TEXAS AGRICULTURAL EXPERIMENT STATION
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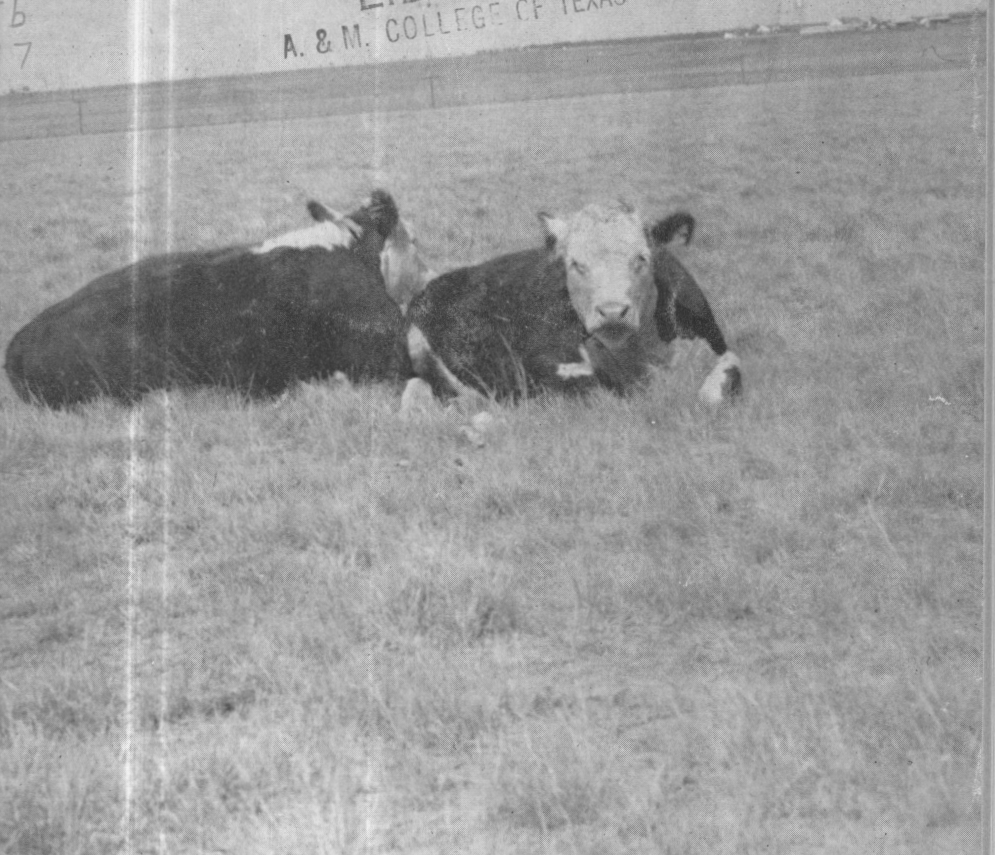
GRAZING STUDIES

ON THE AMARILLO CONSERVATION EXPERIMENT STATION

1943-49



in cooperation with the
UNITED STATES DEPARTMENT OF AGRICULTURE

The TEXAS AGRICULTURAL AND MECHANICAL COLLEGE SYSTEM
GIBB GILCHRIST, Chancellor

THE COVER PICTURE

Choice grade yearling steers are shown on summer pasturage at the Amarillo Conservation Experiment Station.

Fall-purchased steer calves which are well wintered, become grass fat by September, provided the pasturage is grazed according to conservation practices. This has been true even in dry years.

These studies on the Amarillo Conservation Experiment Station are carried on as a cooperative project between the Texas Agricultural Experiment Station and the Branch of Research, Soil Conservation Service, U. S. Department of Agriculture.

M20-1249-5M-L180

Preface

This bulletin gives a summary of the grazing studies made on the Amarillo Conservation Experiment Station from 1943 through 1949.

Investigations have been made of the grazing values of: (1) native blue grama-buffalograss pasturage; (2) seeded cool-season grasses, such as crested wheatgrass and western wheatgrass; and (3) temporary pasture crops, such as Sudan grass and winter wheat. Tables show the gains made from these various types of pasturage.

Forage production and the chemical composition during different seasons of the year for the important plants studied are also presented.

With favorable rainfall, a well balanced, year-round, green grazing program for this section of the Southern Great Plains may be had from a combination of the following pasturage: *winter*—winter wheat, crested wheatgrass and western wheatgrass; *spring*—crested wheatgrass, western wheatgrass, little barley and early weeds; *summer*—blue grama, buffalograss, Sudan grass and lake weeds; and *fall*—crested wheatgrass, western wheatgrass and winter wheat.

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GRAZING STUDIES ON THE AMARILLO CONSERVATION EXPERIMENT STATION

1943-49

CHARLES J. WHITFIELD, JOHN H. JONES and JOHN P. BAKER*

LIVESTOCK gains on heavy soils in the High Plains area are closely related to the kind and amount of feed available. One of the primary objectives of the grazing studies at the Amarillo Conservation Experiment Station has been the development of an all-year green pasturage system. Climate plays important roles in the availability of green pasturages in the Southern High Plains.

Plants that can grow throughout the year are being used in both permanent and temporary pastures on the Amarillo station. Cool-season grasses such as crested wheatgrass, western wheatgrass and Canada wild-rye, and small grains such as wheat, barley and rye provide fall, winter and spring grazing. Warm-season grasses such as blue grama, buffalograss, sideoats grama and Sudan are available in the late spring, summer and early fall.

The availability of this forage, however, is dependent on the amount and distribution of precipitation and on temperatures. Lack of moisture during the summer may limit the amount of forage produced (Table 1). Similarly, temperature and moisture

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Table 1. Monthly rainfall, 1939-48, at the Amarillo Conservation Experiment Station

Month	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	Average
January	2.36	.15	.03	.11	T	.76	.79	.55	.09	.15	.50
February	.05	.49	.19	.14	.....	.73	.16	.10	T	2.04	.39
March	.09	.09	1.81	.43	.05	T	.31	.29	.33	.55	.40
April	1.87	.68	1.17	4.78	.61	1.80	.63	.37	1.22	.29	1.34
May	1.17	4.15	5.66	.20	2.90	3.02	.36	1.03	5.64	3.32	2.74
June	4.13	1.13	4.05	1.22	2.12	3.52	1.55	2.03	2.03	2.25	2.40
July	1.42	.24	3.06	.58	5.26	2.66	1.30	.30	.84	1.88	1.75
August	2.99	.82	3.26	3.53	1.33	3.58	2.70	1.57	1.94	5.09	2.68
September	.11	.55	3.43	1.68	1.15	2.68	4.44	1.44	.26	1.18	1.69
October	1.04	.31	9.14	4.35	.05	.69	.68	7.23	.12	.83	2.44
November	.06	3.44	.21	.....	.18	1.22	T	.68	.97	2.79	.96
December	.79	.08	.55	1.48	3.41	1.03	.01	.29	.91	.01	.86
Total	16.08	12.13	32.56	18.50	17.06	21.69	12.93	15.88	14.35	20.38	18.15

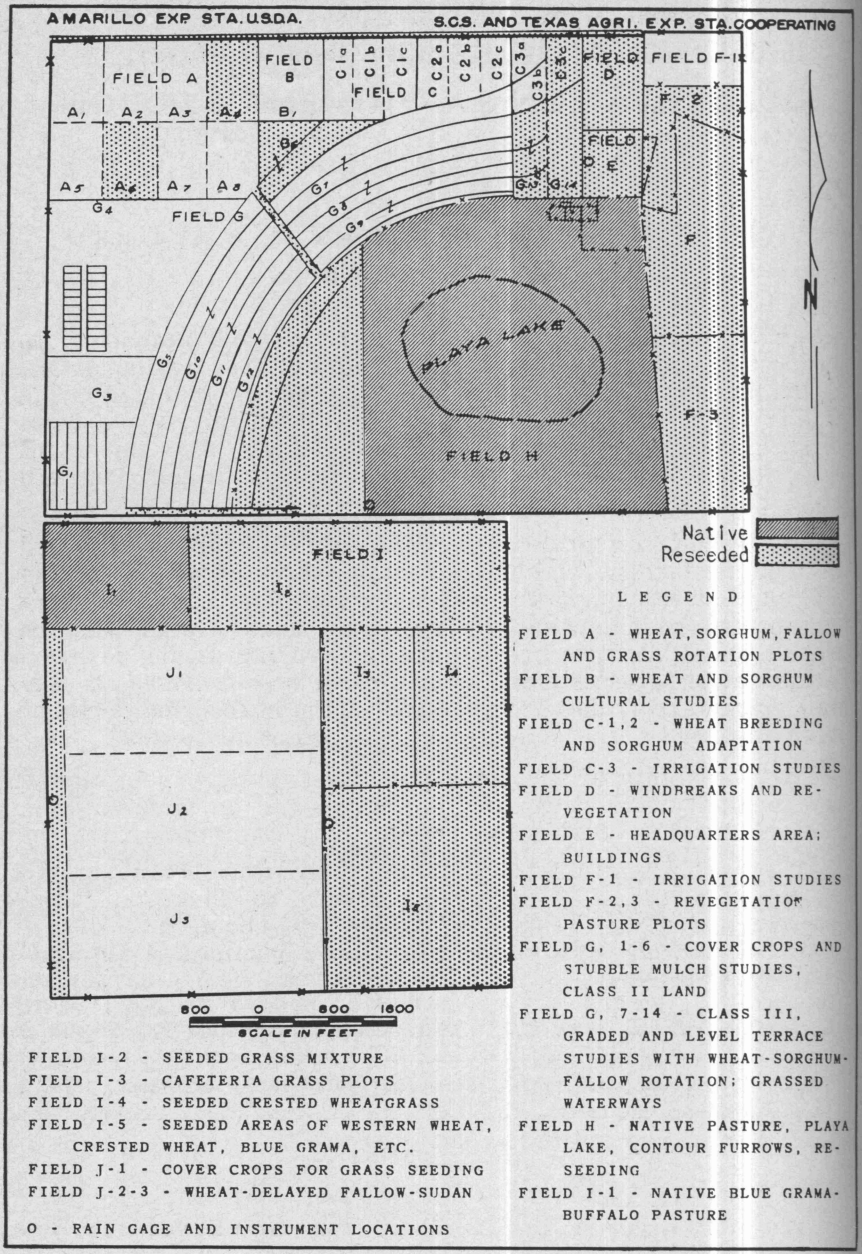

Figure 1. Land use on the Amarillo Conservation Experiment Station at the end of the 1949 season.

are important in the amount of growth made by the grasses and small grains in the colder months.

In 1940 and 1941, cool- and warm-season grass pastures were seeded on the Amarillo station (Figure 1). Studies were initiated in the fall of 1942 to test their effectiveness for erosion control and beef production and the use that could be made of winter wheat and Sudan as supplemental pastures for grazing.

In these investigations, two native and five seeded pastures, along with wheat and Sudan, were used from 1943 through 1949. They were grazed with Choice Hereford steer calves purchased in the fall from local ranchmen.

Winter grazing tests were conducted from November to April. In these tests, the principal studies were on wheat pasturage and grass and cake. The summer grazing tests were conducted from April to October, and were primarily comparisons between 44-acre native and seeded pastures and Sudan. The steers were weighed on the first of each month. Weights were obtained on two successive days at the start and close of each major test period, the average being used as the initial and final weight, respectively. Weights were taken on the fifteenth of the month when a change had to be made in pasturage.

Steers were sold when there was not enough grass in prospect to produce gain, or if continued grazing would be inconsistent with conservation practices. Each year, however, at least one group of 10 steers was provided with the best available feed throughout the summer in an attempt to produce grass-fattened yearling beef.

THE AMARILLO STATION

The station is in Potter and Randall counties, 14 miles west of Amarillo, Texas, on U. S. Highway No. 66. This is the west-central part of the Texas Panhandle. It is about the center of the Southern Great Plains, which includes portions of Colorado, Kansas, Oklahoma, New Mexico, and Texas. The Amarillo station is so situated with relation to the varied soils and climatic conditions of the Southern Great Plains that results of its research are applicable to a considerable portion of this territory. The 1,637 acres comprising the station were purchased in 1936. Improvements were started in 1938 and the first experiments were initiated in the fall of that year.

Climate and Soils

The station lies in the 15- to 20-inch rainfall belt, an area susceptible to both wind and water erosion. The annual precipitation averaged 18.15 inches for the 10-year period, 1939-48 (Table 1). The elevation is 3,825 feet; the growing season is about 200 days; the mean annual temperature is 57° F.; and in the spring, it is not unusual to have wind velocities of 30 to 35 miles per hour at vegetation height.

The predominant soil type in the station area is Pullman silty clay loam, a deep, fine-textured, slowly permeable soil, high in fertility, moderately high in organic matter under native conditions, a blocky clod structure, a slow rate of infiltration and a topsoil that crusts upon drying after rains. Other characteristics are: approximate thickness of surface soil 9 inches, subsoil 36 inches (the upper subsoil is about 26 inches); a high moisture-holding capacity, high wilting-coefficient, moderately susceptible to wind erosion, and slightly susceptible to water erosion; susceptible to forming plow-sole, and is slightly acid with a pH of 6.5 to 7.0. Other soils of importance are Lofton silty clay loam, also a deep, fine-textured slowly permeable to very slowly permeable soil, and Randall clay, the lakebed soil.

The soil on the station is fairly typical of the deep, heavy soils of the Southern High Plains. There are, in this region, about 11,750,000 acres of deep soils intermixed with shallow soils, deep moderately sandy soils and rough broken land, from the southern limits of Lubbock county, Texas, Curry and Quay counties of Eastern New Mexico, and as far north as Ford county, Kansas.

Other Conditions

The surface of the High Plains is dotted with numerous enclosed flat-bottomed depressions, the low parts of which are occupied by intermittent lakes, or playas. One such area, 110 acres in size, is on the station. These depressions reach a maximum size of several square miles. Most of them consist of three parts: (1) a central low flat occupied by an intermittent lakebed constituting from one-fourth to one-half of the total area of the depression; (2) a surrounding concentric poorly drained flat usually known as "second bottom"; and (3) an outer surrounding slope from one-eighth to one-fourth mile wide with a gradient sufficiently steep to encourage some water erosion.

Slopes vary on the Amarillo station from 0 to 3 percent. The land, with slopes from 0-1 percent, is suitable for cultivation with moderate intensity of practices, which include stubble mulch tillage, seeding on the contour, successive deep to shallow cultivation through each season and the use of a flexible cropping system. On the slopes of 1 to 3 percent, the land is suitable for cultivation with intensive practices. These are the same as those listed for the 0 to 1 percent slope, with terraces for gully control, permanent guides for contouring and avoiding of fallow when there is insufficient residue. The cultivated land on the station is about equally divided between 0 to 1 and 1 to 3 percent slopes.

About 70 percent of the Southern High Plains is cultivated; the remainder is in pasture and range land. The principal crops are wheat, sorghum, grass and cotton. No cotton is grown on the Amarillo station as it is north of the cotton belt.

RESULTS

Results are presented of (1) summer grazing tests on native and seeded pastures, (2) two methods of wintering steer calves, (3) mineral and chemical composition of the principal forages and (4) forage yields.

Summer Grazing Tests on Native Pastures

Native pasturage on the Amarillo station, typical of High Plains vegetation, is represented by Field I-1, a 44-acre level upland site dominated by blue grama and buffalograss (Figure 2). Ten yearling steers on this pasture made an average gain of

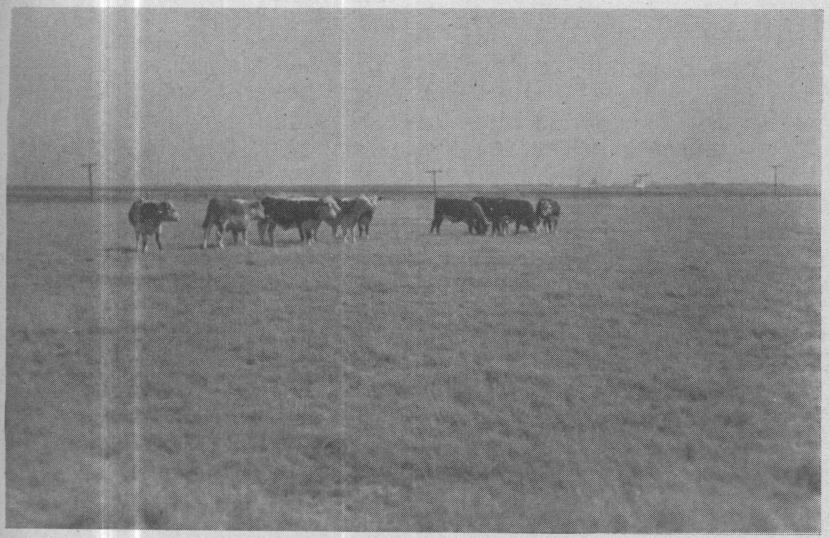

Figure 2. Steers grazing native blue grama-buffalograss, Pasture I-1.

239 pounds per head in 167 days in 1943, 221 pounds in 213 days in 1944 and 231 pounds in 163 days in 1945. The yearlings used each year had been well-wintered as calves. They gained from 662 to 901 pounds in 1943, from 626 to 847 pounds in 1944 and from 641 to 872 pounds in 1945.

The total gains were similar for the 3 years (Table 2). The highest daily gains were in April and May, or just after the steers came off winter pastures and during the period of rapid spring growth. After 1945, limited grazing tests indicated similar trends in beef gains.

Native lake pasture. The lake pasture H is a 311-acre field, 110 acres of which is an intermittent or "wet weather lake," which is well protected in dry weather by weeds and remnants of buffalograss and western wheatgrass. Of the remaining acreage, 140 acres is primarily native blue grama, buffalograss and western wheatgrass (Figure 3). Sixty-one acres of cul-

Table 2. Steer gains on native blue grama and buffalograss, Pasture I-1

Month	Average daily gain in pounds per head				Average
	1943	1944	1945	1949	
April	2.13	1.60	1.97	.....	1.90
May	1.48	2.27	1.97	2.2	1.98
June	.92	1.22	1.36	.94	1.11
July	1.33	1.71	1.19	1.27	1.37
August	2.12	1.05	1.14	.....	1.43
September	.60	1.07	1.28	.....	.98
Days grazed	167	183	163	92	151
Gain per head	239	271	231	136	219
Daily gain	1.43	1.48	1.41	1.47	1.45

tivated land on the west side of this pasture were reseeded to grass in 1944. A good stand had developed by 1947.

Pasture H is not comparable with other station pastures because of its size and diversity of vegetation. It is typical of conditions on large acreages over the Southern Great Plains, and the steer gains pretty well show what may be expected from an abundance of forage and a variety of species. The dominant plants found in this field include blue grama, buffalograss, western wheatgrass, barnyard grass, spiked rush, spotted primrose, bur ragweed, wedge-leaf fogfruit and weedy mallow. This pasture has been kept in practically continuous light use.

The results from grazing for six summers indicate a high rate of gain (Table 3). Along with good gains, the steers on the lake pasture had good finish, especially in 1943 and 1944 when weeds were abundant. Results from pastures I-1 and H show that fat

Figure 3. Native lake pasture H, the station headquarters in the background.

Table 3. Steer gains on native lake pasture, pasture H

Month	Average daily gain in pounds per head							Average
	1943	1944	1945	1946	1947	1948	1949	
April	2.61	1.75	1.99	1.49	2.29	1.75	.67	1.79
May	2.39	2.03	1.99	2.40	2.62	2.42	1.42	2.18
June	1.21	1.48	1.83	1.40	.....	2.32	.....	1.64
July	.64	1.37	1.58	2.10	.59	2.25	.....	1.42
August	1.46	1.31	.47	1.49	1.31	1.10	.....	1.19
September	2.49	1.45	1.65	1.13	1.34	2.59	.....	1.77
October	.....	2.03	1.85	.....	.....	.62	.....	1.50
Days grazed	167	213	163	183	153	218	53	164
Gains per head	301	347	264	305	249	395	59	274
Daily gain	1.80	1.63	1.62	1.67	1.63	1.81	1.11	1.61

900- to 950-pound yearlings cannot be produced from pasturage alone, unless it is abundant and high in quality.

Summer Grazing Tests on Seeded Pastures

Three seeded pastures have been outstanding for soil protection, steer gains and seed production. These are pasture F, western wheatgrass and Canada wild-rye; pasture I-2, a mixture predominated by western wheatgrass and blue grama; and pasture I-4, crested wheatgrass.

Pasture F is a 44-acre field, 31 acres of which were planted to western wheatgrass and 13 acres to Canada wild-rye. Steer gains from this pasture were good, giving a higher average daily gain than pasture I-1, the native short-grass field (Table 4). Canada wild-rye has not held up as well as western wheatgrass, probably because livestock prefer it, especially in the late spring and early summer. Western wheatgrass is grazed readily, especially in early spring (Figure 4). As it matures, it becomes less desirable forage, but will continue to be grazed if prevented by adequate stocking from making a rank growth.

Pasture I-2. The following mixture was seeded in 1940 and 1941 on the east half of this field at the rate of 15 pounds per acre: blue grama, sideoats grama, buffalograss, western wheatgross, Canada wild-rye, sand dropseed and weeping lovegrass. By 1943, when the pasture was first placed under regular use, it had become primarily western wheatgrass and blue grama.

Table 4. Steer gains on seeded western wheatgrass and Canada wild-rye

Month	Average daily gain in pounds per head							Average
	1943	1944	1945	1946	1947	1948	1949	
April	1.94	1.71	1.35	1.65	1.90	2.10	.....	1.77
May	1.45	1.40	1.35	.....	2.27	2.11	1.20	1.63
June	.05	2.03	2.07	.....	2.05	.....	.....	1.55
July	.....	1.40	.....	.....	.60	.....	.....	1.00
August	.....	1.02	.....	.....	.....	.....	.....	1.02
September	.....	.....	.....	.....	.....	.....	.....	.....
October	.....	.74	.....	.....	.....	.....	.....	.74
Days of grazing	84	184	71	30	106	61	31	81
Gains per head	96	254	117	50	198	128	37	125
Daily gain	1.14	1.38	1.65	1.65	1.87	2.10	1.20	1.57

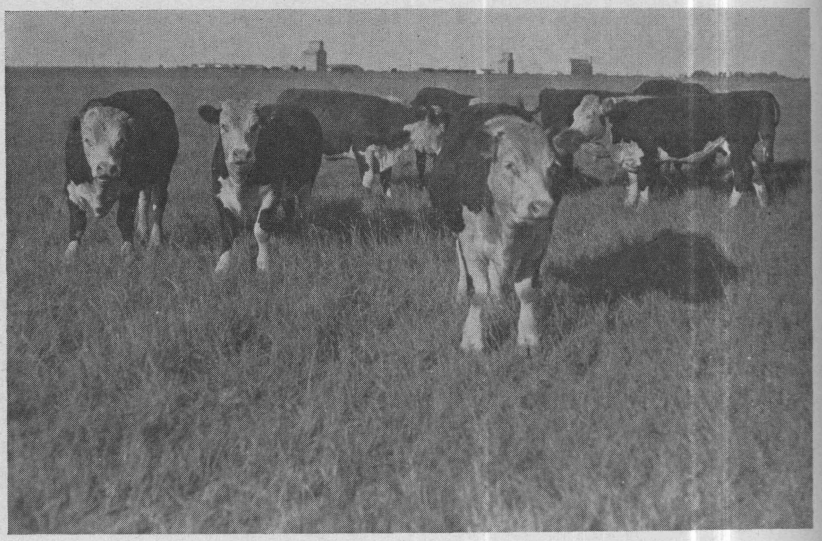

Figure 4. Steers grazing western wheatgrass, pasture F.

Beef production from this pasture was varied, but gains have been good in the spring and early summer (Table 5). Definite relationships are found to occur between climate, forage and beef production. Summer gains were good in 1943 and excellent in 1944, when yearling steers became grass fat. Gains were lower in 1945 and the steers did not get as fat as those on pasture I-1, which had native blue grama and buffalograss. The pasture was hard hit by the 1945 drouth and summer usage. With the drouth continuing in 1946, it was grazed only in April. It made good recovery after October 1946 rains, and in 1947 was again productive. Growth and utilization of western wheatgrass was much the same in 1944 and 1947. Seed crops were produced both years, and also in 1949.

Pasture I-4. This 44-acre field was seeded to crested wheatgrass at a rate of 10 pounds per acre in October 1944. A good stand was obtained and 10 yearling steers were placed on the

Table 5. Steer gains on seeded western wheatgrass and blue grama

Month	Average daily gain in pounds per head							Average
	1943	1944	1945	1946	1947	1948	1949	
April	.....	1.98	2.13	1.99	2.93	2.42	.....	2.29
May	.....	2.40	2.13	.....	2.63	2.10	.....	2.32
June	.....	1.33	1.88	.....	2.25	1.62	.....	1.77
July	1.52	1.65	1.19	.....	1.19	1.60	.....	1.43
August	1.75	1.31	.47	.....	.....	.....	.....	1.18
September	1.33	1.20	1.01	.....	.....	.....	.....	1.18
October	.....	.26	.....	.....	.....	.....	.....	.26
Days of grazing	92	213	163	30	122	122	.....	124
Gains per head	141	310	228	59	273	240	.....	209
Daily gain	1.53	1.46	1.40	1.99	2.24	1.96	.....	1.76

Table 6. Steer gains on crested wheatgrass, pasture I-4

Month	Average daily gain in pounds per head					Average
	1945	1946	1947	1948	1949	
April	3.00	2.02	3.03	2.66	2.65*	2.67
May	3.00	.....	3.02	.....	2.30	2.77
June	1.58	.....	1.73	.....	1.90	1.74
July	.....	2.14	.....	.....	.....	2.14
Days of grazing	71	44	91	30	91	65
Gains per head	170	91	237	80	208	157
Daily gain	2.39	2.05	2.60	2.66	2.29	2.40

*44 head.

pasture April 21, 1945. Good to excellent beef gains have been recorded from this pasture (Table 6). In favorable years, it has been the practice on the station to remove livestock from this field at the end of June to let the grass produce seed. Good seed crops were harvested in 1947 and 1949. This field produced 303 pounds of seed per acre in 1947, in addition to 54 pounds of steer gain in 3 months of grazing. An average of 436 pounds of seed per acre was harvested from adjoining areas which were not grazed during the year.

Crested wheatgrass has proved to be highly satisfactory as an introduced cool-season grass on the station (Figure 5). It is easy to establish, and is high in both quality and quantity of forage. Stands established at other points over the Southern Great Plains indicate that it is doing well.

Weeping Lovegrass. Weeping lovegrass has been seeded in pure stands and in mixtures on the Amarillo station. Although

Figure 5. Crested wheatgrass on the Amarillo station.

it is a good erosion control plant, grazing values have varied widely. In mixed seedings, it has not withstood competition with other species. When making good growth in either spring or fall, it shows good to high values for protein and phosphorus; yet, its long fibrous leaves and lack of succulence tend to make it less palatable than most other grasses under test. In one field, 65 percent of the stand established in 1944 died out in the summer of 1946. The chief cause for the loss appeared to be the severe drouth of 1945-46.

Summer Grazing Tests on Temporary Pasturage

Sudan grass has been used in the Southern Great Plains for nearly 40 years. During the studies on the Amarillo station, various acreages have been planted from year to year for summer supplemental pasturage. Sudan grass may afford green forage high in protein during periods which are critical for native and seeded grass pastures. Cattle, when shifted to Sudan grass, ordinarily make good rates of gain (Table 7).

Table 7. Steer gains on Sudan grass

Month	Average daily gain in pounds per head						Average
	1943	1944	1945	1946	1947	1948	
July	1.53	.....	.....	3.59	1.68	.66	1.86
August	.93	2.13	.....	1.70	2.02	1.82	1.72
September	1.84	.70	.....	.....	1.34	1.38	1.31
Average	1.43	1.41	.....	2.64	1.68	1.28	1.68

Sudan, planted in 42-inch rows in 1947, produced about 50 percent more forage than Sudan drilled in 10-inch rows. In addition, protein content was about 30 percent greater for the plants in the wider-spaced rows. Wider-spaced plantings will probably give better results year after year.

Winter Grazing Tests

Winter wheat forage is highly valued for pasturage. Wheat makes considerable forage growth during mild winters with favorable moisture, but makes little growth during drouth or long periods of severe cold. In the seven wintering periods, 1942-43 to 1948-49, winter wheat supplied grazing throughout the winter for only 2 years, about half of the time for 3 years, and no grazing at all for the other 2 years. Livestock are usually kept on wheat as long as it can be grazed without reducing grain yields. This varies from mid-February through March, according to growing conditions, but as a rule for best grain production, it is best to get off of wheat not later than March 15 for medium maturing wheat, and not later than March 1 for early maturing wheat, according to studies at the station. In two winters, 1945-46 and 1946-47, plots clipped to simulate grazing produced about half a ton more green weight per acre than unclipped plots. There was nearly twice as much production

from unclipped plots in 1945-46 as in 1946-47. The average production of green weight per acre for the 2 years was about three tons.

Table 8. Daily gains in pounds per head of steer calves on winter wheat and grass plus 2 pounds of 41 or 43 percent protein cottonseed cake

Year	Daily gain in pounds per head	
	Winter wheat	Grass plus cake
1942-43	1.23	....
1943-44	none	0.84
1944-45	1.44	0.99
1945-46	1.45	0.78
1946-47	1.23	1.47
1947-48	none	0.90
1948-49*	1.14	0.49
Average	1.30	0.78

*1948-49 results are for long yearlings.

Gains of livestock on winter wheat have been higher than gains on grass and cake (Table 8), except during the winter of 1946-47. On the other hand, grass calves have tended to make higher summer gains than the wheat-pastured calves, but in no instance quite equalled the latter in weight or finish in the fall.

PROTEIN AND MINERAL CONTENT OF FORAGES

Samples of the principal forage plants on the station were analyzed for crude protein, lime and phosphoric acid. The samples, clipped at different dates, represented the forage available for grazing. Analyses based on air-dry weight are shown in Table 9. The results for buffalograss are not presented since numerous analyses have shown that blue grama and buffalograss are similar in chemical composition.

Blue grama may be either good or rather poor in protein and phosphorus, depending on moisture received during the growing season. Dead or "carry-over" grass in winter or spring is low in protein and phosphorus. Many of the samples clipped through the year showed low values because of the factor of dead grass. Except when dry or mature, western wheatgrass shows relatively high values for protein and phosphorus in all seasons. Green crested wheatgrass and winter wheat show very high values. Weeping lovegrass, from the standpoint of chemical composition, seems to be as good as blue grama, yet, it is not palatable when mature. All of the grasses showed adequate to high content of lime.[1]

Grasses and other plants which make up the animal's supply of forage may vary widely in feed value between seasons (Table 10). However, with good growing conditions, the forage plants which grow in the region may furnish good feed for livestock

[1]Grasses, basis air-dry weight, are considered adequate in lime (CaO) at 0.35 percent; phosphoric acid (P_2O_5) at 0.27 percent, and crude protein 6.0 percent. Bulletin 644, TAES, 1944.

Table 9. Percentage crude protein and mineral content of grasses by seasons 1943-49

Date sampled	Blue grama grass			Western wheatgrass			Crested wheatgrass			Weeping lovegrass		
	Crude protein	CaO[1]	P_2O_5[2]	Crude protein	CaO	P_2O_5	Crude protein	CaO	P_2O_5	Crude protein	CaO	P_2O_5
Winter												
1/9/48	6.50	.48	.18	.....	.....	.....	7.08	.37	.39	.....	.....	.....
1/10/47	6.45	.41	.24	11.40	.51	.34	23.19	.71	.58	8.35	.50	.28
1/30/46	4.91	.38	.21	4.45	.56	.18	10.93	.64	.34	6.07	.55	.24
2/4/47	7.65	.50	.23	11.37	.70	.34	26.15	.91	.63	9.16	.51	.29
2/12/45	4.22	.31	.19	5.25	.39	.23	.....	.....	.....	3.44	.34	.19
2/21/44	3.98	.27	.17	4.96	.28	.18	.....	.....	.....	4.15	.32	.16
3/1/46	4.89	.40	.17	6.20	.44	.24	13.92	.58	.40	5.75	.59	.17
3/4/47	7.06	.41	.21	10.36	.61	.32	26.73	.80	.67	6.98	.51	.25
3/22/48	6.00	.21	.10	4.80	.22	.10	9.18	.25	.16	.....	.....	.....
Average	5.74	.37	.18	7.34	.46	.24	16.74	.60	.45	6.27	.47	.22
Spring												
4/1/47	6.61	.40	.19	18.29	.51	.50	33.15	.61	.89	9.12	.41	.21
4/2/46	4.85	.43	.16	7.35	.45	.23	18.03	.67	.53	7.28	.52	.19
4/5/49	2.50	.57	.12	4.20	.57	.23	13.80	.83	.50	.....	.....	.....
4/15/44	4.44	.37	.19	11.30	.46	.40	.....	.....	.....	5.05	.37	.22
4/29/48	10.70	.39	.17	9.79	.35	.16	12.20	.57	.18	.....	.....	.....
4/30/46	5.51	.38	.21	6.10	.54	.22	13.64	.64	.40	6.97	.49	.20
5/2/47	17.31	.56	.48	15.08	.39	.48	22.42	.50	.67	11.28	.57	.32
5/17/49	7.17	.45	.42	9.55	.39	.45	15.40	.59	.73	.....	.....	.....
5/18/45	6.18	.29	.26	9.21	.41	.35	.....	.....	.....	12.10	.62	.44
5/27/48	8.94	.57	.31	9.46	.40	.33	14.07	.45	.47	.....	.....	.....
5/31/46	5.62	.39	.23	7.71	.41	.27	18.63	.49	.59	7.51	.53	.27
6/3/47	10.25	.56	.51	10.50	.37	.48	11.20	.38	.66	8.02	.37	.48
6/6/49	5.93	.39	.41	6.35	.27	.41	10.10	.40	.63	6.30	.36	.47
6/28/48	8.58	.51	.44	8.72	.56	.25	13.10	.45	.40	.....	.....	.....
Average	7.47	.44	.29	9.54	.42	.34	16.31	.54	.55	8.18	.47	.31
Summer												
7/1/47	8.24	.37	.39	7.55	.42	.34	7.08	.37	.39	4.75	.47	.27
7/1/46	7.69	.43	.30	9.75	.46	.31	24.34	.66	.65	6.41	.57	.27
7/5/49	.....	.....	.....	4.20	.41	.29	6.20	.41	.46	.....	.....	.....
7/30/47	8.20	.70	.35	6.00	.32	.25	6.30	.32	.32	3.90	.39	.24
8/2/45	5.85	.38	.28	7.49	.47	.31	.....	.....	.....	6.94	.50	.30
8/2/44	6.45	.49	.46	8.39	.40	.38	.....	.....	.....	6.79	.47	.34
8/23/43	6.29	.49	.40	11.26	.51	.38	.....	.....	.....	8.82	.57	.32
8/29/47	7.60	.56	.34	5.15	.30	.22	4.18	.25	.20	3.85	.40	.22
8/30/48	13.20	.60	.73	10.80	.64	.50	6.89	.40	.24	.....	.....	.....

8/30/46	7.34	.39	.30	9.07	.44	.32	21.81	.63	.57	11.76	.58	.44
9/30/46	8.35	.40	.30	10.05	.40	.30	22.11	.73	.59	7.38	.52	.28
Average	7.92	.48	.38	8.15	.43	.32	12.36	.47	.42	6.73	.49	.29
Fall												
10/3/45	7.76	.44	.37	15.62	.48	.43	18.14	.53	.52	11.99	.50	.30
10/5/44	5.03	.31	.30	8.12	.36	.30	.....	.....	.....	8.12	.43	.29
10/6/47	6.30	.55	.29	5.42	.36	.22	4.20	.28	.21	2.70	.42	.14
10/8/43	5.05	.34	.29	8.32	.44	.31	.....	.....	.....	5.64	.50	.24
10/15/46	9.62	.59	.35	16.30	.51	.52	24.20	.71	.77	10.06	.51	.38
11/1/46	9.25	.43	.36	19.00	.60	.53	23.30	.65	.79	12.99	.59	.45
11/4/47	6.80	.44	.22	5.75	.31	.21	4.20	.27	.15	4.25	.72	.16
11/29/46	7.61	.44	.29	15.50	.54	.51	20.51	.70	.72	7.60	.54	.30
12/13/48	2.20	.53	.16	3.45	.49	.20	9.07	.65	.37	.....	.....	.....
Average	6.62	.45	.29	10.83	.45	.35	14.80	.54	.50	7.91	.52	.28
Average all analyses	7.02	.44	.29	9.03	.43	.32	15.16	.54	.49	7.31	.49	.28

[1]To convert lime (CaO) to calcium (Ca) multiply value for CaO by .7147.
[2]To convert phosphoric acid (P_2O_5) to phosphorus (P) multiply value for P_2O_5 by .4368.

Table 10. Extremes in crude protein, lime and phosphoric acid content of forage, 1943-49

Description of sample	Date sampled	Crude protein	Lime	Phosphoric acid
Blue grama:				
55% green; 45% cured	5/2/47	17.31	.56	.48
2% green; 98% cured	12/13/48	2.20	.53	.16
Crested wheatgrass:				
65% green; 35% cured	4/1/47	33.15	.61	.89
24% green; 76% cured	8/29/47	4.18	.25	.20
Western wheatgrass:				
90% green; 10% cured	11/1/46	19.00	.60	.53
12% green; 88% cured	12/13/48	3.45	.49	.20
Weeping lovegrass:				
85% green; 15% cured	11/1/46	12.99	.59	.45
47% green; 53% cured	10/6/47	2.70	.42	.14
Winter wheat:				
60% green; 40% cured	3/4/47	27.72	.50	.58
60% green; 40% cured	5/31/46	8.74	.28	.45
Highest values found for other forages consumed by steers:				
Canada wild-rye, green	4/27/43	21.38	.65	.52
Sweet Sudan, 80% green	7/30/47	20.15	.69	.70
Little barley, green	5/18/45	13.70	.30	.55
False ragweed, green	6/3/47	14.38	2.38	.95
Weedy mallow, green	7/1/46	10.20	3.01	.55
Wedgeleaf fogfruit, 75% green	7/1/46	6.40	6.04	.73
Russian thistle, green	5/2/47	21.29	4.25	.78

the year-round. Native blue grama and buffalograss are the foundation summer grasses and may furnish year-round feed. Western wheatgrass, either native or seeded, is a valuable supplementary grass and may furnish both winter and summer feed. Seeded crested wheatgrass is rich in protein and phosphorus until maturity. Although a cool-season grass, it apparently greens up at any season moisture is available. Lakeweeds are high in protein and phosphorus and very high in lime. Russian thistle, likewise, shows high feed values when young and growing. Sudan grass is characterized by high feed values in midsummer, except in years of high rainfall during the growing season.

FORAGE PRODUCTION OF NATIVE AND SEEDED GRASSES

Forage production of various grasses is closely related to the amount and distribution of precipitation. Heavy fall moisture in 1946 greatly stimulated production of crested wheatgrass and western wheatgrass in 1947, but did not have much effect on the short grasses. Good moisture during the growing season increases production of blue grama and buffalograss (Table 11).

Table 11. Forage production, pounds of air-dry forage per acre, 1943-48

Pasture	Forage species	1943	1944	1945	1946	1947	1948
I-1	Native blue grama-buffalograss	664	1,354	629	242	321	716
Bush	Overgrazed blue grama-buffalograss	.....	.....	447	174	.....	.....
F	Seeded Canada wild ryegrass	920	1,135	307	.....	.....	.....
F	Seeded western wheatgrass	667	1,542	207	328	1,669	742
I-4	Seeded crested wheatgrass	.....	.....	506	546	2,244	641
F-2	Seeded weeping lovegrass	.....	.....	.....	962	1,263	.....

Clippings were made April 1, and November 1, at a height of 1 inch, except for weeping lovegrass which was clipped at 2 inches.

Forage Growth and Pasture Management

Detailed studies of blue grama and buffalograss on pasture I-1 indicated that the major growth period for unclipped plants was from April to June. With unclipped plants, natural decay or dying back from June to August practically equalled the growth made from April to June. There was very little growth from August to November, and there was only 6 percent more forage on November 1 than on April 1.

The major growth period for clipped plants was from April to June. There was only about 50 percent as much growth from June to August and only about 25 percent as much growth from August to November as from April to June.

The growth of grasses may be used as a guide in their usage. In a conservation program, it appears that saved pasturage may be grazed heavily in the spring, otherwise old plants will produce little in the growing season. It is evident that plants closely grazed the preceding year cannot be heavily used the succeeding spring.

Blue grama-buffalograss pastures are dependable sources of summer feed. The wheatgrasses definitely have a place in early spring and fall grazing. Native blue grama-buffalograss pastures may also furnish early spring pasturage in years favorable to little barley. On June 1, 1944, the I-1 pasture had 961 pounds per acre of little barley, but there were only traces of this grass in the November clippings. Little barley must be used in season or its forage is lost to cattle. This plant also competes strongly for moisture and may harm the growth of the summer grasses.

Cattle are selective in grazing and grass growth is affected not only by grazing but by season and the supply of moisture. Thus, with variable growth and natural decay, in addition to grazing and trampling, conservative usage of pasturage is indicated.

PRACTICAL APPLICATION OF THE RESULTS

The Amarillo station grazing experiments show that, with favorable rainfall, year-round green feed may be realized from a combination of the following pasturages:

SEASON	PASTURAGE
Winter	Winter wheat Crested wheatgrass Western wheatgrass Canada wild-rye
Spring	Crested wheatgrass Western wheatgrass Canada wild-rye Little barley Early weeds
Summer	Blue grama Buffalograss Sudan grass Lake weeds

Fall	**Crested wheatgrass**
	Western wheatgrass
	Canada wild-rye
	Winter wheat

Under ideal conditions, the cool-season grasses—crested and western wheatgrass—bridge the gap between wheat pasturage and the summer grasses in both spring and fall. The cool-season grasses are able to use late fall moisture which the summer grasses cannot use because of cold weather.

Winter wheat and cool-season grasses cannot be relied upon to make much growth in winter because of the short days and the cold. However, given moisture and freedom from excessive cold, a great deal of valuable pasturage is produced. Excessive trampling and grazing must be avoided as such treatment may result in losses from wind erosion.

It is desirable to have a green pasture to keep steers gaining after they are taken off the wheat fields, March 1. Crested wheatgrass and western wheatgrass have proved to be adapted to this purpose and for fall grazing. These grasses were also used in mid-summer during drouths.

Blue grama and buffalograss native pasture may sustain steer gains throughout the summer. Seeded blue grama and buffalograss and western wheatgrass pastures equaled or exceeded native pastures in the production of steer gain. Native or seeded pastures produced little steer gain in the fall except under unusual conditions. Values of all the pasturages for beef production varied each year with climatic conditions during good and drouth years.

A flexible program of grazing, which will provide ample forage during good seasons and leave enough carry-over grass for emergencies, is desirable. Grazing management was based on the idea of keeping plenty of forage before the steers, then removing them before the pastures were stripped. Flexibility in the grazing program is necessary because recurrent drouths reduce the capacity of the pastures and quick advantage should be taken of favorable years.

The Amarillo station practice is to buy Choice feeder steer calves, winter feed them well and put on good early spring gains, even at the expense of grazing out small acreages of wheat. Then, if summer feed is not in sight, sharply reduce the numbers by sale. In addition, steers are not held over the winter, nor calves bought unless there is ample pasturage and bundle feed. Over a period of years, the number of cattle that can be handled without injury to the pasturage and with maximum returns is gained by experience.

Drouths of two successive growing seasons should be expected, and plans laid in advance. Under semi-arid conditions, native and seeded pastures which are heavily used quickly lose their vigor and fail to respond to moisture. On the other hand, an accu-

mulation of carry-over grass beyond the need for soil protection and emergency use results in scant growth of new forage, and forage of low food value. Western wheatgrass and crested wheatgrass permitted to reach maturity become weathered hay of low palatability and food value. Heavy use keeps the forage green as long as moisture is available. Light use permits some of the grass to cure, weather and lose food value, but the vigor of the pasture is maintained; cattle are able to select the best feed and make high gains. The extent to use pastures, thus, becomes a matter of judgment; but over a period of years, light to moderate use is indicated.

Evidence of the need for a rest period for the storage of root reserves was found in the failure of Canada wild ryegrass and some weeping lovegrass to come through the 1945-46 drouth under grazing; also, in the failure of pastures I-1 and I-2 East to furnish any appreciable amount of feed in 1946 after 3 summers of moderate to heavy use.

Carrying through fewer good quality steers with maximum gains makes a reduction in number possible without any heavy loss. It is significant that in 1947, a dry year, very high gains were realized per steer. It is only through light use that maximum gains per steer can be realized from pasturage.