Mechanical and Chemical Range Renovation in Southeastern Wyoming

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Highlight: *Range renovation by strip spraying atrazine, pitting, and a combination of the two treatments was evaluated at the Archer Substation near Cheyenne, Wyoming. Perennial grasses plus sedges produced significantly more on the renovation treatments than on the check. Blue grama was more vigorous, remained green later into the season, and was more available for livestock use on the plots strip sprayed with atrazine than on the pitted or check treatments. Forage yields and composition were influenced by years and by amount and distribution of the April, May, and June precipitation.*

Range renovation has been defined as "the improving of rangeland by discing or other mechanical means" (Huss, 1964). Rangelands have been improved by managing grazing; controlling undesirable species such as sagebrush, cacti, and poisonous plants; and by using chemicals. Fertilization of some range sites has proved beneficial by increasing forage production and changing the species composition.

Pitting, furrowing, and ripping are the mechanical renovation methods most widely accepted in the Great Plains. At the Archer Substation in southeastern Wyoming, over a 24-year period (1942-1965), pitted pastures were stocked 25% heavier than moderately grazed non-pitted pastures (Rauzi, 1968). Branson et al, (1966) stated that factors related to soil moisture capacity are the most important determinants of success of mechanical treatment. They also pointed out that medium to medium fine textured soils are the most suitable for mechanical treatments. According to Wight and Siddoway (1972), surface modification increased plant growth and precipitation use efficiency by increasing the plant-available water, changing the species composition, and increasing the nutrient supply. They also stated that the effectiveness of a surface modification treatment depends on site and vegetation characteristics.

Rangelands that have been mechanically treated must be properly managed to obtain maximum benefits. Renovation may be of little or no benefit with certain site and climatic conditions.

The purpose of this study was to compare forage production and composition as affected by range pitting with and without a herbicide applied in strips, and a herbicide applied in strips with no other treatment.

Methods

The study area was in southeastern Wyoming at the Archer Substation, approximately 10 miles east of Cheyenne, at an altitude of about 6,100 ft. The soil on the experimental area is a Ascalon fine sandy loam, a member of the fine loamy, mixed mesic family of Aridic Argiustolls formed by fluvial outwash.

The native vegetation is characteristic of the shortgrass plains. Blue grama (*Bouteloua gracilis*) and buffalograss (*Buchloe dactyloides*) are the principal species. Midgrasses include western wheatgrass (*Agropyron smithii*), needle-andthread (*Stipa comata*), and Junegrass (*Koeleria cristata*). Sandberg bluegrass (*Poa secunda*) is scattered throughout the area. Grasslike plants include both needle-leaf sedge (*Carex eleochris*) and thread-leaf sedge (*Carex filifolia*). The abundance of annual grasses and forbs common to the area is largely determined by the prevailing weather.

In early April, 1967, replicated plots 25 x 100 ft were established in a randomized block design. Approximately one-half of the experimental area is nearly level; the slope of the other half ranges from 1% to 3%. Twenty pounds per acre of active atrazine was applied in strips on six plots with a tractor-mounted spray boom. The sprayed strips were 7 inches wide with 15 inches of nonsprayed area between strips. Three of the atrazine-treated plots were pitted parallel with the sprayed strips. Pitting was done with a four-disc eccentric range pitter 10 days after the six plots were sprayed with atrazine. Three other plots were also pitted at this time, and three plots were left as check.

In the spring of each year (1967 through 1971) three subplots 4 ft^2 (14 5/16 x 40 1/4 inches) were located at random within each main plot, and the previous year's vegetation was removed before plant growth started. Forage within the subplots was harvested each September. The harvested forage was separated by major species. Annual grasses, forbs, and Sandberg bluegrass generally matured earlier than the other species, and a large part of their production was lost before harvest. After the subplots were harvested, the experimental area was grazed by sheep.

Yield of air-dry forage was determined for the major speices, total grass, dryland sedges, and total forage. Forage yields were analyzed by analysis of variance. Duncan's multiple range test for significance was applied at the 5% probability level. Vegetation composition was determined by weight.

Results and Discussion

Yields of the individual major species and total forage yields varied with years and treatments. Seasonal precipitation for the 51-year record averages 78% of the annual total, and 58% of the seasonal precipitation normally occurs during April, May, and June. The annual, seasonal, and April, May, and June precipitation for the study period and the 51-year average are shown in Table 1. Significant

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Table 1. Annual and growing season precipitation (inches) for the 1967–71 period, and the 51-year average at the Archer Substation, Wyo.

Year	Annual	April to September	April, May, and June
1967	16.54	13.74	9.93
1968	15.85	13.10	9.49
1969	13.98	9.74	5.74
1970	15.30	11.30	7.35
1971	13.15	9.86	6.69
5-year average	14.96	11.55	7.84
51-year average	14.65	11.45	6.67

differences in yields of individual species and total forage found between years may be due to variation in amount and distribution of the precipitation. The results obtained for each treatment will be discussed separately

Check

The stand of western wheatgrass was good on the check plots, but growth was generally stunted except during 1967 when precipitation was above-average. Table 2 shows the yields of individual major species during the study. The lower yields of the individual species and total forage in 1969 was due to below average precipitation. Average yields of buffalograss, total perennial grass, and sedges were significantly less on the check than the average yields for the other three treatments.

Forbs and annual grasses were important the first, fourth, and fifth year, when they accounted for 13% to 16% of the total forage produced. Dryland sedges remained nearly constant in the composition and contributed less than 10% of the total forage produced.

The average total forage on the check was significantly less than on the pitted or pitted plus atrazine treatments, and was the same as on the atrazine treatment.

Total forage was highest the first year (1967) because of above-average precipitation. Below-average precipitation occurred during 1966, which may have influenced the high forage yields obtained in 1967. During 1968 the amount and distribution of the precipitation were nearly the same as during 1967, but forage yields were half those obtained in 1967. Apparently, soil nutrients were insufficient in 1968 to sustain forage yields comparable to those of 1967.

Vegetative composition was determined by weighing the separated and air-dried herbage harvested in the fall each year. The vegetative composition was influenced mainly by precipitation and treatment. Blue grama and sedges increased on the check during 1969, a year of below-average precipitation, then declined as other species increased (Figs. 1 and 2). The amount of buffalograss tended to decrease slightly after the first year.

Pitted

The eccentric range pitter reduced vegetative cover by approximately one-third; additional vegetation was covered by the sod thrown out of the pit (Fig. 1). Lambsquarters (*Chenopodium album*) was abundant on these plots the first year and accounted for 24% of the total forage produced. It has been observed that a disturbance to the native sod or a year of

Table 2. Yields (lb/acre) of western wheatgrass, blue grama, buffalograss, dryland sedges, forbs, total perennial grass and sedges, and total forage from mechanically and chemically treated plots at the Archer Substation. 1967–1971.

Species and years	Treatments				
	Check	Pitted	Atrazine	Pitted & atrazine	Mean
Western wheatgrass					
1967	484	460	136	108	297[a] [1]
1968	251	307	214	156	231[b]
1969	55	183	89	267	148[b]
1970	201	338	242	365	286[a]
1971	253	651	334	507	436[a]
Mean	248[a]	387[a]	203[a]	280[a]	
Blue grama					
1967	624	439	912	604	645[a]
1968	324	344	679	831	544[bc]
1969	291	281	268	595	358[d]
1970	396	482	562	881	580[ab]
1971	435	267	613	468	446[cd]
Mean	414[a]	363[a]	607[a]	676[a]	
Buffalograss					
1967	125	121	214	269	182[a]
1968	93	87	136	282	150[ab]
1969	25	85	57	139	76[c]
1970	76	207	101	210	148[ab]
1971	30	73	131	176	102[bc]
Mean	70[c]	115[bc]	128[b]	215[a]	
Dryland sedges					
1967	66	89	20	11	47[b]
1968	56	81	38	4	45[b]
1969	59	91	22	7	45[b]
1970	77	149	39	10	69[a]
1971	67	137	21	27	63[ab]
Mean	65[a]	109[a]	28[a]	12[a]	
Forbs					
1967	189	665	4	12	217[a]
1968	16	96	0	13	31[c]
1969	3	21	1	210	59[bc]
1970	120	105	271	319	204[a]
1971	186	83	107	103	120[b]
Mean	103[a]	194[a]	123[a]	131[a]	
Total perennial grass and sedges					
1967	1300	1123	1280	993	1174[a]
1968	723	819	1068	1273	971[b]
1969	430	640	435	1007	628[c]
1970	750	1198	944	1466	1090[ab]
1971	785	1128	1100	1178	1048[ab]
Mean	798[c]	982[b]	965[b]	1183[a]	
Total forage					
1967	1488	1788	1286	1004	1392[a]
1968	741	953	1068	1286	1012[b]
1969	435	672	435	1217	690[c]
1970	927	1394	1121	1785	1307[ab]
1971	1144	1485	1337	1454	1355[a]
Mean	947[b]	1258[a]	1049[b]	1349[a]	

[1] Means among treatments and years with the same letters are not significantly different at the 5% level.

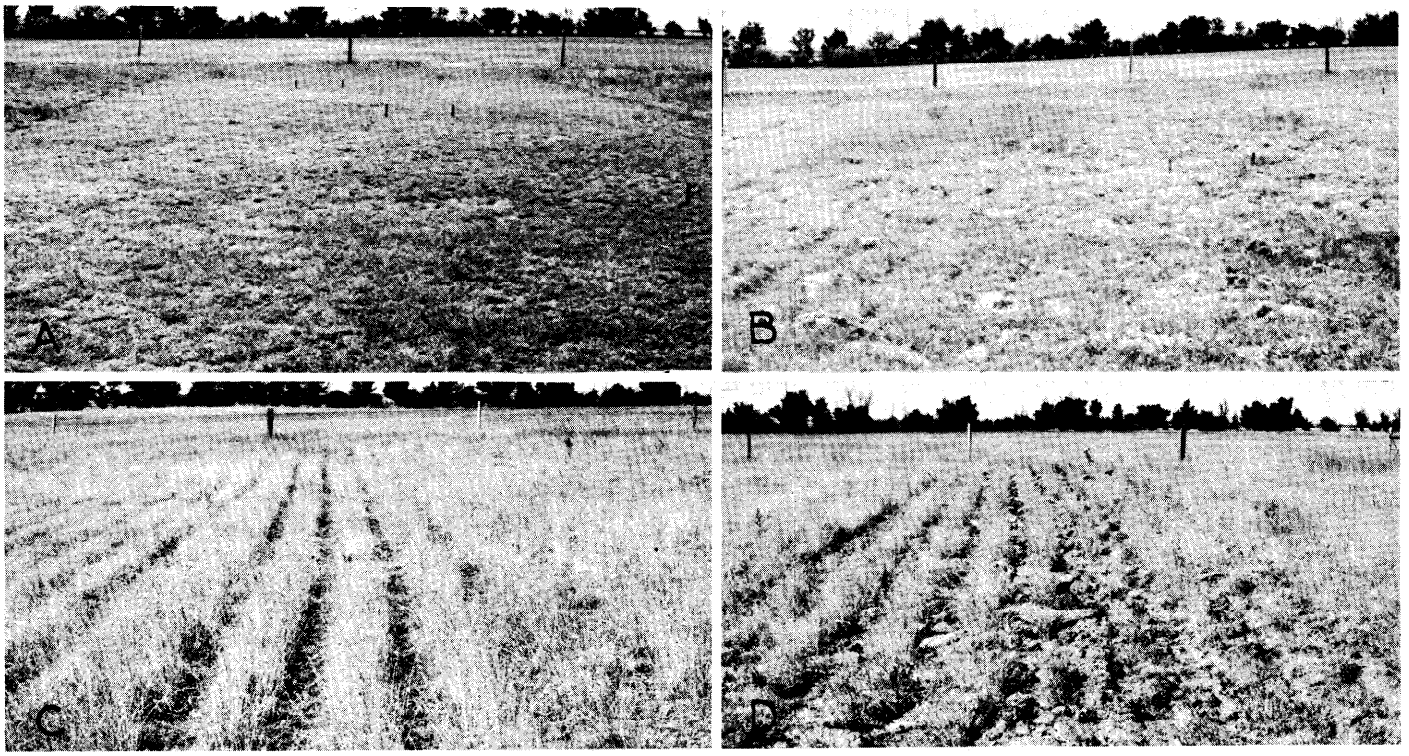

Fig. 1. *Check, mechanically, and chemically treated plots at the Archer Substation in August 1969. (A) check plot; (B) pitted with the eccentric range pitter in the spring of 1967 (Note the sod thrown out of the pits has not completely broken down); (C) strip-sprayed with atrazine (Note the growth and seed heads on the blue grama); (D) pitted and strip-sprayed atrazine treatment. (Pitting effect is noticeable as well as the vigorous growth of the blue grama.)*

above-average precipitation at this location generally results in an abundance of lambsquarters. Western wheatgrass and buffalograss tended to increase and blue grama to decrease (Fig. 2).

There was a small increase in the amount of dryland sedges, and the amount of forbs varied with years after the first year. Annual grasses, mainly sixweeks fescue (*Vulpia octoflora*) and cheatgrass brome (*Bromus tectorum*), increased. The abundance of sixweeks fescue varied with years and was never considered a problem. Hylton and Bement (1961) stated that the density of sixweeks fescue may be related directly to prevailing temperature and moisture availability during August, September, and October preceding the summer growing season.

Significantly more total perennial grass and sedges and total forage were produced on the pitted plots than on the check. As the pits weathered and partially revegetated, their effectiveness decreased. Western wheatgrass, buffalograss, scarlet globemallow (*Sphaeralcea coccinea*) and some annual grasses occupied the pits at the end of the study.

Atrazine

Six days after the atrazine was strip sprayed on the plots a snow storm deposited 1.15 inches of water. The wet snow caused the atrazine to migrate laterally as well as vertically. As a result, annual and perennial forbs and annual grasses were not present on these plots for the first 3 years. The atrazine was sprayed in 7-inch strips with 15 inches of untreated native sod between strips. After the migration of the atrazine, the sprayed strips averaged 10 inches in width. Thus about 45% of the vegetation was removed on these plots.

In the spring for the first 3 years following treatment, numerous chlorotic western wheatgrass plants were noted in the sprayed strips. These plants died back when available water became limiting. During the fourth year, other species as well as numerous western wheatgrass plants became established in the sprayed strips. Annual forbs, mainly Russian-thistle (*Salsola kali*) and lambsquarters, occupied the sprayed strips the fourth year, indicating that the atrazine was no longer active. Soil samples were taken from the 0- to 2-inch, 2- to 4-inch, and 4- to 6-inch depths in September, 1970, for a bioassay to determine activity of the atrazine. Oats were grown in the soil samples and survived, indicating that the atrazine was no longer effective.

Blue grama was the dominant species in the nonsprayed area and gave the appearance of having been seeded in rows (Fig. 1). The first 3 years, blue grama produced a profusion of seed heads on stalks averaging 16 inches in height. The basal leaves made excellent growth and remained green late in the season. Buffalograss, western wheatgrass, and dryland sedges were scattered throughout the nonsprayed area. Sedges were a minor constituent of the composition and added little to the total forage production. Total perennial grasses and sedges accounted for 88% of the total forage over the 5-year period; blue grama accounted for 83% of that total. Kay (1971) reported dry matter yields from a sward of red brome (*Bromus rubens*), Arabiangrass (*Schimus arabicus*), and red stem filaree (*Erodium circutarium*) were increased six-fold by atrazine at 1 lb/acre in California. Forage crude protein was also increased significantly, as was nitrate-nitrogen.
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By 1971 the atrazine-sprayed strips were between 7- and 8-inches wide, as the grasses were reoccupying the sprayed strip. Further encroachment by native vegetation into the sprayed strips was noted in 1972. Thus, the longevity of this treatment appears to be between 5 and 7

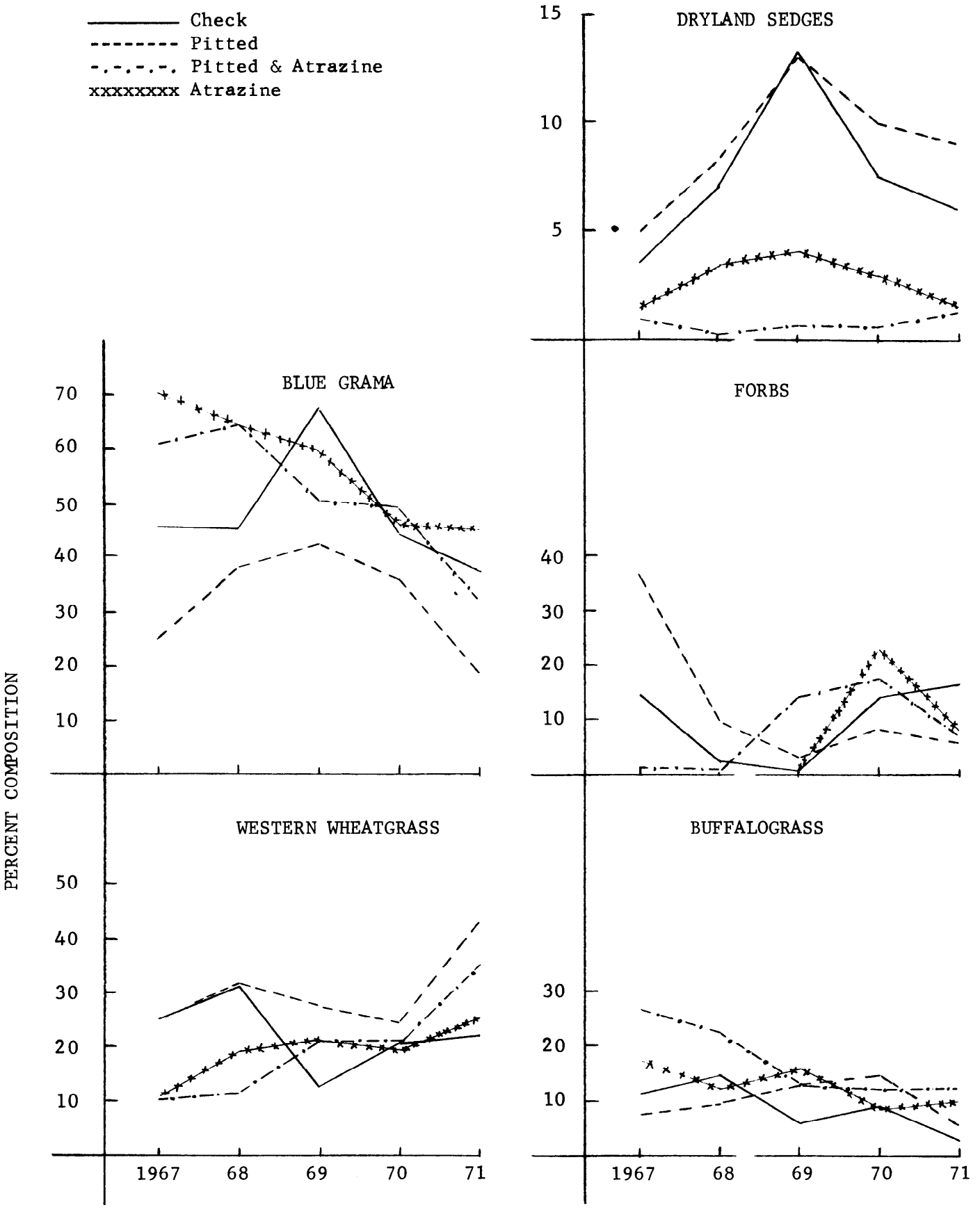

Fig. 2. *Percentage composition by weight over a 5-year period from shortgrass rangeland mechanically and chemically treated in 1967 (Archer Substation).*

years under these soil and moisture conditions.

The atrazine strips were east-west oriented, and the prevailing winds at this location were northwesterly. Wind, water, and splash erosion removed approximately 1 1/2 inches of soil from the center of the sprayed strips and smaller amounts at both sides, giving the strip a somewhat dish-shaped appearance. Thus, continuous strips would not be recommended because of the erosion hazard on some soils. Atrazine-sprayed strips should be broken in a pattern similar to that obtained with an eccentric range pitter.

Blue grama and buffalograss declined in the percentage composition, as western wheatgrass and forbs increased. Western wheatgrass increased because numbers of plants in the sprayed strip increased. Forbs were nonexistent until the fourth year when they accounted for 23% of the total. By the fifth year, however, they accounted for less than 10% of the total.

Pitted and Atrazine

This treatment reduced the vegetation an estimated 75% to 80% the first year. The migration of the atrazine in April may have been partially responsible for this large reduction (Fig. 1). Annual and perennial forbs were not found on this treatment for the first 2 years, but grasses rapidly occupied the bare areas. During the third year, Russianthistle, lambsquarters, and a species of mustard were numerous on this treatment. These plants became established where the atrazine either was not active or had lost its effectiveness during the third year following treatment. Because of soil disturbance from pitting, and possibly the atrazine, there was significantly more buffalograss on this treatment than on any other treatment.

Blue grama and buffalograss declined rapidly after the first year of treatment, whereas western wheatgrass steadily increased. After 2 years of practically no forbs, their population increased for 2 years and then declined to about the same amount on all treatments except the check. Sedges were of little importance but showed a slight increase the fifth year.

Despite severe reduction of vegetation the first year following treatment, production of perennial grass and sedges and total production over the 5-year period was greater than for the other treatments. However, there was no difference between any of the renovation treatments the fifth year after treatment.

Conclusions

Herbage yields and the botanical composition were largely influenced by the amount and distribution of the April, May, June precipitation regardless of treatment. A significantly larger total production of perennial grasses and sedges was obtained from the renovation treatments than from the check.

Blue grama increased in vigor and volume particularly on the plots strip sprayed with atrazine. Thus more blue grama was available for livestock use, and blue grama on sprayed plots remained green later in the season than it did on the check.

The effectiveness and longevity of a renovation treatment depends upon the range site, climate, and management. At this location longevity of pitting alone appears to be about 15 years (Rauzi, 1968). The longevity of range pitting and strip spraying of atrazine should be the same as pitting alone. It is estimated that the longevity of the strip spraying alone would be 5 to 7 years.

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SRM ANNUAL ELECTION RESULTS

The ballots returned in this year's election of officers were counted on December 12. A total of 1,994 ballots were received by the November 30 deadline, and the following candidates were selected by the membership to serve the Society over the next 3 years.

President Elect . . . . . **Dillard H. Gates**
Directors . . . . . **Richard E. Eckert, Jr.**
Carlton H. Herbel

These new officers will be installed at the 1974 Annual Meeting in Tucson, at which time **Peter V. Jackson,** the current president elect, will succeed Martín H. González as president of the Society. Gates will serve as SRM president in 1975 and the two newly-elected directors will serve for the 3-year term 1974-76.

Retiring next month from the Board of Directors are Floyd E. Kinsinger, the immediate past president, and S. Wesley Hyatt and Bob J. Ragsdale, directors. These three men have made substantial contributions to the Society's programs; their past service is acknowledged with sincere gratitude.

Dr. Gates is a native of Nebraska. He received his training at the University of Nebraska and Utah State University, and currently is director of the Rangeland Resources Program, Oregon State University. He has served as an FAO consultant in Iraq and in 1971 was coordinator of the BLM's California Desert Program.

Both Dr. Eckert and Dr. Herbel are associated with the Agricultural Research Service, USDA, the former as Western Region range scientist, stationed at Reno, Nev., and the latter as range scientist at the Jornada Experimental Range, Las Cruces, N. Mex.

Ballots and tally sheets are kept on file in the Executive Secretary's office for a period of 1 year.