GRASSES AND SEASON OF PLANTING FOR RANGE REVEGETATION IN THE CONTINENTAL CLIMATE AREA OF CALIFORNIA

by
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INTRODUCTION

More than five million acres of land in northeastern California, in Major Land Resource Areas, 5, 21, 22, 23, 26 and 29, lie in the Continental Climatic Area typified by low rainfall, high elevation, dry summers, and cold winters. The bulk of this area is covered with sagebrush, rabbitbrush, cheatgrass with localized areas of saltgrass. At one time it supported a cover of native perennial grasses, bluebunch wheatgrass, Sandberg bluegrass and Idaho fescue with needle-and-thread grass, and Indian ricegrass on the sandy soils.

The land varies from 2,500 to 6,500 feet in elevation. It is characterized by a series of valleys and basins surrounded by rolling uplands and steep mountains. Chestnut, Grumusol, and Brown soils occur dominately on terraces, fans and rolling uplands. Alluvial soils are found principally on the better drained flood plains and valleys. Grumusol, Humic-Gley, Solonetz, and Solonchak soils occur on dry lake beds and poorly drained low-lying plains and terraces. The land capability ranges from Class III to Class VI because of soil factors primarily texture, depth, alkali and slope. Strong winds in the valleys present a serious erosion problem on soils of coarse texture. With proper management much of the land is well suited for the growing of dryland perennial range grasses.

A site was selected for a Field Evaluation Planting in Butte Valley near Macdoel, Siskiyou County, California, and planted to selected perennial grasses and legumes.

The main objectives of the Field Evaluation Planting were: (1) to develop improved plants for reseeding rangeland; (2) to determine suitable cultural methods for establishing forage plants on rangeland; and (3) to find suitable management methods for established stands.

The work was conducted by the Plant Materials Center, Soil Conservation Service, U. S. Department of Agriculture, Pleasanton, California, in cooperation with the University of California Agricultural Experiment Station, Davis, California.

Methods

Work on the establishment of perennials was begun in the summer of 1949 at the Butte Valley Field Evaluation Planting on abandoned grainland overgrown with rabbitbrush, sagebrush, cheatgrass and volunteer rye. Figure 1 is typical of the area. The site, formerly a portion of a Land Utilization Project, is available under a Land Use Permit from the Forest Service, U. S. Department of Agriculture.

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FIGURE 1 - The Butte Valley Field Evaluation Planting of the Soil Conservation Service before work was initiated in 1949. PI-1490 SCS PHOTO

The climate in this area is Continental. During the period of these trials the average of the yearly minimum temperatures was -12°F and the average of the yearly maximums was 95.40°F. Killing frosts can occur any month of the year.

Precipitation averages 11.15 inches per year but varied from 4.94 to 19.69 inches. This is shown in Figure 2. Much of the precipitation falls during the winter months in the form of snow. The least amount of precipitation is received in July and August. Local thunder showers are common. Strong winds in the valleys present a serious erosion problem on coarse textured soils and cause sand blasting of young seedlings. Frost heaving is a common occurrence.

A detailed soil survey was made of the area. The soil was tentatively mapped as Henley sandy loam Solonchak and two phases were mapped. The soil occurs on low-lying lake terraces, is moderately well drained, and has moderate permeability. The A horizons are moderately coarse textured, moderately alkaline, dark brown or dark grayish brown, and about 18 inches thick. They lie over a dark grayish brown, strongly alkaline, strongly calcareous, moderately fine textured C horizon about 10 inches thick. The C horizon abruptly overlies a strongly cemented hardpan that is strongly alkaline and strongly calcareous. It is about 23 inches thick. Under dryland conditions the area is placed in capability unit VIs6. When the land can be irrigated it is placed in capability units IIIs6 with inclusions of IIs6.

The site was used for the production of rye hay (Secale cereale), and then abandoned for several years prior to the establishment of the Field Evaluation Planting. The main native cover prior to disking was rabbitbrush, (Chrysothamnus nauseosus); sagebrush (Artemisia tridentata); saltgrass (Distichlis spicata); and cheatgrass (Bromus tectorum).

The site was disked in the spring and allowed to remain fallow during the summer.

In the fall, 3 acres of land were harrowed and cultipacked two ways to prepare a fine firm seedbed. Prior to making spring seedings the land was also harrowed. A buffer strip of volunteer rye was used to separate the fall and spring seedings and also to control soil movement. Seeding was done with a double-disk grain drill with 6-inch drill spacing, and the seed was mixed with rice hulls.

Seedings were made in the fall and in the spring for five successive years to check the effect of climate on establishment. There were no replications within years, although the trials were designed to obtain an estimate of soil variation.

Eleven perennial grasses, three perennial legumes, and one forb were seeded in pure stands to test adaptation to the site, cultural requirements, production, and suitability for grazing. The grasses and legumes represented five use groups.

The species, varieties, and seeding rates were:

			LBS.
Crested wheatgrass	---	Agropyron cristatum	6
Desert wheatgrass	---	Agropyron desertorum	6
Siberian wheatgrass	P-27	Agropyron sibiricum	8
Beardless wheatgrass	WHITMAR	Agropyron inerme	8
Intermediate wheatgrass	GREENAR	Agropyron intermedium	8
Pubescent wheatgrass	TOPAR	Agropyron trichophorum	8
Slender wheatgrass	PRIMAR	Agropyron trachycaulum	8
Tall wheatgrass	ALKAR	Agropyron elongatum	8
Russian wildrye	P-9012	Elymus junceus	6
Big bluegrass	SHERMAN	Poa ampla	4
Sheep fescue	P-274	Festuca ovina	4
Siberian alfalfa	Alaskaland	Medicago falcata	2
Cicer milkvetch	CICAR	Astragalus cicer	15
Sweetclover	Yellow	Melilotus officinalis	5
Burnet	---	Sanguisorba minor	3

Observations were made and data taken on establishment, season of growth and relative production. Stand counts were made when the seedings were one year old. The number of plants in 10 1/4 milacre quadrats taken at 20 foot intervals in each plot were averaged. Counts were made again after five years. Forage production was determined by harvesting plants from fully established stands within 10 1/4 milacre quadrats, airdrying the forage, and weighing. All production data were taken for six successive years.

Nitrogen and phosphorus were applied to an established stand of TOPAR. Two rates of N, one of P alone, and combinations of N and P were applied to a different series of plots each fall for five years. Ammonium sulfate was used for supplying the N at 42 and 84 pounds/A. Treble superphosphate was used to provide P at the rate of 39.6 pounds/A. Forage yields were taken each year for five successive years from each set of plots.

Seedings of all species in these trials were treated with Isotox before planting to prevent damage by wireworms to new seedings. One plot of crested wheat was untreated. CAPTAN 75 was used in one year on Siberian wheatgrass because the Agricultural Research Service had reported that a soil-borne fungus (Podosporiella verticillata) was often responsible for reducing stands of grasses in range reseeding work.

TABLE 1. INFLUENCE BY SEASON OF PLANTING ON NUMBER OF PLANTS PER 1/4 MILACRE QUADRAT AT THE END OF THE FIRST AND AT THE END OF THE FIFTH GROWING SEASON. ALL VALUES ARE THE AVERAGE FOR FIVE CONSECUTIVE YEARS OF SEEDING.

NO.	SPECIES	VARIETY	AVERAGE NUMBER OF PLANTS			
			END OF FIRST YEAR		END OF FIFTH YEAR	
			FALL	SPRING	FALL	SPRING
1	Crested wheatgrass	Fairway	3.25	16.38	4.68	19.23
2	Desert wheatgrass	Standard	4.98	19.62	6.78	18.00
3	Siberian wheatgrass	P-27	7.59	16.83	6.13	12.35
4	Beardless wheatgrass	WHITMAR	2.42	11.40	3.35	14.10
5	Intermediate wheatgrass	GREENAR	7.24	17.44	14.76	21.30
6	Pubescent wheatgrass	TOPAR	12.27	17.87	24.83	29.63
7	Slender wheatgrass	PRIMAR	2.91	9.48	2.26	7.73
8	Tall wheatgrass	ALKAR	4.00	11.29	6.13	9.78
9	Russian wildrye	P-9012	.63	10.90	1.57	11.72
10	Big bluegrass	SHERMAN	.75	5.56	1.53	6.78
11	Sheep fescue	P-274	1.34	5.06	2.03	6.88
		AVERAGE	4.26	12.89	6.74	14.32

RESULTS

Table 1 shows the influence of season of planting on stands of the 11 grasses seeded in the fall and in the spring. Data are averages from five successive fall and spring seedings made from 1949 thru 1954. Average number of plants obtained in the first year and in the fifth year for each species is given. Plantings of all legumes were failures.

These data show that spring seedings were superior to fall seedings. The average first year data for all species planted in the spring was 12.89 plants per 1/4 milacre quadrat. The average number of plants for fall seedings was 4.26. In the fifth year the average number of plants per quadrat had increased to 14.32 and 6.74 plants for spring and for fall seedings, respectively. These large differences are clearly in favor of making plantings of these grasses in the spring in the Continental climatic area of California. TOPAR wheatgrass is a possible exception. The average number of plants established from fall seedings indicates that TOPAR can also be successfully seeded in the fall. Typical stands are shown in Figures 3 and 4.

In general the density of all species increased from the first to the fifth year. This was true for 9 of the 11 species seeded in the fall. There were very minor reductions in fall-seeded stands of PRIMAR slender wheatgrass and Siberian wheatgrass.

Eight of the spring-seeded species increased in stand (number of plants per quadrat). Density of the two sod-forming grasses--GREENAR and TOPAR wheatgrass--nearly doubled in the 5 years. Again there were slight reductions in stand of PRIMAR, Siberian, and ALKAR wheatgrass during this period. However, spring-seeded stands of all 11 grasses were satisfactory and were adequate for erosion control.

Volunteer seedlings of SHERMAN big bluegrass and sheep fescue invaded adjoining plots. Sheep fescue was more aggressive in this respect. Figure 5.

The data in Table 1 do not show why spring seedings were superior. Undoubtedly a combination of factors was involved, including frost heaving and weed competition. Spring seedings were made in late March and early April on clean seedbeds after the danger of frost heaving was past. Fall seedings were made during the last week of October and first two weeks of November, but germination usually was delayed until early spring. Frost heaving in early spring reduced the number of seedings of each grass that emerged from fall seedings in each of the five years. Cheatgrass and cereal rye competition were always severe with fall seedings, and wind erosion was a problem.

The data are not shown but there was a relationship between total annual precipitation and the number of seedlings that emerged and could be counted at the end of the first year. The differences were greater from seedings made in the spring than from the seedings made in the fall. The average values for fall seedings of all grasses made from five years beginning in 1949 were 4.83, 6.08, 7.00, 2.29, and 1.11. By reference to Figure 2 it will be seen that these values are generally related to the total annual precipitation. For seedings made in the spring beginning in 1950 the averages were 4.02, 11.72, 36.32, 15.49, and 6.47. These are not as clearly associated with rainfall as the fall plantings.

Table 2 shows the forage production of 11 grasses seeded in the spring of 1951 at the Butte Valley Field Evaluation Planting. The yields were taken each year starting in 1956 for six successive years. All quadrats were cut with a mower, leaving an average stubble of 3.5 inches, except that eight inches of stubble was left on tall wheatgrass.

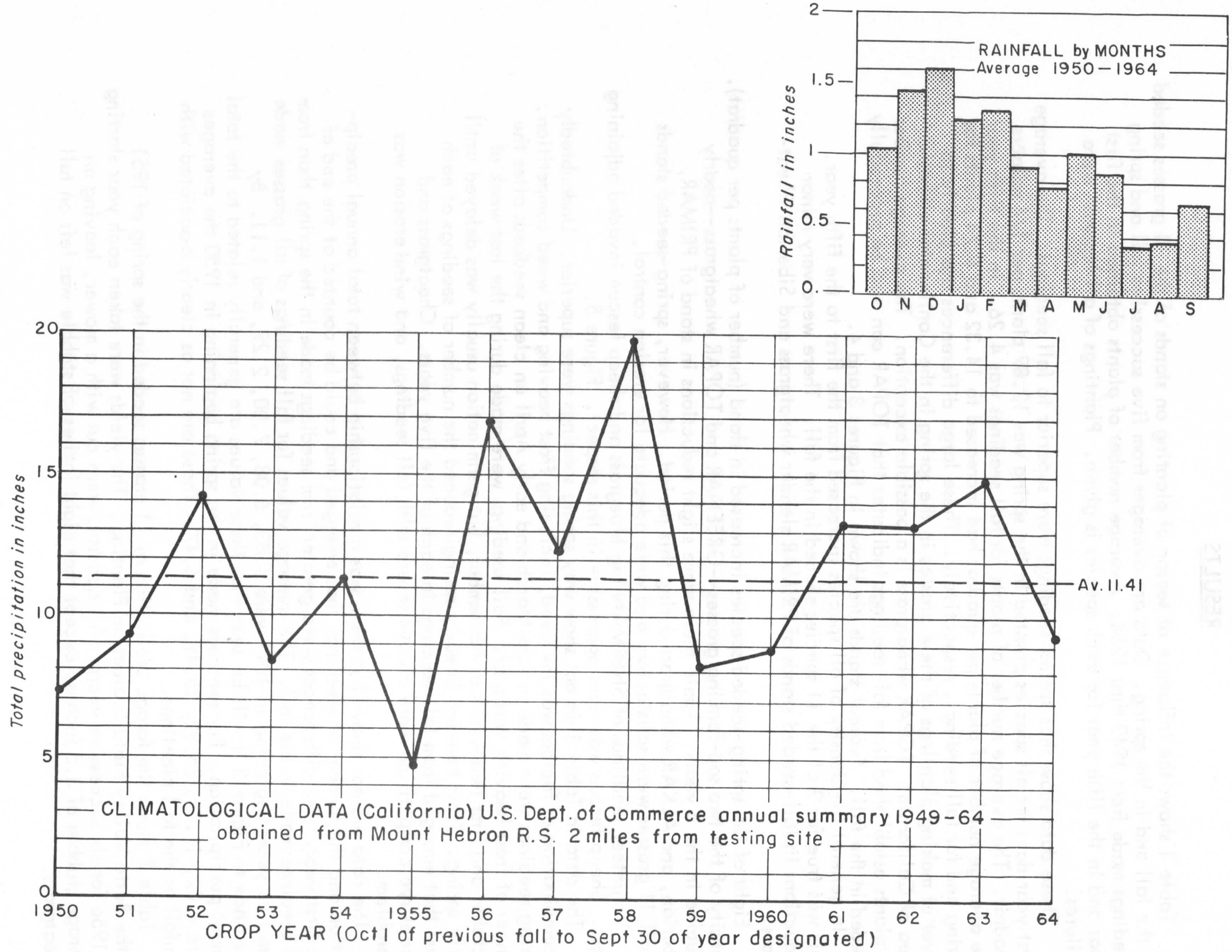

FIGURE 2 - Distribution of rainfall at Butte Valley Field Evaluation Planting

FIGURE 3A - Five year old stand of wheatgrasses: ALKAR (left), WHITMAR (center) and GREENAR (right). Seedings were made in the spring. P1-1141 SCS PHOTO

FIGURE 3B - Typical stand of TOPAR wheatgrass six years old, from fall seeding. P1-1200 SCS PHOTO

FIGURE 4A - Four years old spring seeded stands of Standard crested wheatgrass (left) and Desert wheatgrass (right). P1-1201 SCS PHOTO

FIGURE 4B - Siberian wheatgrass planted in spring of 1951. Photographed in 1956. WHITMAR is on the right, PRIMAR is on the left. P1-1213 SCS PHOTO

FIGURE 5A - Four year old stand of SHERMAN big bluegrass (left) and sheep fescue (right). P1-1203 SCS PHOTO

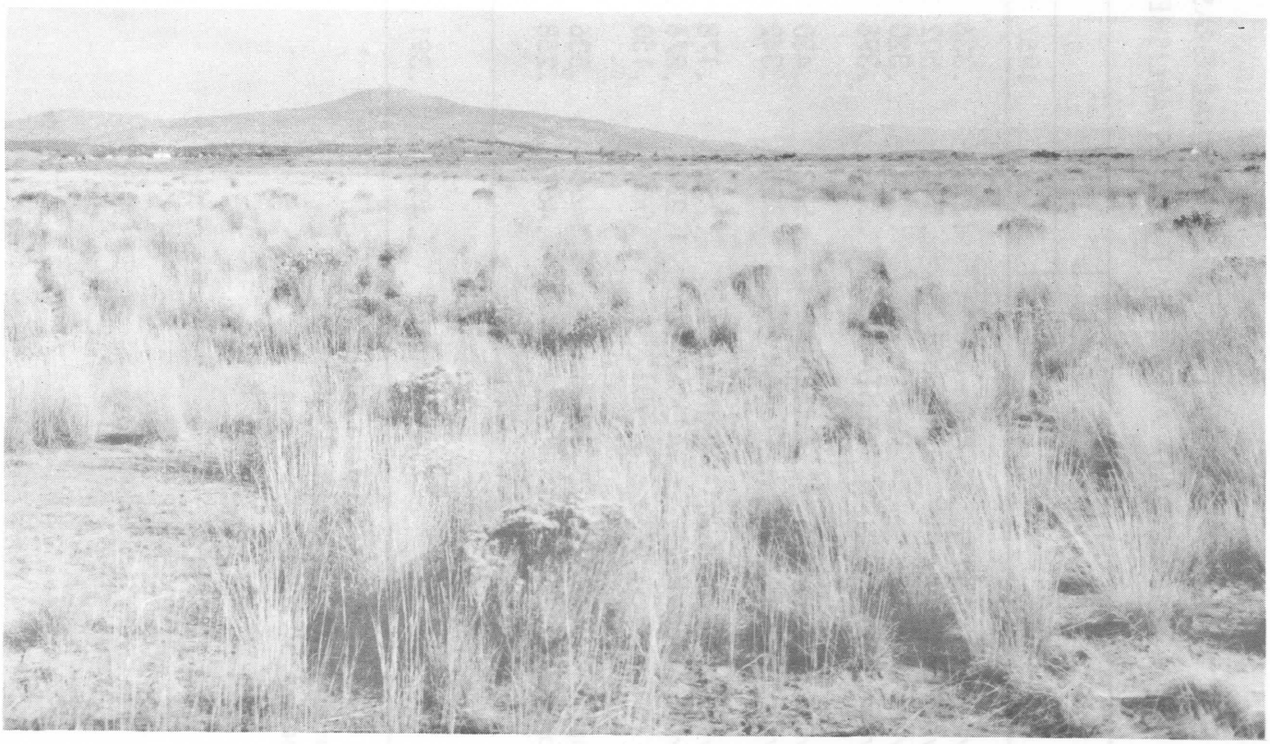

FIGURE 5B - From a ten foot plot on the right the sheep fescue after eleven years had invaded the adjoining plots. P1-2083 SCS PHOTO

TABLE 2. PRODUCTION OF PERENNIAL GRASSES AT BUTTE VALLEY, CALIFORNIA. DATA ARE FROM FULLY ESTABLISHED STANDS.

SPECIES		FORAGE YIELDS TONS/A							AVERAGE	lb/A
		1956	1957	1958	1959	1960	1961	TOTAL		
Agropyron cristatum	Fairway	.394 1/	.336	.200	.144	.186	.260	1.520	.253	500
Agropyron desertorum	Standard	.594	.502	.240	.180	.182	.258	1.956	.326	650
Agropyron sibiricum	P-27	.534	.320	.340	.164	.176	.214	1.748	.291	580
Agropyron inerme	WHITMAR	.506	.398	.380	.254	.290	.228	2.056	.343	690
Agropyron intermedium	GREENAR	.572	.430	.420	.256	.210	.306	2.194	.366	730
Agropyron trichophorum	TOPAR	.352	.342	.300	.104	.133	.270	1.501	.250	500
Agropyron trachycaulum	PRIMAR	.256	.178	.160	.114	.098	.038	.844	.141	280
Agropyron elongatum	ALKAR	1.274	.876	.880	.770	.938	.756	5.494	.916	1830
Elymus junceus	P-9012	.068	.150	.140	.098	.092	.190	.738	.123	250
Poa ampla	SHERMAN	.466	.506	.500	.334	.238	.334	2.378	.396	790
Festuca ovina	P-274	.462	.258	.260	.138	.136	.148	1.402	.234	470
	AVERAGE	.498	.391	.347	.232	.244	.273	21.831	.331	

1/ Values = Av. ten 1/4000 acre quads.
A. elongatum forage above 8" stubble;
All others 3.5" stubble.

The average production obtained by years shows some fluctuation, but this could not be coordinated with changes in total precipitation. Other climatic factors operating in the area--such as incidence of rainfall, temperature, and wind velocity--probably account for the differences obtained.

The average annual production for 11 grasses is satisfactory. The highest five year average production--0.916 tons per acre--was obtained from ALKAR tall wheatgrass. Even though the density of this grass was only 9.78 plants per 1/4 milacre as shown in Table 1, the ability of ALKAR to produce high yields was exceptional. The low yields of PRIMAR, slender wheatgrass, and Russian wildrye indicate that they are not well adapted to the soils (and climate) in the area. A typical stand of ALKAR is shown in Figure 6A.

WHITMAR wheatgrass, among the adapted bunchgrasses, had the most consistent level of production from year to year. Consistency in production among years is characteristic of native grasses such as WHITMAR and SHERMAN big bluegrass. In addition, WHITMAR is used after crested wheatgrass is grazed. This use extends the green-feed grazing period into the early summer.

TOPAR wheatgrass yields were low because the 3.5 inch height of clipping did not include all of the useable forage available from this sod former. TOPAR provided the best ground cover, and the yields were satisfactory for this capability land. The more than 160,000 acres of TOPAR that have been seeded in northeastern California verify this. See Figure 6B.

GREENAR wheatgrass was the third highest producing grass. Its performance at this location was surprisingly good. Reports from other locations in the Northwest have indicated that GREENAR was not suited to low rainfall areas or low fertility soils such as characterize this location.

SHERMAN big bluegrass produced a satisfactory amount of forage and was almost as consistent in production among years as was WHITMAR wheatgrass. This is a vernal dominant grass. It is the earliest in spring recovery and the earliest to reach range readiness. It escapes drought by completing its life cycle before the soil moisture is gone. SHERMAN must be fully established before it is grazed. When grazing is deferred for two years it will provide early spring feed.

Sheep fescue produces a moderate amount of feed, but its chief ability is to volunteer from shattered seed. It has spread into adjoining plots where the stands were sparce.

Siberian alfalfa, milkvetch and yellow blossom sweetclover were the legumes used with these plantings. None of these plants showed any more than a trace on this site. Depredation from jackrabbits may have caused failure to establish alfalfa and sweetclover. The annual precipitation may have been too low for the survival of milkvetch. Burnet, a forb, may either not have been adapted or was quickly destroyed by rodents. Alfalfa or yellow blossom sweetclover are frequently added in small amounts in range seedings. Cicer milkvetch is showing adaptation in other high-elevation seedings.

The influence of fertilizer on yields of TOPAR wheatgrass is shown in Table 3. The data show that phorphorus alone had very little influence on yields. The combination of phosphorus with nitrogen depressed yields slightly. Split applications of nitrogen proved an exception, in which case the total yield was slightly increased, as can be seen by comparing treatment 6 with treatment 3. Even so the influence by phosphorus was slight and may not have been significant.

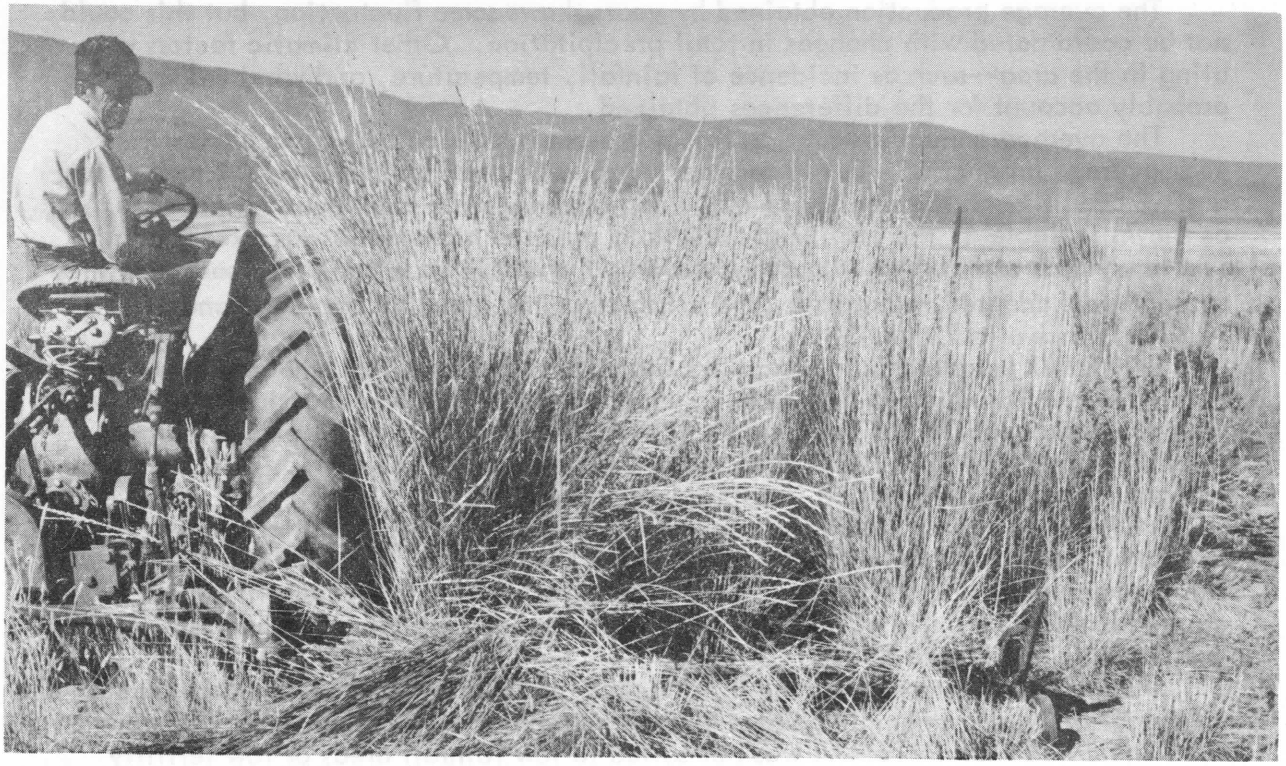

FIGURE 6A - ALKAR wheatgrass being mowed above eight inch stubble. P1-1198 SCS PHOTO

FIGURE 6B - Harvesting a stand of TOPAR wheatgrass five years old. The mower was set to leave 3.5 inch stubble. P1-1199 SCS PHOTO

TABLE 3. THE EFFECT OF RATES OF NITROGEN ALONE AND IN COMBINATION WITH PHOSPHOROUS ON FORAGE PRODUCTION OF FULLY ESTABLISHED STANDS OF TOPAR WHEATGRASS

TREATMENT		YIELD OF HAY AND LBS/A						INCREMENT
NO.	KIND	1st Year	2nd Year	3rd Year	4th Year	5th Year	TOTAL	FOR N
1	None	397 /1	368	342	392	322	1,821	----
2	N_1P_0 /2	827	580	504	479	423	2,813	23.62
3	N_2P_0	952	673	592	587	407	3,211	16.55
4	N_1P_1	720	583	495	419	.437	2,654	----
5	N_2P_1	762	746	494	562	424	2,988	----
6	$N_1P_1 + N_1$	980	672	583	615	459	3,309	----
7	N_0P_1	391	381	465	495	318	2,050	----

/1 Each value in this table represents the average from 5 plots.

/2 N_1 = 42 Lbs N/A
N_2 = 84 Lbs N/A
P_1 = 39.6 Lbs P/A

The data in Table 3 also show that both rates of nitrogen increased first-year yields and provided a carryover response for four more years. However, in no one year were the yields due to nitrogen economical. The cumulated total of yields for five years from one application did pay off. The increment from single applications of 42 pounds of nitrogen was 23.62 pounds of forage per pound of N. Using 15 cents per pound for the cost of N and 20 cents per pounds as the value of beef, and 25 pounds of hay per day per animal, the net profit was $5.61 per acre. The increment from single applications of 84 pounds of N per acre was 16.55 pounds of forage per pound of N. Similarly the net profit was $4.08 per acre. Thus in these studies the application of 42 pounds of N was more profitable than was the application of 84 pounds of N.

The forage yield in Table 3 is the production above 3.5 inches in stubble height. It is entirely possible that this was more stubble than would be left if the forage were grazed by livestock. The differences among treatments probably would have been somewhat greater under actual grazing. Even so it would appear that the application of nitrogen would have been economical. It is doubtful if the application of phosphorus would have had any preceptible influence on yields under grazing.

SEED TREATMENTS

Seed was treated with Isotox for control of wireworms for three years. Both fall and spring seedings were treated. The data obtained indicates that the use of Isotox had no influence on stands obtained from fall seedings. However, in two of the three years a definite advantage was obtained from spring seedings of species treated with Isotox. The average cost to treat the seed was less than 50 cents per acre. Results obtained more than offset this nominal charge. Application of CAPTAN 75 had no influence.

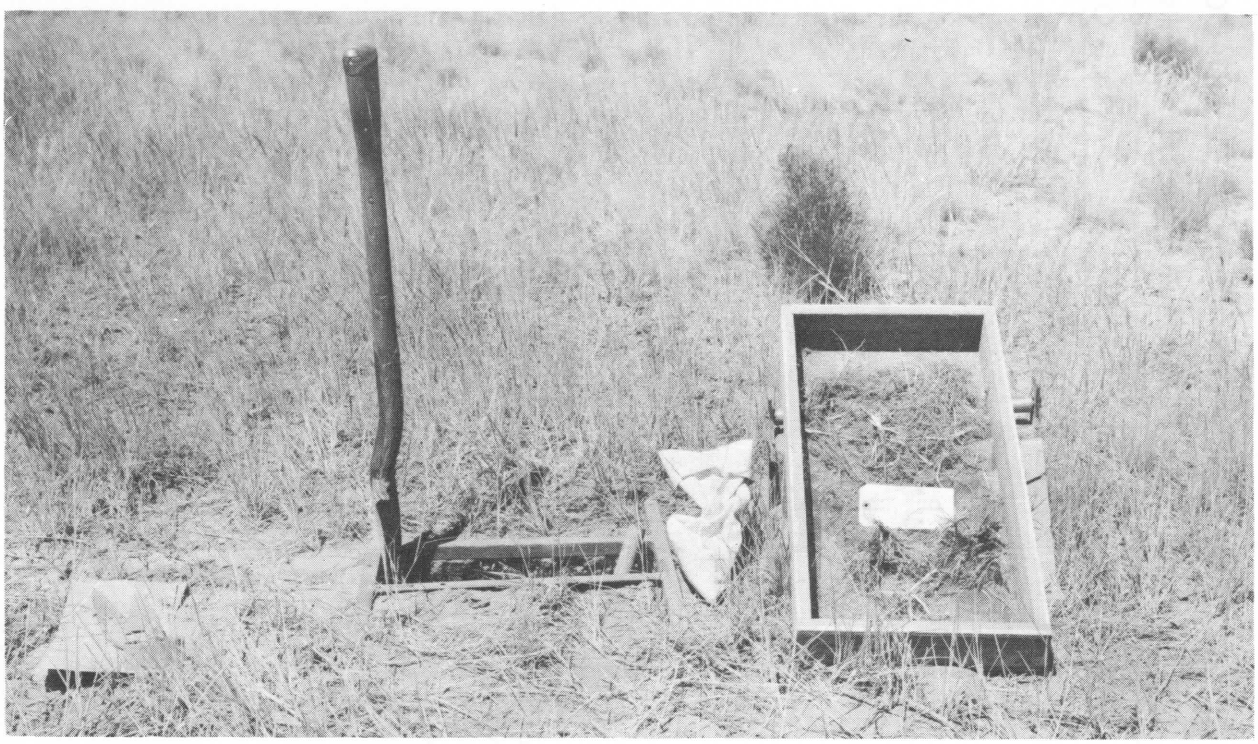

FIGURE 7 - Harvesting roots from fully developed stand of TOPAR wheatgrass. PL-1990 SCS PHOTO

ROOT SAMPLES

In 1962 a study was made to determine the amount of root production on established stands of TOPAR and GREENAR wheatgrass. Root samples were taken inside an angle iron frame 18 inches long, 8 inches wide, and 8 inches deep. The method is illustrated in Figure 7. Five samples were obtained in each planting. The roots and rhizomes were separated from the soil. In addition, all of the top growth was removed and production was determined.

The two sodgrasses were used because they represented uniformly well-developed stands in all seedings. All plantings were at least five years old. In previous years the top growth had been removed to a 3.5 inch stubble.

The data are represented in Table 4. It will be seen that production of roots in the surface eight inches of soil for both TOPAR and GREENAR wheatgrass was essentially the same and became stabilized at an average of 4,900 pounds/A. Since all of the top growth was removed from each sample, some stubble residue from previous mowings was included. Therefore, the values for top growth are greater than those presented in Table 2. However, here again top growth from GREENAR wheatgrass exceeded that obtained from TOPAR wheatgrass, as was the case in the data presented in Table 2. The average of 4,900 pounds of roots is considered adequate on this class of land. This amount should have a favorable influence on soil texture.

OTHER SPECIES

Plantings of varieties and strains of wheatgrass were made in the spring of 1957, 1961, 1963, and 1965. These were largely observational to determine, if possible, the superiority of new varieties that had been developed by other Plant Materials Centers. Some of these varieties have been named and are on the market. In each of the four years the total annual precipitation was above average.

There were no significant differences between three varieties of crested wheatgrass. The new variety, Nordan, is on the market. A planting of bluebunch wheatgrass was inferior to WHITMAR wheatgrass. Three varieties of pubescent wheatgrass were seeded, and there was evidence that LUNA was slightly superior to TOPAR in the early stages of development. Among four varieties of intermediate wheatgrass, GREENAR was superior to Amur and Ree.

Excellent stands of thickspike, western, and streambank wheatgrass were obtained. Although measured yields were lower than that of intermediate wheatgrass, they were well adapted to the site. All provided good ground cover and were not affected by frost heaving. Streambank wheatgrass (SODAR) provides good ground cover and is not especially palatable to livestock or subject to depredation by jackrabbits and big game.

Comparisons were made among SHERMAN big bluegrass, Nevada bluegrass, Canby bluegrass, and three bluegrass hybrids obtained from the Carnegie Institution of Washington. SHERMAN big bluegrass was the only one successfully established.

New plantings of legumes--including varieties of alfalfa, sainfoin, and perennial vetch--were compared. All of these plants are attractive to jackrabbits and are grazed locally by them. The most successful legume was Ladak alfalfa.

Miscellaneous perennial grasses-Romanian false brome, meadow brome, and Russian brome--were apparently not adapted to the site. Plantings of Great Basin wildrye and <u>Elymus sabulosus</u> produced good initial stands but deteriorated rapidly after the first year.

TABLE 4. AVERAGE PRODUCTION OF TOPS AND ROOTS OF ESTABLISHED STANDS OF TWO SODGRASSES AT THE BUTTE VALLEY FIELD EVALUATION PLANTING. VALUES FOR ROOTS ARE FOR THE SURFACE ACRE 8 INCHES.

SPECIES	VARIETY	SEASON OF PLANTING	NO. OF SAMPLES	TOPS	ROOTS AND CROWNS
				Lbs.	Lbs.
Agropyron trichophorum	TOPAR	Fall	5	1548	4997
		Spring	6	1543	4755
Agropyron intermedium	GREENAR	Spring	3	2235	4948

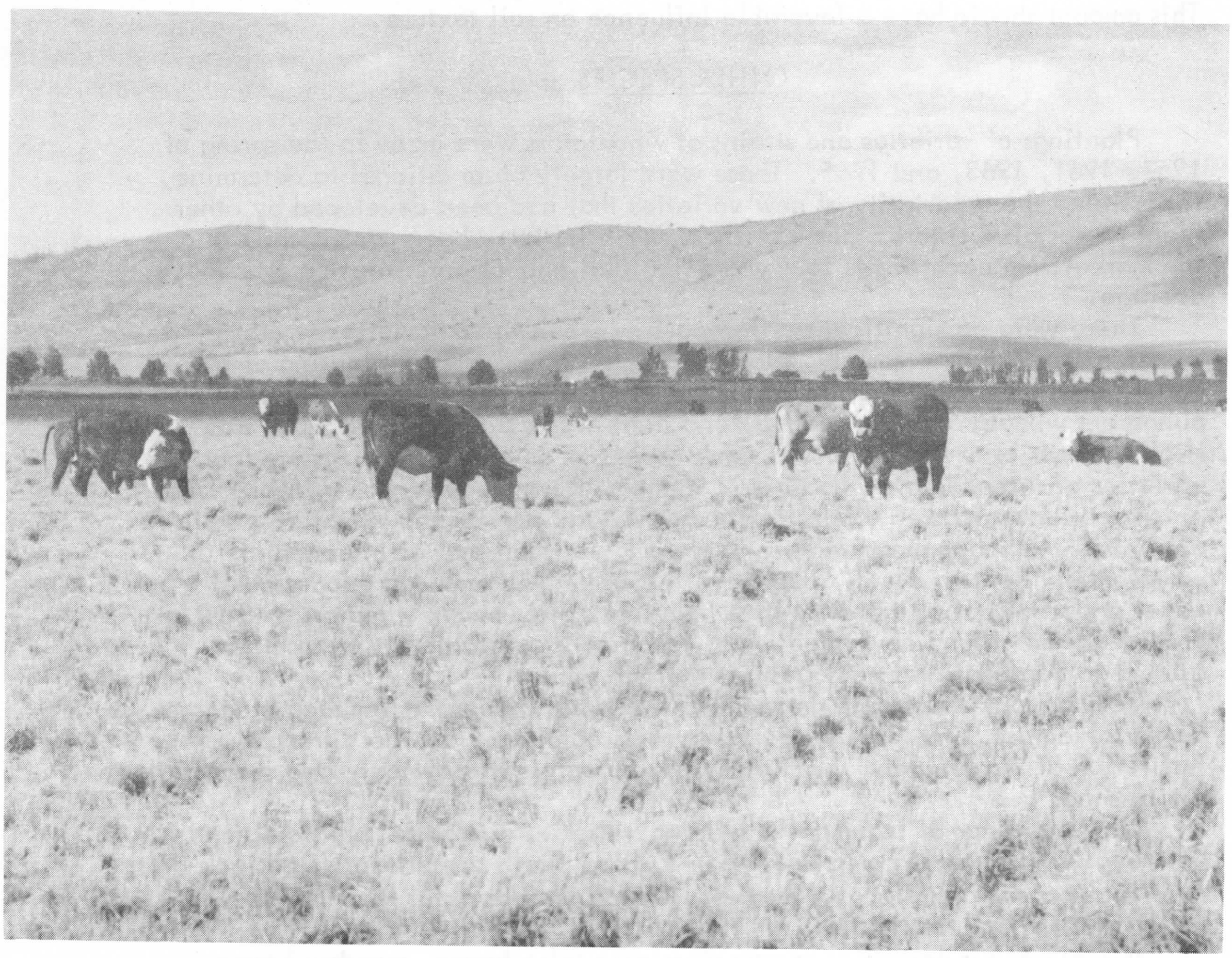

FIGURE 8A - Livestock grazing ALKAR in Adin-Lookout SCD P1-1772 SCS PHOTO

SUMMARY

1. The Butte Valley Field Evaluation Planting represents more than five million acres of land in northeastern California in major resource areas 21, 22, 23, 26 and 29. All of this land is Continental climate characterized by high elevation, low rainfall, warm summers, and cold winters. Much of the rangeland in the area is in fair or poor condition. A large part of the land could be improved by reestablishing perennial species.

2. The studies of the Field Evaluation Planting indicated that the time of seeding is especially critical for most grasses among the adapted species. Late March and early April seedings were greatly superior to seedings made in late October or early November. There was one exception. TOPAR wheatgrass could be established as well from late fall as from very early spring seedings.

3. The best adapted grasses were ALKAR, GREENAR, WHITMAR, crested and TOPAR wheatgrass and SHERMAN big bluegrass. The production of ALKAR was the highest, which reflected its known adaptation to strongly alkali soils. On the low-lying terraces where these studies were conducted, the yields from GREENAR, WHITMAR, and standard crested wheatgrass and SHERMAN big bluegrass were about equal. Yield of TOPAR wheatgrass was slightly lower, but its ability to establish itself in both fall and spring was unique.

4. Fall seedings of alfalfa, milkvetch, sweetclover, and burnet were failures. These failures were attributed to depredation by jackrabbits.

5. All seedings were made on good clean fallow land. The land was disked in early spring, fallowed during the summer, and harrowed just prior to seeding the following spring. In the case of TOPAR wheatgrass that is to be planted in the fall, the land must be disked and firmed with a roller.

6. Seed should be treated with Isotox before being planted in these resource areas. The Isotox guards against seedling destruction from wireworm. The total cost per acre is low.

7. It is doubtful whether fertilizing established stands is economically feasible. However, when TOPAR wheatgrass was fertilized with 40 pounds/A of nitrogen an economical return was realized after five crop years.

FIGURE 8B - Four hundred acre soil bank seeding of TOPAR wheatgrass in Butte Valley SCD. P1-1391 SCS PHOTO

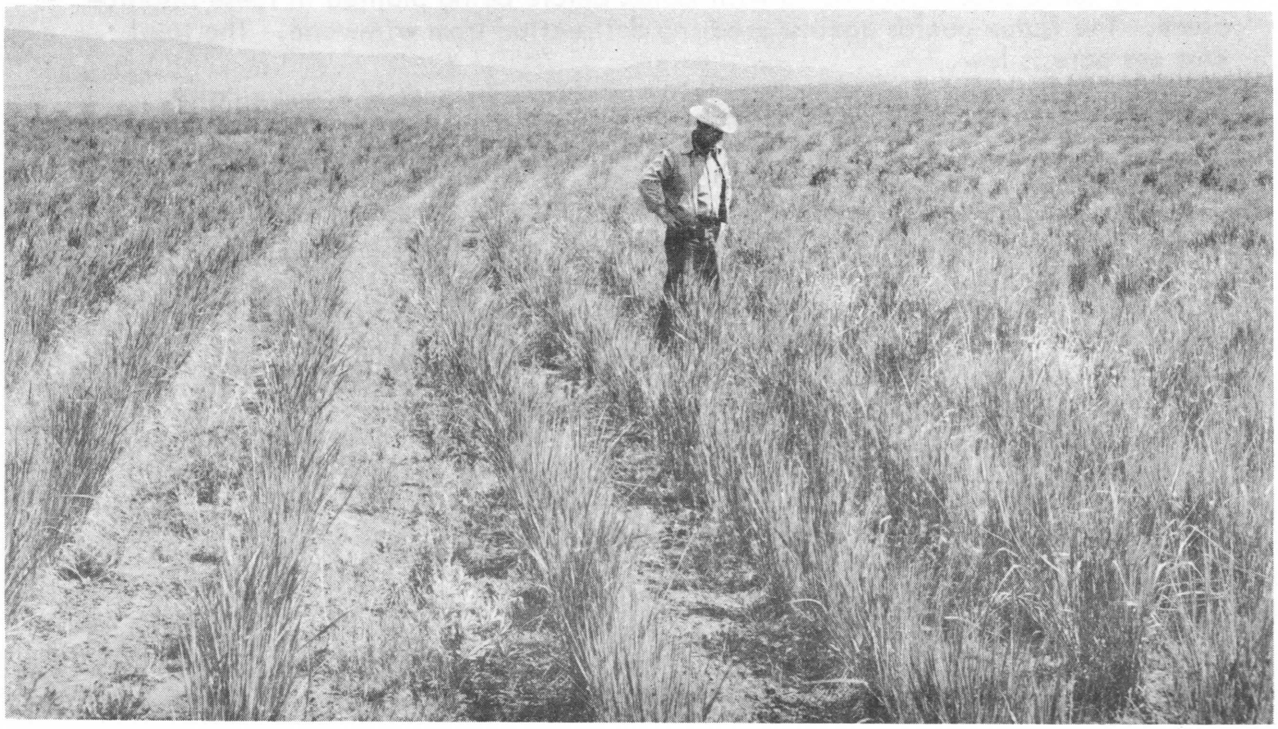

FIGURE 8C - Intermediate wheatgrass planting in Pit SCD 3-194-7 SCS PHOTO

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