.0	51.4	7.6
Dormant	Jan., 1963	6.3	1.6	52.4	7.7
Annual Grasses					
Bouteloua barbata (sixweeks grama)					
Overripe	Feb., 1962	4.1	1.4	51.3	6.2
Dormant	Mar., 1962	5.0	1.5	53.2	1.7
Perennial Forbs					
Bahia absinthifolia (bahia)					
Late bloom	Oct., 1962	13.3	8.4	43.2	2.8
Overripe	Oct., 1962	10.2	6.3	37.9	10.5
Baileya multiradiata (desert baileya)					
Late bloom	Sept., 1962	10.0	6.0	37.9	6.9
Full bloom	Oct., 1962	12.1	6.0	39.9	8.5
Chamaesaracha coniodes (chamaesaracha)					
Early bloom	May, 1962	14.9	2.6	51.1	3.8
Croton corymbulosus (leatherweed croton)					
Late bloom	May, 1962	16.3	3.9	31.7	8.1
Mature	Aug.-Sept., 1962	13.6	5.3	40.2	16.4
Mature	Oct., 1962	13.9	5.9	33.9	13.0
Dormant	Nov., 1962	11.1	6.3	42.2	19.3
Dormant	Dec., 1962	8.4	3.0	35.7	14.2
Lesquerella fendleri (bladderpod)					
Mature	June, 1962	14.9	2.2	45.8	8.6
Dormant	Jan., 1963	13.7	1.8	33.2	4.3
Melampodium leucanthum (plains blackfoot)					
Dormant	May, 1962	17.6	4.3	33.6	15.9
Dormant	Dec., 1962	7.2	2.4	50.5	12.4
Perezia nana (desert holly)					
Dormant	Jan., 1963	8.3	4.4	45.6	7.0

* Less than 0.20 percent potassium

** Less than 0.06 percent magnesium

Composition of Dry Matter																
Ash	Calcium	Phosphorus	Potassium	Magnesium	Manganese	Iron	Boron	Copper	Zinc	Aluminum	Strontium	Molybdenum	Cobalt	Sodium	Silicon	Barium
---------percent---------					---------------mg/kg---------------									- percent -		mg/kg
15.2	0.19	0.08	0.30	**	31	405	2	11	13	488	19	1.1	0.51	0.01	0.35	14
15.7	0.32	0.10	0.37	0.05	50	510	3	25	22	590	25	1.5	0.47	0.01	0.43	29
19.9	0.62	0.10	0.26	0.07	59	933	3	21	19	798	28	3.4	0.64	0.01	0.92	30
9.0	0.30	0.05	*	**	31	346	2	34	15	413	25	1.0	0.69	0.01	0.56	66
12.3	0.63	0.05	*	0.04	35	689	3	19	23	633	29	2.0	0.67	0.01	0.72	43
16.5	1.83	0.15	2.44	0.41	44	866	36	18	23	753	57	5.7	0.78	0.01	0.68	35
11.1																
15.4	1.90	0.20	2.13	0.15	24	562	26	20	17	635	69	2.5	0.72	0.02	0.52	39
12.8	2.37	0.19	1.64	0.19	26	665	38	15	18	655	67	2.6	0.76	0.01	0.62	40
53.7																
10.4	1.90	0.18	1.68	0.42	24	508	17	23	17	495	71	4.3	1.06	0.01	0.38	16
8.2																
10.8	1.66	0.18	1.35	0.32	35	954	28	17	23	697	51	4.6	0.72	0.01	0.69	22
9.2	2.00	0.13	1.25	0.34	35	472	36	14	15	492	65	3.0	0.70	0.01	0.39	30
9.9	2.51	0.09	0.87	0.32	26	562	21	18	11	553	65	3.7	0.91	0.01	0.42	36
15.0																
26.6	5.62	0.21	1.03	0.35	44	660	28	14	22	626	89	3.8	1.55	0.01	0.38	112
10.9																
24.2	1.55	0.11	0.99	0.20	5	1325	15	55	17	843	56	5.4	0.51	0.01	0.84	33
11.7																

Table 3 (continued)

Group, Species, Common Name, and Stage of Maturity	Month and Year of Collection	Protein	Ether extract	Acid detergent fiber	Acid detergent lignin
		percent			
Psilostrophe tagetinae (woolly paperflower)					
Full bloom	June, 1962	16.0	2.1	32.3	4.9
Full bloom	July, 1962	14.7	2.7	30.4	5.1
Full bloom	Oct.-Nov., 1962	14.4	2.7	56.1	5.8
Dormant	Dec., 1962	10.2	1.6	52.5	2.8
Dormant	Jan.-Feb., 1963	12.9	2.5	57.7	2.8
Sphaeralcea subhastata (globemallow)					
Late bloom	Aug., 1962	18.9	2.2	38.1	12.7
Zinnia grandiflora (rocky mountain zinnia)					
Full bloom	Aug.-Sept., 1962	12.9	4.4	33.3	8.9
Late bloom	Oct., 1962	11.7	5.7	27.2	5.9
Overripe	Sept., 1962	10.5	6.1	33.3	13.0
Dormant	Nov., 1962	9.2	3.6	43.9	9.7
Annual forbs					
Corispermum nitidum (tickseed)					
Dormant	Mar., 1962	6.0	2.6	41.3	6.3
Mature	Sept., 1962	7.2	1.6	42.4	6.0
Overripe	Dec., 1962	10.2	3.3	33.0	8.3
Dithyrea wislizeni (wislizenus spectaclepod)					
Dormant	Mar., 1962	18.1	1.1	37.5	5.6
Dormant	Nov., 1962	12.1	3.1	35.6	8.3
Dormant	Dec., 1962	14.2	2.7	39.2	9.5
Dormant	Jan., 1963	17.1	2.0	31.4	5.0
Dormant	Feb., 1963	20.9	1.4	28.9	4.7
Gutierrezia sphaerocephala (annual snakeweed)					
Dormant	Nov., 1962	11.8	11.9	31.3	9.9
Dormant	Dec., 1962	8.4	7.3	38.5	9.0
Iva dealbata (sumpweed)					
Immature	June, 1962	22.2	6.6	24.7	4.0
Mature	Oct., 1962	19.9	5.9	37.5	15.6
Dormant	Dec., 1962	9.0	3.0	53.8	10.3
Mentzelia albicaulis (whitestem stickleaf)					
Dormant	Mar., 1962	21.4	2.1	54.5	17.9

Composition of Dry Matter

Ash	Calcium	Phosphorus	Potassium	Magnesium	Manganese	Iron	Boron	Copper	Zinc	Aluminum	Strontium	Molybdenum	Cobalt	Sodium	Silicon	Barium
percent					mg/kg									percent		mg/kg
12.8	2.32	0.16	1.62	0.54	22	289	32	14	14	394	78	3.0	0.75	0.01	0.15	19
12.9																
44.4	2.48	0.14	1.87	0.26	40	1330	26	25	20	874	60	6.0	0.84	0.01	0.54	37
60.2	1.54	0.12	1.28	0.12	35	1281	14	16	17	897	51	5.2	0.58	0.01	0.57	24
60.3	1.74	0.15	1.72	0.18	47	1412	16	16	20	907	53	5.8	0.62	0.01	0.51	34
13.4																
18.6	2.63	0.15	2.29	0.57	52	1121	122	32	14	811	78	6.7	0.99	0.01	0.81	32
17.9	3.02	0.13	1.49	0.79	56	1456	129	14	12	938	80	11.8	1.11	0.01	1.36	35
18.9																
32.1	2.99	0.11	1.44	0.44	57	1571	115	25	16	997	68	10.4	0.89	0.01	1.42	44
9.1	2.93	0.07	0.34	0.21	38	429	10	12	12	517	61	2.0	0.72	0.01	0.35	34
10.8	2.20	0.10	0.95	0.36	36	398	15	15	12	470	59	3.3	1.06	0.01	0.27	40
8.4	1.46	0.17	0.39	0.23	29	348	9	15	19	381	42	1.8	0.65	0.01	0.20	16
33.3	3.80	0.40	1.79	0.47	59	1527	25	17	32	1049	80	12.2	1.17	0.03	1.04	68
9.3	2.03	0.22	1.47	0.16	17	290	17	9	18	367	55	1.3	0.75	0.01	0.21	45
10.1																
22.8	2.60	0.29	1.36	0.23	38	807	16	9	26	792	60	4.4	0.91	0.01	0.38	47
21.2	3.21	0.28	1.50	0.22	45	764	34	15	30	744	67	4.0	1.01	0.02	0.44	53
5.3	0.69	0.18	1.38	0.19	40	140	28	28	27	138	67	1.1	0.69	0.01	0.08	14
4.4	0.62	0.13	0.91	0.11	27	298	24	26	19	357	40	1.6	0.72	0.02	0.28	13
18.6																
16.0	2.54	0.21	3.15	0.56	48	1172	86	23	36	820	76	7.3	1.08	0.02	1.04	29
30.2	3.59	0.10	0.55	0.40	77	1619	74	31	16	1021	68	11.3	1.21	0.01	1.20	53
39.3	2.32	0.31	2.35	0.41	141	1493	51	19	47	1010	62	10.6	0.87	0.02	1.07	47

Table 3 (continued)

Group, Species, Common Name, and Stage of Maturity	Month and Year of Collection	Protein	Ether extract	Acid detergent fiber	Acid detergent lignin
		------------- percent -------------			
Salsola kali (russianthistle)					
Early bloom	June, 1962	12.9	1.1	27.6	4.5
Full bloom	Aug.-Sept., 1962	17.2	1.6	21.6	3.8
Late bloom	Oct., 1962	14.4	1.3	31.8	5.6
Mature	Oct., 1962	16.2	1.1	31.5	8.2
Dormant	Nov., 1962	11.8	3.2	31.0	6.8
Overripe	Dec., 1962	11.0	3.4	32.6	6.7
Overripe	Jan., 1963	9.8	2.0	40.6	8.7
Overripe	Feb., 1963	11.2	2.1	40.8	9.1
Shrubs					
Atriplex canescens (fourwing saltbush)					
Mature	Sept., 1962	13.4	1.2	36.6	8.7
Ephedra torreyana (torrey mormontea)					
Mature	Dec., 1962	8.7	2.2	37.6	12.6
Ephedra trifurca (longleaf mormontea)					
Overripe	Dec., 1962	6.7	1.4	49.8	17.7
Flourensia cernua (tarbush)					
Dormant	Dec., 1962	11.5	7.8	28.0	11.1
Stems, seedheads	Nov., 1962	14.8	16.3	25.7	10.5
Gutierrezia sarothrae (broom snakeweed)					
Dormant	Mar., 1962	15.2	4.9	45.0	15.5
Prosopis juliflora (honey mesquite beans)					
Mature	Dec., 1962	12.9	1.8	46.2	9.4
Yucca elata (soaptree yucca leaves)					
Early leaf	Mar., 1962	10.2	2.5	43.4	10.6
Overripe	Nov., 1962	10.9	1.6	46.2	9.0
Overripe	Dec., 1962	10.8	2.9	36.0	10.4
Overripe	Jan., 1963	8.6	3.2	37.1	9.1
Overripe	Feb., 1963	10.6	2.5	43.5	10.6

Composition of Dry Matter																
Ash	Calcium	Phosphorus	Potassium	Magnesium	Manganese	Iron	Boron	Copper	Zinc	Aluminum	Strontium	Molybdenum	Cobalt	Sodium	Silicon	Barium
---------percent---------					---------------mg/kg---------------									- percent -		mg/kg
28.1	3.36	0.14	6.60	0.90	36	161	31	19	12	323	94	5.4	0.92	0.14	0.09	24
20.4																
16.7																
22.8	2.53	0.20	5.58	0.71	57	296	28	20	19	456	79	4.6	0.71	0.28	0.22	20
14.2	2.26	0.16	2.72	0.89	50	149	36	18	16	230	77	4.8	0.77	0.05	0.03	14
16.0	3.90	0.13	1.54	0.78	64	333	27	20	19	470	78	5.9	0.93	0.04	0.16	30
8.6	1.90	0.12	1.07	0.72	29	134	23	15	15	196	70	4.2	0.75	0.01	0.04	18
11.7	2.66	0.14	1.30	0.96	42	148	27	20	16	242	83	5.7	0.83	0.03	0.04	26
14.0																
7.5	3.67	0.10	0.31	0.10	45	129	8	8	10	201	85	0.8	1.02	0.01	0.10	93
9.7	2.11	0.12	0.61	0.31	33	335	7	6	15	390	80	2.3	0.81	0.01	0.27	22
8.7	1.49	0.11	1.95	0.26	37	219	54	14	20	264	52	1.1	0.69	0.01	0.20	14
8.6	1.10	0.20	2.00	0.20	30	642	30	24	30	575	49	2.1	0.52	0.02	0.53	11
14.7	1.32	0.24	2.74	0.17	69	1427	30	22	47	957	34	7.9	0.75	0.02	1.25	32
12.8	0.56	0.19	0.87	0.08	24	735	11	34	17	562	38	2.0	0.75	0.01	0.24	10
1.6	1.05	0.13	0.74	0.23	16	106	7	8	16	184	63	0.7	0.51	0.01	0.03	16
4.4	0.95	0.19	1.07	0.23	28	53	10	9	20	47	57	0.6	0.64	0.01	0.02	18
5.4	1.43	0.16	0.83	0.25	33	111	21	6	12	144	69	1.0	0.64	0.01	0.06	22
4.8	1.25	0.11	0.57	0.18	34	104	22	6	8	152	76	0.9	0.53	0.01	0.08	26
5.8	1.58	0.16	0.78	0.28	38	149	25	6	15	216	72	1.2	0.67	0.01	0.09	33

crease very rapidly as the plants mature. The calcium content of grasses remains relatively constant or increases slightly with advanced maturity.

The other common change in major constituents is the increase in fiber with advancing maturity. Young grass contains a relatively low level of fiber. Not only does mature and dormant grass contain more fiber, but it is also less digestible or less available to the animal. The acid-detergent fiber values reported herein are higher than the values obtained by the conventional A.O.A.C. procedure for crude fiber. Acid-detergent fiber contains constituents such as cellulose, lignin, and silica, and it is becoming widely accepted as a better means of expressing the quantity of tough and fibrous portions of plants than the conventional crude fiber.

The ether extract (fat) content of most forages in New Mexico is very low. Although there are differences among species, the differences among stages of maturity within the same species are quite small and relatively unimportant in range livestock production. Some of the fatty materials in the ether extract have high nutritive value to animals, but others, such as essential oils, are of no value to animals. Since the level of ether extract in range plants is low, its relative importance as an indicator of nutritive value is low.

Total ash is not a meaningful nutritional measurement. It indicates the total quantity of minerals in the sample; however, animals require specific minerals and not the total inorganic matter as measured by ash. The ash content of many samples of range plants is very high, partly because of contamination from surface soil, but perhaps also because of high levels of silicates in the plants.

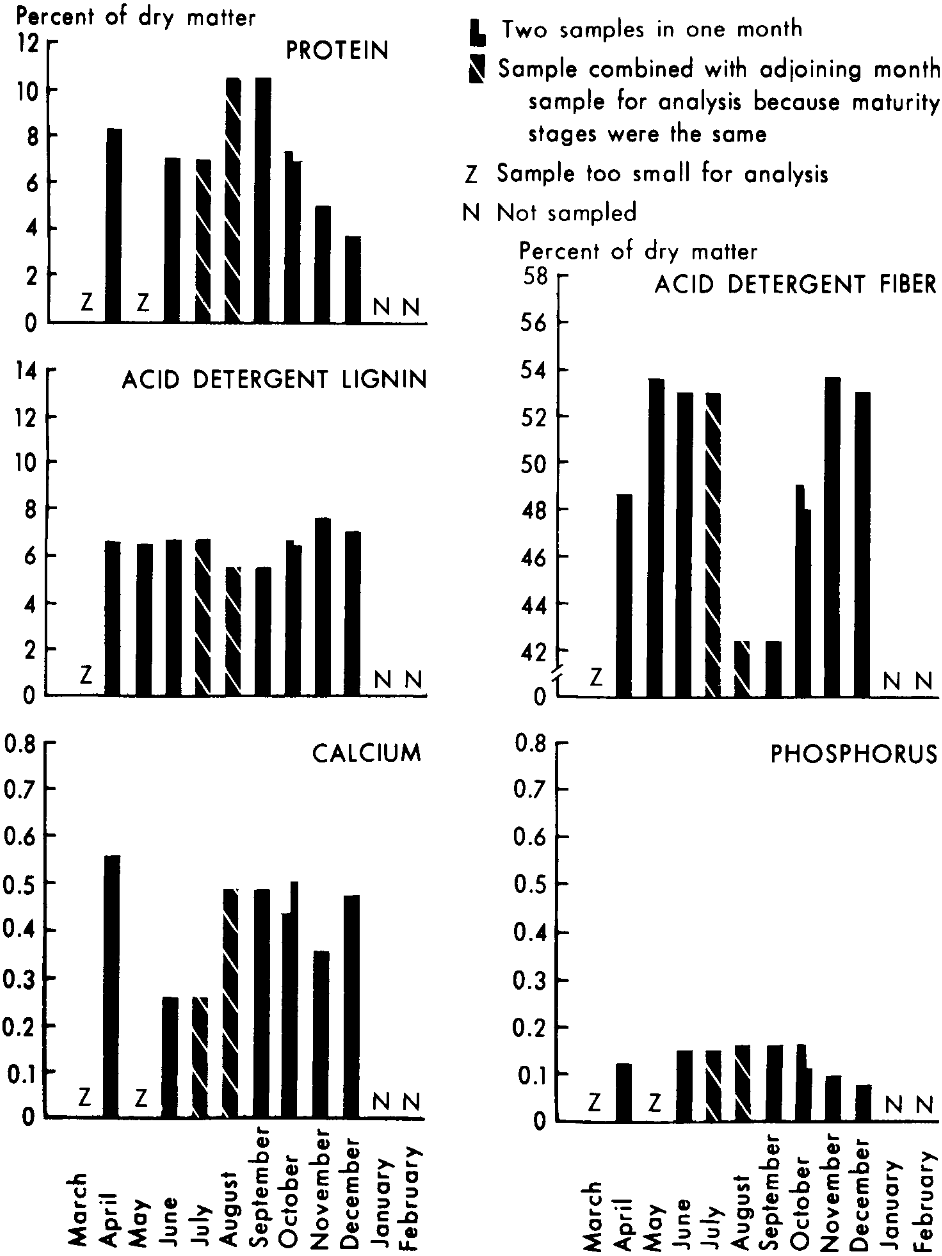
Perennial Grasses

The seasonal protein, ether extract, acid-detergent fiber, acid-detergent lignin, calcium, and phosphorus contents of five of the most important species of perennial grasses (red threeawn, black grama, burrograss, alkali sacaton, and mesa dropseed) are shown in figures 1 through 5.

RED THREEAWN (*Aristida longiseta*). This species was consumed during most of the year. Only in January and February were the test cows not observed eating it (table 2). The ash content varied from a low of 8.0 percent in June and July to a high of 15.4 percent in October (table 3). The protein content also varied considerably (figure 1). It was relatively high in April during the early leaf stage of maturity, but the highest value (10.4 percent) was for the August-September sample. After this, the protein content decreased, as expected, with advancing stage of maturity and weathering. The protein content of the various samples indicates that supplemental protein would be necessary for cattle during the winter months if red threeawn were the only species grazed.

The detergent lignin content of red threeawn was relatively stable and was not particularly high at any of the dates on which it was consumed. The lowest value was for the August-September sample. The acid-detergent fiber content of the early leaf sample in April was 48.7 percent, but exceeded 53 percent in May, June, and July. The very low fiber value near 42 percent in August-September corresponds to the lowest lignin value and highest protein value of this sample. By November and December, the fiber content had increased to near 53 percent.

Fig. 1 Chemical composition of red threeawn at Jornada Experimental Range



The calcium content of red threeawn was high for grasses in the April sample. It was low in the June-July sample, and the late summer, fall, and winter samples usually contained 0.4 to 0.5 percent calcium. The calcium content was considered to be adequate in all samples. The phosphorus content was highest during the growing season and lowest in December. It was probably slightly deficient in the December sample.

BLACK GRAMA (*Bouteloua eriopoda*). This species was consumed during all months. Its protein content varied only slightly during the year (figure 2) and barely met the protein requirement of most cattle only when its protein content was highest, from June to October. Of the five major grasses studied, this species contained the least protein (about 6 percent) during the summer.

The lignin values, which varied only from 7.0 to 8.5 percent, were slightly higher than for red threeawn in the same months, but lower than for the other important perennial grasses. Detergent fiber values were relatively low during the dormant season. Calcium values were adequate for cattle throughout the year. Phosphorus content varied from 0.07 to 0.12 percent and was highest and adequate from June to October.

BURROGRASS (*Scleropogon brevifolius*). This species was not grazed in April, May, and June. Its protein content was very high (nearly 12 percent in July and August and still almost 10 percent in September and October, figure 3). It retained relatively high protein values, between 7 and 8 percent, during the dormant season, and this is considered adequate for many classes of beef cattle.

The lignin content was considered to be normal, with lowest values during the summer and highest values during the winter. Acid-detergent fiber values were also lowest during the summer. All fiber values were relatively low except in January.

The calcium content was more than adequate in all samples. The phosphorus content was considered adequate during the summer and borderline in the winter.

ALKALI SACATON (*Sporobolus airoides*). Cattle were not observed grazing this species in June, July, August, and February. Its protein content was quite variable; the values were highest, 8.7 percent, in October and declined to a low of 4.2 percent in December (figure 4).

Some of the lignin values were relatively high during the dormant season and were higher than values for red threeawn and burrograss in most months. Detergent fiber content was variable; it increased rapidly from 42.7 percent in September to 54.4 percent in January.

Calcium was adequate in all samples, with a high value of 0.56 percent in October. Phosphorus was plentiful in September and October but deficient in November, December, and January.

MESA DROPSEED (*Sporobolus flexuosus*). Of the perennial grasses, only this species and black grama were observed being eaten in every month. Low protein values (around 5 percent) were in the samples collected in the winter (figure 5). The protein content exceeded 7 percent during the spring and summer and reached a high of 9.2 percent in September. This is quite similar to the protein content of red threeawn and alkali sacaton, but the winter values were lower than those for burrograss.

Fig. 2. Chemical composition of black grama at Jornada Experimental Range

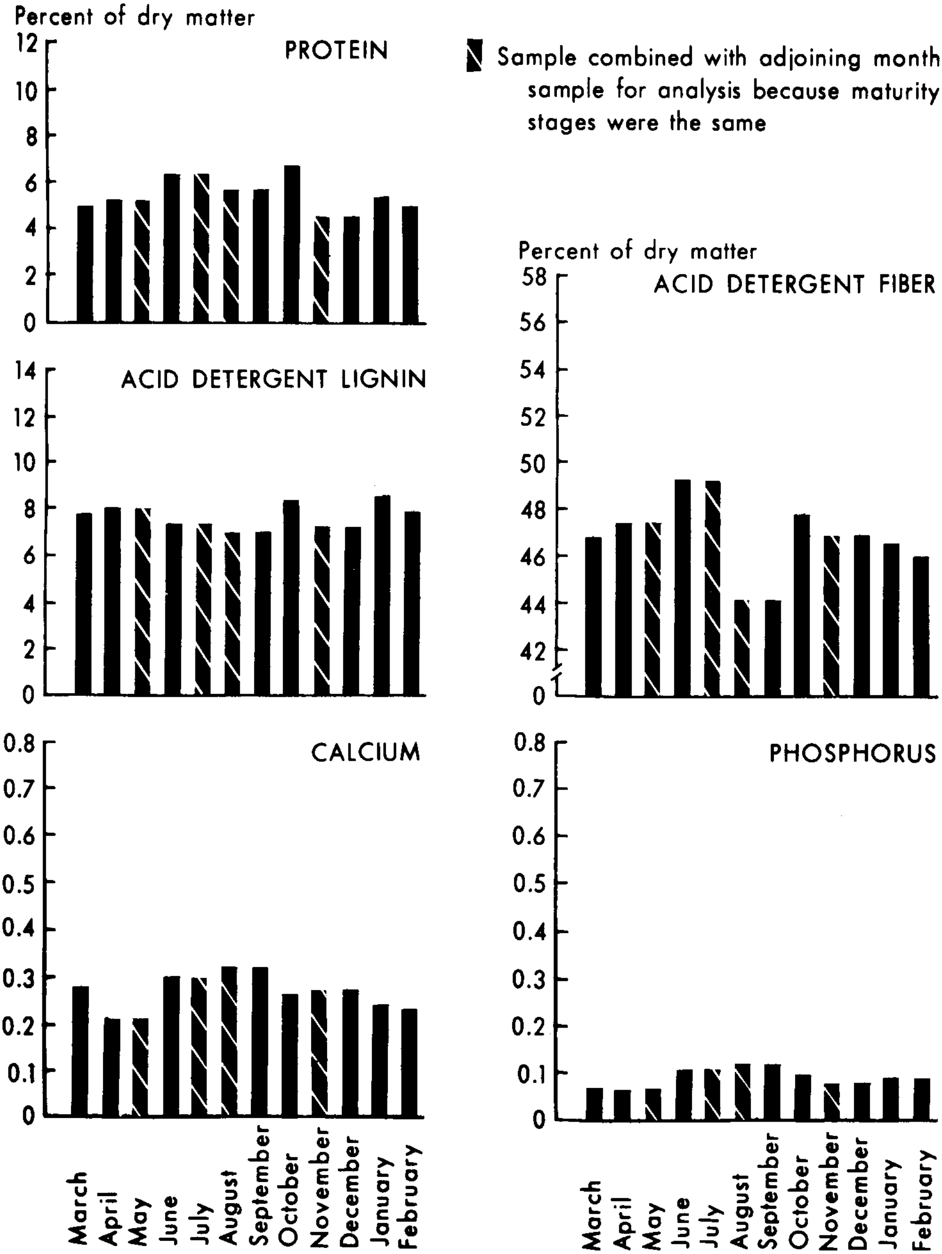


Fig. 4. Chemical composition of alkali sacaton at Jornada Experimental Range

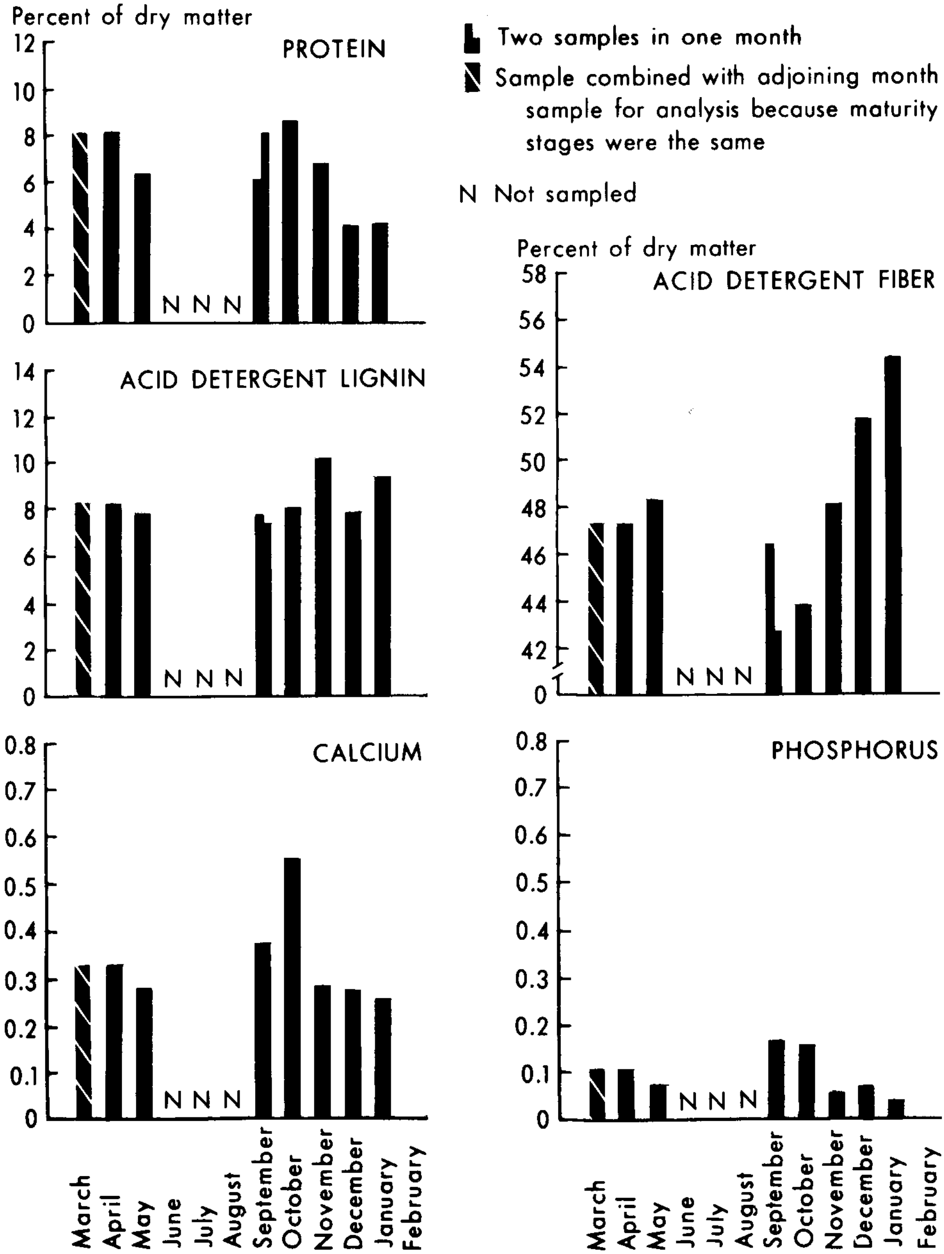
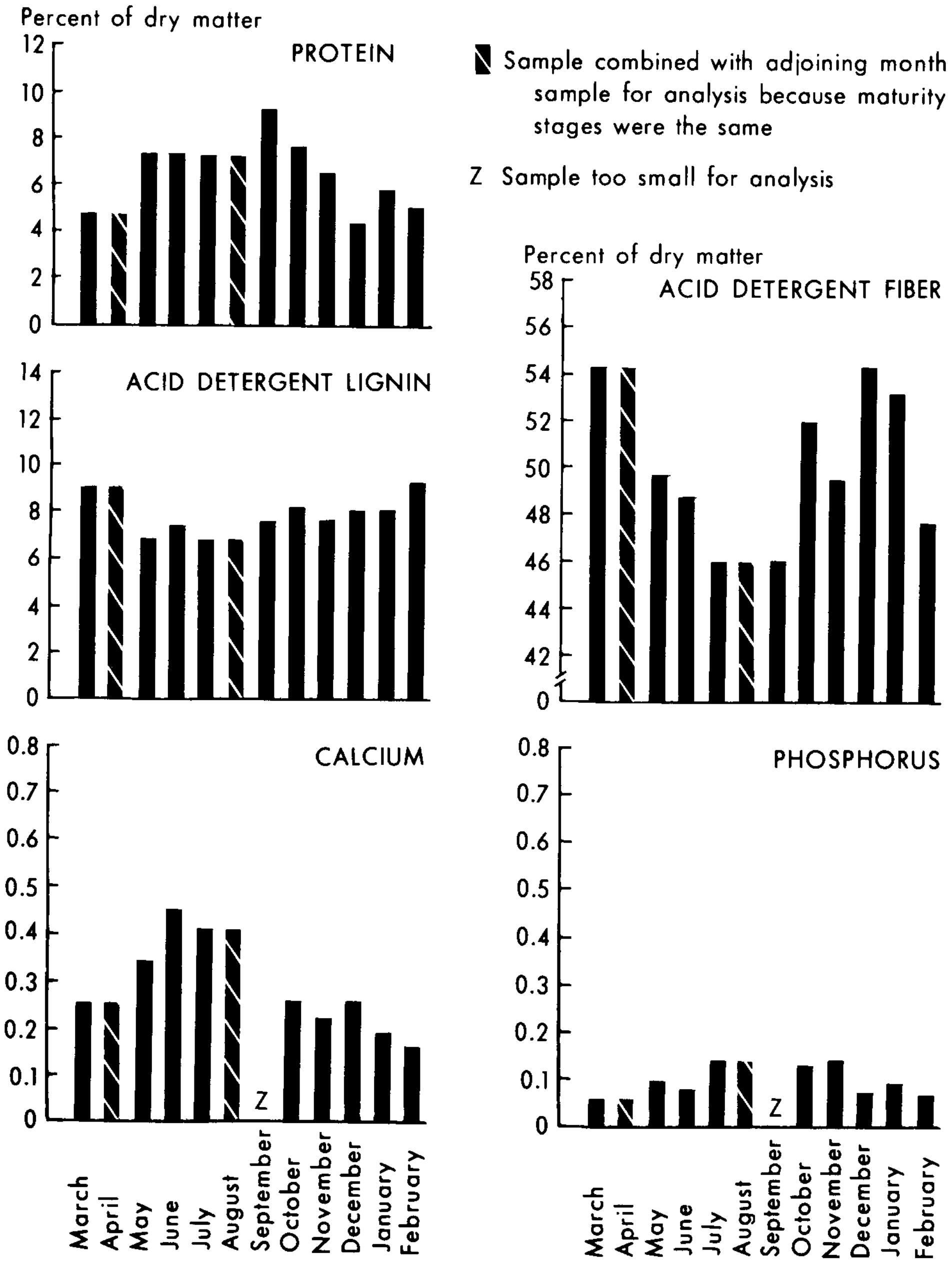


Fig. 5. Chemical composition of mesa dropseed at Jornada Experimental Range



OTHER PERENNIAL GRASSES. Several other perennial grasses were consumed by the cattle during the observation periods. Tobosa was grazed regularly during July, August, September, and October. It was also grazed in February. The protein content was 8 to 9 percent in the summer and fall, but it had decreased to a low of 4.8 percent in February (table 3). Its lignin content was relatively low in the summer. Calcium and phosphorus contents were considered adequate during the summer and fall but the phosphorus content was low in February.

Sand dropseed was sampled when it was eaten in March, November, and January. Its composition was similar to that of mesa dropseed except that it was lower in protein.

Fluffgrass was eaten from October through January. All of the samples were unusually high in ash (the December sample was 30.9 percent ash). This likely was the result of contamination with surface soil. The high ash is associated with the very high acid-detergent fiber. Such fiber includes insoluble ash. The protein content was similar to that in other grasses.

Single samples of sideoats grama, ear muhly, and vine mesquite were not unusual in chemical composition except for relatively high protein in mature ear muhly and dormant vine mesquite and low protein content in dormant sideoats grama. High protein values for vine mesquite have also been reported for the Ft. Stanton area of New Mexico (3).

Annual Grasses

Sixweeks grama was eaten in August, February, and March. The sample collected in August was too small for analysis. The protein content was similar to that of black grama, but the fiber content was higher than in black grama.

Perennial Forbs

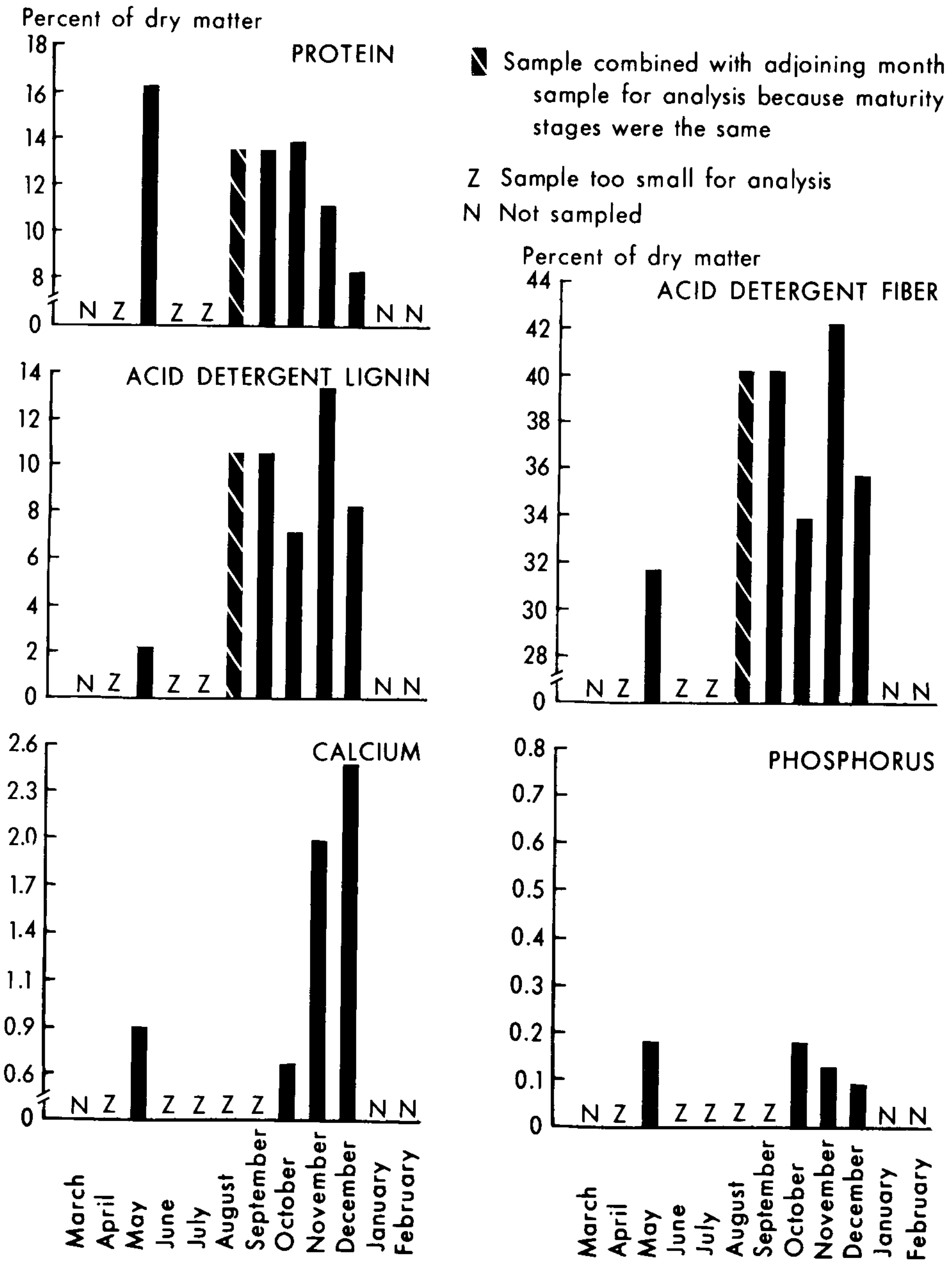
Ten species of perennial forbs were observed being eaten. Only leatherweed croton and woolly paperflower were eaten in several of the months. Five of the chemical constituents for each of these two species are shown in figures 6 and 7.

LEATHERWEED CROTON (*Croton corymbulosus*). This species was characterized by high protein, low acid-detergent fiber, high detergent lignin in mature and older samples, high calcium, and relatively high phosphorus (figure 6). Early samples contained between 16 and 19 percent protein. The two dormant samples contained 11.1 and 8.4 percent protein. The ether extract (fat) content, which may affect the energy value, was considerably higher than that in the grasses. In this instance, it is not known whether the increased ether extract is useful to the cattle or whether it is unavailable materials, such as essential oils.

The lignin content of the May and June samples was similar to the lignin content of grasses, but the September through December samples contained high levels of lignin. Detergent fiber varied from a low of 27.8 percent to a high of 42.2 percent. This high value is lower than nearly all of the fiber contents of the grasses.

The calcium content was higher than in grasses in May, October, and particularly in November and December, when the values were 2.0 and 2.5 percent, respectively. The phosphorus content was considered adequate except for the borderline level of 0.09 percent in December.

Fig. 6. Chemical composition of leatherweed croton at Jornada Experimental Range



WOOLLY PAPERFLOWER (*Psilostrophe tagetinae*). The ash content of this species was unusually high, particularly during the winter (table 3). Such high levels are not incorporated in the plant tissue and are likely due to contamination from the soil. Apparently large quantities of "sand" were on the various plant parts. Associated with the abrupt increase in ash in the November samples was an abrupt increase in acid-detergent fiber, which, as noted before, contains insoluble ash. The protein content of this forb was very high and the detergent lignin content was very low (figure 7). Such values are usually indicative of forage of high nutritive value. As with leatherweed croton, the calcium content of woolly paperflower was very high and the phosphorus content was adequate in all samples.

OTHER PERENNIAL FORBS. Eight of these were consumed at certain times during the study period. In general, the composition of these forbs was characterized by high ash, high protein (even in advanced stages of maturity), high fat (ether extract), relatively low acid-detergent fiber except in those samples containing very high levels of ash, and variable detergent lignin. Many samples contained low levels of lignin at all stages of maturity; however, later stages of leatherweed croton, both samples of plains blackfoot, the sample of globemallow, and the overripe sample of rocky mountain zinnia contained high levels of lignin. Perennial forbs apparently furnish much of the nutrients consumed by grazing cattle while the grasses are dormant, although woolly paperflower was consumed in all months from May through January.

Annual Forbs

Six species of annual forbs were consumed, mostly during the dormant season of the grasses. Two species, wislizenus spectaclepod and russianthistle, were consumed during several months. The chemical composition of these two species was very similar (table 3) and certain constituents of russianthistle are shown in figure 8.

RUSSIANTHISTLE (*Salsola kali*). This and other annual forbs contained high levels of ash. Generally, the more mature samples contained less ash, which may mean that the older plants were less contaminated with soil. The protein content was higher than in grasses in nearly all samples and varied from 9.8 to 17.2 percent. Both the lignin and fiber contents were low in the earlier samples. Even at maturity, the lignin content was similar to that in grasses and the fiber content was lower than in grasses. The calcium content was very high and the phosphorus was adequate at all stages.

SOME SPECIES, particularly annual snakeweed and sumpweed, contained high levels of ether extract. The fat may or may not be of a kind that is useful to animals. Both groups of forbs were high in calcium and relatively high in phosphorus.

Shrubs

Eight different shrubs were observed being eaten, generally when other plants were in short supply. Four species were eaten only once. They were fourwing saltbush in September, torrey mormontea in December, longleaf mormontea in December, and broom snakewood in March. Dor-

Fig. 7. Chemical composition of woolly paperflower at Jornada Experimental Range

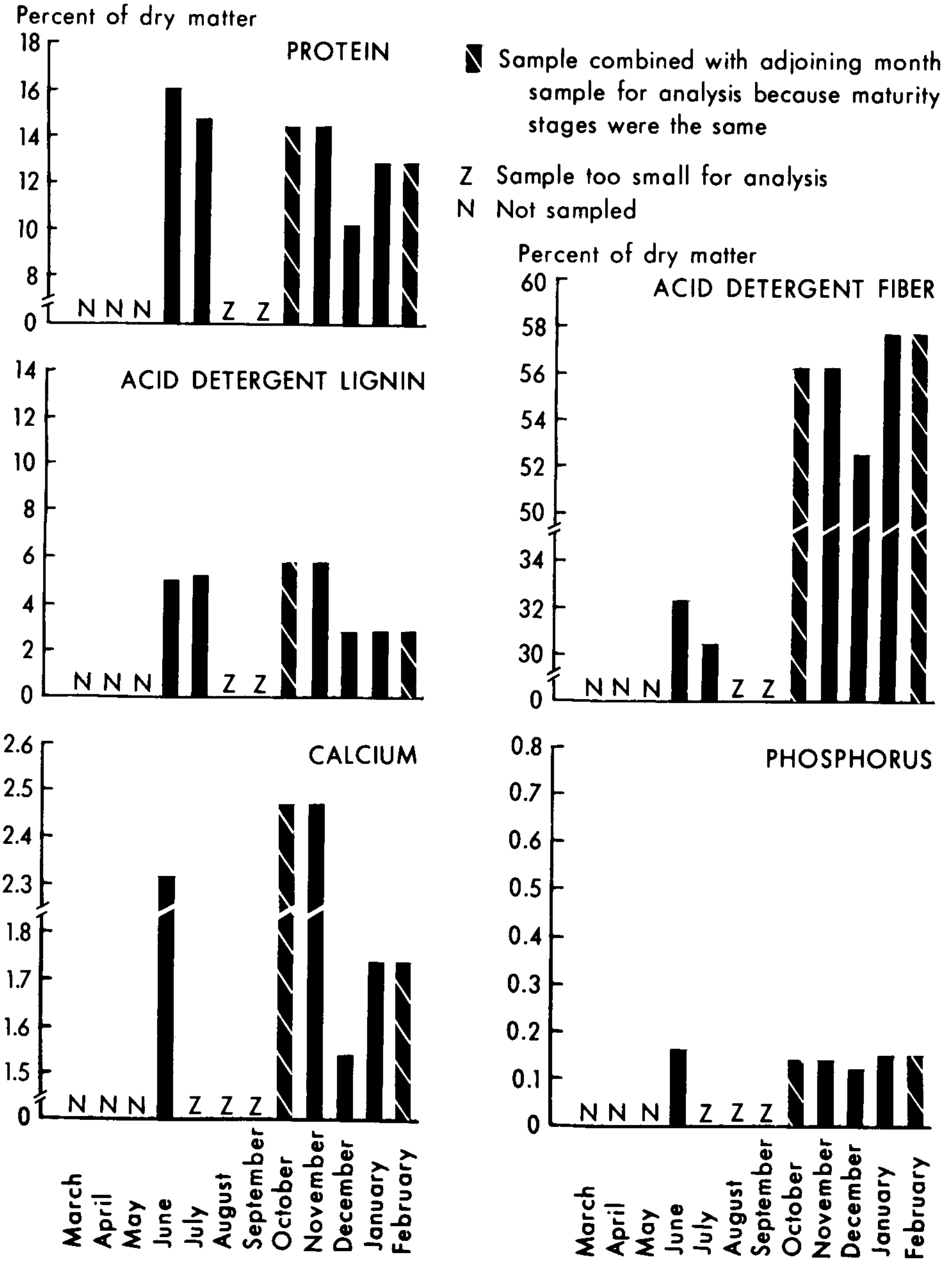
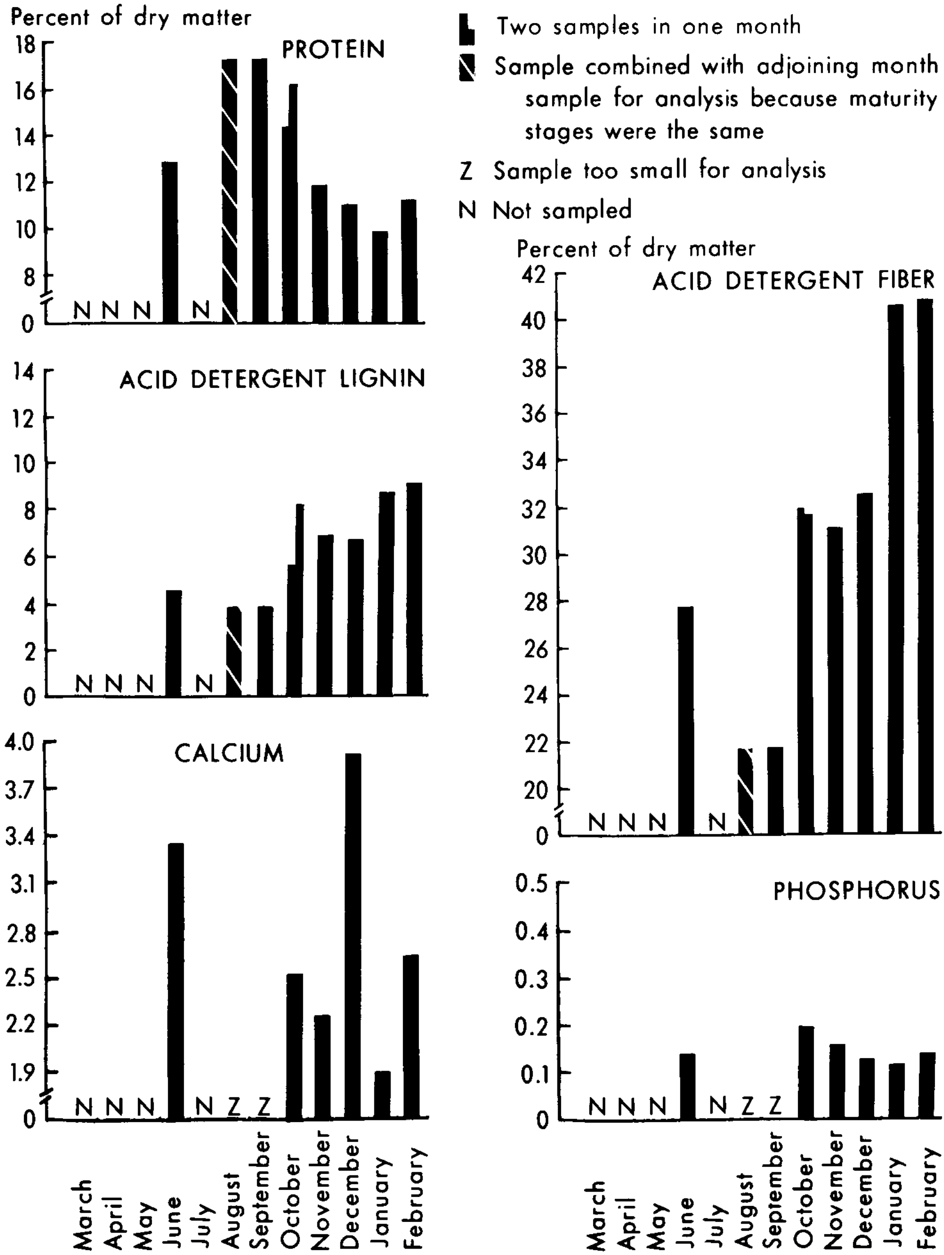


Fig. 8. Chemical composition of russianthistle at Jornada Experimental Range



mant tarbush was eaten in December, and tarbush stems and seedheads were eaten in November. Soaptree yucca was consumed frequently when few other green plants were available.

SOAPTREE YUCCA (*Yucca elata*). Certain constituents of the leaves of this species are shown in figure 9. The protein content was higher than in all but a few samples of grasses and was more than 10 percent in four of the five samples. The lignin content was also high. The fiber content was similar to that in grasses but higher than in forbs. The calcium content was high and the phosphorus content was adequate. The ash content was very low, the lowest of any species of plants known to be eaten.

OTHER SHRUBS. All of the other shrubs were high in ash, and all except the two mormonteas were high in protein. Dormant tarbush and particularly the stems and seedheads of tarbush were high in ether extract. Most samples were above average in lignin content. All were high in calcium, and phosphorus was adequate to meet the requirements of range cattle.

Mineral Composition

The calcium and phosphorus contents of the more important plants were given in figures 1 through 9 and have been briefly discussed. The content of calcium, phosphorus, and 14 other minerals are given in table 3. Livestock requirements are known for only 10 and possibly 11 of those listed (10). Five of the minerals listed in the table (boron, aluminum, strontium, silicon, and barium) are not known to be required by livestock.

Magnesium (Mg) is present in the plants at levels from just barely adequate to considerably more than adequate. The level is considerably higher in most of the forbs and shrubs than in the grasses.

Sodium (Na) is present at very low levels in most plants. The requirement for sodium is not known, but the provision of common salt is recommended as a means of alleviating any deficiency.

Potassium (K) is found at fairly high levels in most plants, and the requirement is believed to be met by these forages. As with calcium and magnesium, the potassium level was higher in the forbs and shrubs than in the grasses.

Manganese (Mn) is present at levels from 16 to 144 mg/kg of dry matter and is not likely to be deficient.

Iron (Fe) content varies considerably with most of the forbs containing higher levels than the grasses. All of the levels are apparently adequate.

Copper (Cu) requirement is believed to be near 4 mg/kg for cattle, and all the samples of forages contained more than this level. The content varied from 6 to 55 mg/kg.

Cobalt (Co) levels are all more than adequate. The requirement is between 0.05 and 0.10 mg/kg., which is much lower than the levels of 0.38 to 1.55 mg/kg. found in the samples.

Zinc (Zn) content of the feeds is low, but the requirement is also low, and levels in the plants apparently are adequate.

Molybdenum (Mo) has only recently been listed as probably required by livestock. The requirement is unknown but is very low and is probably only 0.1 mg/kg of ration or less. The usual consideration is toxicity at levels of 50 to 100 mg/kg of forage dry matter. Neither a deficiency or a toxicity is probable with the levels present in the samples.

Fig. 9. Chemical composition of soaptree yucca at Jornada Experimental Range

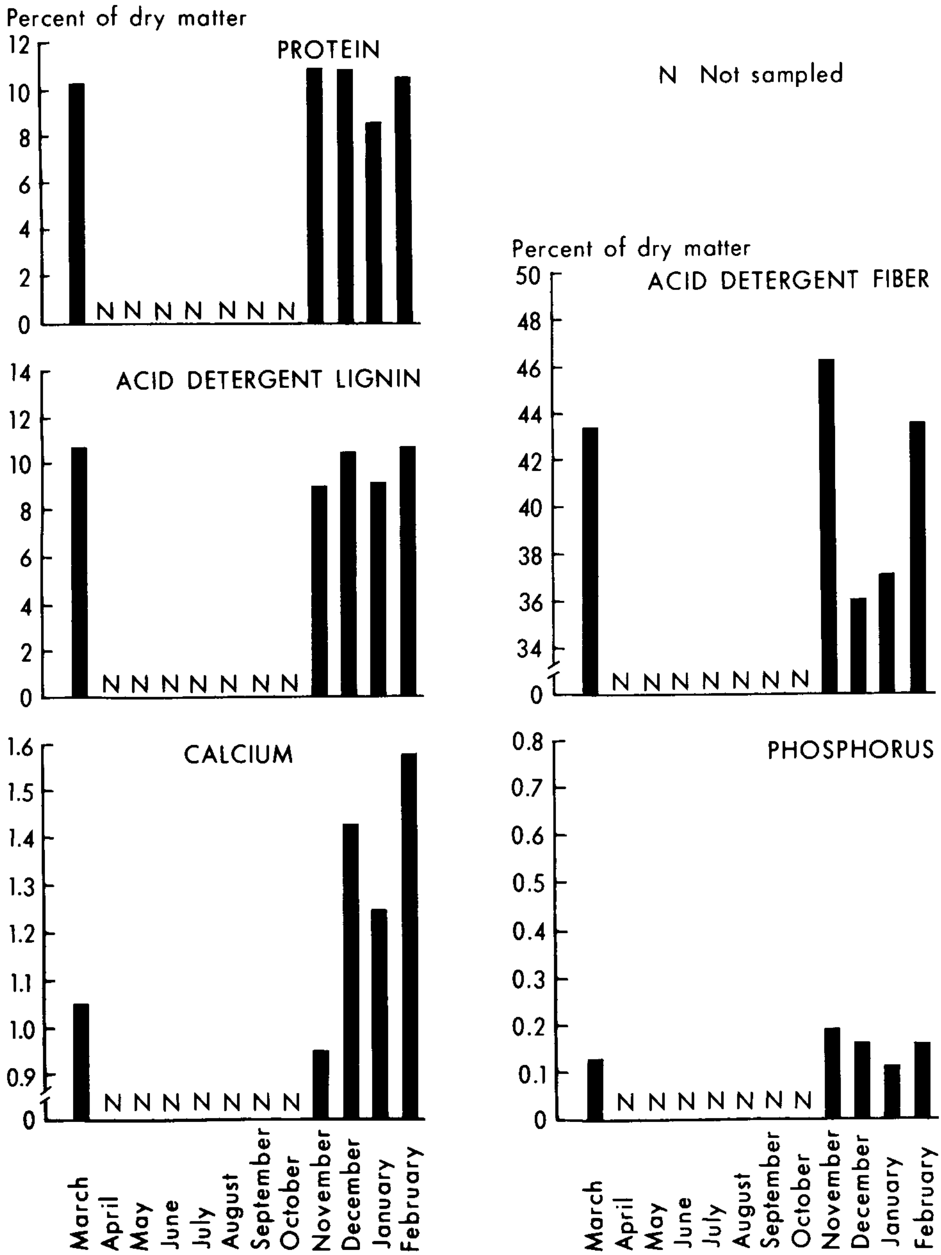
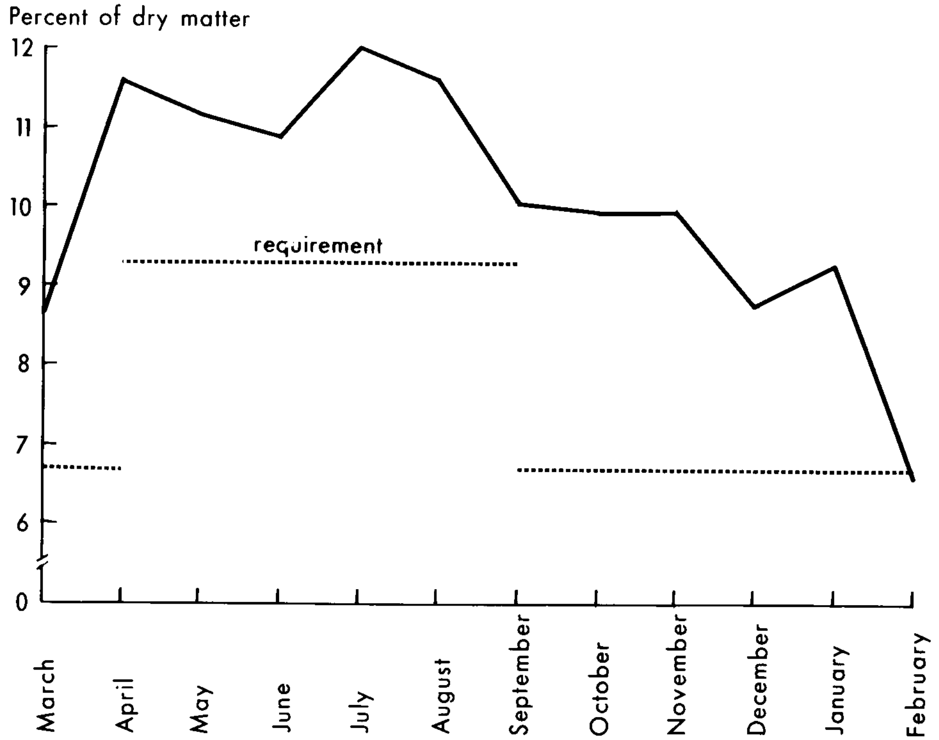


Fig. 10. Protein content of composite samples of cow diets at Jornada Experimental Range and beef cow requirements set by National Research Council



Protein of Composite Samples

The protein content of hand-plucked samples representing the diets of grazing cows equalled or exceeded National Research Council (10) requirements for beef cows during all months except February (see figure 10). The lowest protein values were 6.6 percent in February, 8.6 percent in March, 8.8 percent in December and 9.2 percent in January. October and November values were 9.9 percent. The values were 10.0 percent in September and 10.9 percent in June. The four other values (in April, May, July, and August) exceeded 11.0 percent with the highest value (12.0 percent) in July. If the diets had consisted of only grasses, protein would have been deficient for at least nine months of the year. Many samples of leatherweed croton, woolly paperflower, and russianthistle contained between 14 and 16 percent protein, and these forbs contributed considerably to the protein intake of the cows. Another source of protein was soaptree yucca leaves, which contained an average of more than 10 percent protein and were eaten during the winter months when the grasses were dormant.

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