CURRENT RANGE MANAGEMENT RESEARCH AND RESULTS

at the

MANITOU EXPERIMENTAL FOREST

ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

November

1966

LOCATION

The Manitou Experimental Forest Was established in 1936 to study problems of land use as they relate to the management of all the resources. The experimental forest lies 28 miles northwest of Colorado Springs. the experimental area totals 25 square Miles, and represents the land of the Colorado Front Range within the ponderosa pine zone.

The ponderosa pine zone in the Front Range of the Colorado Rocky Mountains encompasses approximately 4 million acres. An area of numerous mountain ranges and interspersed valleys with open parks and grasslands, this zone is well suited for the production of live-stock. Unfortunately, the land in many of the open parks and grasslands has been used for purposes to which it was not adapted.

LAND-USE HISTORY

Fur trading in the early 1800's was the first land-use activity prior to settlement. Mining followed, and by the late 1800's, was the major incentive for occupancy and use of the accessible pine lands.

Logging commercial stands of ponderosa pine began in 1860. Pine timber furnished fuel, charcoal, mine props, railroad ties, and building lumber. No large merchantable stands of pine remained after 1900.

Farming supplemented mining activities from 1900 to the mid-thirties.

Grazing by livestock, which supplied meat to miners and settlers, rapidly increased between 1880-90. Hay crops for cattle, horses, and mules were in high demand. Following this, reduced forage resources forced livestock grazing to decline, especially during the 1930-50 period.

Early reductions came slowly but today less than one-half of peak numbers are grazing surrounding National Forest lands. Animal months of use dropped even more as shorter grazing seasons were adopted.

The land of the Manitou Experimental Forest is typical of Front Range history. It *has* been logged and burned. And, during the late 1800's and early 1900's[1] numerous areas were cultivated and attempts made to raise row crops or annual hay crops. The inherent low fertility of the soil, erratic moisture and depressed economic conditions of the 1930's made farming a failure and the lands were simply abandoned.

GEOLOGY, SOILS AND CLIMATE

Manitou Park Valley which is similar to other mountain valleys of the Front Range has a rather narrow floor situated between two north-south mountain ranges, the West Creek Range to the west and the Rampart Range to the east. Trout Creek, a small stream which flows north drains the valley and contributes its flow to the South Platte River. Elevations in the valley range from about 7,600 to 8,300 feet.

Geologically, the valley is classified as the Manitou Park graben, formed by the Ute Pass Fault of the West Creek Mountains and the Devils Head Fault of the Rampart Range. Sedimentary and granitic rocks are exposed on the steep mountain slopes. Adjacent to the street are flood plains of recent alluvium. Older alluvial fan deposits grade in gentle slopes from the base of the rocky ridges to the out-wash plain of the creek.

Most alluvial soils have developed primarily from deposits of Pikes Peak granite. In general, the soils complex is characterized by quartz, microcline and large orthoclase crystals with biotite or mica as the accessory mineral. Surface soils range from 8 to 10 inches thick, contain moderate amounts of organic matter and are slightly acid with a pH between 6,0 and 6.5. They have a moderate granular structure with soft coftsistence when wet, but firm when dry. Some areas have a gravelly-sandy-clay loam subsoil, but others lack a subsoil and grade into unconsolidated parent material at a depth of 3 to 4 feet. Most all the soil is susceptible to severe erosion whenever the vegetative cover is removed.

The climate of the experimental forest is characterized by open, dry winters and mild summers. Rainfall averages approximately 15.5 inches and nearly three-fourths of this falls from April through August. Convectional storms, frequently of high intensity and short duration, account for most of the summer precipitation and erosion.

Temperatures during the summer are moderate, seldom exceeding 90^{0} F. Winter temperatures are often very cold with temperatures below -40^{0} F. However, like many areas, there are wide fluctuations in both rainfall and temperature from year to year.

VEGETATION TYPES

Vegetation of Manitou Experimental Forest is typical of ponderosa pine lands of the Front Range country. In the basin area and adjacent alluvial slopes currently under study in our range program five major vegetation types are recognized. They are: (1) dense timber-overstory of ponderosa pine with canopy closed or nearly closed; ground cover

primarily litter or duff from old needles with understery species few or nonexistent. (2) Open timber-overstory of ponderosa pine with openings in the canopy, unnerstory vegetation of sedges, grasses, forbs or shrubs present. (3) Grasslands-native grasses together with forbs and shrubs similar to the open timber type. The fourth type is man induced and is classified as abandoned fields. These areas are readily recognized by the presence of Stipa robusta or the outlines of old plow ridges. The fifth type is a stringer meadow which borders the stream and is characterized by willows, wheatgrasses, sedges, clovers and numberous other grasses **or** forbs. They, of course, are important for hay crops and some winter grazing.

Within the experimental area the percentages of the four upland range types are as follows: Dense timber 4%, open timber 63%, grassland 26%, and 7% abandoned field. A list of the main plant species occurring in the four principal vegetation types is found at the end of this report.

HIGHLIGHTS OF CURRENT RESEARCH

Intensit -of-Grazin Studies - Seeded Ranges

Between 1946 and 1949, abandoned fields were seeded to crested wheatgrass, smooth brome, intermediate wheatgrass, Russian wildrye, and a mixture of crested wheatgrass, smooth brome and yellow blossom sweetclover. Yearling Hereford heifers grazed these seeded ranges at several intensities for 9 to 12 years. Similar studies on Sherman big bluegrass were not started until 1959 because of seeding establishment failures. For each species, measurements were made to determine what effect the different rates of use had on the vegetation, ground cover, and livestock production.

Forage yields of each species varied appreciably from year to year (Figure 1). Variation 6 were in response to kecipitation with April through August rainfall accounting for 65 to 90 percent of the differences in forage ptoduction. Lengtil of grazing season and animal days of use per acre varied in relation to the forage yields for each species and its associated treatments.

Mixture ranges provided the best sustained forage yields and livestock production (Table 1 and 2). By the end of the study, however, the pastures had been converted to nearly pure stands of crested wheatgrass. Grazing to a 2-inch stubble height was the optimum treatment on these ranges. Forage yields and grazing days per acre decreased in years of low rainfall, but when precipitation was greater, the 2-inch treatment permitted more grazing than any other treatment. Also, under this rate of use, grazing was more uniform and fewer wolf plants developed which remained ungrazed. With lighter use, patches were often severely grazed year after year, which resulted in spot depletion of the stands. Heavier grazing resulted in an appreciable reduction in yield and cover, particularly litter.

On both the mixture and crested wheatgrass ranges, the number of plants and tillers per square inch of crested wheatgrass increased with heavy use, but plant size decreased. Invasion of the stand by undesirable species was approximately the same within all treatments.

The optimum intensity of grazing for Russian wildrye was a 3-inch stubble height (Table 1). This intensity of use gave maximum, sustained yield, and the best cover-density characteristics as well as the best livestock production. Lighter use created very uneven utilization and

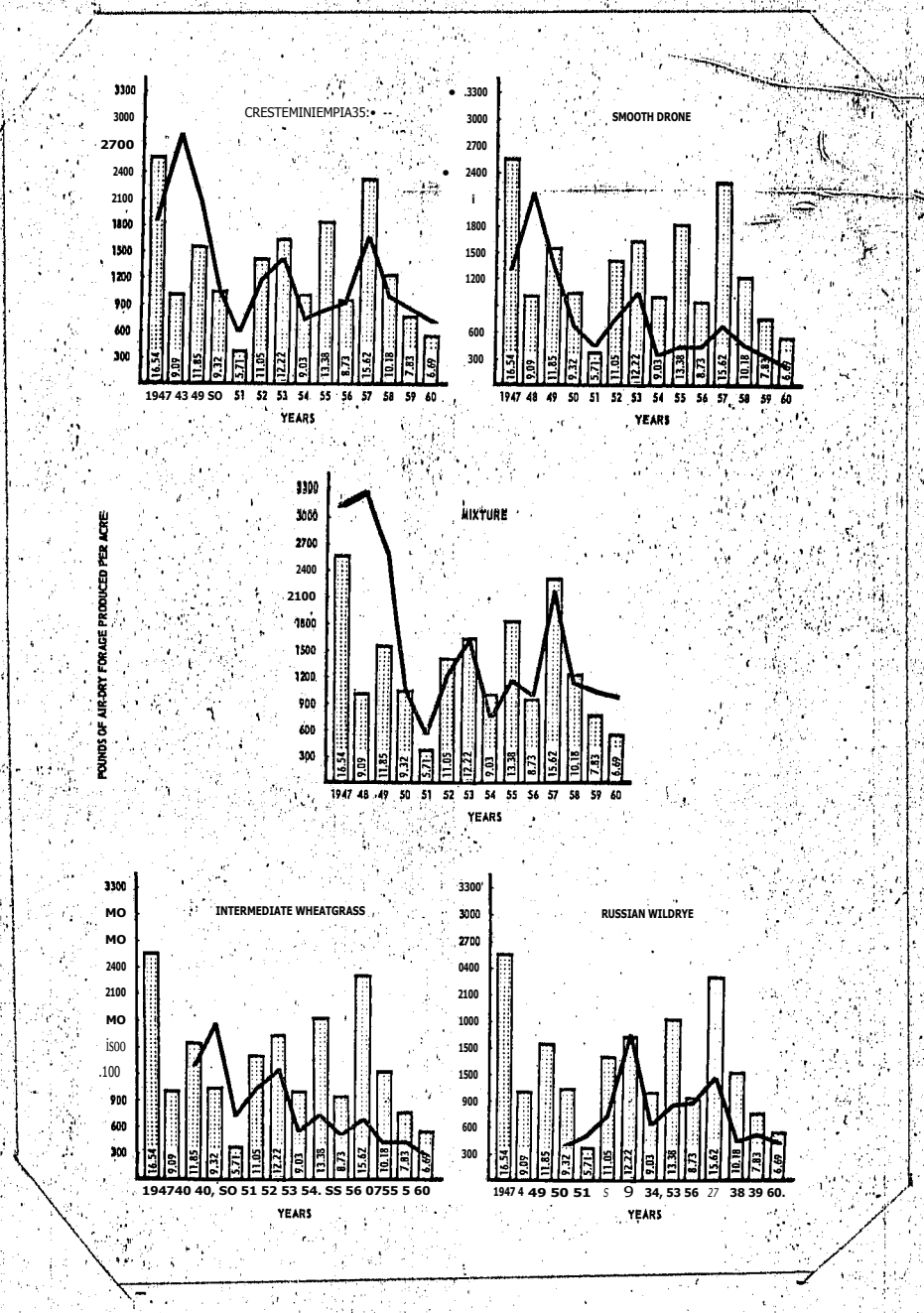

Figure 4,--Average forage production of seeded ranges for all intensities of grazing in. relation to April 1 through August 31_ precipitation (vertical dotted bars show inches of precipitation).

Table 1.--Effect of grazing intensity on forage production of seeded Mmecies

Species	Stubble Height Inches	Av. Util-ization Percent	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1956	1959	1960	Average
			pounds of sir dry forage per acre													
Crested whestgrass	1	81		7·		..	--	1513	494	893	807	1644	1051	701	644 .	968
	2	67	2862	2025	964 .	536	1210	1085	579	17 957	850	1848	1050	885	692 .	, 1196 -
	4,	46	3279	1902	1045 .	618	1138	1422	848	. 828	952	1895	933	890	762	1270
		31	2300	2347	1202 .	626	1237	1691	986	, '776	1081	1399	944_	987 -	848	1264
	Average		2814	2091	1070	593	1195	1428	727	864	923	1697	994	866	.736	1174
Smooth . brunt		78	--	--		. --		884	261	-_ 428	378 .	555	- 446	. 361	176	436
	2	61	2274	1330-	627	410	596	981- .	259	264	352	654 '	474	309		674
	4	41	2096_	1432	734	470	832	979	454	548	- 539 -	726 .	. 457	308	242	_ 755
	6	31	2114	1162	647	443	820	1404	459 ,	' 531	-- 497,	853_	' 504	.572	222	787
	Average		2161	1308	669	441 -	749	1061	358	443	- ' 443	697	470	- 388.	218	663:
Mixture Agar (A) grin (B)			A B 1/	A B	A B	A B	A B	A B	A B	A 8	A	A	E B	A B	A B	3/A B 4/A B
	1	82	--	--	-- --	-- --	-- --	-- --	)730 134	482 31	1038.	11733	1794 49 813 22	680 58	11750	1090 53. 1042
	2	65	21 3624	21 2017	415 912	377 113	1006 115	1130 268'	' 590 24	1125 29	855		2186 13 1082 2	913' 1 '.	950	981 120 1335
	4	46	3552	2801	651 469	487 116	1292 92	1446 129	834 4 .	1160 19	1200		2695 0 1196 6	1208•'• 0 i.	1154	1219 93 - 1578
	6	35	' 2542	2938	497 520	416 192'	- 976 187	1350 316 .	888 65	1266 75	1202		1870 127 1304 108	1250 46	1128	1091 171 1479
	Average		3239	2585	521 900	426 127	1091 131	1414 212	698 31	1147 37	998		2136 47 1099 34	1014 26	t 996	1095 111 : 1358
Inter-mediate T,wheatgrass	2 (New)	66-							496	502	329	618	353	281	I 200	397
	2	63			1592	572'	749	721	282	379 -	382	790	153	290	218	557
	4	47			1954	809	1.087		835	937	582	690	463	493	358	494 .
	6	13			1761	751	,1230		575	- 71074_	7517	690	704	612	418	1907
	Average		--	--	1769	711	1022		547	- 723	51z	69/	418	414	1 298	689
Russian wildrye		41	--	--	--	475	685	1607	599	, 770	828	610	348	185	276	638
	3	20	--	--	--	532	839	1620	526	841		1.312	614	754	646	894
	4½	11	--	--	--	510	734	1824	743	1008	1614	—	392	653	404	875
	Average		--	--	--	506	751	-1684		873'	899 -	1199	451	531	442	796

11 "A" is crested whestgrais and '11" smooth brunt in the mixenre.
1:/ Species not recorded separately.
31 Average of Years when species were recorded separately.
4/ Average of loth species for all years.

Table 2. --Average daily gain and ffiain per acre of yearling heifers on seeded and native bunchgrass range

Species	Daily gain	Acre gain
		Pounds - - - - -
Mixture	1.81	71.6
Crested wheatgrass	1.67	59.2
Smooth brome	1.52	40.2
Intermediate wheatgrass	1.92	52.3
Russian wildrye	1.53	48.8
Sherman big bluegrass	1.64	88.2
Native range (moderate use)	1.51	13.5

caused spot deterioration which reduced forage yields. With the heavier rate of grazing, yields were further reduced and the stands were invaded by more undesirable species.

Daily gains on Russian wildrye averaged about 1-1/2 pounds per day and gains per acre averaged 50 pounds which was only mediocre compared to the other species. However, this species was consistently ready to be grazed 5 to 20 days sooner than other seeded ranges and 30 to 60 days sooner than native bunchgrasses, which would recommend its use in a grazing program for early spring ranges.

Both smooth brome and intermediate Wheatgrass stands deteriorated under all levels of use tested and are not suited in this area for seeding in pure stands. However, either species and a legume are recommended for seeding in mixture planting with crested wheatgrass. In early years of the stands, both species provided good daily gains, per acre gains, and high grazing capacities. As they die out in mixture plantings, daily animal gains may decrease but the yield of forage and beef will probably be greater than from pure crested wheatgrass stands.

Grazing intensity trials on Sherman big bluegrass during the last 6 years have produced daily gains on big bluegrass comparable to crested wheatgrass but less than that for intermediate wheatgrass or the mixture. In terms of total beef production and grazing capacity, however, it is much superior to any of the other species. Beef production on Sherman big bluegrass averaged almost 17 pounds per acre more than the mixture and 30 pounds per acre more than crested wheatgrass. In addition, it furnished 18 and 24 days of grazing per acre more, respectively, than these ranges.

Season-of7Grazing Crested Whaatgrass

On crested wheatgrass ranges grazed in the spring, fall, or both spring-fall, precipitation had more influence on the plants than the season of grazing treatment. The iangeb have retained the same relative ranking in terms of production, density, and other plant characteristics as they had at the start of the Study 8 years earlier.

severe drought in the spring of 1963 either completely or partially killed a large number of crested wheatgrass plants. As shown in Table 3, basal intercepts of crested wheatgrass on all treatments increased appreciably from 1959 until 1961, but then decreased sharply as a result of the drought. Prior to 1963, plants on pastures grazed only in the fall were tending to aggregate with fewer plants yielding a large basal intercept. These plants were then partially killed with the drought which reduced the basal intercept and also caused a fragmentation of the plants.

Plants on the spring only or spring-fall grazed ranges also suffered from the drought. On these ranges, however, crested wheatgrass clumps had become fragmented into smaller more numerous plants prior to the drought. The drought simply killed entire clumps of these smaller plants which reduced basal intercept and plant numbers.

The number of crested wheatgrass plants per square foot (density) increased on the fall only grazed pastures because of the fragmentation into smaller, more numerous clumps from the partial death of larger clumps, but on spring or spring-fall pastures density was reduced by the death of entire plants (Table 4). The density of invading species increased except on pastures grazed in the spring. On these areas,

Table 3.--Aggregation, dispersal and cover changes of crested wheatgrass on ranges grazed seasonally during an 8-year period,

Grazing Treatment	1959	1961	1964	1959	Plants 1961	1964
	Percent			Number		
Fall only	8.5	17.4		21	17	11
Spring Only	6.3	13.0	4.5	21	22	12
Spring-Fall	6.1	14.7	4.5	24	22	14

Table 4.-,Density changes of crested wheatgrass and invading species on ranges grazed seasonally during an 8-year period

Grazing Treatment	Crested wheatgrass			Invading species		
	1959	1961	1964	1959	1961	1964
	Plants/square foot					
Fall only	3.47	3.32	3.6o	2.59	1.22	2.73
Spring only	4.38	5.62	4.83	3.46	11.65	7.32
Spring-Pall	4.20	5.28	4.80	3.19	4.31	5.93

Table 5.--Litter cover changes on crested wheatgrass ranges grazed seasonally during an 8-year period

Grazing Treatment	1959	1961	1964
	Percent		
Pall only	48.5	30.7	31.0
Spring only	47.8	29.5	36.0
Spring-Fall	43.8	30.3	32.4

invasion occurred prior to 1963 and many of the invaders were killed by the drought. On the fall or spring-fall pastures, the death of the crested wheatgrass plants opened the stands, particularly to late summer-or fall-growing species and invasion increased following the drought.

Litter decreased appreciably on all ranges between 1959 and 1961 with only small changes after that time. The largest decrease in litter cover occurred on ranges grazed only in the fall (Table 5). The next largest decrease in litter cover was on spring only grazed ranges with the smallest decrease resulting from spring-fall grazing.

A method of stepwise regression analysis was found successful for estimating forage yields of crested wheatgrass ranges grazed during spring, fall, and spring-fall seasons by measuring the monthly precipitation received during the growing season. Precipitation accounted for 88 to 97 percent of the differences in yields and the amounts received during different months or combinations of months determined the effective forage production available for use by livestock at each season. Precipitation received in April primarily determined forage yields on ranges grazed only in the spring. Por ranges grazed only in the fall, May-July rainfall was most useful for predicting yields. When ranges were grazed both spring and fall, April-May precipitation determined spring yields and June-July rainfall controlled fall forage production.

Stocking rates in relation to forage yields during the different grazing seasons were also determined. Correlation coefficients

between stocking rates (y) and effective forage production at each season (x) ranged from .94 for spring grazing on spring-fall used ranges to .99 for those ranges grazed only in the fall. The methods of analyses used should be applicable to determining production and stocking rates on many of our western rangelands, and also serve as a means of accounting for variation in certain types of research studies.

Integrated Use of Seeded and Native Ranges

Grazing of seeded and native range on an integrated basis was started in January 1962 to determine whether *seeded* ranges incorporated in a grazing system could effectively be used to extend the grazing season on green, actively growing forage and thereby permit more flexibility in season of stocking as well as remove grazing pressure from spring and fall bunchgrass ranges while at the same time materially increasing livestock production. Two 12-cow herds, one grazing native vegetation on a year-round basis, the other grazing seeded ranges integrated with native range were graded and started on the respective treatments. Both herds were uniform in weight, age, and grade when the study started.

Following 4 years of treatment and three calf crops, weaning weight per calf has averaged 32 pounds more than from native ranges wtih an added income of $7.70 per calf by incorporating seeded ranges into the livestock management system (Table 6).

Most of the difference in weaning weights between the two systems came while the animals were grazing Sherman big bluegrass ranges in the fall. Calf weights on October 15 averaged 395 and

Table 6.--Weaning weights and dollar values of calves from seeded ranges integrated with native ranges compared to those for animals grazing only native range.

Herd	Year	Oct. 15 Weight	Nov. 15 Weaning Wt.	Selling Price
		Pounds - - -		
Integrated	1963	384	416	$107.90
	1964	385	415	96.03
	1965	415	440	116.51
Average		395	424	$106.81
Native Range	1963	383	399	$103.80
	1964	386	358	82.84
	1965	418	418	110.69
Average		396	392	$ 99.11

396 pounds for the two herds. Following 30 days of grazing with their mothers on big bluegrass, calves averaged 424 pounds compared to 392 pounds for calves grazing native range with their mothers. Thus on big bluegrass, the calves averaged about 1 pound per head per day more gain than their counterparts on native range.

In addition to more beef per acre from big bluegrass range, forage supply and market prices were also important in determining the increased returns. For example in 1964, forage supply on native ranges was sufficient but cured early in the fall. Calf prices on the Denver Market averaged about $23.00/cwt. As shown in the table, calf weights and difference in income was highest during this poorer feed and price year. In 1965, a good forage year with higher market prices, big bluegrass gave higher returns than native range although they were lower than in 1964.

Nutritional Aspects

In conjunction with the grazing system study of integrating seeded and native range, a Cooperative Aid Study with the Range Management Department at Colorado State University was made to evaluate the diet and chemical composition of the forage being consumed by animals grazing each of the two combinations of range.

Chemical and botanical analysis of forage collected from freely grazing ruminal fistulated steers on this phase of the study indicated seeded ranges increased the time range cows were on a better quality diet than cows grazing only native ranges. Using standards of nutrition

set by the National Research Council, crude protein in the diet of the herd grazing both native and seeded ranges on an integrated basis was adequate to excessive for 10 months out of the year, whereas crude protein in the diet of the herd grazing native ranges only was adequate for only 8 months. The seeded ranges provided a 2-,month advantage of adequate dietary protein because they started growth earlier in the spring, and became dormant later in the fall. Phosphorus in the diet followed a similar trend and seasonal trends in both dietary crude protein and dietary phosphorus indicated that the stage of forage maturity at time of consumption was of major importance in determining the general nutritive quality of the diets of both herds.

Studies Currently Being Installed

1. Comparisons of cattle gain under rotation and season-long grazing on ponderosa pine-bunchgrass ranges.

This study is being undertaken at the request of, and in cooperation with Region 2 to specifically answer the question: Do cattle (cows and calves) grazing under a rotation grazing system gain equally as well as cattle grazing under a season-long system?

2. Range recovery of depleted ponderosa pine-bunchgrass ranges through combinations of herbicide and fertilizer application and grazing.

The specific objectives are to compare the possibilities of hastening range recovery of depleted range by: (1) reducing competition

of undesirable plants, (2) promoting growth of remnant bunchgrass by fertilizing, (3) providing maximum or optimum recovery of the bunchgrasses by seasonal deferment and rotation and (4) using the various combinations of these three treatments.

3. Physiology and rooting characteristics of Sherman big bluegrass.

The specific objectives for this study are divided into two phases. Both are oriented toward determining what features in the physiology, morphology,or both, permit big bluegrass to be pulled up, roots and all, through normal animal grazing.

Phase 1 is a field study oriented toward finding out if changes in plant nutritive level through application of fertilizers have an effect on pull-up. Phase 2 is a greenhouse study to follow root development and changes in rooting characteristics, or a detailed study of what features change and "why."

4. Cattle gains and vegetative characteristics on Sherman big bluegrass ranges grazed in late fall, winter, and early spring.

Study objectives and their assignments are to: (a) Evaluate the effects of late fall, winter, and early spring grazing practices on forage production and vegetative characteristics of Sherman big bluegrass, (RMF&RES);, (b) Determine if animal weights can be maintained or increased by fall, winter, or early spring grazing use of Sherman big bluegrass ranges, (RMF&RES); (c) Compare the minimum level of supplemental feeding necessary to provide both maintenance and

satisfactory weight gains on the animals grazing these treatments; and (d) Compare livestock responses from this practice with those obtained under the present system used by livestock operators, (C&D Cooperative--RMF&RES livestock cooperator will furnish and feed supplements under the direction of C.S.U.).

Principal Plant Species

Symbol	Scientific Name	Family	Common Name
	TREES AND SHRUBS		
Pipo	Pinus ponderosa	Pinaceae	Ponderosa pine
Aru-u	Arctostaphylos uva-ursi	Ericaceae	Kinnikinniek
Arfr	Artemisia frigida	Compositae	Fringed sagebrush
Cemo	Cercocarpus montanus	Rosaceae	Mountain mahogany
	FORBS		
Ac la	Achillea lanulosa	Compositae	Yarrow
Agau	Agoseris aurantiaca	Compositae	Mountain dandelion
Alce	Allium cernuum	Liliaceae	Wild onion
Anse	Androsace septentrionalis	Primulaceae	Rockjasmine
Arfe	Axenaria fendleri	Caryophyllaceae	Sandwort
Anpa	Antennaria parviflora	Compositae	Pus sytoes
Caro	Campanula rotundifolia	Campanulaceae	Mountain hairbell
Cain	Castilleja integra	Scrophulariaceae	Paintbrush
Chvi	Chrysopsis villosa	Compositae	Hairy goldaster
Cioc	Cirsium ochrocentrum	Compositae	Horse thistle
Erfl	Erigeron flagellaris	Compositae	Trailing fleabane
Eral	Eriogonum alatum	Polygonaceae	Umbrella plant
Gefr	Geranium fremontii	Geraniaceae	Fremont geranium
Hepa	Helianthella parryi	Compos itae	Wood sunflower
Lare	Lappula redowskii	Boraginaceae	Beggar lice
Lupa	Lupinus parviflorus	Leguminosae	Lupine
Me la	Mertensia lanceolata	Boraginaceae	Mountain bluebell
Oxla	Oxytropis lambertii	Leguminosae	Locoweed

Peun	Penstemon unilateralis	Scrophu-lariaceae	Penstemon
Pohy	Potentilla hippiana	Rosadeae	Horse cinquefoil
Pope	Potentilla pennsylVanida	Rosaceae	Petinsylvania cinquefoil
Sode	Solidago decumbepa	catpo6itite	Goldenrod

GRASSRS

Agsm	Agropyron smithii	G.(Hordeae)	Western wheatgrass
Bltr	Blepharoneuron tricholepis	G.(Agrostideae)	Pine dropseed
Bogr	Bouteloua gracilis	G.(Chlorideae)	Blue grama
Dapa	Danthonia parryi	G.(Aveneae)	Parry oatgrass
Fear	Festuca arizonica	G.(Festuceae)	Arizona fescue
Mumo	Muhlenbergia montana	G.(Agrostideae)	Mountain muhly
Sihy	Sitanion hystrix	G.(Hordeae)	Bottlebrush squirreltail
Stco	Stipa comata	G.(Agrostideae)	Needle-and-thread
Stro	Stipa robusta	G.(Agrostideae)	Sleepygrass