PROGRESS REPORT

Osterli

Range Demonstration 1958

University of California
Range Management Investigations

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RANGE MANAGEMENT INVESTIGATIONS
DEMONSTRATION RANGES

Progress Report for Year Ending December 1958

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INTRODUCTION

The Range Demonstration project has been administered by the Director of Field Stations since its beginning in January 1950. At the beginning it was apparent that much research information had been developed which should be demonstrated by direct application on the brush ranges of the cooperating ranchers. Economics of many of the improvement techniques had not been sufficiently studied to warrant improvement recommendations, and thus economic studies have been an important part of the program during the past nine years.

As the work has progressed it has become more apparent that many gaps still exist in basic research information necessary to solve the problems encountered on the demonstration ranges. Much additional information must be secured in basic and applied research areas to bring the brush ranges into their full productive capacity. This lack of information has led to a gradual shift of emphasis from "demonstrations" to applied and basic research plots in close cooperation with departments responsible for the research in the various subject matter areas. As information has been developed the "demonstration" aspects of the projects have utilized the results on the cooperating ranches. The demonstration ranches have been effective tools in furthering the statewide program of range improvement, and general acceptance of demonstrated improvement techniques.

Accompanying the gradual trend toward expansion of the research phases, particularly in the agronomic problems of perennial grass stand establishment and maintenance, legume establishment, inoculation and maintenance, it has been necessary to lean more heavily on the Agronomy Department for guidance and council. Close cooperation with the Department of Botany in chemical control and chemical treatment following control burns has been maintained. Wildlife problems have been encountered at all sites and cooperation with wildlife research staff members has been essential.

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As the research work has expanded the logical question has been raised concerning the desirability of shifting the administrative responsibility for the project to the department most vitally concerned. Since continued progress with the "demonstration aspects" of the project must depend on development of additional research information, this shift of responsibility seems desirable.

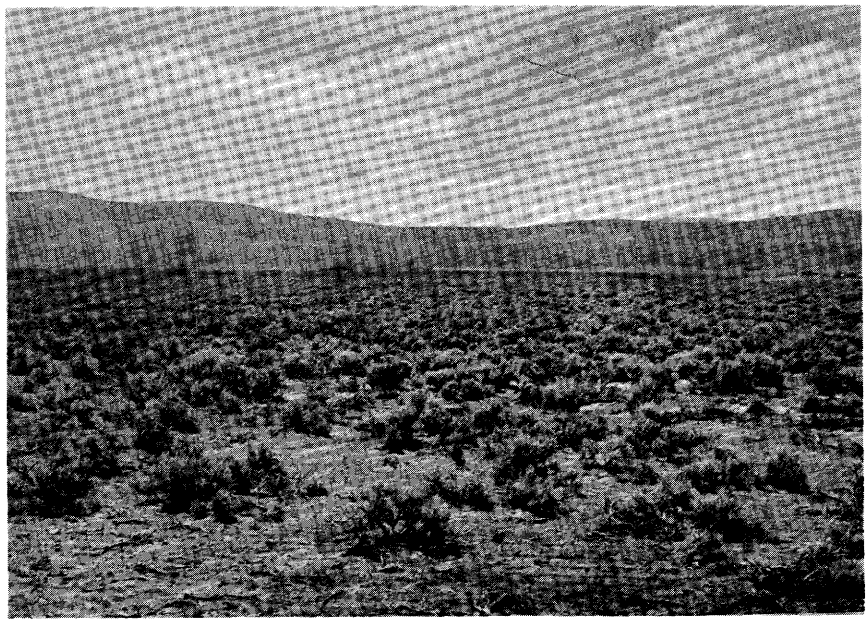
Thus on July 1, 1959 the staff and their supporting budget will be transferred to the Department of Agronomy. This will be the final annual report issued by Field Stations. Reporting in future years will be in agronomy under Experiment Station numbered projects, and the decision as to the desirability of continuing the annual report in its present form will be a departmental decision.

A summary of range improvement activities for the calendar year of 1958 are reported in the following pages. Accomplishments on the primary demonstration ranches appear in the first sections of the report. Later sections are devoted to vegetation manipulation on experimental watersheds and demonstrations and investigations in other counties. Results of previously established plots and projects are reported. Some of these have been published elsewhere. Reference is occasionally made to last year's report, Range Demonstration 1957. A few copies are still available for distribution. New projects are also included in this progress report.

All activities have been closely correlated with research specialists of the Experiment Station and Farm Advisors and Specialists of the Agricultural Extension Service. The assistance of cooperating ranchers and their neighbors is essential. Their spontaneous cooperation is greatly appreciated. Able assistance has also been received from the California Division of Forestry, State Department of Agriculture, U. S. Forest Service, Agricultural Research Service, and the Bureau of Land Management.

Range field days in San Diego and Modoc Counties were the outstanding demonstration activities for 1958. Range operators have taken great strides in range imporvement in the past decade. They are more cognizant of the potential of the range resource and many are eager to apply the latest discoveries of research. The non-ranching populace have a vested interest in our rangelands. All ranges are watersheds. Fire control, watershed management, wildlife, and other land uses in our foothill range country are of paramount importance to California. At the Southland Range, Livestock and Watershed Tour in San Diego County and on similar tours at other locations people of many interests participate in discussion of the various facets of rangeland management. Meeting in the field and observing the various methods of management greatly facilitates a common understanding of the problems and leads to management of greater mutual benefit.

FLOURNOY RANCH, MODOC COUNTY



The Flournoy Demonstration Range is located two miles northeast of the town of Likely, Modoc County. The area is commonly referred to as table land and usually grows big sagebrush (Artemsia tridentata), cheatgrass (Bromus tectorum), squirrel tail (Sitanion histrix), Sandbergs bluegrass (Poa secunda), and red-stem filaree (Erodium cicutarium). Rainfall averages 12½ inches although seasonal totals may vary widely. The elevation is 4500 feet. The growing season is short and variable. The annual bromegrass may germinate as early as October. However, grazable growth may not appear until May of the following year. In a warm wet spring growth may start as early as February. In all years the annual grasses are dry by the end of June. Winter temperatures may fall below zero. The soil is Lassen Stony Clay Loam of 0 to 20 inch depth.

The cooperator is Mr. Warren Flournoy of Likely, California. Special credit is due Mr. Flournoy for the work accomplished during the past year. The 300-acre pastures for the grazing trial could not have been established without his excellent cooperation.

Seedings

Range seeding trials have been carried on at different times of year, after various methods of sagebrush removal, and with a variety of grasses and legumes over a period of four years. These trials and their results are described in Range Demonstration 1956, and Range Demonstration 1957.

The following general recommendations have developed from these trials.

1. Date of Seeding: Early spring seedings (February and March) are the most reliable. Fall plantings produce better results than early spring seedings - if they are successful. However, fall seeding is not as reliable as early spring seeding. If fall seedings are attempted they should be late - November or December.

Late spring seeding in late April or May has not been successful.

2. What to seed: Greenar intermediate wheatgrass has proven to be well adapted to the study area during the four seasons it has been tested. It produces more forage, has a longer green feed season, is easier to establish, and spreads more readily than crested wheatgrass.

Persistence of Seeded Species

One of the important questions in range seeding is how long will the seeded species persist? Will it continue to increase as a component of the forage or will it gradually be replaced with locally abundant species such as cheatgrass? The final answer to these questions remain to be determined. However the results of four growing seasons indicate intermediate and pubescent wheatgrasses are increasing.

The stand in question was seeded in March, 1955 to a mixture of crested, tall, intermediate, and pubescent wheatgrasses. Samples of per cent stocking indicate that the wheatgrass component of the stand is increasing. Observations indicate the increase is due to the rhizomes of pubescent and intermediate wheatgrass.

Cheatgrass showed a sharp decline in ground cover with the advent of grazing from 32.8% before grazing (June, 1957) to 6.6% after grazing (July, 1958). Grazing reduced wheatgrass from 8.26% in 1957 to 3.56% in 1958. This is an 80% reduction in cheatgrass due to grazing and a 57% reduction in wheatgrasses. This can be considered a healthy situation - discouraging the cheatgrass in favor of the wheatgrass.

Stocking figures appear in the following table. These figures bear out the observation that the wheatgrass is spreading. Most striking is the stand of mixed wheatgrasses seeded in November of 1954. Samples taken in July, 1955 indicate the stand is poor. The stand was more or less abandoned as a failure and not sampled again until it was noticed this year that it had improved. Stocking in July 1958 indicate the stand has improved from poor (21%) to just inside the good class (40%).

Grazing of Experimental Area

Fifty-eight acres of sagebrush range was fenced in 1954 to provide a study area with controlled grazing. By May of 1957 all of the brush had been killed by spraying or plowing and seeded with perennial grasses and legumes. This includes most of the seedings described in Range Demonstration 1956 and 1957. There were new seedings each year which needed protection from grazing with the result that none of the area was grazed from July 1954 until May 6, 1958. The pasture was moderately grazed by fourteen cows and calves from May 6, 1958 to June 10. This amounts to 24.8 AUM* for 58 acres or about 2.3 acres per AUM. Unimproved sagebrush range would require at least 10 acres AUM.

*Animal Unit Month as described by Shultis and Burlingame, "Figuring Pasture Production," Agricultural Extension Service, Mimeo., 3.26, June 1949.

Percent stocking of wheatgrasses (Percent of square feet having at least one wheatgrass plant)			
Management	Date of Sample	Percent Stocked	Rating*
Seeded 3/22/55	7/26/55	64.5	Excellent
No grazing except by rabbits, deer, antelope and rodents.	7/25/56	62.5	Excellent
Accidentally burned September, 1957	6/18/57	65.0	Excellent
	4/22/58	80.0	Excellent
Grazed for first time from May 6 to June 10, 1958	7/1/58	90.0	Excellent
Seeded 11/2/54	7/5/55	21.0	Poor
Management same as stand seeded 3/22/55	7/1/58	45.0	Good

*As judged by Hyder and Sneva, Journal of Range Management Vol. 7, Number 2, pp. 89.

329 Acre Grazing Trial

Three-hundred and twenty-nine acres of sagebrush range was cleared and seeded to Greenar intermediate wheatgrass in preparation for a grazing trial. An adjacent area of equal size was cleared of sagebrush by control-burning and allowed to revegetate naturally.

The two pastures were burned in August of 1957. The pasture to be reseeded was double disked, harrowed, and drilled to Greenar intermediate wheatgrass and alfalfa in alternate 7-inch rows during 1958. Plowing was included as a cultivation method on 87 acres to determine if the extra operation was of any benefit. Small rodents were controlled by broadcasting poison bait at the time of seeding.[1] The seeded area was not grazed by domestic livestock during the summer of 1958. The economics of the range improvement appear in the following table.

The seeding was an outstanding success. Stocking samples taken on June 9, 1958 on the area which was plowed before disking, harrowing and drilling indicate 73% stocking of wheatgrass, 39.5% alfalfa stocking and total stocking of 84%. In the

[1] Rodent poisoning was done by Loring White, Modoc County Agricultural Commissioner.

Cost of Development Record 329-Acre Grazing Trial, Likely Demonstration Range					
	Equipment				
Acreage	Operation	No. Hours	Cost /Hr.	Total Cost per Operation	Material
87 Acres	Plowing	35	$8.00	$280.00	Grass Seed 8 lb/acre at 35¢/lb. $243.60
	Disking	22	8.00	176.00	Alfalfa Seed 2 lb/acre at 50¢/lb. 87.00
	Harrowing	12	8.00	96.00	
	Drilling	22	8.00	176.00	
				$728.00	$330.60
	Total cost for 87 acres $1058.60				
	Cost/acre $12.17				
242 Acres	Disking	45	8.00	360.00	Grass Seed 8 lb/acre at 35¢/lb. 677.60
	Disking	43	8.00	344.00	Alfalfa Seed 2 lb/acre at 50¢/lb. 242.00
	Harrowing	24	8.00	192.00	
	Drilling	43	8.00	344.00	
				$1240.00	$919.60
	Total cost for 242 acres $2159.60				
	Cost/acre $8.92				
	Fence One mile $1,000.00				
329 Acres	$4,218.20 Cost/acre $12.82				

adjacent area which was not plowed, but only double disked before harrowing and drilling the stocking was 62.5% wheatgrass, 41% alfalfa, and 77% total stocking. Either of these stands would be rated excellent by the method described by Hyder and Sneva.

An adjacent area which was cleared of brush by the same control-burn and allowed to revegetate naturally is being fenced to use as a check plot in the grazing

trial.

Grazing of the two pastures will begin in April of 1959. Animal gains as well as animal numbers and forage clippings will be recorded.

Miscellaneous Small Plots

1. Rate of seeding intermediate wheatgrass: Plantings were made with the range drill at rates of 3, 4, 6, 8, and 14 pounds of greenar intermediate wheatgrass per acre in four replications. Seed was planted 1½ inches deep in a disked seedbed on March 19, 1958. The resulting stands were poor, but differences were evident. The number of seedlings were counted in 50 feet of row with the following results.

Seeding rate lb/acre	Mean number of plants per 50 feet of row
3	14
4	17
6	25
8	41
14	61
L.S.D. .05	32

The low number of plants per foot of row is probably due to the effect of rainfall pattern on germination. Under these conditions at least eight pounds of seed was necessary to obtain a satisfactory stand.

2. Depth of seeding intermediate wheatgrass: Greenar intermediate wheatgrass was seeded at depths of 0 (broadcast), 1/2, 1½, and 3½ inches in a disked seedbed with the range drill on March 19, 1958.

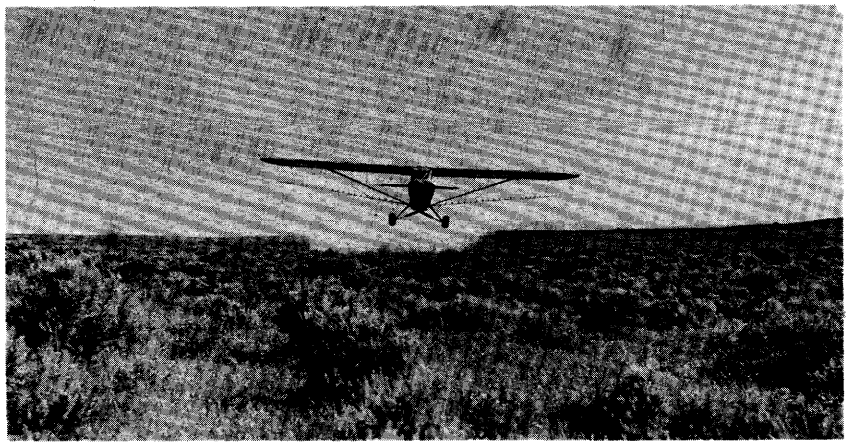
Seedlings were counted in an area five by 10 feet in each of four replications on July 18, 1958 with the following results.

Depth of seeding in inches	Mean number of seedlings per 50 square feet
0	16
1/2	29
1½	26
3½	34
L.S.D. .01	10

Again the resulting stands were poor due to something other than the treatment, but differences are evident. The only significant difference is between broadcast and drilling. This indicates seed coverage is more important than how deep it is covered.

3. Row spacings: A planting of wheatgrass was made with one-foot and two-foot row spacings. Yield from these plantings will be compared in later years.

Chemical Sagebrush Control



Spraying sagebrush with 2,4-D

Sagebrush acreages were sprayed in June of 1956 and 1957 using agricultural aircraft. Two pounds of low volatile ester 2,4-D (4 pounds acid equivalent per gallon) and two quarts of diesel oil in nine gallons of water were used. Results appear in the following table.

Per cent kill resulting from application of 2,4-D to sagebrush

Treatment	Sample date	Kill*			
		Dead	30% alive	60% alive	100% alive
Sprayed June 1956 40 acres	6/57	64.2	29.1	4.9	1.8
	6/58	89.0	10.0	1.0	---
Sprayed June 1957 30 acres	6/58	67.5	30.2	2.3	---

*Kill refers to all sagebrush plants including seedlings.

It is interesting to note that the first-year sample results are nearly identical on the two sprayed areas. In each case two thirds of the sagebrush was dead at the end of the first year and almost one third of the plants had 30% of their crowns living. Second-year results on the 1956 spraying show another 25% to have died bringing the kill up to 89%. Samples of both areas will be made next year.

Competition Control

Drilling after spraying or burning without spring cultivation to control weeds is hazardous. Some drilling after spraying in 1954-55 was successful. These years followed "dry" years. There was no grass growth between sagebrush plant and hence, no supply of weed seed.

Seedings of March 1957 into sagebrush killed by spraying in 1956 were not successful. Seedling counts were high, but counts a year later show the wheatgrass seedlings had not been able to compete with the cheatgrass.

The same is true of drilling after burning. Fire destroys the sagebrush plants and the weed seeds immediately adjacent to the brush plants. A large amount of weed seed, primarily cheatgrass, is left between the plants. Drilling into this competition cannot be recommended.

It is interesting to note that crested wheatgrass appears better able to withstand this competition than pubescent or intermediate wheatgrass as shown in the following table.

Table No. 3

Stocking of Wheatgrass Seedlings after Drilling into Severe Competition

Treatment	Species	Per Cent Stocking
Area sprayed June 1957		
Drilled Oct. 1957	Crested wheatgrass	69.0
	Pubescent wheatgrass	11.5
	Intermediate wheatgrass	32.0
Drilled March 1958	Mixture of the above wheatgrasses	20.0
Area burned September 1957		
Drilled Oct. 1957	Crested wheatgrass	73.0
	Pubescent wheatgrass	39.0
	Intermediate wheatgrass	15.0

These high stocking figures would normally indicate poor to good stands. However, poor seedling vigor indicates the stands will likely all be rated failure when measured next year.

Fertilizer Plots

1. Nitrogen carryover on cheatgrass range: Replicated fertilizer trials on native cheatgrass range have shown nitrogen carryover. Nitrogen applied before the growing season in the spring of 1955 failed to show any response during the spring and summer of 1955. However, these same plots yielded a threefold increase in forage at the end of the second growing season, June 1956, from the initial application of nitrogen in May of 1955. Sulfur did not produce a response in either 1955 or 1956*.

These plots were clipped again on June 7, 1957. Yields were significantly higher on plots receiving 60 and 120 pounds of N in 1955. There was no difference between

*Reported by: Kay, B. L., Street, J. E., and Rimbey, C. W. Nitrogen Carryover on Range. Calif. Agr. 11(10):Oct. 1957.

plots receiving 30 pounds of N and the check plots.

Clipping in June of 1958 showed a significant increase from the initial application of 120 pounds of nitrogen. The lesser rates were not significant.

Thus, the effects of an initial application of nitrogen are evident for four growing seasons and promise to continue to show increases in future yields. Sulfur still did not produce a significant response. Mean nitrogen yields appear in the following table.

Mean Yields from Nitrogen Treatments

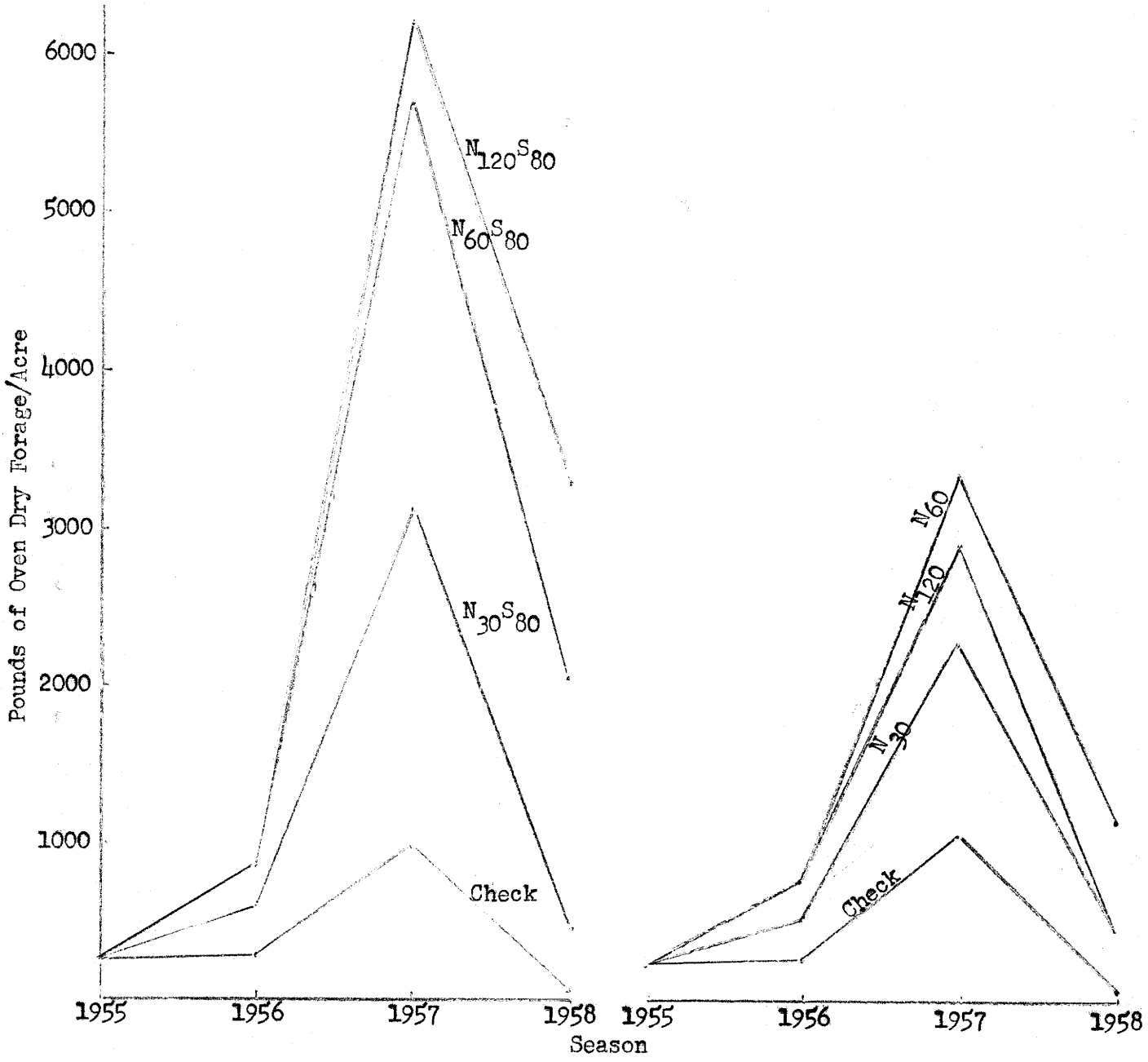
Treatment	Pounds of oven dry forage per acre			
	1955	1956	1957	1958
N_0	212	244	966	86
N_{30}	- -	411	1220	70
N_{60}	- -	614	1548	150
N_{120}	- -	694	1875	170
L.S.D. .01	- -	128	504	- -
L.S.D. .05	- -	- -	- -	78
Annual Rainfall	8.73	14.61	15.48	17.40
Rainfall during April and May	2.2	2.3	5.3	1.5

The variation in yield from year to year is also interesting. Yield on check plots varied from 86 pounds on the "poorest" year to 966 pounds on the "best" year. Yield on the plot fertilized with 120 N varied from 170 pounds to 1875 pounds. The yield on the year with the highest total rainfall was the lowest of the four years clipped.

Cheatgrass yields seem to be highly correlated with spring rainfall as is shown by comparing the check yields (N_0) with the rainfall during the months of April and May. Cheatgrass yields show a complete lack of correlation with total seasonal rainfall.

2. Results of repeated N application on cheatgrass range: On a cheatgrass range four rates of nitrogen, 0, 30, 60, and 120 pounds per acre, were crossed with four rates of sulfur, 0, 20, 40 and 80 pounds per acre. The nitrogen application has been made on four successive years. Sulfur was applied only the first year. Nitrogen was applied as ammonium nitrate. Sulfur was applied as gypsum. Results of nitrogen applications with and without sulfur appear in the following table.

Forage Yield from N and NS Applications



The nitrogen responses in 1956, 1957, and 1958 are significant. The nitrogen sulfur yield was significantly higher than the nitrogen alone in 1957 and 1958.

The 1958 yields from this plot represent the sum of two clipping dates - April 22, and May 27. The April clippings show the first encouragement of economically

feasible returns. Yields from the early clipping appear in the following table:

Pounds of Oven Dry Forage/Acre

	N_0	N_{30}	N_{60}	N_{120}
S_0	0	60	59	44
S_{20}	0	--	38	1665
S_{40}	0	23	497	2093
S_{80}	0	211	1070	2069

This increase in feed was especially important because there was no feed produced at this date on the unfertilized range. The ton of feed produced with $N_{120}S_{80}$ had a protein analysis of 30.83% compared to 15-25% for good alfalfa hay. The plant involved is tansy mustard. Cheatgrass did not produce any growth until later in the season - even with fertilizer. Cows on the newly burned sagebrush range were seeking out the mustard at this date.

This early response was not noted in the three previous years. An explanation of this might be the occurrence of unusually high minimum temperatures during the last half of March and the first three weeks of April. Minimum temperatures were 28°F or above during much of this period. It is a common observation elsewhere in California that fertilized forage will grow at colder temperatures than unfertilized forage. The temperatures involved here were high enough for the growth of fertilized forage, but not unfertilized forage. March and April temperatures in the three previous years were too low for even fertilized forage to grow. This indicates that this is not a dependable source of early feed, having occurred only once in the four years tested.

3. First-year results from fall applied nitrogen and sulfur: The following treatments were applied to cheatgrass range in the fall of 1957. Yields were taken on April 22 only. The higher yields are mostly tansy mustard. Yields were significantly increased by applications of 120 pounds of nitrogen in ammonium nitrate and 40 pounds of sulfur in gypsum, but not enough to pay for the fertilizer. Total season production was not measured.

Forage yields in pounds oven dry forage per acre.

Treatment	Yield on April 22, 1958
Check	22
N_{30}	47
N_{60}	84
N_{120}	100
S_{40}	20
$N_{30}S_{40}$	17
$N_{60}S_{40}$	82
$N_{120}S_{40}$	164
300 pounds Ammonium Sulfate ($N_{63}S_{36}$)	64
L.S.D. .01	88

4. Results of repeated nitrogen applications on wheatgrass seeding: The nitrogen and sulfur plot described in section 2 above was applied to a one-year-old stand of wheatgrass at the beginning of the second growing season. Yields at the end of the growing season indicate a highly significant response to nitrogen and a slightly significant response to sulfur. However, these responses were due to the cheatgrass component of the forage. There was no significant response by the wheatgrass.

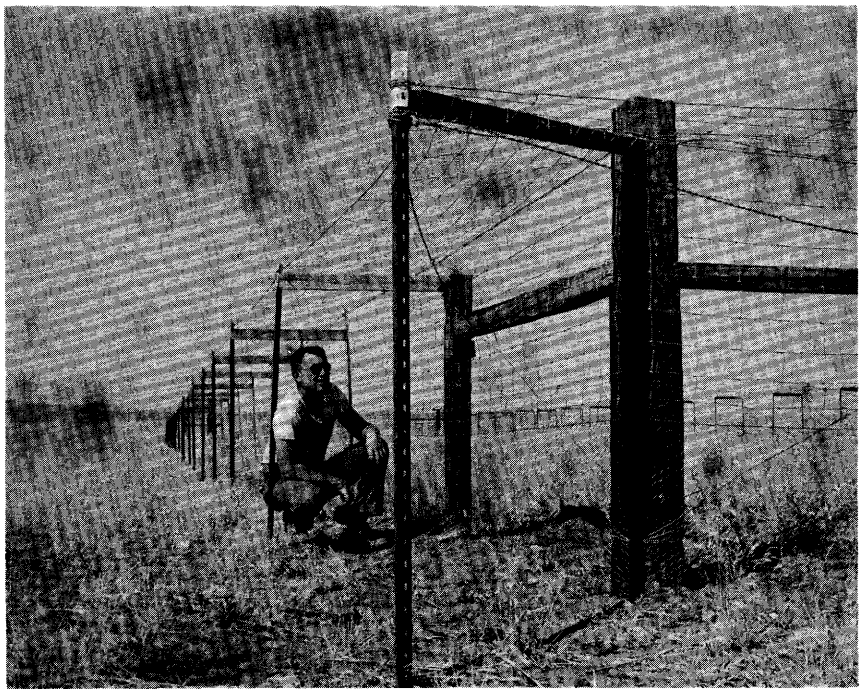
The nitrogen treatments were repeated the following year. Again the nitrogen response was significant and the sulfur response slightly significant. The response was from cheatgrass alone. Wheatgrass was about 30 per cent of the check in 1956 and 10 per cent of the check in 1957.

Clipping at the end of the grazing season probably does not give a true picture of what happens when a cow grazes relative to percent of cheatgrass and wheatgrass. In order to obtain a better picture of this relationship plans were made to clip several times during the growing season of 1958.

Clippings on April 22 (in a snowstorm) showed wheatgrass to be 90% of the available forage on the check plots compared with 30% and 10% at the end of 1956 and 1957 growing seasons. With high rates of N and S the forage was 41% wheatgrass clipped early compared to 27% and 6% at the end of 1956 and 1957. Thus, fertilization may not reduce the relative production of wheatgrass in favor of cheatgrass as much as was indicated from previous samples.

Antelope and or deer jumped the fence and harvested the remainder of the seasons growth before it could be sampled. This and new fertilizer plots established in the fall of 1958 were fenced to exclude deer and antelope as well as livestock and rabbits. (See the following photograph.)

The 45 pounds of oven dry forage measured on the check plots illustrates one of the advantages of wheatgrass over the annual plants normally used as forage in the area. The check plots based on annual plants had no yield at this date.



This type of fence is currently being used to protect forage plots from rabbits, deer, antelope, and domestic livestock on the Modoc range. The three-foot-high, one-inch-mesh chicken wire is buried about four inches in the soil. The remainder of the vertical portion as well as the horizontal portion is hog wire fastened together with hog rings. This fence is patterned after the one described by Jones and Longhurst, Jour. of Wildlife Man., Vol. 22, No. 3, pp. 325-326. Dr. R. A. Evans of Agricultural Research Service, University of Nevada is shown inspecting the fence.

Species Trials

Fifty-one species of perennial grasses and 19 legumes were tested in the spring of 1956. These were planted in replicated trials of five 16-foot rows in each trial. The species which showed promise in this test were tried again in the spring of 1956 as well as many new species.

Fifty-three species of perennial grasses were band seeded in March of 1956. These were placed in five 16-foot rows in each of three replications. Approximately 125 lbs. per acre of ammonium sulphate was drilled into the bottom of furrows made with the heavy duty range drill. The seed was then added to the furrow with a Columbia planter. The stand obtained in every case was outstanding.

Production during the first growing season did not appear to merit harvesting. Those species which survived the first winter and appeared to be good producers were

clipped on June 20, 1957, and July 21, 1958. Production during these two years appears in the following table.

None of the 1957 yield figures are statistically significant. There are statistically significant differences in yield in 1958. The 1958 yield figures appear to be low, but they represent a 400% to 500% increase over the unfertilized cheatgrass range described earlier.

Many of the orchard grasses which looked so good in 1957 did not survive the winter. There are eight wheatgrasses which appear to outyield the best orchardgrass. Greenar intermediate wheatgrass was the best yielding commercially available species tested.

Field Day

A Field day was held on the Likely Demonstration Range on June 10, 1958. About 40 local ranchers and technicians attended. The program included discussions of fertilizer plots, methods of brush clearing, time of seeding, and forage species testing. The new 310-acre seeding of greenar wheatgrass was the highlight of the program.

Modoc County Species Trial

Planted March 23, 1956

	Yields in pounds of oven dry forage per acre		Ranking of Orchardgrasses	
	June 20 1957	July 21 1958	1957	1958
Commercial orchardgrass		150		9
Orchardgrass varieties (from		280		3
Dr. Stebbins - either		220		6
Collections from the mediterranean		220		6
Or crosses between these		370		1
Collections and common orchardgrass).		120		11
		190		7
Trogdon Orchardgrass		110		12
Danish Orchardgrass		80		13
Potomac Orchardgrass		60		14
Akaroa "		130		10
Oron "		260		4
Pa.Med. Syn "	1540	250	2	5
Pa. Early Syn "	1440	320	3	2
Pa. Late Syn "		150		9
M2-11142-53 "		80		13
P-2453 "		120		11
I.O.G.-1 "	1990	80	1	13
I.O.G.-6 "	1270	160	4	8

			Ranking of Wheatgrasses	
			1957	1958
Commercial Crested Wheatgrass	980	360	12	9
Commercial Pubescent "	1170	270	8	
Commercial Tall "	1350	440	5	3
Commercial Intermed. "	1240	380	6	8
Commercial Slender "	1110	80	9	
Utah Wheatgrass		400		7
Nebr. 10 Crested "		410		6
A 1770 Wheatgrass		260		
Nordan " (A. desertorum)	1550	400	3	7
A-144 "	1490	420	4	5
Ree " (A. intermedium)		550		1
Amur " (A. intermedium)	1600	320	2	
Mandan 759 (A. trichophorum)	1820	350	1	10
Commercial Fairway Crested Wheatgrass (A. cristatum)	1000	170	11	
Commercial Standard Crested Wheatgrass (A. desertorum)	1490	430	4	4
Nebraska (PI.98526) Wheatgrass		380		8
Topar Pubescent Wheatgrass	1060	340	10	
Greenar Intermediate Wheatgrass	1180	520	7	2
Western Wheatgrass		100		
Commercial Big Bluegrass	1770	400	1	1
Poa ampla-pratensis		180		4
" " "		270		2
Big Bluegrass (Albion)	1650	260	2	3
Commercial Tall Oatgrass	1676	210		
Manchor smooth brome	815	190		
L.S.D. .05	NS	220		
L.S.D. .01	NS	290		

ALDRIDGE RANCH, SHASTA COUNTY

This photograph taken on the Aldridge ranch in Shasta County shows an excellent stand of hardinggrass and rose clover. Before control burning and seeding this area was a solid stand of manzanita and oakbrush eight to fifteen feet high.

History

The Aldridge Ranch is located 35 miles east of Redding in Shasta County. The elevation varies from 1,500 to 3,000 feet above sea level. Average rainfall measured on the ranch between 1951-1957 is 47.30 inches.

This ranch was part of a large cooperative control-burn conducted on August 10, 1950. Nearly 10,000 acres comprising land of nine different ownerships were successfully control-burned on the above date. Reseeding and experimental plot work has been conducted on these ranches since the control-burn of 1950.

On August 10, 1957 another control-burn of 9800 acres was held on the same general area. Some portions of the 1950 burn were included. Several new properties were involved and three ranches of the original nine were not included.

The W. B. Aldridge ranch had 3500 acres included in the 1950 control-burn. Twenty-five hundred acres of this area was reburned in the 1957 control-burn. The remaining 1000 acres was reburned on September 7, 1958.

Grazing Returns

Grazing returns increased more than threefold after the original control-burn. The animal unit months (A.U.M.) of grazing are shown in the following table. The 1957-58 stocking rate was reduced to protect the seeding which followed the 1957 reburn.

	A.U.M. Grazing	A.U.M. Increase Since Burn
Before 1950	300	- -
1951-1952	1139	839
1952-1953	1221	921
1953-1954	1361	1061
1954-1955	834	534
1955-1956	1349	1049
1956-1957	1306	1006
1957-1958	794	494
Total		5904

Economic investments and returns are discussed in previous Range Demonstration Reports.

Brush Encroachment (See Range Demonstration 1957, pp. 28-29)

Measurements of brush encroachment following burning and subsequent reburning are summarized in the following table.

Brush Encroachment

Pine Basin - Aldridge Ranch

Total number of brush plants in 50 milacre plots.

	Sprouts	Sprouts & Seedlings			Seedlings	
	Live Oak	Blue Brush	Yerba Santa	Poison Oak	Manzanita	Buck Brush
August 12, 1953	2	34	9	61	4	55
August 4, 1955	1	34	51	60	6	46
July 9, 1957	4	28	19	55	5	40
September 6, 1958	1	23	11	45	1	13

Reburning reduced the number of sprouts and seedings that had appeared since the original control-burn. Complete control was not achieved with any of the species. Control would have been better except for the poor burning conditions. (Range Demonstration 1957, p. 29.)

Effect of Fire on Reseeded Forage Species*

Improved forage species used in reseeding California brush ranges are often burned in follow up brush control fires or by accident. The effect of burning on

*A paper by this title is being prepared based primarily on the work done on the Aldridge Ranch.

forage plants has been shown by others in other parts of the world to vary according to species, time of burning, location and condition of pasture, etc.

Hardinggrass measured on the Aldridge Ranch appears to be very fire tolerant. The following table shows a seven-year-old stand of hardinggrass increased nearly 30% in ground cover during the year following burning. The number of plants appeared to increase, probably due to new rhizomes intersecting the transects rather than new plants. This measurement also appears in a following table.

Rose clover was slightly reduced in density by burning. A large portion of the shattered rose clover seeds were blackened by fire, these would not germinate. However, sufficient undamaged seed remained to produce a satisfactory stand of rose clover.

Smilo in rocky areas did not burn well and was not affected by reburning. However smilo plants growing in heavy fuel accumulations were all killed by fire.

Per cent Ground Cover of Reseeded and Resident Species Before and After Burning[1] with Light and Heavy Fuels

Species	Light Fuel Conditions[2] (No Fuel Added)			Heavy Fuel Conditions[3] (Fuel Added)	
	Aug. 3 1955	July 9 1957	Sept. 6 1958	Aug. 3 1955	Sept. 6 1958
Hardinggrass	10.60	12.59	16.33	19.0	26.4
Orchardgrass	0.53	0.06	-		
Tall Fescue	0.25	0.04	0.04		
Rose Clover	64.00	79.64	73.59	58.0	68.6
Annual Grass	24.62	7.74	10.04	23.0	5.0

1 Burned August 10, 1957
2 Sample based on 37 ten-foot transects
3 Sample based on 4 ten-foot transects

Numbers of Perennial Grass Plants Recorded Before and After Burning[1] with Light and Heavy Fuels

Species	Light Fuel Conditions (No Fuel Added)			Heavy Fuel Conditions (Fuel Added)	
	Aug. 3 1955	July 9 1957	Sept. 6 1958	Aug. 3 1955	Sept. 6 1958
Hardinggrass	100	93	105	11	10
Orchardgrass	12	1	1		
Tall Fescue	7	3	0		

1 Area burned August 10, 1957

WAGNER RANCH, HUMBOLDT COUNTY

The above photograph was taken on the Wagner Ranch during a field day on August 22, 1957. Doug Pine, County Director of Agricultural Extension, welcomes a group of ranchers to the field day.

The Wagner ranch consists of 2,900 acres, located in the Eel River watershed about five miles west of Garberville. The present vegetation is broken up into grassland or glade areas, timber areas, and brush areas which once grew timber. Much of the area had been tanbarked prior to World War I and was swept by a wildfire about 1920. Elevation varies from 500 to 1500 feet above sea level. Annual rainfall varies from 30 inches to over 100 inches.

1954 Sub Clover Seeding

This ten-acre seeding started as a simple test to measure the costs and returns of establishing sub clover from seed. The cost of establishment was returned from the increase in forage production during the first growing season.

Clipping studies and plant counts indicate that total pasture production and the abundance of sub clover has decreased during the second growing season.

Third-year measurements indicate an increase in stand and yield.

Fourth-year measurements indicate an increase in stand and a maintained increase in yield. Four-hundred pounds of single super phosphate per acre was applied in the fall of 1958.

Management, clipping and plant count studies on this area will be continued for several more years to measure the pattern of clover establishment and production. Observations on older seedings indicate that stands of sub clover which are good, initially, tend to decline for several succeeding years and then again become very productive.

The results of plant counts and clipping studies from 1955 to 1958 are included in the following tables.

1954 Ten-acre Sub Clover Seeding
Yields - Pounds oven dry forage per acre

Harvest Date	Sub Seeding			Check	
	Yield	% Protein		Yield	% Protein
May 10, and July 14, 1955	3,010	6.5		825	3.0
July 10, 1956	2,930	- -		2,831	- -
June 8, 1957	5,341	10.6		3,730	8.4
May 15, 1958	5,090	- -		3,240	- -

1954 Ten-acre Sub Clover Seeding
Step - Point Analysis

Sample Date	Per Cent Species Composition				Density	Per Cent Ground Cover Sub Clover
	Sub	Forbs	Native Grasses	Native Clovers		
April 13, 1955*	12	25	47	16*	68.0	8.2
April 19, 1956	0	27	63	10	75.0	<1.0
April 16, 1957*	1	15	49	35*	88.5	0.9
April 16, 1958	5	9	81	5	92.0	4.6

*These years the stand received 400 lbs. single superphosphate per acre.

Variations in Methods of Establishing Sub Clover

A number of different methods of establishing sub clover were tried in the fall of 1954 on a Laughlin soil. The same trend in establishment is indicated here as was noted above. The treatments and results of step-point analysis are summarized in the following table.

Step-Point Analysis of Sub Clover Established by Five Different Cultural Practices				
Treatment All Plots Seeded October 1954	Per Cent Ground Cover Sub Clover			
	April 13, 1955	April 19, 1956	April 16, 1957	April 16, 1958
Disked, sub clover, straw and burs broadcast, rolled, fertilized with 400 lbs. SSP	9.7	11.6	20.8	43.0
Disked, harrowed, seeded, rolled, fertilized with 400 lbs. SSP. 400 lbs. SSP reapplied Oct. 1956 and Oct. 1958	8.2	<1	0.9	4.6
Disked, harrowed, seeded, rolled, fertilized with 800 lbs. SSP	19.6	6.2	24.0	35.7
Disked, harrowed, fertilized with 400 lbs. Ammonium sulphate, seeded, rolled. 400 lbs. SSP applied December 1955	12.4	6.2	2.0	2.7
Disked, harrowed, seeded, rolled	8.6	2.6	0.8	7.6

Chemical Tree Control

An experiment was undertaken to determine the best treatment to prevent hardwood stumps from sprouting after logging. Forty madrone and 40 tanoak trees or clusters of sprouts were sawed down and the stumps treated on each of four dates during the year. Months of treatment were January, April, July, and October.

Treatments being used:	Cost of chemicals/sq. ft. of Stump*
1. Check - trees sawed down and stumps allowed to sprout.	
2. Stump tops dobbed with 2,4-D Amine at 4 lbs. A.E./gal.	5.63¢
3. Entire stump sprayed wet to ground surface with mix of four per cent Ester 2,4-D (4 lbs. A.E./gal.) and 96 per cent diesel oil.	9.27¢
4. Entire stump sprayed wet to ground surface with a brushkiller mix of two per cent Ester 2,-4-D (4 lbs. A.E./gal.) and two per cent Ester 2,4,5-T (4 lbs. A.E./gal.) and 96 per cent diesel oil.	11.58¢

*Based on the following costs: Amine 2,4-D at $2.88/gal.; 2,4-D Ester at $4.47/Acre; 2,4,5-T at $6.78/gal.; diesel at $0.20/gal.

Sprout measurements taken one growing season after treatment were presented in Range Demonstration 1957, page 23. Measurements taken a year later indicated many stumps which had not sprouted earlier sprouted during the second growing season after treatment, also the number and height of the sprouts increased during the second growing season. The original plans had been to terminate this study during the summer of 1958. Now it seems advisable to delay the final examination of stumps and analysis of data until we are sure all of the stumps which are going to sprout have sprouted.

In general it can be said that painting the stumps with amine of 2,4-D is equal to or superior to the other treatments. Also, this is the most economical practice. However, present measurements indicate the sprout control achieved is far from complete.

Painting hardwood stumps with 2,4-D amine to control sprouts has proven to be the cheapest and most effective of the three chemical treatments tried. Only the outer three inches of the stump tops are treated. None of the treatments completely eliminated sprouting.

Range Reseeding on Three Soil Types

The adaptability of perennial grasses and annual legumes and methods of their establishment is being studied on three soil types on the Wagner Ranch. Areas on each of the Josephine, Laughlin, and Yorkville soil types were prepared and planted to sudangrass in the spring of 1955. In the fall of the same year these areas were

drilled to a mixture of perennial grasses and perennial and annual legumes. The plot seeded on Laughlin soil was abandoned due to heavy washing from a road above the plots. Descriptions of these seedings appear in the Range Demonstration 1956 Report, page 17. 1956-1957 yields are discussed on pages 20 - 21, Range Demonstration 1957.

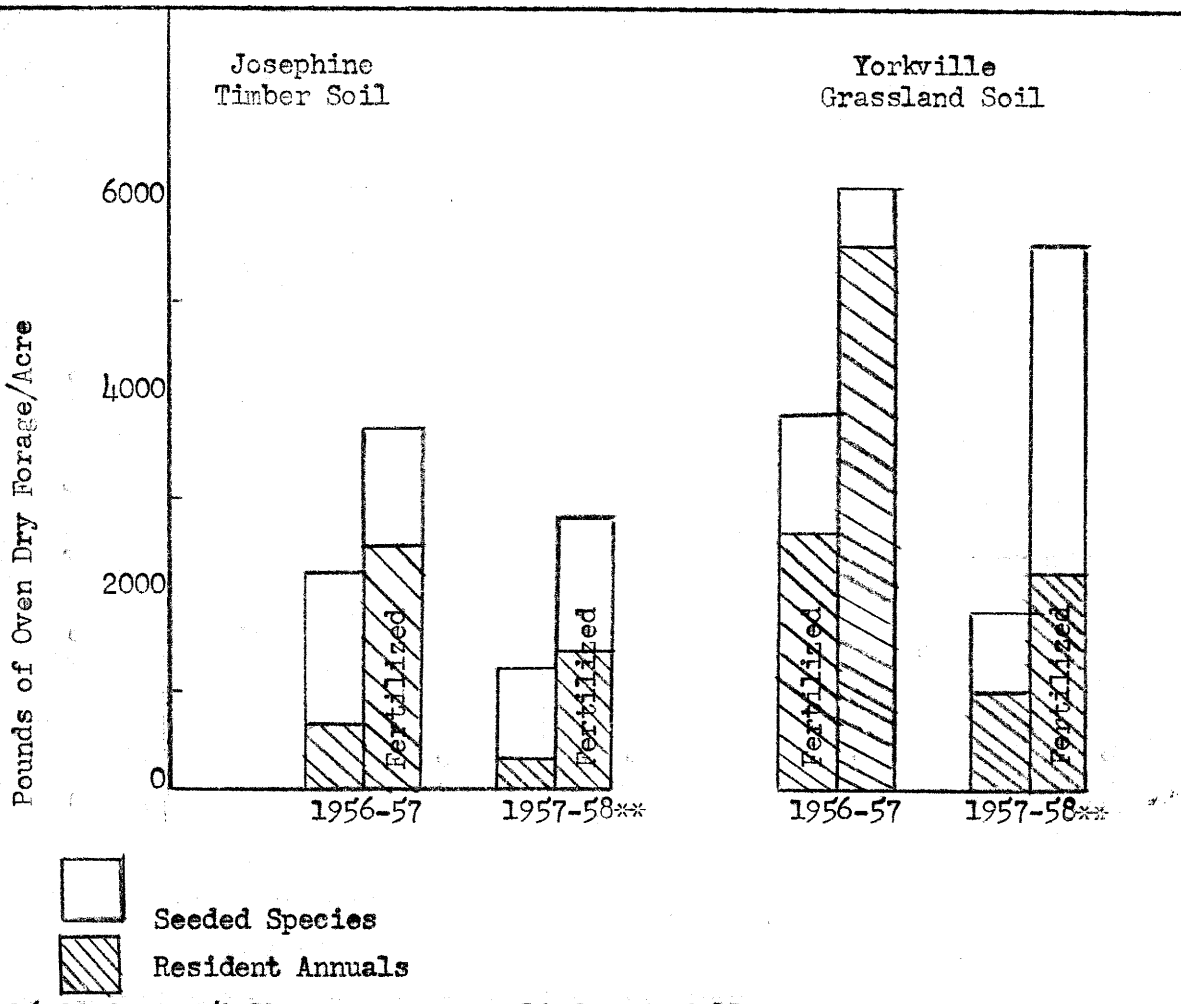
Yields were slightly less on all treatments during 1957-58 than in 1956-57. The Yorkville (grassland soil) continued to outyield the Josephine (timber soil).

Two clippings were made to measure the yield instead of the single clipping at the end of the season as in 1957. Multiple clippings should more nearly duplicate the effect of grazing. The net effect of two clippings was to increase the perennial component of the forage.

In 1957 it was noted that nitrogen fertilization decreased the amount of production from the perennials as well as the percentage of perennials in the stand. However, this may not be a true picture of what happens when the crop is grazed. The same seedings will be sampled at least four times during the 1958-59 growing season to measure the relative production from annuals as compared with perennials in a mixed stand under nitrogen fertilization.

Mr. Wagner and his foreman are inspecting the results of range seeding on a former timber site. The grasses pictured are hardinggrass, orchardgrass, and tall oatgrass. This area formerly grew redwood, douglas fir, madrone, tanoak, and various brush species.

Forage Yields on Two Soil Types; With and Without Fertilizer*, for the 1956-57 and 1957-58 Seasons



* 16-20-0 at 350 lbs. per acre applied each fall.

** 1957-58 yields are the sum of clippings taken on April 7, 1958 and July 31, 1958.

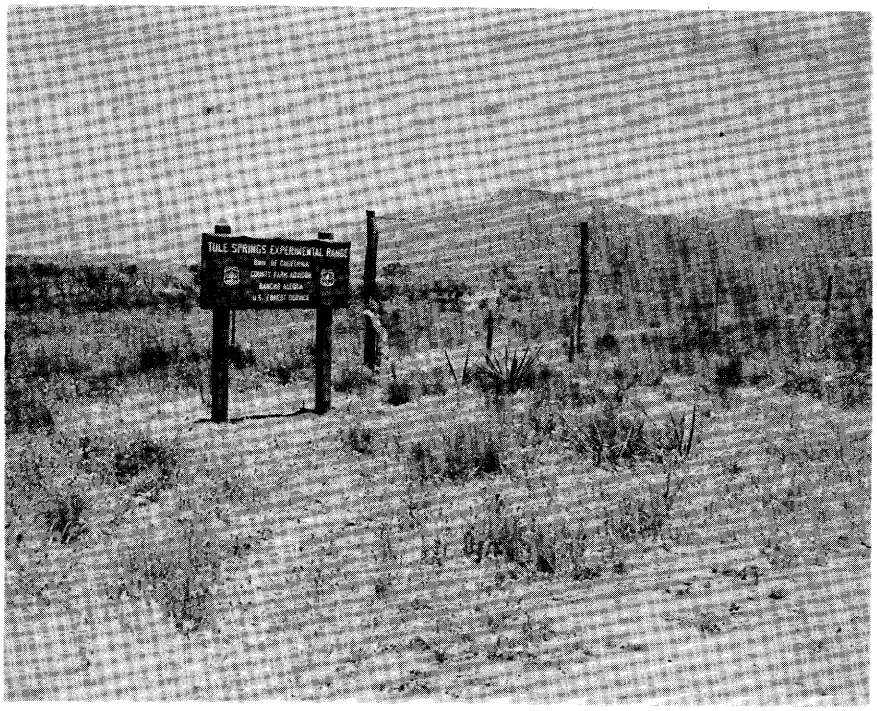
The relative yields of the two components may be seen in the above graph. The seeded species are primarily perennial grasses (harding, tall oat, orchard, and tall fescue) with some subterranean clover. The resident annuals are mostly undesirable grasses such as annual fescue, nitgrass, and hairgrass, with some legumes such as white-tip clover and annual lotus species, plus various annual forbs. Even though the total production was less than the previous year the yield of seeded species in the fertilized areas showed an increase - probably due to multiple clippings.

Step-point sampling in the third growing season on the Josephine (timber soil) indicates a ground cover of perennials of 17% on an unfertilized area as compared with 42% on the fertilized area. Both stands are fully stocked at 99% and 98% respectively. Step-point data are included in the following table.

Step-Point Data from Perennial-Grass Seedings
Josephine Soil, Wagner Ranch

	Percent Ground Cover					
	Not Fertilized			Fertilized 16-20-0 at 350 lb./Acre		Oct. 1956 Oct. 1957
	April 19, 1956	April 16, 1957	April 15, 1958	April 19, 1956	April 16, 1957	April 15, 1958
Harding	1.1	2.3	-	1.1	1.9	2.8
Tall Oat	1.0	5.2	12.1	1.0	9.7	32.9
Tall Fescue	0.6			0.6		
Orchard	1.9	9.2	5.0	1.9	9.0	5.6
Total seeded perennial grasses.	4.6	16.7	17.1	4.6	20.6	41.3
Sub clover	0.5	2.3	0.7	0.5	3.9	0.9
Annual grass	2.2	11.5	19.2	2.2	21.2	41.5
Annual clover	0.2	6.9	7.1	0.2	5.2	0.9
Annual forbs	0.5	4.6	9.2	0.5	5.2	6.6
Lotus		15.5	17.7		8.4	2.8
Total Ground cover	8.0	57.5	71	8.0	64.5	94

MASSEY RANCH, SAN DIEGO COUNTY



The study area consists of approximately 600 acres of a grazing allotment in the Cleveland National Forest east of the town of Alpine. The elevation is 2500 feet with 18 inches average annual rainfall. The work here is a cooperative study with the rancher, the Agricultural Extension Service and the U.S. Forest Service.

Forage Inventory and Comparisons of Pastures B and C.

Pastures B and C were control-burned by the Forest Service in 1953. In the fall of the same year pasture B was disked, broadcast seeded and disked again for seed coverage. An excellent stand resulted from this procedure.

Following the control-burn pasture C was disked and broadcast seeded to cereal oats. After a season of heavy grazing, the area was disked and band seeded with selected perennial grasses and annual legumes drilled over 100 pounds per acre of 11-48-0 fertilizer placed in the bottom of the furrow.

The step-point analysis method was used to sample the pastures for the past four seasons. The average of 300 points in each pasture are included in the following table. The ratings are total ground cover by species.

Hardinggrass, veldt and smilo are the predominant perennials composing the ground cover in both pastures. However, hardingrass is the principal species in C in 1957. Smilo is the more abundant species in B. This is a good example of a

Forage Inventory, Total Ground Cover by Species								
	Pasture B				Pasture C			
	1955	1956	1957	1958	1955	1956	1957	1958
	4-24-55	4-29-56	5-31-57	4-12-58	4-24-55	4-29-56	5-31-57	4-21-58
Hardinggrass	1.74	2.47	4.02	6.24	2.9	4.32	11.74	11.6
Veldt	1.32	1.42	2.07	2.30	1.45	2.52	.77	1.16
Smilo	1.2	2.38	4.72	7.50	.30	.96	.77	1.16
Orchardgrass	.06							
Brome 25	.48							
Tall Fescue	.12		.12	.3				
Rose Clover		.10			1.05	4.08	3.85	5.22
Alfalfa					.40	.36	.58	.17
Lotus Spp.					.05	.12		
Soft Chess	3.36	3.89	4.02	20.0	.10	.24	1.35	2.90
Red Brome	.12	.10	.58	4.4	.15	1.20	2.50	2.50
Annual Rye	2.82	8.36	6.78	7.3	.35	3.96	8.86	13.05
Tame Oats					2.05	3.24	5.58	.38
Ripgut	.06			1.6			1.73	12.18
Annual Fescue				.3			.19	.75
Filaree							.19	.17
Miscellaneous Weeds	.60	.28	.69	2.0	1.05	2.76	.38	6.38
Wild Oats	.18							
Total Ground Cover	12%	19%	23%	52%	10%	24%	38.5%	58%

cultural practice such as drilling definitely favoring the establishment of harding. Once established, harding has been very persistent as the data indicates. The cultural practice of broadcasting with seed coverage of perennial grasses favors smilo as well as harding.

No doubt the banding of legume seed over the phosphate in 11-48-0 was partly responsible for the retention of rose clover in pasture C. The annual legumes in pasture B have not reproduced after the first season.

Note the high incidence of soft chess in the overall composition of the forage in B. From the original 1/4 lbs. of soft chess broadcast after the control-burn, there is now a very good stand.

The step-point data recorded the first growing season after seeding in pasture C indicated a 10% ground cover of forage plants. This means 90% of the ground is bare. If a very light rate of soft chess would have been drilled with the perennials, it is conceivable that much of this bare ground would eventually support this species. Competition studies have pointed up the value of keeping the seeding rate low so as not to discourage establishment of the stable perennial grasses such as harding and smilo.

Fertilizers

A large scale fertilizer trial was held on pastures B and C. Cattle were weighed on and off the pastures. Weighing was preceeded by standing the cattle overnight in the corrals without water or feed. Fifty-four lbs. of actual nitrogen and 53 lbs. of P were applied by ground application in November of 1957. The livestock were turned into the pastures on January 14, 1958 (average weight 363 lbs.). The cattle were weighed off the pastures on June 6, 1958 (average weight 611 lbs.). The results of this trial are found in the following table.

Comparisons of Fertilized and Unfertilized Range

1.	TREATMENT	FERTILIZED	UNFERTILIZED
	ACRES	90	150
	Materials per acre	100 lbs./acre 21-53 100 lbs./acre ammonium nitrate	- - - -
	Nutrients per acre	54 lbs. N; 53 lbs. P	- -
	Costs per acre	$13.87	- -
2.	STOCKING AND GRAZING		
	Animal unit months per acre	2.05	1.08
3.	EVALUATION		
	Beef produced/acre	117.60 lbs.	41.77 lbs.
	Forage produced/acre	4671 lbs. dry matter*	1754 lbs.* dry matter
	Extra beef from fertilizer/ acre	75.83 lbs.	- -
	TOTAL BEEF INCREASE/ACRE (Beef at 20¢/lb.)	$15.16	- -
	LESS FERTILIZER COST/ACRE	$13.87	- -
	NET PROFIT/ACRE	$ 1.29	- -

*Forage yields recorded from clipping study reported in table, see next page.

From an exclosure constructed on a typical site in pasture C, several clippings were made. The results of these clippings appear in the following tables. Perennial grasses were hand separated from annual grasses in the April sample. January and May samples were not separated.

Mean Air Dry Weights of Forage Harvested April 1958					
Fertilizer Treatment	Annual Grasses	% Protein	Perennial Grasses	% Protein	Total Forage
Check	1150	6.37	683	8.56	1833
$N_{54}P_{53}$	4060*	5.78	970	8.45	5033*
$N_{108}P_{106}$	4590*	6.21	1230	9.27	5815*
*L.S.D. 5%	2627		781		2786

The clipping results indicated a significant increase in production of annual grasses, but not significant for perennial grasses.

Mean Air Dry Weights of Forage Harvested Jan. 14, 1958 and May 21, 1958					
Fertilizer Treatment	1/14/58	% Protein	5/21/58	% Protein	Beef Per Acre
Check	566	8.13	1754	4.65	41.77 lbs
$N_{54}P_{53}$	1506	13.42	4671*	3.46	117.60 lbs
$N_{108}P_{106}$	1784	18.90	7927**	5.00	- -
*L.S.D. .01 = 3139					
**L.S.D. .05 = 1893					

Relation of Protein of Forage to Livestock Gains		
	% Protein of Forage	Average Daily Gain of Livestock
Jan. - Feb.	13.42%	1.84 lbs.
April - May	7.11%	2.09 lbs.
June	3.46%	.59 lbs.

Monuron and Fenuron Applications on Chamise

Only at the highest rate tested did any chamise die during the first year. The chloratic symptoms appear soon after treatment with death resulting during the second or third year.

Monuron has a greater killing effect on grass than does fenuron.

Results of Monuron - Fenuron Applications on Chamise Observations made April 24, 1958			
Treatment lbs./acre	Date of Application	% Grass Cover	% Chamise Kill
8 Fenuron	Nov. 7, 1956	80	10
16 "	"	70	95
32 "	"	85	100
64 "	"	75	100
8 Monuron	"	70	50
16 "	"	35	70
32 "	"	5	100
64 "	"	3	100
8 Monuron	March 14, 1957	70	Yellowing of Leaves
16 "	"	60	"
32 "	"	30	"
8 Fenuron	Feb. 26, 1958	--	"
16 "	"	--	"
32 "	"	--	"

Field Days

The second day of the very successful two-day Southland Range, Watershed and Livestock Tour was held on the Massey Ranch. One-hundred and seventy-one people were in attendance. The following table was constructed by Victor Brown, San Diego County Farm Advisor. It contains a break-down of the occupations of the people who were present for the second day of the tour.

Attendance at Southland Range, Watershed and Livestock Tour, Massey Ranch				
	No. Registered	Est. not Registered	Total	Per Cent
Ranchers	56	12	68	40
Students	37	0	37	21
Technical - Univ., Forestry, SCS, etc.	28	0	28	16
Sales, News, Radio	20	8	28	16
Other	7	5	12	7
	148	25	171	100

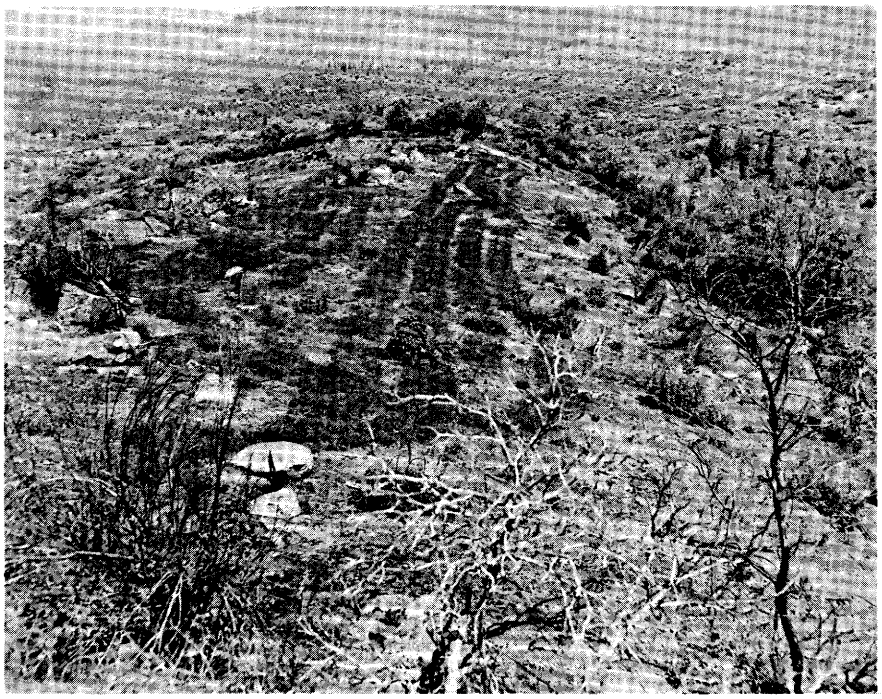
The subject topics covered on the tour were as follows:

1. New chemicals for brush control.
2. Brush control seeding and costs involved.
3. Band seeding, sprout spraying, growing legumes.
4. Range fertilization.
5. Shrinkage and cattle weighing demonstration.

A panel of spreakers discussed these subjects for the noon program.

a. Fuel breaks research program.
b. Range research in California.
c. Range improvement associations in Central California.
d. Watershed studies.
e. Soil-grass-animal relationships.
f. Planning a range improvement program.

HYDE (FORMERLY MANLEY) RANCH, TULARE COUNTY



The Hyde Ranch is northeast of Visalia near Badger, at an elevation of 3000 feet. Average annual precipitation is 35 inches. Prior to control burning the range was of a mixed chaparral type. Frost heaving of the soil is sometimes a serious factor in establishing stands at this location.

The soils are for the most part of the Auberry Series, as described by Gordon Huntington, Soils Department at Berkeley. The series consist of grayish-brown, moderately deep, developed Prairie soils which have weathered in place from crystalline granular acid igneous rocks. The soils have a profile reaction trend from slightly to moderately acid. The Auberry soils are associated with the Ahwahnee, Holland and Tollhouse soils.

The work here has involved two pastures, a 300-acre pasture and a 1000-acre pasture. The 300-acre pasture was control-burned on August 14, 1951 and airplane

seeded in September 1951. Following three grazing seasons there was a reburn on July 24, 1954. The pasture was burned again on September 6, 1958. The 1000-acre pasture was control-burned in August 1956. A small portion of this pasture was drill seeded and the balance airplane seeded in the fall of 1956.

Preparations are underway to develop an additional 1700-acre pasture. This area now is comprised of large islands and ridges of brush surrounded by open resident annual forage species. There is also a dense population of oak trees in the pasture. Five-hundred acres of brush have been walked down in preparation for control-burning. The actual burn area will be divided into two separate burning dates. Part of the area will be burned prior to the usual burning season for safety purposes. The topography is such that the risks of a wild fire would be lessened by this type of procedure.

1000-Acre Pasture

This pasture was control-burned in August of 1956. The burn followed months of preparation. Brush was mashed down wherever it was possible to operate a crawler tractor.

1. Broadcast seeding and forage inventory: After a successful burn, the area was airplane seeded in October. Five type-acres located on typical sites were permanently located by marking the corners of each type-acre with metal fence posts. These areas will be sampled each year using the step-point method of analyses. The following table includes this sampling to date.

Annual grass-tarweed Areas

Portions of the 1000-acre pasture have been grassland for many years. These open areas surrounded by brush were probably farmed to oat hay. These areas now support resident annual vegetation.

1. Sudan plot mulch study: Previous history of this study area include planting a sudan grass crop in the spring of 1955. A range mix was band seeded in the fall of 1955 with a very poor resultant stand. Annual clovers were broadcast seeded and disked in the fall of 1956, with very poor stand results except where litter had accumulated. Sudan was planted again in the spring of 1957 with fair stand results. The tarweed was sprayed in July of 1957.

The mulch study included the following treatments:

a. Rose-clover seeded with 250 lb./acre single superphosphate.

b. Rose-clover without fertilizer.

Treatment 1. No mulch

2. Sawdust (790 lbs./acre)

3. Rockwool (602 lbs./acre

4. 1/2 chicken manure 1/2 sawdust (640 lbs./acre)

Forage Inventory of 1000-Acre Pasture Sampled July 16, 1957 and June 28, 1958		
Species	Total Ground Cover, Per Cent	
	Broadcast Seeded	
	7/16/57	6/28/58
Orchardgrass	6.80	4.90
Perennial rye	4.47	15.31
Smilo	1.81	6.84
Tall oat	1.30	1.28
Mountain brome	1.23	.46
Crested wheat	1.17	1.40
Tall fescue	.84	1.62
Hardinggrass	.58	3.36
Intermediate wheat	.58	.70
Rose clover	.19	--
Crimson clover	--	--
Sub clover	--	--
Narrowleaf trefoil	1.23	.35
Alfalfa	.65	.35
Burnet	.13	.35
Yellow sweetclover	.20	--
Total Ground Cover Seeded Species	21.18	36.92
Miscellaneous Resident Vegetation	11.22	21.08
Total Ground Cover	32.40	58.00

The following table includes numbers of rose clover plants per eight square foot sample (2 each 4 square foot frame measures per plot).

Treatment									
1		2		3		4			
A*	B**	A	B	A	B	A	B		
32	27	46	29	19	7	61	16		237
24	13	19	28	15	5	23	12		139
17	13	20	10	17	17	22	27		143
20	27	21	27	29	42	19	10		195
19	5	73	24	24	11	29	12		197
14	15	10	37	13	29	5	18		141
126	100	189	155	117	111	159	95		
226		344		228		254			

*no fertilizer **fertilizer

Results:

Using the split plot factorial method of analysis, there were no significant differences between treatments. There was no significant difference between phosphate vs. no phosphate.

Fertilizers: A three year study involving the effects of sulfur and nitrogen fertilizers on resident annual vegetation is being completed.

The 1958 plot was designed as a split plot factorial with one area receiving fall application and the adjacent area receiving the same application in February. There were eight treatments and six replications in the design. The carriers of nitrogen were urea, ammonium nitrate and ammonium sulfate. The sulfur carriers were gypsum, sulfate and elemental sulfur. The plots were harvested May 14, 1958. A grab sample from each clipped swath was frozen until it could be hand separated into two components; grass and forbs. The responses were calculated for total yield, grass yield and forb yield.

Grasses composed 85% of the total yield. The following tables are concerned with the results obtained from the various treatments as related to grass yields.

	Time of Application	
	Sept.	Feb.
Check	63.7	62.5
Urea	81.8	80.8
NH_4NO_3	89.7	80.4
Urea + Gypsum	87.0	90.9
NH_4NO_3 + Gypsum	87.8	81.5
Urea + S	89.6	91.9
NH_4NO_3 + S	80.0	84.6
$(NH_4)_2SO_4$	90.1	90.3

Yield of Grass, lbs./acre		
	Time of Application	
	Sept.	Feb.
Check	702	518
Urea	1938	1740
NH_4NO_3	2029	1733
Urea + Gypsum	2466	2604
Urea + Sulfur	2774	2437
NH_4NO_3 + Gypsum	3062	2299
NH_4NO_3 + Sulfur	2331	2535
$(NH_4)_2SO_4$	2913	2410
$\bar{X}$ =	2277	2034
L.S.D. (.05) 218		

Mean Yield of Grass, lbs./acre	
Check	610
N	1860
NS	2583
N vs NS**	
Check vs N**	

There was no significant difference between urea and ammonium nitrate. There were no differences among treatments of N + S. Nitrogen vs nitrogen + sulfur was significantly different at the .01% level.

Yield of Protein in Grasses

	Applied September			Applied February		
	% Protein (Grass)	lbs per acre		% Protein (Grass	lbs per acre	
		grass	protein		grass	protein
Check	9.52	702	67	9.52	518	49
Urea	8.41	1938	163	12.12	1740	211
NH_4NO_3	8.46	2029	172	10.98	1733	190
Urea + Gypsum	6.90	2466	170	11.55	2604	301
NH_4NO_3 + Gypsum	7.72	3062	236	10.58	2299	243
Urea + S	7.59	2774	210	12.00	2437	292
NH_4NO_3 + S	8.49	2331	198	10.95	2535	278
$(NH_4)_2SO_4$	7.66	2913	223	12.25	2410	295
			1439			1859

1. On whole plot grass was 85% of total yield.

2. Fall applied fertilizer produced 243 lb. per acre more grass than spring applied fertilizer.

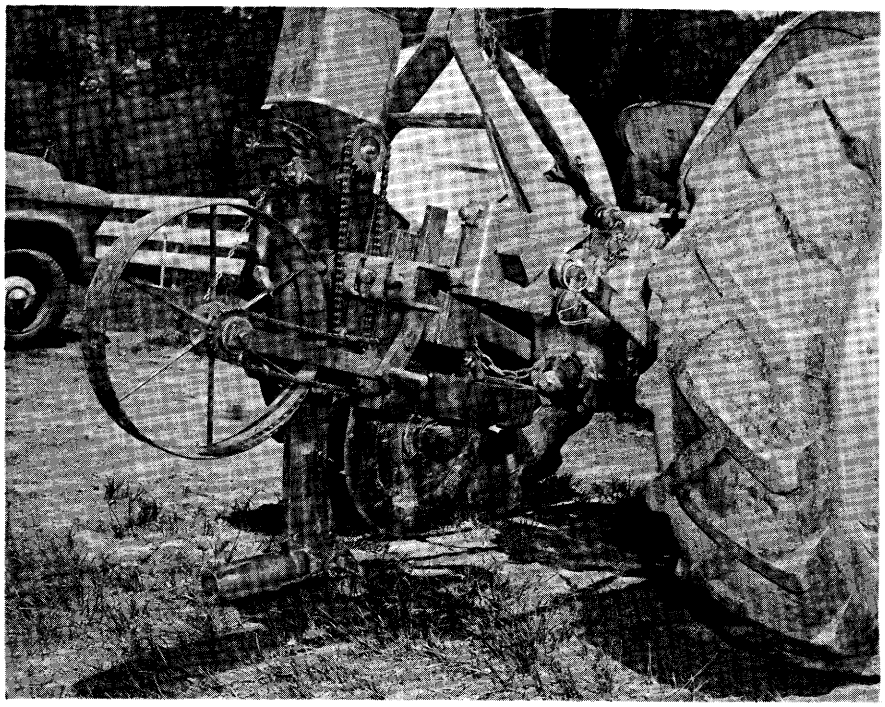
3. Urea vs ammonium nitrate: no significant difference. Mean yield of nitrogen = 1860 lb./acre.

4. Comparison of N + S, 5 treatments. No differences among treatments. Mean yield = 2583 lb./acre.

5. Comparing Check with N $\begin{matrix} N = 1860 \\ \text{Check} = 610 \end{matrix} > 1250\#$.

6. N vs NS $\begin{matrix} NS\ 2583 \\ N\ 1860 \end{matrix} > 723\#$ Significant difference (5%) L.S.D. .05 663.

Rodent poisoning with a new tool - a mechanical gopher bait applicator.



The pcoket gopher is a serious pest of improved range lands. Current methods of control are not adequate because an area must be retreated a number of times before successful control can be achieved. The reason for this is twofold. First, most baits do not give 100 per cent control, and secondly an operator cannot locate all active gopher systems at any one time, because all gophers do not dig at the same time. To overcome these difficulties, cooperative tests were run with W. E. Howard, Field Station Zoologist, and R. A. Kepner, Agricultural Engineer, using a mechanical gopher bait applicator (note photo). The device is pulled behind a wheel tractor that is equipped with a hydraulic 3-point suspension attachment. The mechanical gopher makes an artificial burrow 8 to 10 inches in the soil and poison bait is released into this burrow. The key to complete success with this equipment will rely on the development of durable bait, so that not only is the occupant of a certain burrow killed by any gopher subsequently moving into the system will find some of the toxic bait that was cached by the former occupant.

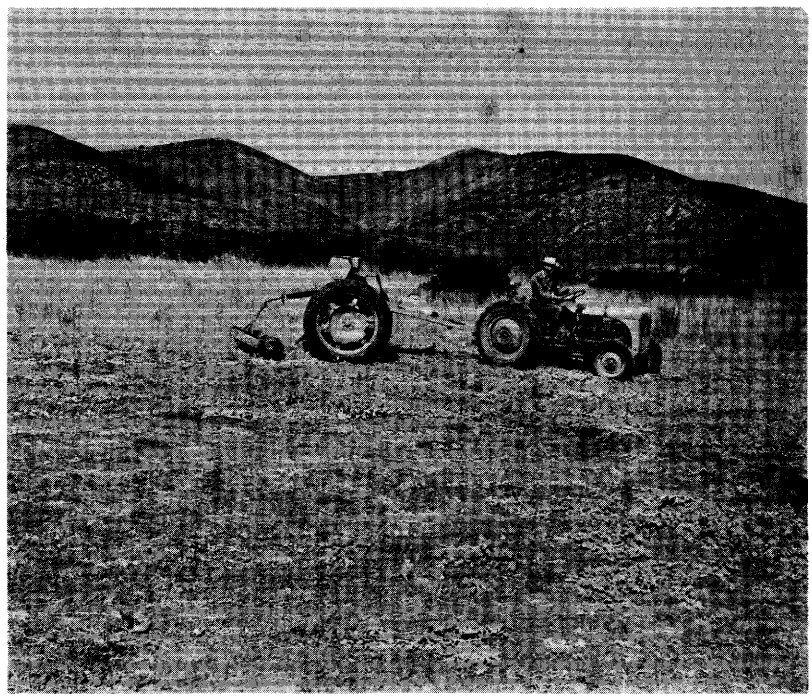
The material used as bait in the trials on the Hyde Ranch was equal parts of corn, milo, wheat, oats, and barley soaked 48 hours in 1% Para-Nitrophenol and 1080 (1 oz. per 100 lbs. of bait). The Para-Nitrophenol kills germ of grain, prevents mildew and largely waterproofs the seeds.

Effective control was obtained in a 10-acre trial. Burrows were made at intervals of 30 to 60 feet. Several counts at the time of putting out the bait (May 13, 1958) indicated 90 to 95 fresh gopher workings (systems) per acre. For the first six months after treatment there were very few fresh workings in this field. At seven months, a gradual reinfestation appeared to be in progress.

Field Tour

On May 16, 1958, 35 range management students from Fresno State College were given a tour of the Hyde Ranch range improvement activities.

BROOME RANCH, VENTURA COUNTY



The study area is located south of Oxnard in Ventura County. Efforts here have been directed at establishing hardinggrass and legumes in an annual type range. It is thought that once a good stand of perennials in association with annual legumes is established, these species will perform two functions. These functions are: 1) Lend stability to the range by increasing the total number of days that green feed would be available to livestock. This increase would be due to earlier green feed in the fall and an extended period in late spring over the present annual cover. 2) An overall increase in the protein level of the forage due to the presence of annual legumes.

The plots are located on better than average range soils. The present cover consists of predominantly annual ryegrass, wild oats, filaree and soft chess. These

species are very good but are quite dependent on seasonal rainfall. Being shallow rooted, good spring rainfall means the difference in the forage production.

Competition from these annuals present the major difficulty in introducing perennials into the pasture. For example, two pounds of hardinggrass seed per acre would have to compete with many times that amount of the quick starting annuals.

Competition Control

Seven methods of establishing good range species are being tested on this ranch.

The seven methods are:

1. Direct seeding following seedbed preparation 1953.
2. Seeding to cereal barley after seedbed preparation in fall of 1953 followed by broadcast seeding range species in barley stubble in fall of 1954 and seed covered by harrowing.
3. Broadcast seeding into sudan stubble 1954.
4. Drill seed over band of fertilizer after seedbed preparation in fall of 1955.
5. Drill seed over band of fertilizer on spring fallowed ground in fall of 1956.
6. Drilling a range mix with various row spacings, keeping area between rows fallow by cultivation.
7. Drilling sub clover with hardinggrass in the fall of 1957.

Stand Establishment by Various Cultural Practices

Date of Seeding	Site Preparation	Date of Sample	Per Cent Stocking of Seeded Species
Dec. 9, 1953	Native range disced, harrowed, broadcast seeded.	7-30-55	- -
1954	Broadcast seeding into barley stubble; covered with harrow.	7-30-55	30
1954	Broadcast seeding into sudan stubble; covered with harrow.	7-30-55	- -
Dec. 1, 1955	Native range disced and harrowed; drilled seed with range drill.	- - -	- -
Nov. 6, 1956	Area ploughed in spring, kept fallow; drilled seed with range drill.	3-18-57	82
Nov. 5, 1957	Disced and seeded in 1955 (stand failure) disced in fall of 1957 and drilled.	- - -	- -

1. The direct seeding after seedbed preparation in 1953 had severe competition from annual species common to this area. However, in 1956, hardinggrass, veldtgrass, alfalfa and rose clover gave indications of being permanently established. The rose clover stand is considerably improved from the original seeding in 1953. Large scattered colonies exist throughout the plot. This situation has been observed in other parts of the state. A seeding that looks like a failure the first growing season can gradually form a dense solid stand over a period of years.

2. Broadcast seeding following cereal barley had fair success. Hardinggrass and veldt seem to live through the severe competition but do not develop for several seasons after seeding.

3. Broadcast seeding into sudan stubble was rated as a failure. Where nitrogen and phosphorous were applied, a dense stand of filaree resulted.

4. Banding seed over a row of fertilizer after fall seedbed preparation was a failure. The seeded species did not survive the annual competition. This area was seeded in the fall of 1957 to sub clover and hardinggrass.

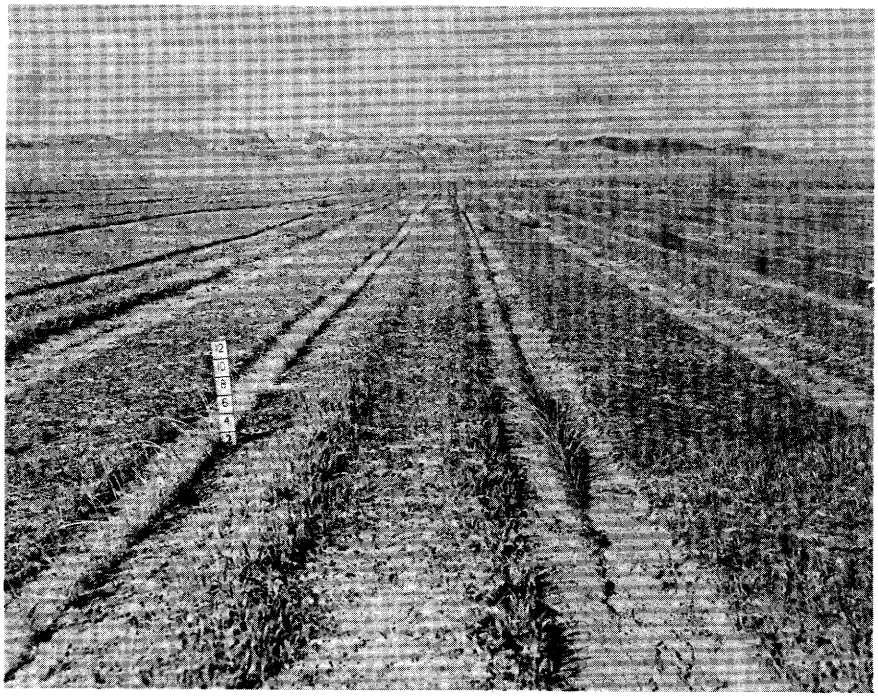
5. Banding seed over a fow of fertilizer into an area that had been spring fallowed was successful. Using the per cent stocking method of sampling, measurements indicated an 83 per cent stocking rate of seeded species. A sub clover plot did very well. A dense stand of sub clover resulted in first year reduction of annual grasses. Hardinggrass is compatible with sub clover. The sub clover results led to the 1957 seeding.

6. Drilling a range mix with various row spacings, with the intention of keeping the area between the rows cultivated, resulted in stand failure due to severe filaree and mustard competition. An unusually wet spring for this area prevented any attempts at cultivation. Mustard plants grew to a height of eight feet.

7. Drilling sub clovers with hardinggrass in the fall of 1957 also resulted in a stand failure. On this plot, competition was not the chief factor concerning the failure. Filaree plants were very scarce and grew very little, this in a year of higher than average rainfall. There is a possibility that soil crusting at the normal time for germination was one of the reasons for the lack of seeded species.

Plots in the fall of 1958 include broadcasting several rates of the preemergence herbicide, eptam on the 1957 fall seeding of sub clover and hardinggrass. There should be sufficient hard seed from the initial seeding for another growing season.

WESTSIDE EXPERIMENTAL RANGE PLOTS



Work has continued on three sections of land on the west side of the San Joaquin Valley in Fresno, Kings, and Kern Counties. The principal effort has been to establish a ground cover that would reduce wind erosion. A search is underway to find suitable species that would be adaptable to this low rainfall area.

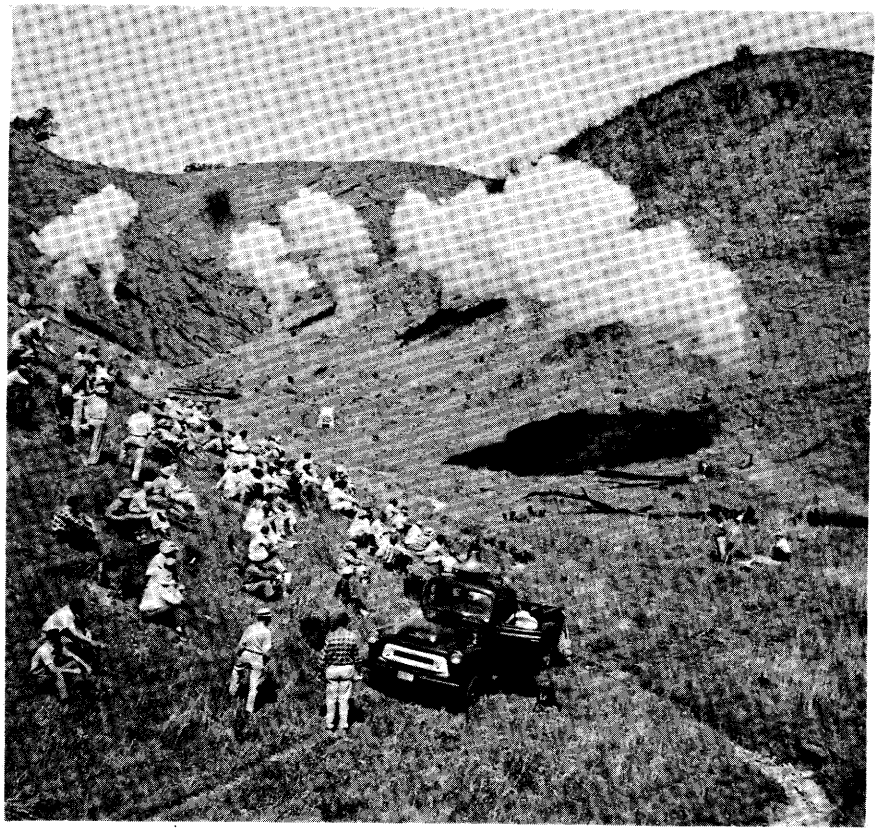
Light rainfall limits the growth of perennials sufficient to prevent their establishment. In an effort to hasten maturity and seed set, phosphorous alone was placed under the banded species planted in November 1956. This practice was not successful.

The 1957 plots included drilling seed at various row spacings. The area between the rows was kept free of vegetation. Although the rainfall for the west side was abnormally high this past season, there was considerable difference in growth of some seeded species in the cultivated rows as compared with growth in uncultivated rows. Tall wheatgrass, wimmera ryegrass and Dr. Stebbin's hybrid orchardgrass set abundant seed. The plots will be cultivated during the spring months of 1959 to see if the perennials will survive with this type of treatment.

The study area in Fresno County is divided into two pastures. The grazing period on Area A has been managed the previous two seasons. Management includes allowing plants to mature seed before grazing was allowed. Area B was managed for

uniformity of treatment throughout a watershed. Uniformity of treatment greatly facilitates interpretation of data and description of procedures.

Watershed I-A, Hopland Field Station, Mendocino County



Ignition techniques used in control-burning Watershed I-A are demonstrated at Hopland Field Day in May of 1958. The area where the crowd is gathered is now a productive pasture. Prior to treatment the area was dense brush and woodland.

1. Description of area: The hydrologic effects of brushland range improvement practices are being studied on a watershed of about 40 acres. This area above the stream flow and sedimentation measuring station comprises the entire upper end of a canyon or draw. The whole draw, 1000 feet wide by 3000 feet long, is included in a pasture and treatment unit of 60 acres. Steep slopes prevail. The lowest point is 900 feet elevation and the highest is 1100 feet. Division of the pasture into three areas on the criterion of exposure, soil type and pretreatment vegetation facilitates description. Area one is typically gentle slopes of southerly exposed Laughlin soils formerly grown to open blue oak woodland-grass. Four acres of this type occurred on ridge tops at the upper end of the canyon and six acres in the mouth of the canyon below the gauging station. The second classification is thirty-two acres of north exposure Josephine soils formerly covered with primarily black oak and madrone. The third division of south facing slopes of Los Gatos soils total 18 acres and were

covered with chamise and chamise-grass mixtures prior to burning. Annual rainfall varied from 19 to 60 inches during the past six years.

2. Control-burn: Three months prior to burning, all oak and madrone trees were felled and left to dry. Standing trees are almost impossible to burn. The burn was ignited at 4:10 p.m., September 5, 1956. First the center of the drainage was fired with electric ignitors. Then the perimeter of area was ignited by hand carried torch in two minutes. Thus using a simultaneous ignition technique a major portion of a very intense but safe burn was completed in 17 minutes.

3. Seeding: The entire burn was airplane seeded on September 18, 1956. The seed mix was composed of the following species and poundage per acre: hardinggrass 4, smilo 2, Palestine orchardgrass 1/2, Tallarook sub clover 1/2, Mt. Barker sub clover 1/2. Legumes were inoculated the day before seeding. Although the seeding plane flew on 20-foot intervals bucket samples of the seeding pattern showed great variation in seeding rate in a line perpendicular to line of flight.

4. Brush control: Fuel preparation and execution of the control-burn were the major steps of brush removal. The freshly cut surface of all tree stumps were painted with 2,4-D amine immediately following slashing. This stump treatment was not as effective as anticipated. The burn three months after stump treatment may have hampered translocation of 2,4-D.

Deer and sheep browsing undoubtedly reduced the growth of brush sprouts and seedlings. Application of herbicide spray was delayed in deference to browse use and sprout control by browsing. Chamise sprouts were hand sprayed with high volume foliage spray of 2,4-D ester in April 1957. Sprouts of madrone, oak, buckeye, photinia and other miscellaneous shrubs were sprayed the last week of November 1957. Vigorous sprouts were slashed with an axe prior to hand application of a basal spray, one part brushkiller in 25 parts diesel oil. The basal spray procedure was repeated in the fall of 1958 to treat the few remaining sprouts. Browsing, together with occasional touch up spraying in the future will keep the area essentially free of brush in the absence of invasion of new aggressive brush species.

5. Fertilizers: Plots of 16 treatments in 4 replications were established on Josephine and on Los Gatos soils by cooperative effort of M. D. Jones on October 30, 1957. No significant clover responses were evidenced by step-point sampling of the Josephine plot in spring of 1958. Clipping from cages in a portion of the Josephine plots indicated a small total forage yield increase from S and P alone, a greater increase from N alone and still greater increase from N P S combination. Pot test assays of the two soils collected on the watershed were conducted by R. A. Evans and W. R. Powell. With the Josephine soil no significant responses were measured. Yield

increases were measured from N and P interaction and from addition of molybdemm to N P S with the Los Gatos soil. Rose clover plants were clipped from selected fertilizer treatments on Josephine and analyzed for P and S content. Phosphate was adequate on check and other treatments. Sulphur levels in rose clover indicate a deficiency corrected only in part by addition of S 100 in October. Plots were refertilized in fall of 1958 by M. D. Jones. In September single superphosphate at 200 lb. per acre was flown onto 20 acres of the Los Gatos soil.

6. Grazing: Early rains promoted far above normal forage growth in September and October of 1957. Grazing of the 1957-58 forage crop started on October 28, 1957. Fairly heavy grazing continued until April 26, 1958. An average of 70 ewes and rams plus 20 lambs grazed in this 60-acre field all winter. In September and early October, Watershed I-A was grazed to utilize dry feed and browse and to trample legume and grass seed into the soil. Grazing to date in sheep days per acre has been as follows: pretreatment, 25; 1956-57 forage crop, 135; 1957-58 forage crop, 315. Absence of rain retarded growth in fall of 1958. Fairly heavy grazing will be resumed early in 1959 and continued to utilize forage and to reduce grass competition with clovers until full bloom of clovers.

7. Herbaceous cover: Herbaceous density and species composition have been measured in the fall and spring at the beginning and end of the high intensity storm period. Henceforth only density or total ground cover measurements will be made in the fall. Density and distribution of herbaceous cover probably is more closely correlated with hydrology and erosion than any other characteristic of this type of vegetation such as species, height or total volume.

The herbaceous inventory employed two systems; 1) step-point analysis and density estimates of Evans and Love*, and 2) per cent stocking measurement as developed by Hyder and Sneva in Oregon**. The latter indicates the per cent of random square feet stocked with one or more of the measured species. Step-point analysis was designed for measurement of California's annual plant ranges and the per cent stocking system was created for inventory of wheatgrass seedings of eatern Oregon. The former is more closely correlated with production by a given species but is influenced by

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*Evans, Raymond A., and Love, R. Merton. The step-point method of sampling -- a practical tool in range research. Jour. of Range Mgmt. 10(5): 208-212. Sept. 1957.

**Hyder, Donald N. and Sneva, Forrest A. A method for rating the success of range seeding. Jour. of Range Mgmt. 7(2): 8-9. March 1954.

differential seasonal development and grazing of different segments of the vegetation. Per cent stocking is an easier measurement to make and may be a useful tool for comparing hardinggrass seedings throughout the state. The adjoining table includes both systems for comparative purposes.

Although the per cent of ground covered by seeded species is small it comprises about one third of the total herbaceous density. A multitude of hardinggrass and orchardgrass seedlings appeared in the fall of 1957. A portion of these seedlings survived until at least April of 1958 as evidenced by per cent stocking measurements. The step-point analysis tends to obscure the frequency of occurrence and distribution of legumes as depicted in per cent stocking figures.

Observations indicate the current herbaceous densities of 30 to 50 per cent offer relative stability against soil movement. A ground cover of less than 12 per cent during the 1956-57 rainy season probably did not have an appreciable affect upon run-off and erosion.

Although not necessary for range improvement a reburn at a future date would provide an opportunity to study the hydrologic aspects of burning a grassed watershed.

8. Field days: The first stop of the general Hopland Field Day in May was at Watershed I-A. The area was of major importance on six other field days and to four additional special study groups visiting the station in 1958.

Piney Creek Watershed, Mariposa County

Piney Creek experimental watershed. The photo on the left was taken before treatment in 1957 shows and impenetrable jungle of chamise brush. The photo on the right shows the identical area after it has been control-burned, seeded and sprayed. A brush-field is transformed into a productive pasture.

Herbaceous Inventory, Hopland Watershed I-A
Summary of Two Sampling Systems

Sampling System and Cover Type	Acres	Species and Date of Sample																		
		Hardinggrass			Orchardgrass			Smilo			Seeded Clovers			Soft Chess			Herbaceous Density 3/			
		Apr. 57	Dec. 57	Apr. 58	Apr. 57	Dec. 57	Apr. 58	Apr. 57	Dec. 57	Apr. 58	Apr. 57	Dec. 57	Apr. 58	Apr. 57	Dec. 57	Apr. 58	Apr. 57	Dec. 57	Apr. 58	Dec. 58
Woodland-grass	10	Not Sampled 4/																		
STEP-POINT ANALYSIS. 1/																				
North exposures (250 pts.)	32	3	10	10	2	5	7	T	T	T	1	1	T				12	33	41	41
South exposures (50 pts.)	15	1	7	2	T	6	1	T	1	T	T	1	T	4	28	15	11	50	38	24
Chamise walked down (50 pts.)	3	4	7	10	1	6	5	1	1	T	T	1	1				10	50	64	48
PER CENT STOCKING. 2/																				
North exposures (1000 sq.ft.)	32	71	62	79							42	57	28							
South exposures (200 sq. ft.)	15	24	28	53				21	4	7	8	9	3							
Chamise walked down (200 sq.ft.	3	50	39	70						11	22	30	24							

1/ Species evaluations are per cent of ground covered as derived by multiplying step-point per cent composition by density.

2/ Species evaluations are the per cent of square feet sampled which contained one or more of the named species. Seedlings were not included in the April sample.

3/ Total of green plant material and forage residue for December, 1958. Forage residue not present in appreciable amount at prior samplings.

4/ Blanks indicate not sampled.

T Species measured in sample but less than 0.5 per cent ground cover.

1. Description of area: The experiment is designed to study the influence of brush range improvement practices on the runoff from a 2,000-acre area of gentle slopes between elevations of 800 and 1,400 feet in northern Mariposa County. Dense chamise, unburned for about 25 years, predominated in the central bulk of the area. Brush averaged 5,500 plants per acre and 5.9 feet in height. Estimated shrub crown closure of 95 per cent reduced herbaceous ground cover to four per cent.

2. Burning: Three or more months prior to burning about a third of the brush area was crushed with crawler tractor and log drag. On August 25, 1957 the chamise cover within the watershed was burned. Only a few isolated spots were not burned. Electric ignitors were used to start portions of the fire. The ignition system took advantage of predicted wind shifts and was combined with a drainage pattern ignition system.

3. Seeding: With the exception of 20 acres of plot work all burned chamise was seeded by aircraft on October 12, 1957. The seed mix was composed of the following species and poundage per acre: annual rye 2 1/2, blando brome 1/2, smilo 1 and rose clover 1. W. B. Sturtevant, rancher cooperator, dragged approximately 200 acres following seeding to cover the seed and uproot brush burls. The drag was made of discarded crawler tractor treads.

Seed distribution samples taken at time of seeding measured seed swath distribution similar to distribution at Hopland Watershed I-A. Fifty-foot swath width produced satisfactory seed distribution.

Summary of Step-point Sample of Piney Creek Watershed, June 1958
1000 points and 200 density estimates

Total herbaceous ground cover by species:	Per cent
Ryegrass	8
Blando brome	4
Smilo	2
Rose clover	1
Resident annuals, grass	3
Resident annuals, broadleaf	3
Total herbaceous ground cover	21
Ground cover of chamise	4

The four per cent ground cover of chamise should be greatly reduced or eliminated by spraying. Better stands were obtained by dragging. Preburn dragging effected a more intense burn and also roughed the soil surface slightly permitting better seed placement. Dragging after seeding covered the seed and enhanced germination and stand establishment.

A ten-acre block of burned chamise was hand seeded to hardinggrass, smilo, Palestine orchard and clovers. A good stand of grasses and fair stand of rose, crimson and sub clover were produced the first year. This seeding was on an area that was dragged before burning. With exception of a few check strips the seeding was dragged again after seeding. In general a much better stand resulted from seed coverage. The smilo stand was as good if not better without dragging. Clippings on the 10th of May measured 542 pounds per acre oven dry forage from perennial seeding as compared with 802 pounds from the adjacent airplane seeding by the ranchers.

4. Brush control: Airplane spraying of herbicides was employed to kill brush sprouts and seedlings, primarily chamise. A joint effort of Bureau of Land Management, livestock operators and California Division of Forestry sprayed 280 acres on the 6th of May 1958. Spray mix was about three pounds acid equivalent low volatile ester 2,4-D, two quarts diesel and 3 3/4 gallons of water per acre. The above groups together with Agricultural Stabilization and Conservation Committee assisted in spraying ten-acre chamise control test blocks.

Experimental Airplane Spray Plots, Piney Creek Watershed, May 1958

Plot	Herbicide, pounds per acre acid equivalent			Spreader, ounces per 100 gals.	Diesel, gallons per acre	Water, gallons per acre
	2,4-D ester	2,4,5-T ester	2,4-D amine			
A	2	1			1/2	3 3/4
B	3				1/2	3 3/4
C	2				3/4	3 3/4
D	4				1/4	3 3/4
E	3				1/2	8 3/4
F			2	6		9 1/2
G			4	6		9

These plots will be sampled in late summer of 1959.

All tree forms within 100 feet of the main water courses were cut-surface treated with 2,4-D amine prior to May 18, 1958. Riparian willow growth in the lower portion of the watershed was hand sprayed with 2,4-D in June 1958.

Five rates of Fenuron were applied to 18-foot by 100-foot plots within the perennial grass-clover seeding. Application was in March 1958 and a striking reduction in perennial grass seedlings was noted four months later. Chamise sprouts and seedlings showed effects of herbicide.

Brush sprouts and seedlings in the 10-acre perennial-grass and annual-clover seeding have been partially controlled with hand spraying. This operation will be completed in 1959.

Dragging before burning followed by a dense stand of grasses greatly retarded the regeneration of chamise. Additional dragging after seeding almost eradicated chamise.

5. Fertilizers: In preliminary fertilizer assays by pot tests rose clover responded to additions of phosphate and sulfur. One-half-acre blocks of single superphosphate at 500, 1000 and 2000 pounds per acre were broadcast on the perennial grass-legume seeding in March 1958. Treble superphosphate and 16-20-0 were also applied with rate of phosphate equivalent to the median rate of single superphosphate. The only noted response to date appeared as spring grass growth on 16-20-0 plot.

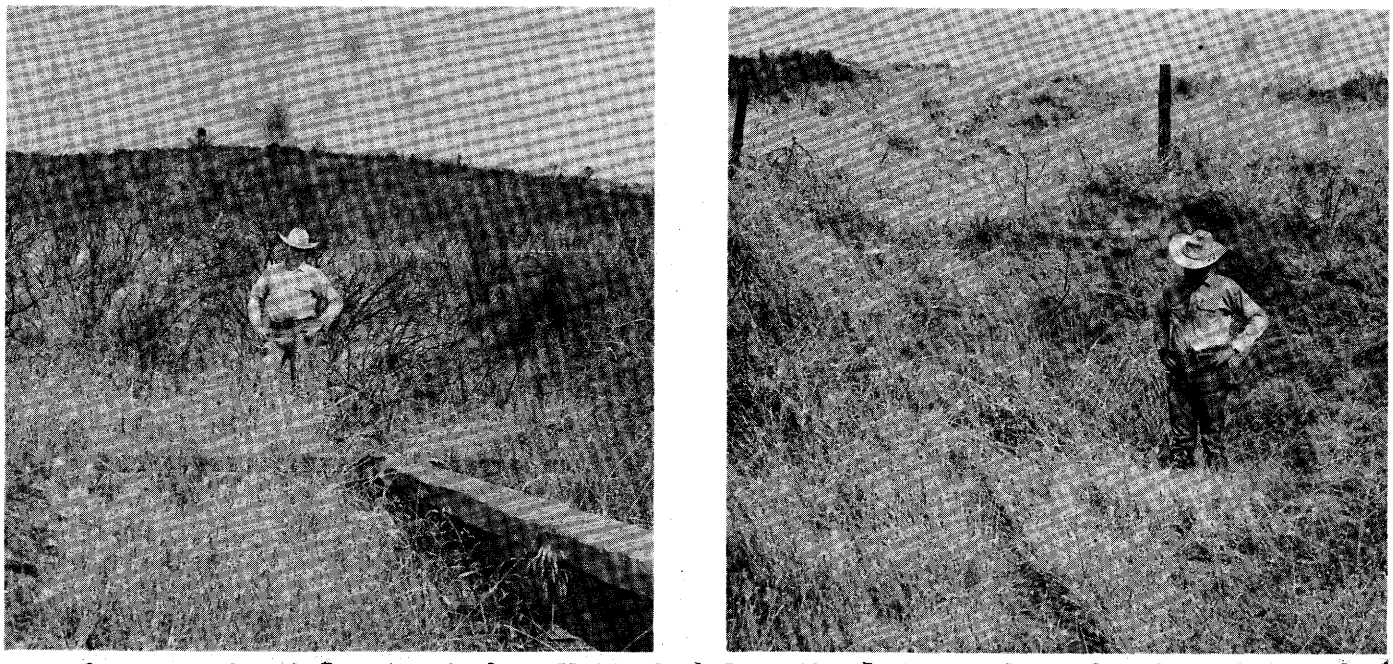
Additional plots were drilled on an adjacent block of burned chamise. This material is reported in following pages under title of Seeding Demonstrations, etc.

6. Grazing: Grazing has varied in different pastures. A portion has been grazed continuously. Another section was grazed from time of seeding until April 1958.

7. Field Days: A ranchers field day was held on the 12th of May. Another field tour was conducted on the 28th of May for research, extension and administrative personnel.

Ono Watersheds, Shasta County

Two of four small (one-half-acre to one-acre) watersheds in western Shasta County were control-burned and seeded in 1949. The herbaceous cover has developed rather slowly on these infertile soils but presents a fairly stable condition at present. The two heretofore untreated watersheds, B and C, were control-burned in June 1957 with the assistance of California Division of Forestry and Shasta County Farm Advisor. Brush sprouts were sprayed on all plots in October 1957 and watersheds



Ono experimental watersheds. Watershed C on the left was burned and seeded in 1957. Watershed A on the right was burned in 1949 and seeded in 1951. Photographed October 1958.

B and C were broadcast seeded to a range mix of primarily smilo and nodding stipa. Smilo has proven itself from the earlier seeding. Combinations of nitrogen and phosphate fertilizers greatly benefit stand establishment and production. Herbicide spray applied in the spring of 1958 will control a majority of sprouting brush. A summary of step-point sampling of October 1958 appears in the following table. Two hundred points were sampled in each watershed.

Summary of Step-point Sample, Ono Watersheds, October 1958

Watershed	Total ground cover, per cent	Total ground cover by species, per cent						
		Smilo	Nodding stipa	Big bluegrass	Tall fescue	Resident annuals, grass	Resident annuals, broadleaf	Brush
A	40	12	1	1	1	20	3	2
D	20	4	T	1	0	8	1	6
B	6	3	1	0	0	1	T	1
C	4	2	T	0	0	T	T	1

Prior to treatment the sites were occupied by chamise and minor associated woody species with almost total exclusion of herbs. Brush sprouts and seedlings that appeared following burning are being controlled with herbicide sprays.

Diamond Range Watershed, Tehama County

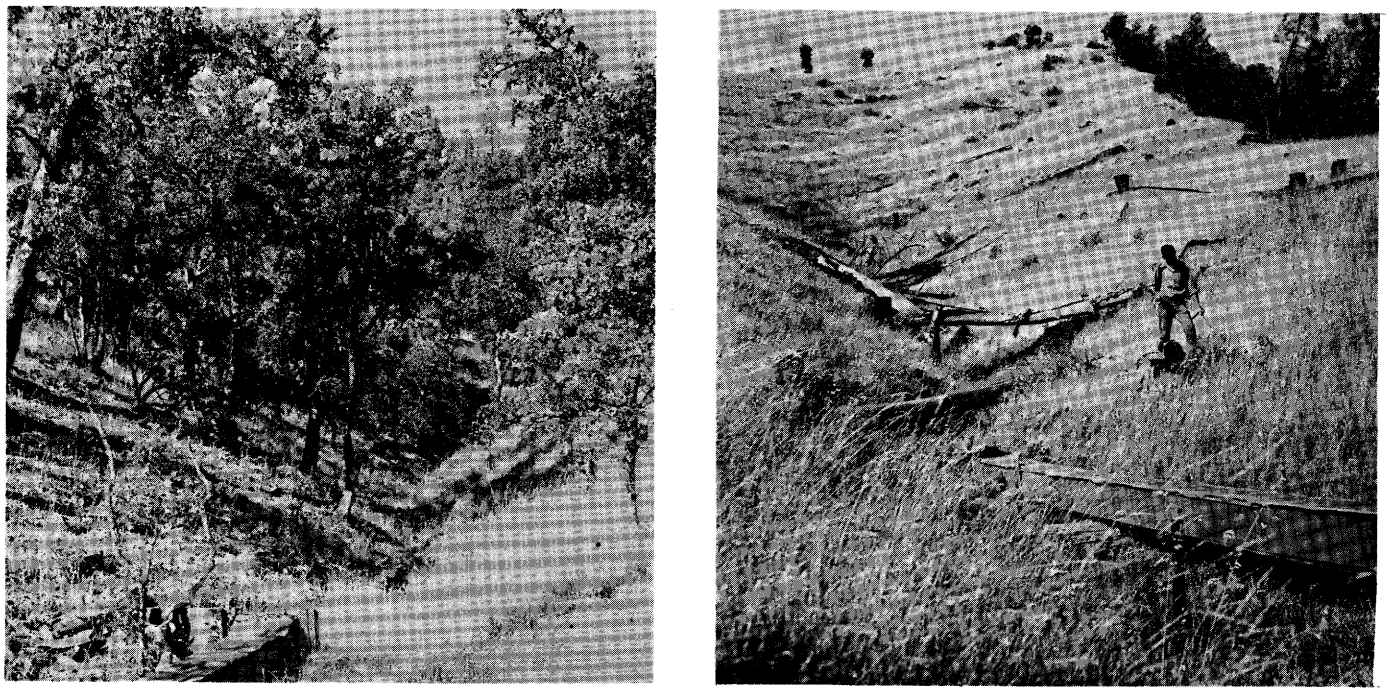
Slashing, burning and seeding in 1953 initiated a brush range improvement treatment on a three-acre watershed in woodland-grass range of western Tehama County. An adjacent five-acre watershed has remained untreated. Subsequent applications of herbicides have eradicated the brush on the treated watershed. Two hundred step-point samples taken on each watershed are summarized in the following table.

Summary of Step-point Sample, Diamond Range Watersheds, October 1958

Watershed	Total herbaceous ground cover, per cent	Total ground cover by species, per cent						Brush and tree crown closure, per cent
		Harding	Orchard	Smilo	Rose clover	Resident annuals, grass	Resident annuals, broadleaf	
Untreated	31	-*	-	-	-	28	3	38
Treated	48	17	1	T	1	22	7	0

*Dash indicates species was not planted.

Blue oak, manzanita, toyon and digger pine comprised a majority of the woody vegetation prior to treatment.



Diamond Range watersheds. Untreated on the left and final stages of sprout control treatment on the right. Photographed June 1957.

Ahwahnee Watersheds, Madera County

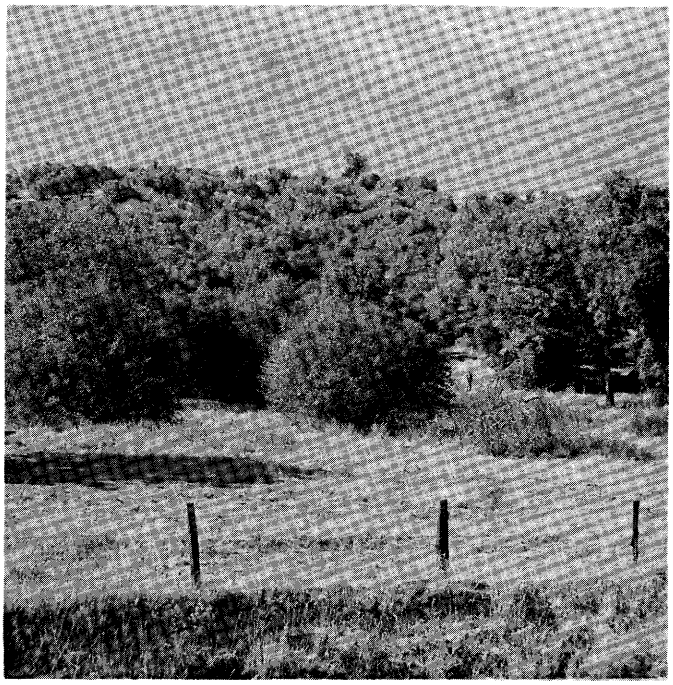
One of a pair of four-acre watersheds at 3000 feet elevation has been treated according to accepted brush range improvement practices. The treatment has been managed by Madera County Agricultural Extension Service. There follows a summary of step-point sampling of 200 points in each watershed in May 1958:

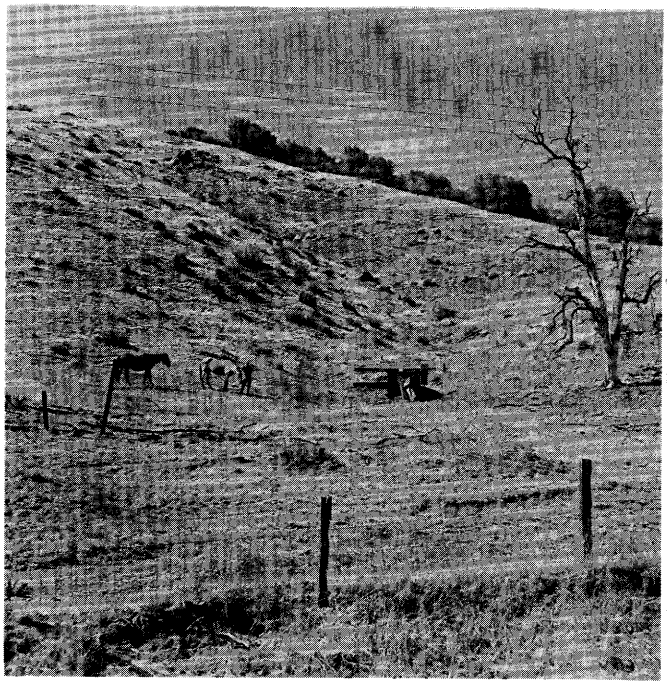
Summary of Step-point Sample, Ahwahnee Watersheds, May, 1958

Watershed	Total herbaceous ground cover, per cent	Total ground cover by species, per cent				Brush and tree crown closure, per cent
		Harding	Rose clover	Resident annuals, grass	Resident annuals, broadleaf	
Untreated	12	-*	-	7	5	60
Treated	25	1	1	20	3	T

*Dash indicates species was not planted.

The woody plants on the untreated area are present in the following order of abundance: interior live oak, whitethorn chaparral, buckeye, wedgeleaf ceanothus and other species of lessor abundance.





Ahwahnee experimental watersheds. Untreated on the left and treated on the right. Photographed October 1958.

Tulare County Watersheds

Hydrologic measurements have been made on two watersheds at about 2800 feet elevation in Tulare County. The smaller or 12-acre watershed was partially bulldozed in 1954. In 1956 remaining brush was bulldozed into the waterways and the watershed was control-burned in the fall. The burn was seeded. No herbicide control of brush was permitted. The area was burned by wildfire in the summer of 1958. Prior to treatment vegetation on the treated watershed was similar to the very dense brush cover growing on the nearby 15-acre untreated watershed. On the untreated area brush averages about 20 feet in height. Crown closure is estimated at 90 per cent. There are a very few openings and none larger than 20 feet in diameter. Herbaceous ground cover of mostly grasses in the openings is estimated at 20 per cent. Under the brush herbaceous ground cover of primarily broadleaf plants varies from zero to ten per cent. Shrubs listed in order of abundance are as follows: interior live oak, wedgeleaf ceanothus, chapparral whitethorn, redbud, fremontia, western hop-tree, California bay, blue oak, mountain mahogany, squaw bush and redberry. A summary of 200 step-point samples taken in May 1958 on the treated watershed appears in the following table.

Experimental watersheds in Tulare County. The area on the left is untreated dense brush. A similar cover on the experimental watershed on the right has been bulldozed, control-burned and sown to forage plants. Photographed in June 1958.

Summary of Step-point Sample of Treated Tulare Watershed, May 1958	
Total herbaceous ground cover by species:	Per cent
Intermediate wheatgrass	3
Tall fescue	2
Resident annuals, grass	28
Resident annuals, broadleaf	7
Total herbaceous ground cover	40
Ground cover by brush	11

Preliminary Studies in Southern California

Farm Advisors and others in southern California have expressed a great need for watershed studies. Watershed management problems are of paramount importance in brush covered hills and mountains of the Tehachapi and Southern California.

Recurrent wildfire is a traditional characteristic of the chaparral. It is rare to find a spot in the brushland zone that does not bear evidence of previous fire. When unusually favorable burning conditions occur as in the fall and winter of 1958 vast acreages are swept by wildfire. Tremendous forces of well equipped fire fighters with amazing organizations and methods of attack are almost powerless to alter the behavior of a large wildfire. The limits of large wildfires are coincident with a change of fuel type, topography or weather.

Broadcasting the seeds of annual grasses and other plants onto newly burned brushland watersheds is a prevailing practice. The watersheds are thereby covered with a fairly effective and stable herbaceous cover by the second growing season after seeding. This vegetation will persist until crowded out by regenerating brush. Records describing this phenomenon are numerous. A majority of these reports state in conclusion that the herbaceous cover has been replaced by "satisfactory" regrowth of the "permanent" brush cover.

Dense chaparral is not a satisfactory watershed cover because it is not permanent and it is not stable. It is very apt to be burned by wildfire at fairly frequent intervals.

The reporting organization and many others have demonstrated that an herbaceous cover can be maintained on sites formerly occupied by brush if properly managed. The primary principle of effective management is brush control.

Dr. D. R. Cornelius of the Agricultural Research Service has established plots of range species at three elevations in burned brushlands of the San Bernardino National Forest. The reporting organization and San Bernardino County Agricultural Extension Service have co-operated with herbicide brush control on these plots. These spots are being maintained as herbaceous cover for purposes of study and demonstration while thousands of surrounding acres are rapidly returning to brush.

Brush control often is achieved by a combination of methods. Judicious use of fire when coupled with other techniques can be an extremely useful tool in brush control. This is illustrated by observations and measurements made very near the low elevation plot at San Bernardino. The brush cover of chamise and sage was burned by wildfire in the fall of 1956 and airplane seeded to annual ryegrass, blando brome and mustard. An estimated 500 or more pounds per acre of dry forage were produced in the 1956-57 growing year. There was sufficient dry herbaceous cover in the fall of 1957 to carry a wildfire into a portion of the area. In July of 1958 live and dead brush plants were counted on paired plots. Ten plots were within the reburn of 1957 and ten plots outside the reburn but within the burn of 1956. All dead or alive chamise was counted. Only live sage was counted.

Chamise Killed by a Reburn in San Bernardino County

	Plants per acre				
	Chamise			California Sage Alive	White Sage Alive
	Dead	Sprouting	Seedlings		
No reburn	4210	2980	8200	690	0
Reburned	6710	290	430	653	0
Killed by reburn		2690	7770		
Per cent killed by reburn		90	94		

The sample also indicates the preburn population of chamise was essentially the same in both areas, reburn and no reburn. Dead and live old chamise sampled inside the reburn totalled 7000 plants per acre as compared with 7190 plants per acre outside the reburn.

Forage production in 1957-58 was not greatly reduced by the reburn. A planned reburn the first or second year after the initial burning and seeding would be extremely easy to manage. Spread of the fire would be limited by steep slopes and ridgetops where soil is very thin and there is insufficient herbaceous fuel to carry the fire. Although the reburn did not eradicate all the brush it reduced the numbers that would have to be controlled by additional burning, browsing, herbicides or other methods.

REDUCTION OF PLANT COMPETITION DURING SEEDLING ESTABLISHMENT ON ANNUAL RANGE BY CHEMICAL APPLICATION*

In the annual range type competition from dense stands of low-value annual grasses and forbs makes difficult the establishment of desirable annual clovers and perennial grasses. A study was developed to investigate the possibility of applying pre-emergent herbicides prior to seeding desirable species.

The study area was burned prior to application of chemicals to remove a large volume of old litter and to concentrate seeds on the soil surface. Three rates plus checks of six chemicals were applied to plots in mid-September 1957 at the beginning of the rainy season. Four weeks and seven weeks following chemical application, plots were seeded with hardinggrass and rose clover.

Plant cover on plots treated with Eptam, Simazine, and CIPC at all rates was significantly lower than on check plots. Conditions for clover growth and establishment were excellent in the 1957 season and no improvement in the stand occurred as a result of chemical treatment. Further work is under way in "difficult clover environments" to test the effectiveness of preemergent control of range weeds in establishing annual clover stands. These plots are described briefly in the following section titled "Seeding Demonstrations."

Significantly better stands of perennial grass were obtained on plots given the following treatments than on check plots: Eptam 4 pounds; Eptam 8 pounds, Simazine 1 pound, Simazine 1/2 pound, and Monuron 4 pounds. Soil moisture conditions on plots given the above treatments were more favorable for plant survival than on check plots.

*This is a cooperative project with Dr. Cyrus M. McKell ARS, USDA, and Jack Major, Botany Dept. U.C. A paper by this title has been submitted for publication.

Successful establishment of hardinggrass and rose clover through the use of chemicals to reduce competition from resident annuals.

Further work appears to be justified in the use of pre-emergent control of noxious range weeds prior to reseeding with desirable species. Costs of the pre-emergent chemicals, although an economic factor limiting use, will be lower as benefits and techniques are demonstrated.

LIMESTONE PELLETING OF SUBTERRANEAN CLOVER TESTED ON ACID SOILS*

Two kinds of legume inocula and two methods of applying limestone were studied as aids to the field establishment of subterranean clover on four acid range soils having pH values of 4.6 to 6.0. A commercial inoculum intended for subterranean and crimson clover, and soil inocula proved equally effective on three of the sites, but the soil inoculum used in one experiment was definitely harmful, drastically reducing stand.

Limestone pelleting was of questionable benefit as an aid to rhizobial inoculation on these acid soils, even though subterranean clover forage responded substantially to inoculation on all four soils. The heavier concentration of

*A paper by this title was prepared by W. A. Williams and B. L. Kay and has been submitted for publication.

limestone provided by the band treatment resulted in a positive yield response in association with commercial inoculum on the most acid soil (pH 4.6). This is a co-operative project with Dr. W. A. Williams of the Agronomy Department.

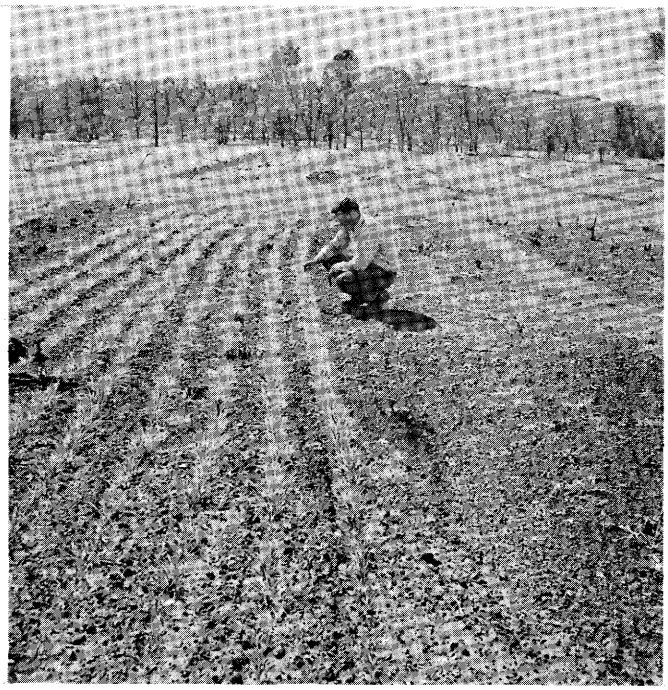
DEMONSTRATION PLANTINGS BY FARM ADVISORS ASSISTED AND SUBSIDIZED BY RANGE DEMONSTRATION PROJECT

The primary objective of this project has been to encourage seeding the best possible forage species a site will support. Satisfaction with species of low seed cost and short duration of quality production is false economy. Supplies of seed, especially of those species that were difficult to obtain have been made available to farm advisors upon their request. These seed lots were planted in pastures and blocks from 1/2 acre to 40 acres in size. In many cases they were the first acreage seedings of perennials in the county. One season inoculation of legumes was stressed in a memorandum included with inoculum for seed sent to Farm Advisors. At present there is a great interest in proper inoculation of range legumes. Often a seeding of this nature gave the county range improvement program a big boost and was of material assistance to extension personnel who had newly assumed responsibility for range improvement work. Very often these county demonstration plots were subject matter for field day meetings with ranchers and not infrequently the success of a planting has been announced in newspapers and other periodicals for popular consumption. Recent efforts have been made to restrict the size of each planting to about two acres.

Year (Fall)	No. Counties	No. Plantings	Acreage
50	12	15	- -
51	--	73	320
52	19	51	217
53	22	54	527
54	24	55	561
55	27	50	212
56	25	64	162
57	25	76	191
58	24	46	146

SEEDING DEMONSTRATIONS

Additional field demonstrations and plot work has been accomplished in cooperation with Farm Advisors and other U. C. Experiment Station personnel. A majority of these projects have required a range seeding. The heavy duty range drill has been very useful for this purpose.



The photo on the left illustrates a comparison between drilling and broadcasting seed on burned brushland. The plots are at Piney Creek in Mariposa County. In March of 1958 there is an excellent stand of forage plants in the 10 drilled rows in front of the observer. Only scattered plants occur from broadcast seeding without seed coverage in the plot behind the observer. Yield data from these plots appear on later pages. In the photo on the right the rangeland drill is being used to band seed annual legumes with single superphosphate in Madera County.

Some of the seedings have been at the initiative of the reporting organization in an effort to answer questions frequently asked by Farm Advisors and ranchers. In every case these plantings have been a joint effort with Farm Advisors. Some of these plots are on demonstration ranches and at least one is in conjunction with an experimental watershed.

These endeavors have been segregated into groups on the basis of objective and nature of seeding. There follows a brief description of each study together with results from seedings established prior to 1958. All plots are tabulated by location at the conclusion of this section of the report.

1. Seed coverage: A series of plots were designed to demonstrate and measure the advantage of covering seed broadcast on burned brushlands. Seed coverage is especially advantageous in southern California and may produce an excellent stand where uncovered seed will produce almost no stand. Broadcasting without covering the seed, broadcasting and ring rolling to cover the seed and drilling are the methods of seeding tested with replicated plots.

One plot planted in Mariposa County on September 29, 1957 was harvested for forage yield on May 10, 1958. A 21-inch by 60-foot strip was clipped from each plot with a power mower. Plots were not grazed prior to clipping. Species not seeded-resident-made up less than five per cent of the samples.

Comparative Forage Yields From Various Planting Techniques

Control-Burned Chamise
Mariposa County

Treatment	Pounds of Oven Dry Forage per acre	
	Annual Mix (1)	Perennial Mix (2)
Seed drilled	2990	1210
Seed drilled with 450 lb. Single Super phosphate per acre in furrow	3140	1930
Seed broadcast and covered with ring roller	2040	340
Seed broadcast, covered with ring roller and broadcast 450 lb. SSP per acre	1900	460
Seed broadcast No seed coverage	1580	240
Seed broadcast No seed coverage, 450 lb. SSP broadcast per acre	1730	190
L.S.D. .05 L.S.D. .01	1020	340 470

(1) 2 1/2 lb. annual rye, 1/2 lb. Blando brome, 1 lb. Smilo, 1 lb. Rose Clover: Total - 5 lb./acre.

(2) 4 lb. Hardinggrass, 2 lb. Smilo, 1 lb. Rose Clover, 1 lb. Crimson Clover, 1 lb. Mt. Barker sub clover: Total - 9 lb./acre.

This study is reported in California Agriculture 12 (10):5-6, October 1958.

The slow starting perennial mix-largely hardinggrass-showed the greatest response to drilling. The increased stand density was achieved by placing the seed in an environment favorable for germination and rapid initial development. The annual mix forage was primarily ryegrass, which germinates readily and grows rapidly. Therefore it was not so greatly benefited by seed coverage as was the hardinggrass.

Even with the annuals the advantage of drilling as compared with broadcasting without seed coverage was significant and more evident during the winter months than in May. Greater competition for moisture during April and May was more apparent in the drilled stands than in the broadcast stands, where the fewer plants grew to larger size. Furthermore, covered seed is partially protected from depredation by

birds and rodents. Inoculum on legume seed is also protected from sunlight when covered.

Potential forage production of many brushlands has been demonstrated to be sufficient to warrant considerable expenditure to establish a highly desirable forage stand. The first season after the burn is essentially the only opportunity to establish the forage stand.

An exhaust seeder of relatively simple construction mounted on a crawler tractor has been used for range seedings in Texas in conjunction with brush-root plowing. It appears this seeder could be used to advantage in burned brushland with a seed covering drag or roller pulled behind the tractor. This organization would welcome the opportunity to test this machine.

2. Row fertilization of drilled clovers: There is a very keen interest in establishing annual legumes on California ranges - brushlands and grasslands. Clovers have been very successfully established and propagated on extensive acreages in many parts of the state. However, in other areas clover production has not been satisfactory, initial establishment often being the major problem.

The range improvement program of the Department of Agronomy places a major emphasis upon annual legume production. A series of rather rudimentary legume establishment plots have been seeded in many parts of the state. In general these plots consist of drill seeding of annual legumes with fertilizer placed in the row as compared with seeding without fertilizer. Usually five replications were employed. In most locations at least one additional replication was planted with a maximum delivery rate of fertilizer to test for fertilizer damage to seed and seedling.

Trials on the Glen Barrass Ranch near Covelo have shown the feasibility of drilling sub clover into annual range sod or burned annual range. Seedings made in the fall of 1956 and again in the fall of 1957 were all successful in establishing sub clover. The drill rows are fully stocked and in the case of the 1956 seeding are spreading rapidly outside the drilled rows. Single superphosphate and ammonium phosphate have both been successfully used in these trials.

3. Row fertilization of drilled grass: A distinct advantage from band seeding or row placement of fertilizers with forage crop seedings has been demonstrated by the reporting group and by others. Seedlings would therefore receive benefit of increased fertility during initial establishment with a minimum expenditure for fertilizer. Also, other resident plants or competing plants would receive less benefit from fertilizers placed in a row close to planted seeds.

Most of these plots have been planted with the heavy duty range drill. In many cases there are five replications of each treatment. The basic seed mixture has been hardinggrass with or without other perennial grasses and annual legumes added. Fertilizers used have been determined from knowledge of local soil deficiencies. The possibility of seed and seedling damage from high rates of fertilizer is being studied. Some of the older stands have been sampled.

A split-plot design was created by the addition of 450 pounds per acre of single superphosphate to one-half of all plots of the Piney Creek seed coverage study described earlier in this section of the report. Note the only measured significant effect of the fertilizer was an increase in yield from addition of single superphosphate to the drilled planting of the perennial mix.

However, this response to single superphosphate was not duplicated on an adjacent series of row fertilization plots. The perennial mix was drilled and harvested the same as the seed coverage study. Fertilizers were placed with the seed in the row as listed with associated yields in the following table:

Fertilizers:	Forage Yield, Pounds per acre oven dry
Check	1520
Single superphosphate at 200 lbs./acre	1430
Single superphosphate at 450 lbs./acre	1380
Treble superphosphate at 240 lbs./acre	1460
16-20-0 at 500 lbs./acre	2330
L.S.D. 0.05 = 305	
L.S.D. 0.01 = 427	

Here there is no significant change in yield of planted forage with addition of single superphosphate. There is an increase from the addition of 16-20-0, Other similar responses from nitrogen phosphate combinations are reported in subsequent paragraphs. In March of 1958 a greater height growth of hardinggrass was observed to be associated with addition of single superphosphate.

Twenty acres of hardinggrass was band seeded near Sloughhouse, Sacramento County, in the fall of 1957. The area had been spring plowed and left fallow all summer. The area was disked very lightly at the time of seeding to kill the few weeds that had started. Hardinggrass was drilled at 3 lb./acre with the range drill over various fertilizer band treatments. Yields are shown in the following table.

Yield of First-Year Hardinggrass, April 1958					
Fertilizer Treatment	No Fertilizer	$39P_{39}$ 195 lb. 20-20	$N_{35}P_{18}$ 177 lb. 20-10	$N_{25}P_{25}$ 125 lb. 20-20	$N_{17}P_{42}$ 80 lb. 21-53
Yield of Hardinggrass (pounds of oven-dry hardinggrass/acre)	16	91	177	154	248
Hardinggrass per cent by weight of total yield.	14	42	52	49	46

The per acre yield of the hardinggrass seedlings was increased 6 to 15 times by the application of a band of fertilizer beneath the seed. The hardinggrass made up only 14% of the total yield when unfertilized. The use of a band of fertilizer beneath the seed increased this to 42-52%.

Seeding rates of 1 1/2 lb., 3 lb., and 6 lb. of hardinggrass per acre were tried. Stocking rates were 91%, 99%, and 99% respectively. These could all be considered excellent stands.

Another plot demonstrating row fertilization of grasses was planted at Hopland Field Station on September 17, 1957 and harvested on June 4, 1958. Both annual and perennial seed mixes were planted. The fertilizer treatment was a single rate of 375 pounds per acre 16-20-0 in the row with the seed at the time of seeding. As shown in the following table addition of 16-20-0 produces a marked increase in forage yield. There is no sheep grazing on the plots. Deer are excluded from one-half of the plot. Note a marked reduction in forage harvested where there is deer grazing.

Grazing Management	Forage Yield, pounds per acre oven dry			
	Perennial		Annual	
	16-20-0	Check	16-20-0	Check
Inside deer fence	1218	181	1575	573
Outside deer fence	286	96	905	348
Difference	932	85	670	225
Per cent reduction	77	42	43	39

The overall benefits of fertilizing at the time of seeding can not be measured by forage production the first season. The primary objective is to assure initial stand establishment for production of high quality forage in future years. A measurement of forage production by seeded species or a measurement of the seeded stand several years subsequent to planting will enable evaluation of the benefit of fertilizers applied in conjunction with planting.

3. Species comparisons: Plots have been established to compare forage production of perennial grasses with forage production of annual grasses. The compared characteristics are forage yield and protein content as determined by clipping and analysis of clippings. Samples are taken at different seasons. Hardinggrass, Palestine orchard and smilo are the chief perennials being compared with annual ryegrass and blando brome. Annual legumes are seeded with both grass mixes.

The first year's growth has been sampled in two cases. This data appears in the preceeding paragraphs of this section of the report which pertain to seed coverage and row fertilization of grasses. Forage production from the annuals was greater than from the perennials for the first growing season.

4. Seeding grasses into clover stands: In New Zealand and Australia introduction of grass into established stands of clover has improved forage production. Dr. R. M. Love has initiated field work to study this practice in California. Several plots were planted with the heavy duty range drill. Hardinggrass, Palestine orchard grass, ryegrass, and blando brome were seeded in replicated plots in established stands of annual legumes. A constant rate of single superphosphate was drilled with the seed at the time of planting.

5. Competition control with herbicides: The investigations described under a previous section of this report entitled "Reduction of Plant Competition During Seedling Establishment on Annual Range by Chemical Application" have been extended to plots in six other counties. The plots are basically four replications of four rates of Eptam broadcast immediately prior to drilling annual legumes with single superphosphate. This study is in cooperation with Dr. C. M. McKell and Farm Advisors.

6. Summary: The plots described in previous paragraphs of this section of the report are tabulated by county in the table following. This includes plots planted previous years as well.

County	Competition control with herbicides	Seed coverage	Row fertilization of drilled clover	Row fertilization of drilled grass	Species comparisons	Seeding grasses into clover
Fresno				1		
Humboldt			1	4	1	
Kern				1		
Kings				1		
Lake				3		
Madera		1	1	1	1	2
Mariposa	1	1	3	2	2	
Mendocino			1	3	2	
Napa		1	1	1	1	
Nevada			1	2		1
Sacramento				1		
San Benito	1		1			1
San Diego			2			
Santa Barbara	1	1	1	3		
Santa Clara			2			
Shasta			1	1		
Solano	2					
Sonoma			2	1		
Tulare			1			
Ventura	1					