Street

PROGRESS REPORT

Range Demonstration 1957

University of California
Range Management Investigations

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Cover Picture: Farm advisors Carl W. Rimbey and Norman E. Nichols discussing sagebrush eradication and range seeding at the Likely Demonstration Range Field Day in Modoc County, June 21, 1957. Standing in the center of the picture with elbows out is Rob Flournoy, rancher cooperator.

RANGE MANAGEMENT INVESTIGATIONS
DEMONSTRATION RANGES

Progress Report

Year ending December 1957

Burgess L. Kay, Charles F. Walker, James E. Street, James L. Myler*

INTRODUCTION

Range improvement activities of a demonstrational nature on acreage operations and smaller plots is herein reported as arranged by location. The objectives are broadly twofold. Present research knowledge is expanded into field scale trials for demonstration and further study. Research facilities are provided in areas distant to a field station or experiment station. The assistance of the ranchers and their neighbors is essential. All activities have been closely correlated with research departments, extension specialists and farm advisors. Their spontaneous cooperation is greatly appreciated. Able assistance has also been received from the California Division of Forestry, U. S. Forest Service and State Department of Agriculture.

Range field days in Humbolt, Modoc and Tulare Counties were the outstanding demonstration activities of the project for 1957. Tours of selected groups were also conducted on other areas. The field days were directed primarily at ranchers and technicians. The Tulare County Range and Watershed Tour at the Manley Ranch was held in conjunction with a meeting of the California State Board of Forestry.

Highlights of the year are mentioned here in brief summary. Reburning and spot-seeding of a 1950 control-burn constituted a final step to a phase of brush range improvement on Blue Mountain in Shasta County. Chemical control of sprouting of tanoak and madrone stumps is being tested in Humbolt County. A three-year carryover of nitrogen fertilizers used in Modoc County was reported in California Agriculture. In Tulare County three carriers of nitrogen and three carriers of sulfur, commonly used as commercial fertilizer, were applied to a soft chess range known to be deficient in nitrogen and sulfur. Cooperative work in San Diego County has led to the first successful control of chamise with pelleted herbicides. An experimental watershed of 2000 acres in Mariposa County was very successfully control-burned. Detailed description of these items together with a resume' of other activities appears on the following pages.

The project has benefitted by the employment of Henry A. Wright, a 1957 graduate in range management from the University of California.

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MASSEY RANCH, SAN DIEGO COUNTY

This project is located east of Alpine in the Cleveland National Forest at 3000 feet elevation. The work here is a cooperative study with the rancher, the Agricultural Extension Service and the U.S. Forest Service. The area involved was formerly a dense brushfield, predominantly chamise. The soils are of granitic origin with low water-holding capacity. Our efforts have been directed at various methods of replacing the brush with legumes and perennial grasses and controlling sprouting brush to complete the conversion.

Pasture A

This pasture was within the Conejos wildfire of 1950. In the fall of 1950 the northern half of the pasture was broadcast seeded to perennial and annual range species after the area was railed. The southern half was broadcast seeded and then railed. It is very evident that a much better stand resulted where seed was covered by railing. To improve the part of the pasture that did not have a good stand the heavy duty range drill was used to seed clovers and perennial grasses on about 40 acres in the fall of 1956. The seed was banded over one hundred pounds per acre of 11-48-0. The results were very poor wherever there was competition from annual species. The initial opportunity for securing a good stand of perennials occurs the first season following the brush burn or before native species invade to offer severe competition to a seeding.

Pasture B

Pasture B and C were control-burned by the Forest Service in 1953. In the fall of the same year pasture B was disked for brush control, broadcast seeded and then disked again for seed coverage. A very good stand of perennial grasses resulted from this method of range seeding. Legumes did not survive the second growing season. The predominant species from the general range mix was harding-grass, veldt and smilo.

Pasture C

Following the control burn of 1953, eighty-six acres of pasture C was disked and broadcast seeded to cereal oats. After a season of heavy grazing to reduce the volunteer crop of oats, the area was disked and legumes and perennial grasses were drilled in rows over one-hundred pounds per acre of 11-48-0 fertilizer. This seeding method was very successful in establishing annual clovers and perennial grasses. The reason for planting cereal oats was to provide additional cultivation to reduce the sprouting chamise. It is doubtful if this extra cultivation and the feed derived from the oats was the most economical approach. Direct seeding of the range species following the burn would be a more ideal method.

Pasture D

On January 15, 1957, the heavy duty range drill was transported to San Diego county to drill seed a new area. The Inaja wildfire of 1956 had burned to the boundary of the experimental pastures. On five acres of this burn perennial grasses and annual legumes was drilled. The five acres was inadvertently over-seeded with ryegrass by the Forest Service. The ryegrass offered severe competi-

tion to the drilled species. A very dense stand of ryegrass occurred wherever the drill covered the seed. The net result was a fair to poor stand of hardinggrass, veldt, smilo.

A plot with seed banded over fertilizer will be sampled in the spring of 1958. The range mix was banded over 16-20-0, 11-48-0, treble superphosphate, ammonium nitrate and no fertilizer. No visible differences were evident in June of 1957. However, some carryover effects of the fertilizer are showing up this winter.

Wherever there was a good stand of grass, there are practically no chamise seedlings.

Forage Inventory and Comparisons of Pastures B and C

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

	Pasture B			Pasture C		
	1955	1956	1957	1955	1956	1957
	4-24-55	4-29-56	5-31-57	4-24-55	4-29-56	5-31-57
Hardinggrass	1.74	2.47	4.02	2.9	4.32	11.74
Veldt	1.32	1.42	2.07	1.45	2.52	.77
Smilo	1.2	2.38	4.72	.30	.96	.77
Orchardgrass	.06					
Brome 25	.48					
Tall Fescue	.12		.12			
Rose Clover		.10		1.05	4.08	3.85
Alfalfa				.40	.36	.58
Lotus Spp.				.05	.12	
Soft Chess	3.36	3.89	4.02	.10	.24	1.35
Red Brome	.12	.10	.58	.15	1.20	2.50
Annual Rye	2.82	8.36	6.78	.35	3.96	8.86
Tame Oats				2.05	3.24	5.58
Ripgut	.06					1.73
Annual Fescue						.19
Filaree						.19
Miscellaneous Weeds	.60	.28	.69	1.05	2.76	.38
Wild Oats	.18					
Total Ground Cover	12%	19%	23%	10%	24%	38.5%

The step-point method of sampling vegetation demonstrates some interesting comparisons between pastures B and C. Pasture B was broadcast seeded to a variety of grasses and legumes in the fall of 1953. One year later pasture C was band seeded to selected grasses and legumes. From observing the data several trends are noted. Hardinggrass, veldt and smilo are the predominant perennials composing the ground cover in both pastures. However, hardinggrass is the principal species in C in 1957. Apparently where the seed is drilled hardinggrass is superior to veldt and smilo. Note the rose clover percentage was reduced slightly from the previous year. Rose clover seed harvest samples each year have followed

this trend. First year yields were 9 pounds per acre, second year 12 pounds per acre with the third year yields down to 6 pounds. Seed from this yield has indicated 100% hard seed being produced. There should be a good reservoir of seed left in the ground for future generations.

Pasture C is one year younger than B pasture. The drilled species with help from 100 pounds per acre of 11-48-0 placed directly below the seed have increased total ground cover substantially above pasture B. No doubt this increase is due to increased root growth from the added fertility. Also the retention of rose clover for three seasons is partly due to the phosphate fertilizer.

Herbicides

1. Control of chamise with fenuron and monuron pellets: Dr. O. A. Leonard of the Botany Department at Davis has been cooperating with the project on use of pelleted herbicides for brush control.

Monuron and fenuron pellets (containing 25% active ingredients) were broadcast with a PCB Spreader (chest type) at the rates of 8, 16, 32 and 64 pounds per acre. The pellets were applied in November of 1956 before the winter rains had started.

The plots were viewed in April, with no effects on the brush being apparent at that time.

One year after treatment the effects of the treatments were noted again. Chamise and brush seedlings were all killed with dosages of 32 pounds per acre of either monuron or fenuron pellets, and most of these plants were killed with the 16 pounds per acre application. Considerable effect occurred with the 8 pounds per acre application. Sprouting manzanita (Arctostaphyllos glandulosa) and scrub oak (Quecus dumosa) were not killed, but showed symptoms. Several years must elapse before the effect on these plants will be known.

Fenuron and monuron appeared to be about equal in their effect on the brush in these tests, but fenuron appeared to be considerably less injurious on annual grass. There was insufficient hardinggrass present on the chamise plot area to draw conclusions on the relative injury caused by fenuron and monuron; however, hardinggrass did not appear to be injured with 16 pounds of monuron pellets applied on some other plots on the same range, but were killed with 64 pounds of the pellets.

2. Control of chamise with low volatile esters of 2,4-D: Pasture A was airplane sprayed in the spring of 1952 and 1953. Seedling control was successful and the sprouting chamise was set back but not entirely killed. Further airplane sprays were discontinued.

Several acre plots were established using ground application techniques. A complete kill of the chamise resulted. Acre plots were established during the months from February through August demonstrating the wide range of application times that a complete kill can be expected.

Approximately 200 acres of the sprouting brush in pastures B and C were sprayed with a ground rig. The equipment included a 4-wheel-drive vehicle that transported a 100-gallon spray tank. Two hoses with shut-off valves allowed the

operators to cover a wide swath. Using high volume low pressure application the job was completed at a cost of ten dollars per acre. The spray mixture used was a one per cent solution of 2,4-D low-volatile ester. Each tank full contained one gallon diesel, one gallon low-volatile ester of 2,4-D and 98 gallons of water. An average of 56 gallons of spray was required to treat each acre, taking three man hours labor for application.

Fertilizer trials

In November 1956, several rates of nitrogen and phosphorous, single and combination treatments, were applied on pasture C using a 5 foot model fertilizer spreader. A very remarkable response occurred wherever N and P were together. Annual grasses that normally do not contribute much feed in the pasture responded very well. Growth increments of fertilized annuals indicated plants that were 20 times larger than unfertilized plants. Yields were not obtained due to stray brahma cattle that jumped the fence into the pastures. The fertilized strips were grazed as first choice by these trespassing cattle.

Broadcast applications of treble superphosphate were placed on plots in pasture C to learn if it will be necessary to keep the phosphate level up to retain rose clover. No noticeable difference between check and phosphate strips was evident. There is a possibility of some phosphate carryover from the 100#/ acre banded in the fall of 1954. Dr. Williams of the Agronomy Department has some replicated phosphate plots within an enclosure that will be observed for several more seasons.

Fifty acres of pasture C was broadcast fertilized in November of 1957. Fifty-four pounds of Nitrogen, 53 pounds of actual P_2O_5 was the rate per acre application. Forty-four head of yearling steers and heifers were turned into the pasture on January 14, 1958. The cattle were held overnight without feed or water and averaged 363.1 pounds per head when weighed the following morning. They will be given the same shrink when they are weighed off the pasture at the close of the grazing season.

Clipping yields were taken on January 14, of some replicated rate plots within an exclosure in the pasture. The results were:

check = 566 lbs. dry matter per acre
54N-53P = 1506 " " " " "
108N-106P = 1784 " " " " "

Livestock Scales

Corrals have been constructed and livestock scales installed on the area. Several springs are being developed with the help of the Forest Service. These features will permit expression of capacity of the pastures in terms of actual animal gains.

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MANLEY RANCH, TULARE COUNTY

The Manley 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 is of a mixed chaparral type. Frost heaving is common at this location and is a serious factor in establishing forage stands.

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 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.

300-Acre Pasture

1. Burning and seeding: No preburn preparations went into the initial control-burn other than building adequate firebreaks. Consequently many islands of brush did not burn. Prior to the reburn in 1954, most of the brush that was still standing was walked down with a crawler tractor. These areas burned clean and were reseeded. Mountain brome and perennial ryegrass are the predominant species on this pasture.

2. Herbicides: The final step in the brush to grass conversion was initiated in 1956 by application of herbicides to the sprouting brush. Ground application of a brush killer mix (1/2 gallon 2,4-D low volatile ester + 1/2 gallon 2,4,5-T low volatile ester + 1 gallon diesel + 98 gallons of water) was very effective on yerba santa and wedgeleaf ceanothus. However, many of the more difficult to kill species such as liveoak (Quercus spp.) red berry (Rhamnus crocea), coffeeberry (Rhamnus californica) will require a follow-up spray for complete kill.

Many of the oak trees that were cut-surface treated with 2,4-D amine in 1952-53 are beginning to fall.

3. Economics: The following summary of costs are based on average going rates for labor and materials. Application of present knowledge of range improvement would cut costs and increase production.

Costs of Range Improvement, 300-Acre Pasture

Original control-burn and seeding in 1951.	$1,672.28
Reburn and area reseeding in 1954.	1,422.00
Chemical control of sprouting species in 1956. . .	1,784.99
	$4,879.27

One-hundred and nine yearling steers grazed from May 25th to June 24th and 43 head of cows grazed from June 29th to August 6th for a total grazing use of 136 Animal Unit Months* for 1957.

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

Grazing Values of 300-Acre Pasture

Year	Actual Use (A.U.M.)	Preimprovement Carrying Cap. (A.U.M.)		Increase in Carrying Cap. (A.U.M.)
1952	100	-74	=	26
1953	288	-74	=	214
1954	87	-74	=	12
1955	184	-74	=	110
1956	395	-74	=	321
1957	136	-74	=	62
			Total	745
			Average	124

Using the value of $2.50 per A.U.M., the average annual increase in carrying capacity resulting from range improvement is worth $310.00 or about 6.3 per cent annual return on the investment. In 1952 and 1955 the pasture was not grazed until the seeded perennial grasses had matured seed. Light grazing in 1954 saved fuel for the reburn. Because of additional feed to be utilized from the 1000-acre pasture the pasture was grazed lightly in 1957.

4. Evaluations of stand employing two sampling methods: Areas with two different seeding dates were sampled using two forage sampling techniques in May 1956. The two methods of sampling were the step-point analysis and the per cent stocking method. Both methods are discussed under Watershed 1-A in the section of this report describing Cover Manipulation on Hydrology Study Watersheds. The following table lists the results of this sample:

Forage Inventory of 300-Acre Pasture

Species	Percent Stocking	Step-Point Analysis	
		Total Ground Cover, Percent	
	1951 Seeding	1951 Seeding	1954 Seeding
Mountain Brome	50	6.8	1.12
Perennial Rye	27	4.3	3.52
Hardinggrass	.7	1.3	.16
Crested Wheat	1.6	.78	- -
Tall Fescue	4.0	.45	.48
Orchardgrass	1.3	.45	.96
Intermediate Wheat	5.0	.45	- -
Smilo		.13	.16
Tall Oat	1.3	.13	- -
Rose Clover	2.0	.13	1.12
Total Ground Cover of Seeded Species		14.92	7.52
Soft Chess		6.4	.16
Ripgut		2.3	- -
Downey Chess		3.6	1.76
Annual Fescue		16.2	.96
Filaree		4.03	.16
Tarweed		3.7	- -
Other Miscellaneous Weeds		14.36	5.44
Total Ground Cover of Resident Species		50.59	8.48
Total Ground Cover		65	16

5. Grazing management: A livestock exclosure 200 ft. x 100 ft. was constructed on an average site on July 15, 1952. The plant population within the exclosure and on an adjoining grazed area of like size was sampled with 109 mechanically randomized permanently located 1/10 milacre plots. There was no grazing in the exclosure the first grazing season. After July 15, 1953, the exclosure has been grazed with the balance of the pasture. The plant populations inside and outside the fence are sufficiently similar to be fairly reliable indicators of the effect of differential grazing treatment. The following table contains a summary of plant counts for the years 1952, 1953, 1954 and 1957.

	300-Acre Pasture Grazing Management Study							
	Inside Exclosure				Outside of Exclosure			
	7-17-52	7-15-53	7-22-54	5-1-57	7-18-52	7-15-53	7-23-54	5-1-57
Tall Fescue	113	67	49	15	98	5	3	6
Per. Ryegrass	141	328	478	37	61	842	545	55
Orchardgrass	99	58	51	19	56	16	2	4
Mt. Brome	46	124	159	245	36	477	538	112
Smilo	19	5	4	0	15	1	1	0
Harding	7	5	5	3	1	2	3	3
Tall Oatgrass	7	6	3	1	4	5	3	0
Prairie Brome	3	2	0	0	5	4	0	0
Burnet	3	3	3	3	3	2	2	0
Rose Clover	10	10	6	11	4	19	46	13
Sweet Clover	23	5	0	0	14	3	0	0
Alfalfa	1	1	0	0	7	2	2	2
Res. Annuals	8%	9%	16.4%	22%	2%	4%	10.8%	23%
Buck Brush	255	61	47	1	178	79	33	0

According to the plant counts, mountain brome and rose clover are the only species that have shown an increase over the original 1952 sampling both inside and outside the exclosure. In general, the seeded species are more abundant inside the exclosure reflecting the advantage of protection from grazing the first season after seeding. Hardinggrass demonstrates its tenacity to survive given initial establishment. Tall fescue and orchardgrass were considerably reduced by grazing. The soils are quite loose and fluffy following a burn. Many of the grass seedlings were pulled out of the ground by the livestock when grazed the first year after the burn. Note the gradual decline of buck brush (Ceanothus cuneatus) seedlings. Competition from the forage species and the reburn in 1954 are responsible for this decline.

1000-Acre Pasture

Successes and failures experienced with the 300-acre pasture were used as a guide in the first step of range improvement on a 1000-acre pasture. A control-burn in August of 1956 followed months of preparation. The value of crushing the brush to concentrate the fuel has been fully realized. Brush was walked down wherever it was possible to operate a big crawler tractor.

1. Broadcast seeding: After a successful burn most of the area was airplane seeded in October. At the same time a plot was established using the heavy duty range drill. An October rain of about 1.75 inches was followed by warm dry

weather. The drilled seed germinated to an excellent stand but most of the broadcast seed did not remain moist long enough for germination until low temperature became a limiting factor. A very good seedling stand was in evidence by February of 1957. A remarkable stand of perennial grasses resulted from the broadcast stand as described later.

2. Heavy duty range drill plot: Part of the drilled area included banding the seed over fertilizer. There was no apparent benefit from fertilizer in this plot. There was an overall stand of dense legume growth during early spring. By late May the grass had grown through the legume overstory and started maturing seed. Six small livestock exclosures protected several areas from being grazed. Seed yields from these exclosures disclosed that 772 lbs. of forage seed per acre resulted from the initial drilling of eight lbs. of seed per acre. The plot also demonstrates the compatibility of a dense annual clover stand with perennial grasses. Indications are that hardinggrass and the annual clovers will do well at this location if good agricultural practices are used in initial establishment.

3. Forage inventory: Five type-acres were selected for sampling. These areas will be sampled annually to test longevity of various seeded species. Type-acres were sampled with step-point analyses.

Forage Inventory of 1000-Acre Pasture Sampled July 16, 1957

Species	Total Ground Cover, Per Cent	
	Broadcast Seeded	Drilled
Orchardgrass	6.80	4.50
Perennial rye	4.47	3.0
Smilo	1.81	- -
Tall oat	1.30	- -
Mountain brome	1.23	- -
Crested wheat	1.17	- -
Tall fescue	.84	2.10
Hardinggrass	.58	15.6
Intermediate wheat	.58	5.10
Rose clover	.19	13.50
Crimson clover	- -	9.30
Subclover	- -	1.20
Narrowleaf trefoil	1.23	- -
Alfalfa	.65	1.20
Burnet	.13	- -
Yellow sweet clover	.20	- -
Total Ground Cover Seeded Species	21.18	55.50
Miscellaneous Resident Vegetation	11.22	4.5
Total Ground Cover	32.40	60.00

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 an annual grass population during the spring months and heavy tarweed

growth during the summer. Original efforts were directed toward improving these areas with introduced species and fertilization plots to see if the tarweed growth could be retarded.

1. Sudan plot: A sudan plot was established during the 54-55 season. Part of the area was broadcast to sudan followed by broadcasting of perennial grasses and annual clovers into the grazed sudan stubble in the fall. Part of the area was drilled to sudan. Perennial grasses and annual legumes were drilled into the sudan stubble. The drilling of range species included a fall planting date and a late winter date. First year results were very poor. The February drilling was superior to the fall drilled or broadcast dates. The tarweed growth, if anything, was stimulated. During September of 1956 an acre of the drilled area was disced and seeded to clovers at a 15 lbs. per acre rate. The resulting legume stand was very poor. Realizing that we were dealing with a problem soil, an extensive mulch plot was established on this area in September of 1957 in cooperation with Dr. Williams.

2. Fertilizer plots: It was thought that fertilizers would stimulate the annual grass cover sufficiently to extract the available soil moisture and thus inhibit heavy summer growth of tarweed. Rate of plots of nitrogen and nitrogen + sulfur were applied in the fall of 1955. The nitrogen-sulfur plots produced 3400 lbs. of dry matter per acre. The control plots produced 575 lbs. dry matter per acre. The tarweed growth and population in the fertilized area was reduced but not controlled. The following season produced a heavy stand of tarweed on the area that was previously fertilized. Annual fertilization might eventually control tarweed.

Yield Data From Nitrogen-Sulfur Plots Clipped May 18, 1955

Fertilizer	Lbs. of N per acre	Lbs. of S per acre	Lbs. of dry matter/acre	Protein %	Sulfur %
Ammonium nitrate	33	0	1410	10.17	.113
Ammonium sulfate	33	37.5	1955	6.51	.150
Ammonium nitrate	66	0	1455	12.28	.129
Ammonium sulfate	66	75	3400	8.67	.175
Ammonium nitrate	132	0	1405	13.09	.064
Ammonium sulfate	132	150	3565	10.78	.213
Check	0	0	575	7.88	.092

A combination of N and S produced a manyfold effect: 1) increase in total production; 2) reduction of tarweed; 3) increase of sulfur content; 4) hastened maturity as evidenced by reduction of crude protein.

Yield data from a nitrogen-sulfur plot which was measured on May 18, 1955 suggested strongly that the resident range vegetation responded to these nutrients. Comparable rates of ammonium nitrate and ammonium sulfate produced vastly different yields.

Two plots were established in early December of 1955. Treatments of one plot consisted of check, ammonium nitrate, ammonium nitrate + gypsum. Treatments of the other plot were two rates of ammonium sulfate.

There was no significant difference between ammonium nitrate and ammonium nitrate + gypsum treatments. However, there is a considerable increase in yield

between comparable rates of ammonium nitrate + gypsum and ammonium sulfate. The plots were in the immediate vicinity of each other. Very heavy rains were recorded in late December, eight inches in 24 hours.

Yield Data From Nitrogen-Sulfur Plots Clipped May 23, 1956

	Ammonium Nitrate and Gypsum Lbs. of Dry Matter/Acre		Ammonium Sulfate Lbs. of Dry Matter/Acre
Check	2125	N52 S60 (Ammonium sulfate)	4076
N100 (Ammonium nitrate)	2904		
S107 (Gypsum)	2019	N104 S120 (Ammonium sulfate)	4561
N100 S107 (A.N. + Gyp.)	3181		
**L.S.D. (at .01 level) = 618		***L.S.D. (at .05 level) = 352	

Previous years' results were influential in the design of the 1957 plots. The rainfall distribution has varied considerably during the three seasons. The 1956 plots suggested there might be different responses from different carriers of nitrogen and sulfur, though both were applied at the same rate. The leaching effect from fall rains might be a factor.

The 1957 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 plots were harvested May 23 - 24, 1957. A grab sample from each clipped swath was frozen until it could be hand separated. The responses were calculated by species.

Yield Data From Nitrogen-Sulfur Clipped May 23-24, 1957

	Sept. Application Mean Yield Lbs. Per Acre D. M.	Feb. Application Mean Yield Lbs. Per Acre D.M.
1. Urea*	1709	1310
2. Urea + gypsum	1825	2323
3. Urea + sulfur	2024	2605
4. Ammonium nitrate	1775	1758
5. Ammonium nitrate + gypsum	2173	2140
6. Ammonium nitrate + elemental sulfur	2256	2405
7. Ammonium sulfate	1957	2505
8. Check	597	664

*Rates = Nitrogen at 105 lbs. per acre; Sulfur at 120 lbs. per acre.

There was a larger yield response resulting from spring application than fall. Nitrogen alone increased yield above check. The effect of treatment with nitrogen and nitrogen sulfur was highly significantly as compared with no treatment. The yield responses of all nitrogen-sulfur treatments were not significanlty different from each other. Yield response from urea alone was significantly lower than the nitrogen-sulfur treatments. Yield response from ammonium nitrate was intermediate between these two groups.

Field Day

The Tulare County Range and Watershed Tour was held on the Manley Ranch on May 17, 1957. One-hundred sixty people were given a tour of the range improvement developed during the 1950-1957 period. One of the groups present for the field day were members of the State Board of Forestry.

Some of the subject topics covered on the tour were:

1. Purpose of the Tulare County Range Improvement Association.
2. Description of preburn preparations and control burn of August 11, 1956 held on the ranch.
3. The use of pyrotechnics in control burns.
4. Range seeding results comparing broadcast and drilling results.
5. Irrigated pastures and their importance to mountain ranges.
6. Fertilization results.
7. Chemical brush and tree control.
8. Watershed research of U.S. Forest Service.
9. Effects of range improvements on a watershed.
10. Riparian control of vegetation along streams.
11. Program and functions of California State Department of Natural Resources.

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BROOME RANCH, VENTURA COUNTY

The study area is located south of Oxnard on the John Broome ranch 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 nitrogen fixation by 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 difficulty in introducing perennials into the pasture. For example, two pounds of hardinggrass seed per acre would have to compete with sixty pounds per acre 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 annual subterranean clover with hardinggrass in the fall of 1957.

Date of Seeding	Site Preparation	Date of Sample	Per Cent Stocked
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 subclover and hardinggrass.

5. Banding seed over a row 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 subclover plot did very well. A dense stand of subclover resulted in first year reduction of annual grasses. Hardinggrass is compatible with subclover. The subclover results led to the 1957 seeding.

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WAGNER RANCH, HUMBOLDT COUNTY

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.

Establishment and Production of Sub Clover

1. 1951 Sub clover seeding: Mr. Wagner seeded a small plot of sub clover on Yorkville soil in the fall of 1951. This seeding looked good during the first growing season. However, it appeared to be less successful during the following season. Since that time the sub clover has been increasing in density. The area was fertilized with approximately 400 pounds single superphosphate per acre during the fall of 1956. The area was step-point analyzed on April 16, 1957. The stand was 62 per cent sub clover, 24 per cent annual grass and 14.7 per cent forbs. Without sampling the area appeared to be solid sub clover. Total density was 86 per cent. Clippings taken on June 9, 1957 had a protein content of 12.73 per cent compared to 8.42 on the unimproved range. Total yields of oven dry forage were 5,987 pounds per acre including 5,448 pounds of sub clover and 539 pounds of annual grass. The sub clover component alone had a protein content of 15.71 per cent. Clippings on an unimproved range yielded 3730 pounds oven dry forage.

Mr. Wagner looks pleased with this 5 year old stand of sub clover. Yield at date picture was taken is 5,987 pounds of dry matter per acre with protein of 12.73 per cent.

2. 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. Establishment methods are shown in Treatment No. 2 of the preceeding table.

Clipping studies and plant counts indicate that total pasture production and the abundance of sub clover has decreased during the second growing season to only slightly more than the unseeded unfertilized area. This can be compared to a threefold increase the first year.

Third year measurements indicate an increase in stand and yield.

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 initially good tend to decline for several succeeding years and then again become very productive.

The results of plant counts and clipping studies from 1955-1957 are included in the following tables:

1954 Ladoo Sub Clover Seeding Yields - Pounds oven dry forage per acre					
Harvest Date	Sub Seeding			Check	
	Yield	% Protein		Yield	% Protein
May 10 & 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

1954 Ladoo 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	0
April 16, 1957*	1	15	49	35*	88.5	0.1
*These years the stand received 400# Single Super Phosphate						

3. Variations in method of establishing sub clover: A number of different methods of establishing subterranean clover were tried in the fall of 1954 on a Laughlin soil. The treatments and results of step-point analysis are shown below:

Step-Point Analysis of Sub Clover Established by Six Different Cultural Practices			
No. Treatment All plots Seeded October 1954	Per Cent Ground Cover Sub Clover		
	Apr. 13, 1955	Apr. 19, 1956	Apr. 16, 1957
1 Disked, sub clover straw and burs broadcast, rolled, fertilized with 400 lbs. SSP.	10-15	10-15	25-30
2 Disked, harrowed, seeded, rolled, fertilized with 400 lbs. SSP. 400 lbs. SSP reapplied Oct. 1956.	10-15	< 5	< 5
3 Disked, harrowed, seeded, rolled, fertilized with 800 lbs. SSP.	25-30	5-10	25-30
4 Disked, harrowed, seeded, rolled, fertilized with 400 lbs. SSP. Mulched with alfalfa hay.	10-15	< 5	< 5
5 Disked, harrowed, fertilized with 400 lbs. Ammonium sulphate, seeded, rolled 400 lbs. SSP applied Dec. 1955.	15-20	5-10	< 5
6 Disked, harrowed, seeded, rolled.	10-15	< 5	< 5

Seeding clover burs and straw appears to be the surest method of establishing sub clover. The plant material is raked from an established stand of sub clover and broadcast on the selected site. The comparison in the above table is probably misleading. All of the other treatments received ten pounds of sub clover seed per acre. The area broadcast with burs probably received far in excess of ten pounds of seed per acre. This method of establishing sub clover can be recommended as a "sure fire" technique, even on uncultivated seedbed. The cost of raking, hauling and broadcasting the straw may be prohibitive.

Treatment No. 3 was also outstanding. The addition of 800 pounds of single superphosphate after seeding resulted in a much better stand than adding only 400 pounds of single superphosphate. This would indicate that most or all of the initial application of 400 pounds of SSP was fixed in the soil. For this reason another application of 400 pounds of SSP was made to Treatment No. 2 in the fall of 1956.

4. Rate of seeding sub clover: A rate of seeding trial of Mt. Barker sub was established on a Laughlin soil. The area was disked after fall germination, harrowed, ring rolled, broadcast seeded, and ring rolled again. The seed was broadcast at rates of 2, 5, 10, 20 and 40 pounds per acre.

Initial germination and establishment appeared to be good. The plants seemed to suffer most from cold damage during the winter months. They appeared red and stunted at the beginning of the spring growing season. Survival at the end of the growing season is shown in the following table:

Rate of Seeding Pounds/Acre Inoculated Seed	No. of Plants/Square Ft. June 7, 1957
2	0
5	0
10	0.5
20	1.0
40	4.0
	L.S.D. .01 2.0

The seeding itself can only be described as a failure, however, it does illustrate that heavy rates do provide some insurance against stand failure. The forty-pound rate would produce a poor stand. Any rate below that is probably a failure.

5. Sawdust mulch and sub clover: The use of sawdust as a mulch was tested in connection with sub clover establishment. An area of annual grasses and forbs on a Laughlin soil was selected for these tests. In October 1956 treatments were applied directly to the residue of the 1955-56 forage crop. Inoculated Mt. Barker sub clover was broadcast on each 6 ft. x 12 ft. plot by hand at a rate of 15 pounds per acre. Four replications of nine treatments were included.

A broadcast application of sawdust should serve to change the microinvironment of the clover seed. The presence of a mulch will reduce evaporation and lessen the magnitude of the temperature changes on the soil surface. In addition to the mulching action the addition of sawdust will result in a reduction

of the available nitrogen due to the activity of bacteria and fungi. Micro-organisms compete with other plants for the available supply of nitrogen. Unless the soil is exceedingly well supplied with nitrogen or supplementary nitrogen is added, the crop will show a nitrogen deficiency. A crop of an inoculated legume should provide its own nitrogen and not show a deficiency to the same degree as a non-legume. Under these conditions the legume should be able to compete favorably with grasses and other forbs.

Douglas-fir sawdust was taken from the burner of a local sawmill. This wet sawdust was applied at rates of one ton per acre and four tons per acre. Rock-wool insulation was included as a treatment at a rate of one ton per acre. This was intended to represent an inorganic mulch that would function solely as a mulch and not tie up nitrogen.

Each mulching treatment was repeated with the addition of 400 pounds of single superphosphate. This soil is known to be phosphorous deficient. Previous tests have shown that the addition of more than 400 pounds SSP may further increase the success of stand establishment. For this reason a plot of 800 pounds SSP was included in the trail.

Sub clover seedlings were counted on three one-third square yard samples on each plot both on March 13, 1957 and June 7, 1957. The treatments and sampling results appear in the following table:

Sawdust Mulch Trial, Wagner Ranch, 1956-57
Figures are numbers of sub clover plants/square yd.

	Treatment	March 13 1957	June 7 1957
1	Check	3.25	1.67
2	Rockwool @ 1 Ton/acre	19.75**	16.39**
3	Sawdust @ 1 Ton/acre	6.75	6.11
4	Sawdust @ 4 Ton/acre	10.75*	6.94
5	Single superphosphate @ 400#/acre	4.00	8.06
6	Rockwool @ 1 Ton/acre plus 400#SSP/acre	11.25*	18.61**
7	Sawdust @ 1 Ton/acre plus 400#SSP/acre	5.75	6.39
8	Sawdust @ 4 Ton/acre plus 400#SSP/acre	8.50	4.44
9	Single superphosphate @ 800#/acre	3.25	3.06
	L.S.D. .05*	5.98	5.49
	L.S.D. .01**	8.11	7.44

All sub clover plants were chlorotic, small, and spindly as though nitrogen deficient. The various treatments affected the numbers of plants but all plants were of poor vigor. The only highly significant treatment was the application of rockwool which increased the insulation effect but had no effect on the available nitrogen.

The apparent lack of available nitrogen was probably due to the presence of a large amount of the previous year's residue. This is estimated at about 2500 pounds of dry matter per acre. The winter of 1956-57 was very cold which probably slowed clover growth as well as decay processes. This in turn prolonged and aggravated the nitrogen deficiency.

In general this trial was a failure. However, it serves to point out that future trials of this nature should not be tried in the presence of a large residue. Other trials of this nature are under way in other counties in cooperation with Dr. Williams of the Agronomy Department.

6. Band seeding sub clover without cultivation: A one-acre area of Laughlin soil covered with the previous year's residue was band seeded in the fall of 1956. Single superphosphate was drilled with the seed at a rate of 100 pounds per acre. Mt. Barker sub clover was seeded at 10 pounds per acre. The area was grazed by sheep from about November 1, 1956 to March 20, 1957. This management should be an aid to competition control.

The area was sampled on June 7, 1957 by the per cent stocking method described under Watershed 1-A of the Cover Manipulation on Hydrology Study Watershed section of this report, and was found to be 15 per cent stocked. This is a very poor stocking rate. The clover plants appeared to be cold damaged. This method of clover planting was tried again on some 5 to 10 acres in Mendocino County in the fall of 1957.

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. A broadcast seeding of sub clover on Laughlin soil was substituted in the following table. Descriptions of these seedings appear in the Range Demonstration 1956 Report, page 17.

Forage Yields on the Three Wagner Ranch Soils
Figures are pounds of oven dry forage per acre.
Clippings made June 7, 1957

Range Improvement Practice	Soil Type: Grassland Soil (Laughlin) 1	2	Grassland Soil (Yorkville) 3	4	5	Timber Soil (Josephine) 6	7	8
	No Range Improvement	Broadcast Seeded Sub Clover 1954 400# SSP 1956	Broadcast Seeded Sub Clover 1951 400# SSP 1956	Band Seeded Perennial Mix 1955	Band Seeded Perennial Mix 1955 350# 16-20-0 1956	Band Seeded Perennial Mix 1955	Band Seeded Perennial Mix 1955 350# 16-20-0 1956	Drilled Perennial Mix 1955
Hardinggrass				517	457	106	55	0
Orchardgrass					5	106	314	31
Tall Oat				586	93	672	531	64
Tall Fescue				104	5	16	125	0
Alfalfa					5			
Trefoil					5			
Sub Clover		137	5448		43	658	187	0
TOTAL SEEDED SPECIES		137	5448	1207	614	1558	1212	95
Native Clover					364	60	1244	24
Lotus						137	73	8
Annual Grass			539	1480	4613	446	1080	484
Forbs				1171	593	16	55	238
TOTAL FORAGE	3730	5341	5987	3858	6184	2217	3664	849
Per Cent Protein(June 7,'57)	8.42	10.55	12.73	7.80	6.92	9.00	8.68	---

A number of interesting observations may be made from this table:

1. Grassland soils continue to produce more forage than timber soils when both soils are growing improved forage species and receiving the same fertilizer treatment (Col. 4 and 5 compared with 6 and 7).

2. Applications of 16-20-0 on established perennial grasses did not produce an increase in the yield of the perennials in the stand. (Col. 4 and 6 compared with 5 and 7.) Clipping figures indicate that fertilizer applications actually decreased the yields of the seeded species although total yields were increased 50 to 100 per cent.

3. Nitrogen fertilization of perennial grass stands increased the annual forage component and resulted in earlier moisture depletion. This resulted in an earlier decline in forage quality which can be seen from the protein figures (Col. 4, 5 and 6,7).

4. Yields from two-year-old drillings of perennial grasses on timber soil show results of band seeding. Band seeded drillings produce twice the forage of the drilled stand (Col. 6 compared with 8).

5. An excellent stand of sub clover on Yorkville soil produced three tons of oven dry forage with a protein content of 12.73 on June 7! Fertilizer treatment used was 400 pounds of single superphosphate (Col. 3).

Band Seeding Trials

Band seeding with various rates of N, P and NP fertilizers as well as rates and mixes of seed again was tried on a Laughlin soil. In general results were poor due to lack of competition control. Most of the plots were disked before seeding in the fall of 1956. Since only part of the native vegetation had germinated weeds were not controlled. Seeding was done with the range drill.

Certain interesting things were observed in spite of poor weed control. In part weeds between the rows were killed by frost heaving while seeded species in the bottom of a three-inch furrow were not greatly affected. This was instrumental in reducing competition. However, severe frost heaving was not the general case.

All seedings which contained Tualatin tall meadow oatgrass standout as being successful. Throughout the growing season this species showed excellent vigor. Tall oatgrass shows the greatest seedling vigor of any of the many species of perennial grasses tested in northern California.

Forage Nursery

A nursery of 61 forage species was band seeded on Laughlin soil in the fall of 1956. In general establishment was poor due to the heavy competition from native grasses. Counts made on June 7, 1957 showed the following to be the most promising species of those tested:

Grasses	Legumes
Tall Meadow Oatgrass	Erect Birdsfoot trefoil
Orchardgrass	Prostrate Birdsfoot trefoil
Goar Tall Fescue	
Alta Fescue	
Domestic Ryegrass	
Uruguay Ryegrass	
Perennial Ryegrass	
Soft Chess	

The area was grazed once during the period of rapid spring growth in an effort to control competition. Although they were planted, some well adapted species are conspicuous by their absence in the list of successful species. Most important here would be hardinggrass and sub clover.

This is a good example of inadequate testing of forage species. Hardinggrass and sub clover, the two species which we know from past experience to be the best adapted and best producers on this ranch do not even appear on the list. If species trials cannot be made under conditions of good competition control it may be better to leave them untested. Such tests as this may be dangerously misleading.

Control-Burn

The Wagner control-burn produced 69 sheep months of grazing during the summer and fall of 1957. This area of 58 acres of tanoak and madrone was control-burned in 1951, and reburned in 1953 and 1956. Before this history of burning and seeding there was no usable forage for livestock.

The most recent reburn appears to have been poor. Of the 12 forage species seeded in 1951 only highland bentgrass is showing any promise. Bentgrasses are becoming more abundant on the area each year. Highland bentgrass was seeded at 3/4 pound to the acre in the 1951 seeding. Bentgrasses are also native to the area. Native bromegrasses and rye also appear to be increasing in abundance.

Chemical Brush Control

Dr. Leonard of the Botany Department has continued to cooperate with us on the Wagner Ranch in an effort to control the brush species with herbicides. A Buffalo Turbine sprayer was used again to apply herbicides to the roadsides in continuation of a cooperative study with the Humboldt County Agricultural Commissioner. Many of the treatments used in 1955 were repeated and some new materials were tried. Brush killer, mixtures of the ester of 2,4-D and ester of 2,4,5-T, continues to be the best material for general use. Amino triazole looks very good on poison oak.

Some resprouting of brush occurred on the band seeded areas. These plants are well as any that were missed in 1956 were sprayed with one gallon of 50-50 brush killer and one gallon diesel in 98 gallons of water. Plants are sprayed until wet. Portions of the control-burned area were sprayed as a demonstration.

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 are:	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 @ $2.88/gal.; 2,4-D Ester @ $4.47/gal ~~Acre~~; 2,4,5-T @ $6.78/gal.; diesel @ $0.20/gal.

Preliminary results of these treatments may be seen in the two following tables. Final results will be read in the summer of 1958. All of the stumps which are going to sprout should sprout by then.

Effectiveness of Stump Treatments
Wagner Ranch June 1957
Numbers are per cent of stumps sprouting.

	Tanoak	Madrone	Tanoak	Madrone	Tanoak	Madrone	Tanoak	Madrone
Date of Treatment	April 1956		July 1956		October 1956		February 1957	
Treatment								
BK + Diesel	30	30	90	40	0	0	10	0
2,4-D + Diesel	40	90	90	100	20	0	11	0
Amine	70	60	70	60	0	0	0	0
Check	100	100	90	100	80	100	90	89

Average Number of Sprouts per Sprouting Stump - June 1957

	April 1956		July 1956		October 1956		February 1957	
	Tanoak	Madrone	Tanoak	Madrone	Tanoak	Madrone	Tanoak	Madrone
BK + Diesel	6	6	1	7	0	0	1	0
2,4-D + Diesel	14	2	1	0	11	0	5	0
Amine	4	2	25	13	0	0	0	0
Check	55	29	22	20	42	20	26	20

Cost of treatment varies with material used, size of trees, and number of trees per acre. Dobbing the stumps with 2,4-D amine is the cheapest treatment and appears to be the most effective. The following table shows the costs of materials per stump and per acre for different size stumps using amine.

Amine Dobbing
Cost of Materials per Size and Number of Stems

Diameter of Stem	Number of Stems per Gallon	Cost per Stem @ $2.88/gal.	Cost/Acre 50/Acre	100/Acre	200/Acre	400/Acre	800/Acre
2	2,346	0.1¢	- - -	- - -	- - -	- - -	- - -
4	586	0.5¢	- - -	$0.49	$0.98	$1.96	$3.92
6	261	1.1¢	$0.55	1.10	2.21	4.42	8.84
10	94	3.0	1.54	3.07	6.14	12.28	- - -
14	48	6.0	3.01	6.02	12.04	- - -	- - -
20	23	12.0	6.14	12.29	- - -	- - -	- - -

Normally the larger the tree the fewer trees per acre. Thus the cost per acre may be very similar with different size trees. Costs will probably vary from $2.00 to $8.00 per acre for materials. A complete analysis of these trials can be made in the summer of 1958.

Cut-Surface Treatments

The use of the cut-surface treatment for killing trees has been discussed in many Range Demonstration Reports. Trials with this method have been made on the Wagner Ranch since 1951. Results of some of these trials appear in the following table. Sprouts resulting from this treatment are generally controlled by deer and sheep browsing.

Cut-Surface Treatment
Wagner Ranch

Treated April 13, 1955 — Readings Taken June 10, 1957

Species	Number Treated	Diameter Range Inches	Aver. No. Stems Per Tree	Average Diameter Per Stem Inches	Per Cent Top Killed	Per Cent Sprouting
Madrone	36	3-32	1.25	11.57	100	22
Tanoak	28	4-14	1.14	9.09	89	46
White Live Oak	7	4-50	3.28	13.03	86	14

Trees which are not completely top killed appear to be in the process of dying. Material used was amine of 2,4-D (4 lbs. A.E./gal.) applied full strength to ax cuts.

Field Day

A field day was held on the Wagner Demonstration Area on August 22, 1957 in cooperation with the Humboldt County Agricultural Extension Service. The field day was attended by about 50 people.

Highlights of the program were:

1. Chemical treatment of stumps to prevent sprouting.
2. Cut-Surface treatment of hardwoods.
3. Humboldt County forestry program.
4. Use of chemical sprays to control brush.
5. Band seeding of perennial range grasses.
6. Forest products outlook.
7. Charcoal production with Humboldt County hardwoods.

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ALDRIDGE RANCH, SHASTA COUNTY

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.

Reseeding

The 1950 burn was reseeded to the following mix:

Annual Ryegrass	1 pound
Perennial Ryegrass	2 pounds
Burnet	1 pound
Rose Clover	1/2 pound
Smilo	1 pound
	5 1/2 pounds

One thousand acres of the Aldridge ranch as well as 3420 acres of the neighboring ranches were seeded with this mix. Seeding was done by fixed wing aircraft with little or no flagging.

There were six normal growing seasons between the 1950 burn and the reburn. During these six seasons the reseeded species have gone through the rigorous tests of adaptability. Ryegrass produced a considerable amount of feed during the first two years but has largely disappeared by the end of the sixth growing season. It remains only on the north slopes. Burnet is spreading. However, it is not grazed during the normal grazing season. Observations on other areas indicate burnet is taken at the end of the grazing season or during the summer and fall. Rose clover was slow to become established. This is probably because of the low initial seeding rate. However, by the fourth season rose clover began to spread noticeably. At present it is well on its way to becoming the number one forage producer on the area. Smilo was a slow starter but has filled an important niche in the forage picture. It now occupies rocky areas that probably would have produced little forage. Excellent stands of smilo are found under logs. These were probably destroyed by the reburn. The large volume of smilo seed produced during recent years may re-establish this plant on these areas. Permanent plots were established to determine the mortality of smilo plants due to fire.

The Range Demonstration Project seeded two fifty-acre areas on and adjacent to the Aldridge ranch in the fall of 1950. The mix used was:

Yellow Blossom Sweet Clover	1 pound
Rose Clover	1 pound
Hardinggrass	1 pound
Orchardgrass	1 pound
Tall Fescue	1 pound
Brome 7	0.5 pound
Brome 25	.4 pound
Brome 100	.3 pound
	6.2 pounds/acre

The yellow blossom sweet clover and bromes have almost entirely disappeared. Tall fescue is gradually disappearing. Orchardgrass is still abundant in the shaded areas but has largely disappeared from the open. Hardinggrass has maintained the original stand. The individual plants have increased in size until some are over a foot in diameter. Rose clover spread much more rapidly in this area than in the general seeding. This may be because of the heavier seeding rate or because of the inoculation which was used on the University seeding and not by the ranchers.

Range Reseeding Results

Pine Basin - Aldridge Ranch — Based on 50 permanent Milacre plots
Average Number Plants/Milacre

Grass Cover								% Density	
	Hardinggrass	Orchardgrass	Tall Fescue	Bromes	Smilo	Yellow Blossom Sweet Clover	Burnet	Rose Clover	Resident Annuals
August 12, 1953	6.1	18.6	6.0	2.6	0	.2	0	5.	12
August 4, 1955	5.7	7.3	1.8	.7	.2	0	T	11.	12
July 9, 1957	6.7	3.5	1.2	.1	.2	0	T	16.	14

As a result of the experience obtained from the above seedings as well as recommendations from the farm advisor and others, Mr. Aldridge bought the following mix to reseed the reburn:

Rose Clover	3 pounds
Hardinggrass	2 pounds
Smilo	2 pounds
Orchardgrass	2 pounds
Perennial Ryegrass	1 pound
	10 pounds/acre

This mix was seeded on some 450 acres. The ten pounds per acre is probably more than is necessary. It will undoubtedly result in an excellent stand of quality forage species.

Only portions of the area needed seeding after the reburn. These were the result of the burning of islands of brush which did not burn in 1950. Due to the scattered nature of these spots it presented a difficult problem in seeding. Fixed wing aircraft would not be able to seed many of the small plots. Large quantities of seed would have to be scattered and on wasted areas where reseeding was not necessary. The areas could have been seeded by hand. However, it would take a lot of time which was not available. The decision was made to use the services of a helicopter. The helicopter was able to do an excellent job of spot seeding. The saving in seed more than paid for the extra per acre cost of helicopter over fixed wing aircraft.

The spots were seeded September 30, 1957. An excellent stand of all seeded species was noticed in November of 1957.

Ranchers and pilot loading seed into helicopter. The helicopter was well adapted to seeding the spots that needed seeding after the reburn. Photo courtesy Walt Spivey.

General Economics

The costs and returns involved in the Blue Mountain control burns are being collected. A summary of costs and returns from the 1950 burn as well as costs of the reburn on the Aldridge ranch appear in the following pages. Complete cost of the reburn will be tabulated from a questionnaire now in circulation to the other ranchers involved.

I. Investment, dollars per acre 1950:

	Rancher	PMA	CDF	Total
Burning	.29		.20	$ .49
Fence Repair	.11			.11
Seed	.45	1.80		2.25
Seeding	.30			.30
Totals	1.15	1.80	.20	$3.15

2. Investment total for initial burn 1950:

Summary of total Costs

Forage used as fuel 150 A.U.M.* at $2.50	$ 375.00
Burned and fence repaired, 3,500 acres @ $ .60	2,100.00
Seed and seeding 1,000 acres @ $2.25	2,550.00
Experimental seeding 50 acres @ $3.75	188.00
1951 Seeding and seed on about 75 acres @ $4.00	300.00
Total Cost	$5,513.00

3. Investment total reburn 1957:

Forage used as fuel (to be determined)			$ 60.00
Fence Repair			497.50
Fire Lines	2,500 acres @ .199¢		1,719.00
Seed	450 acres @ $3.82		422.25
Seeding	450 acres @ .95¢		
Experimental Area ignition			
Pyrotechnics	475 @ .70¢	$332.50	
Airplane		154.36	486.86
	Total		$3,185.61

4. Returns:

	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
Total		5410

The returns on the investment in burning this range can be readily calculated. If a value of $2.50/A.U.M. is placed on this increase in production the investment of $5,513 in 1950 has returned an average of 41 per cent per year during the six normal growing seasons since the control-burn.

*Animal Unit Month as described by Shultis and Burlingame, "Figuring Pasture Production", Agricultural Extension Service, Mimeo., 3.26, June, 1949. Supplemental feed such as hay and barley which was fed during these periods was converted to Total Digestible Nutrients and then to A.U.M. on the basis of 330 lbs. TDN per 800 lb. cow per month equals one A.U.M. These A.U.M. were then subtracted from the gross grazing yields to give the above net figures on Animal Unit Months.

Brush Encroachment

Most of the Aldridge ranch was covered with a solid stand of brush before the 1950 control burn. Many species of brush were present so it is natural that they reacted differently. Areas covered with manzanita were almost permanently cleared by the original fire. Only a few seedlings appeared and most of them were killed by the reburn.

Large areas of oak were completely burned by the original fire. These areas grew back to a solid stand of sprouts -- mostly black oak. These oak jungles would not burn in the reburn.

Bluebrush (Ceanothus integerrimus) reappeared after the burn both from sprouts and seedlings. This valuable browse species produced a lot of feed during the first five years after the original burn. By the time of the reburn many stands of bluebrush were too tall and dense to provide much browse for livestock. The reburn opened these solid stands to some degree. However, it will not be many years before there will again be large areas covered with bluebrush too tall and dense to produce much available feed.

Poison oak is widespread over the ranch. It grows vigorously during the spring and threatens to take large areas out of production. It may grow in solid stands up to six feet in height. However, by the end of the following winter these plants will be browsed down to about two or three feet. The large numbers of deer which winter on the area are largely responsible for the poison oak control.

Yerba santa is not widely distributed and appears to be static. Many buck brush (Ceanothus cuneatus) seedlings became established after the original fire. Many of these were destroyed by the reburn. Measurements of brush encroachment in Pine Basin appear in the following table.

Brush Encroachment

Pine Basin - Aldridge Ranch
Total number of brush plants in 50 milacre plots.

	Sprouts				Seedlings			
	Blue Brush	Poison Oak	Yerba Santa	Live Oak	Blue Brush	Yerba Santa	Buck Brush	Manzanita
August 12, 1953	13	61	7	2	21	2	55	4
August 4, 1955	12	60	31	1	22	20	46	6
July 9, 1957	3	55	19	4	25	0	40	5

Ignition Techniques

Ignition of the original Blue Mountain Burn in 1950 took the entire day. Only the perimeter was lit. Even this took from about one hour before daylight until well after dark. This means that much of the area to be burned was exposed to fire during a period of the day when fire could not be expected to burn well. As a result many areas burned poorly.

Ignition of the 1957 burn was scheduled to complete the burning during the middle of the day. Perimeter igiition was delayed until about 9:00 a.m. on the Aldridge ranch. The fire had burned well back from the fire line by 1:00 p.m.

The use of fire grenades dropped from an airplane enabled us to start fires in the center of the area to be burned without sending a man inside the going fire. At 1:00 p.m., 475 fire grenades were scattered on a grid over the Aldridge ranch portion of the fire. The technique used was a modification area ignition. Many of these grenades started fires which quickly spread over a large share of the area which was to be burned.

However, the resulting burn was poor. Relative humidity measured 30 per cent at 12:30 a.m. An overcast condition created by the smoke as well as cool temperatures prevented the humidity from dropping below 30 per cent. The interior could have been lit safely by men with drip torches at a saving in cost. Much of the area did not burn. The unburned areas were left for better burning conditions before being fired. These were burned by one man during the first week of September. Some of the most successful burning was done at this time.

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FLOURNOY RANCH, MODOC COUNTY

Seedings

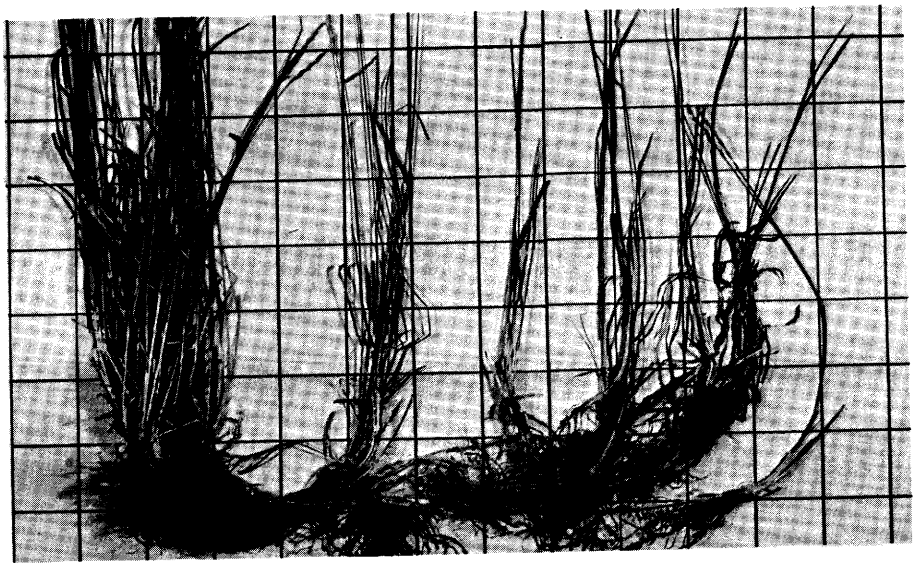
The fall of 1957 completes the third growing season since work began on this range. The results of fall seeding, early spring seeding and late spring seeding indicate that an early spring seeding is the most dependable. The dates of seeding and sampling results are shown in the following table.

The seeding recommendation is undergoing a change. The 1954 recommendation in this area would have been six to ten pounds of crested wheatgrass seed/acre. During the three years the Range Demonstration Project has been operating in Modoc County it has been demonstrated that the more productive wheatgrasses, intermediate wheatgrass and pubescent wheatgrass, are adapted to this poor site and low rainfall.

The more productive and earlier maturing strains of intermediate and pubescent wheatgrass, Greenar Intermediate Wheatgrass and Topar Pubescent Wheatgrass are the present recommendation. These species are easier to establish and may produce excellent drilled stands at four pounds per acre. The seed is more expensive than crested wheatgrass, however, the extra cost may be offset by reduction in seeding rate.

The main advantages of Greenar Intermediate Wheatgrass over Crested Wheatgrass are:

1. Greenar may produce up to half again as much forage.
2. Greenar will remain green much later in the growing season than crested wheatgrass.
3. Greenar is easier to establish and requires less seed than crested wheatgrass.
4. Greenar may spread vegetatively through rhizomes. Crested wheatgrass will not.



Three year old pubescent wheatgrass plant showing rhizomes. Squares are 2 inches.

Table No. 1. 1954-1957 Wheatgrass Seedings - Flournoy Ranch, Modoc County

Date of Drilling and Type of Drill	Site Preparation		Acre-age	Date of Sample	Per Cent Stocked*	Rating**
Sept. 17, 1954 J. D. Van Brunt 12"	Mechanically cleared, subsoiled, and seeded in fall of 1951. Initial stand was a failure. Reseeded in Sept. 1954 without any further cultivation.		40	7/26/55	12.0	Poor
Nov. 2, 1954 J. D. Van Brunt 12"	Area plowed Nov. 1, 1954 to 10" depth-Sagebrush turned under. Seedbed very soft and seed placed at 4".		1	7/5/55	21.0	Poor
March 22, 1955 J. D. Van Brunt 12"	Area plowed Nov. 1, 1954 to 10"-Sagebrush turned under. Seedbed firm.		6	7/5/55 7/26/55 7/25/56 6/18/57	54.0 64.5 62.5 65.0	Excellent Excellent Excellent Excellent
	Same as above with 250 lbs. Ammonium Sulphate broadcast.		1	7/26/55	58.5	Excellent
May 19, 1955 J. D. Van Brunt 6"	Area plowed Nov. 1, 1954 to 10" depth-Sagebrush turned under. Seedbed firm.		2	7/26/55	Less than 9.0	Failure
Nov. 1, 1955 Heavy Duty Range Drill	Sagebrush sprayed in June 1954. Drilled directly into partially killed stand of sagebrush and rabbit brush. Soil very sandy.	Band Seeded	1	7/25/56	34.5	Fair
		No Fertilizer	1	7/25/56	35.5	Fair
	Drilled directly into sagebrush. Soil not sandy. Area sprayed in May 1956. No rabbit brush present.		1	7/25/56 6/19/57	58.0 53.0	Excellent Excellent
	Area double-disked in March 1955.	Band Seeded	<1	7/25/56	46.5	Good
		No Fertilizer	<1	7/25/56	51.0	Excellent

*Per cent Stocked refers to per cent of square feet which has at least one seeded plant.

**As judged by D. N. Hyder and F. A. Sneva, Journal of Range Management, Vol. 7, Number 2, page 89.

Table No. 1. 1954-1957 Wheatgrass Seedings - Flournoy Ranch, Modoc County. (Cont'd.)

Date of Drilling and Type of Drill	Site Preparation		Acreage	Date of Sample	Per Cent Stocked*	Rating**
March 23, 1956 Heavy Duty Range Drill	Brush was sprayed in June 1954. Drilled directly into partially killed stand of sagebrush and rabbit brush. Soil very sandy.	Band Seeded	1	7/25/56	66.5	Excellent
		No Fertilizer	1	7/25/56	73.5	Excellent
	Area double disked in March 1955 and single disked in March 1956. Seedbed soft.	Band Seeded	1	7/25/56	67.0	Excellent
		No Fertilizer	1	7/25/56	56.5	Excellent
	Mechanically cleared, subsoiled and seeded in fall of 1951. Reseeded fall 1954. Stands were failure and poor, respectively. Drilled again on 3/22/56.	Band Seeded	1	7/25/56	30.0	Fair
		No Fertilizer	1	7/25/56	39.5	Fair
	Mechanically cleared, subsoiled and seeded in fall of 1951. Reseeded fall 1954. Stands were failure and poor, respectively. Drilled again on 3/22/56 at 4 lbs./acre. Russian thistle sprayed June 1956.	Band Seeded	1	6/19/57	53.0	Excellent
	Mechanically cleared, subsoiled and seeded in fall of 1951. Reseeded fall 1954. Stands were failure and poor, respectively. Disked and drilled again 3/23/56 at 4 lbs./acre. Thistle not sprayed.	Band Seeded	1	7/25/56	40.0	Good
		No Fertilizer	1	7/25/56	22.0	Poor
May 18, 1956	Area double disked in March 1955 and single disked in March 1956. Seedbed soft. Broadcast seeded to rambler alfalfa and harrowed.		1	7/25/56 6/18/57	36.5 32.5	Fair Fair
April 1, 1957	Brush sprayed in June 1956. Drilled directly into dead sagebrush with heavy duty range drill. Soil not sandy.		4.7	6/19/57	48.0	Good
	Area double disked in March 1955, and double disked March 25, 1957. Seeded with heavy duty range drill to pubescent wheatgrass and rambler alfalfa.		1	6/18/57	86.0	Excellent
	Area double disked in March 1955 and double disced on March 25, 1957. Seeded with heavy duty range drill to a mixture of wheatgrasses.		4	6/18/57	69.0	Excellent

*Per Cent Stocked refers to per cent of square feet in area which has at least one seeded plant.
**As judged by D. N. Hyder and F. A. Sneva, Journal of Range Management, Vol. 7, Number 2, page 89.

Species Trials

Fifty-one species of perennial grasses and 19 legumes were tested in the spring of 1955. 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./acre of ammonium sulphate was banded beneath the seeding with the heavy duty range drill. The seed was then added to the furrow and covered 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. Yields from these more promising species appear in the following table. There is no statistically significant difference in yields between species.

Modoc County Species Trial

Planted March 23, 1956 — Clipped June 20, 1957

Species	Pounds per Acre Oven Dry Forage
Pa. Medium Syn. Orchardgrass	1541
Pa. Early Syn. Orchardgrass	1435
I.O.G.-1 Orchardgrass	1896
I.O.G.-6 Orchardgrass	1274
Comm. Crested Wheatgrass	983
Comm. Pubescent Wheatgrass	1174
Comm. Tall Wheatgrass	1349
Comm. Intermediate Wheatgrass	1235
Comm. Slender Wheatgrass	1112
Nordan Wheatgrass	1554
A-144 Wheatgrass	1492
Amur Wheatgrass	1597
Mandan 759 Wheatgrass	1822
Comm. Fairway (Crested)	1004
Comm. Standard (Crested)	1486
Topar (Agropyron Trichophorum)	1057
Greenar (Agropyron intermedium)	1182
Poa ampla - (Commercial)	1774
Poa ampla (Albion)	1650
Tall Oat - Commercial	1676
Manchar smooth brome	815

None of the legume species tested seemed to merit harvesting in lieu of the poor stands. The most promising species appears to be "rambler alfalfa" or Canadian creeping-rooted alfalfa. The plants which were protected from rabbits are healthy and vigorous at the end of the second growing season. Those plants which have been grazed continually by rabbits resemble pencil stubs. Some means of rabbit control is necessary before alfalfa can be recommended for general range seeding in this area.

Control-Burn

Control-burning on the Flournoy Demonstration Range has been difficult. Only 22 per cent of the ground is covered with sagebrush. The remaining 78 per cent may be mostly bare ground on a year of low rainfall. On years when rainfall is above normal this 78 per cent of the area will be covered with dry cheatgrass during the burning season.

The summer of 1955 followed a year of subnormal rainfall (3.80 inches below average). The areas between brush plants was largely void of vegetation. Control-burning was out of the question. At this time it was decided to defer grazing on an area in effort to build up a forage-fuel reserve.

The summer of 1956 followed a wet year (2.26 inches above the 41 year average of 12.53 inches). Ground cover increased tremendously over 1955. Efforts were made to stage a control burn (Range Demonstration 1956, page 23). There was still not enough grass to carry the fire successfully.

The summer of 1957 followed two growing seasons of above average rainfall. Forage production on various check plots in the areas between brush plants were completely covered with cheatgrass.

A control burn was attempted on August 14, 1957. Fire hazard was high. The cheatgrass was dry and a wind was blowing. Ignition was started into the wind shortly before noon. The fire was out of control almost immediately. The escape covered some 5,000 acres of government land in addition to the 1,000 acres included in the planned burn.

Brush removal was complete on the entire 6,000 acres. Forage production will undoubtedly be increased several times on the burned area due to the additional native annual grasses and forbs that will invade the area. Efforts are being made to reseed portions of the area to wheatgrass.

Drill plots were established on the burned and sprayed areas in the fall of 1957. Competition from the native annuals will probably mean failure for the wheatgrass seedings. Some form of cultivation will be necessary to establish wheatgrass after a year of high cheatgrass seed production such as 1956-57.

Chemical Brush Control

Thirty acres of big sagebrush on the demonstration area was sprayed June 4, 1957. Two pounds of low volatile ester 2,4-D (4 lbs. A.E./gallon) and two quarts diesel oil in nine gallons of water were applied by agricultural aircraft. Observations in the fall indicate a good kill will be achieved.

The forty acres of sagebrush sprayed on May 24, 1956 was sampled in July 1957. Less than 2 per cent of the sagebrush plants showed no effect of spraying. Five per cent were 1/3 top killed, 29 per cent were 70 per cent top killed. The remaining 64 per cent appeared to be dead. Many of the partially killed plants will probably die this year.

Nitrogen and Sulfur Fertilizers

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 showed up to a threefold increase in forage at the end of the second growing season (spring and summer of 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 plots receiving 30 pounds of N and the check plots. Thus the effects of an initial application of nitrogen are felt for three 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. Yields are pounds of oven dry forage per acre.

	1955	1956	1957
N_0	212	244	966
N_{30}	- -	411	1220
N_{60}	- -	614	1548
N_{120}	- -	694	1875
L.S.D. .01	- -	128	504

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

Sample of N x S plot used in Nitrogen Carryover Trials, repeated applications on cheatgrass, and N x S Trial on wheatgrass stand. N applied as ammonium nitrate and S applied as gypsum.

CK	N_{30}	N_{60}	N_{120}
S_{20}	$N_{30}S_{20}$	$N_{60}S_{20}$	$N_{120}S_{20}$
S_{40}	$N_{30}S_{40}$	$N_{60}S_{40}$	$N_{120}S_{40}$
S_{80}	$N_{30}S_{80}$	$N_{60}S_{80}$	$N_{120}S_{80}$

2. Results of repeated N applications on cheatgrass range: The above plot was applied to an area of burned sagebrush growing mostly cheatgrass. The first application of fertilizers was on May 3, 1955. Nitrogen was reapplied in the fall of 1955, 1956 and 1957. Yields of oven dry forage appear in the following tables:

1955

Check plots only were clipped. No response visible. Checks averaged 212#.

1956

	N_0	N_{30}	N_{60}	N_{120}
S_0	247	546	740	781
S_{20}	142	617	773	1335
S_{40}	167	513	713	1464
S_{80}	167	611	847	787

1957

N_0	N_{30}	N_{60}	N_{120}
1097	2323	3367	2914
990	2893	4535	6378
932	2594	5002	6808
609	3110	5690	6205

Rainfall* 8.73 in. 14.54 in. 15.48 in.

*41 year average rainfall is 12.53 inches.

Nitrogen responses are highly significant both in 1956 and 1957. The NS response in 1957 is slightly significant.

3. Results of repeated N applications on wheatgrass seeding: The above nitrogen and sulfur plot 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.

Field Day

A field day was held on the Likely Demonstration Range on June 21, 1957. 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.

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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 include drilling seed at various row spacings. The area between the rows will be kept free of vegetation.

Long range tests in the Fresno County plot have given indication that grazing manipulation has an effect on the total ground cover.

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COVER MANIPULATION ON HYDROLOGY STUDY WATERSHEDS

The following is a report of vegetation management on experimental watershed studies being conducted by R. H. Burgy, Department of Irrigation. The study is designed to measure the effect of brush range improvement practices on watershed characteristics, especially annual runoff, flood peaks and erosion.

Watershed 1-A Hopland Field Station

1. Description of area: The hydrologic effects of brushland range improvement practices are being studied on a watershed of about 40 acres. The commonly used technique of burning, seeding and chemical brush control is employed in conjunction with sheep grazing. Some of the brush and tree control treatments deviate from ranch practices to hasten eradication of woody species. The experiment is thereby accelerated and reporting simplified. Cultural practices were patterned after general recommendations for range operators and not designed to demonstrate maximum production of grasses and legumes.

The 40-acre experimental watershed is part of a 60-acre pasture and treatment unit. The lowest point is at 900 feet elevation and highest point 1100 feet. Annual rainfall varied from 19 to 47 inches in the past five years. Northerly exposures of Josephine soils were formerly covered with dense stands of black oak and madrone. Before the control-burn south exposed Los Gatos soils supported chamise brush and mixtures of chamise and grass.

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 lighted at 4:10 p.m. September 5, 1956. The center of the drainage was fired with electric ignitors and the perimeter of area ignited 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 with Nitragin 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.

Los Gatos soils on steep south slopes were overseeded by hand with soft chess at two pounds per acre.

4. Brush control: Although deer and sheep browsing would have retarded sprout and seedling growth of palatable shrubs chemical control directed by O. A. Leonard was employed to simplify the hydrology study. Relatively unpalatable madrone sprouts would make very rapid regrowth without chemical control.

Chamise sprouts on 18 acres were sprayed in April. A high volume foliage spray, one gallon 2,4-D low-volatile ester and one gallon of diesel fuel in 98 gallons of water, was applied with knapsack sprayers. Madrone, oak, buckeye, photinia and other miscellaneous sprouts on the remainder of the area were chemically treated the last week of November. Madrone sprouts had been browsed but little and some had attained a height of six feet. A basal spray of one gallon of brush killer, one-half 2,4-D and one-half 2,4,5-T low-volatile ester in oil, was applied with knapsack sprayers. Vigorous sprouts were slashed with an ax prior to spraying to facilitate entry of hormone into the plant. Herbicide treatment in the fall of 1953 should complete major brush control activities.

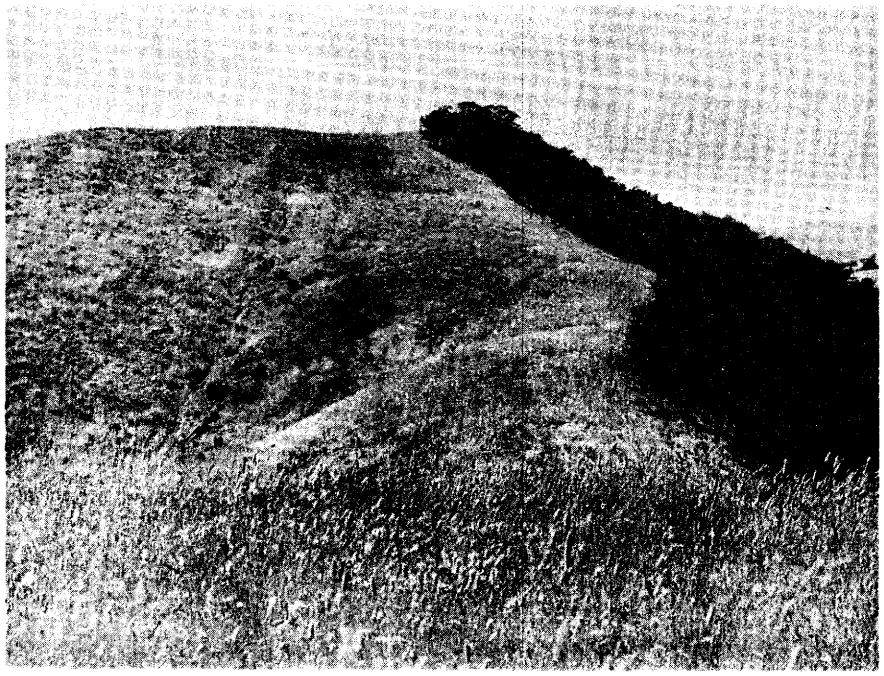
5. Grazing: The pasture was not grazed during the first growing season after seeding until July 17, 1957. By this date a majority of planted grasses and legumes had matured and set seed. Station records show July and August to be the period of greatest browse use by sheep. Therefore, late grazing not only ensured shattering and trampling of a full seed crop but also maximized browsing.

A mixed flock of rams, ewes and bucks remained in the Watershed 1-A pasture until September 9, 1957. The forage was past the period of highest palatability and nutritive level prior to grazing. However, weight changes of sheep in the watershed as compared with weight change of like animals in another pasture indicated no significant difference for the same period. Despite admitted vagaries in verbal description of grazing utilization it is of some value to state the area was moderately to heavily grazed. With five sheep months equal to one Animal Unit Month, grazing use in 1956-57 season amounted to 0.9 A.U.M. per acre.

Early rains and warm temperatures in the fall of 1957 produced feed in late October equivalent to February of an average year. Sheep were put back into the field October 28, 1957 and will remain until about May first. Slow growing clovers are greatly benefitted by early grazing and ensuing reduction of competition from rapid growing grasses. Late summer grazing will be practiced for brush control.

6. Herbaceous cover: Herbaceous density and species composition are measured in the fall and spring at the beginning and end of the high intensity storm period. Presumably the trend of density would not change during this interval except as a function of grazing. Additional midwinter measurements would be made in this event. 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.

Division of the pasture into three areas on the criteria of exposure, soil type and former vegetation facilitates description. Area one is typically gentle slopes of southerly exposed Laughlin soils supporting open blue oak woodland-grass. This cover type of small acreage above the gaging station was not changed materially by burning and seeding and is not included in the inventory. Over half of the pasture is included in the second classification of north exposure Josephine soils formerly covered with primarily black oak and madrone. An excellent stand of seeded grasses and legumes was obtained on this area of relatively deep and productive soils. South facing slopes of Los Gatos soils formerly covered with chamise and chamise-grass mixtures completes the pasture. Three acres of gently sloping dense chamise in the last type was crushed by tractor prior to burning. This small area not over seeded to soft chess is inventoried separately.



Photos taken along north side of the Watershed 1-A burn. Picture on the top taken Sept. 7, 1956, two days after the burn, shows an ideal seedbed for range seeding. To avoid disturbance of the watershed, materials from the firebreak were pushed to the outside. Spot-overs into these slash piles caused trouble after the main burn. The bottom picture shows the same area in August of 1957 has produced enough forage to graze a sheep on one acre for 135 days. Madrone sprouts in the left background were sprayed with brush killer in November of 1957.

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 eastern Oregon. The former is more closely correlated with production by a given species but is influenced by 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 table on page 41 includes both systems for comparative purposes:

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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. Mar. 1954.

Although the per cent of ground covered by seeded species is small it comprises about one-half of the total herbaceous density at both dates of sampling. The Dec. per cent stocking sample shows a slight mortality of old perennial grasses but did not measure the multitudes of seeded grass seedlings growing even in the charred stumps and logs. The step-point analysis tends to obscure the frequency of occurrence and distribution of legumes as depicted in per cent stocking figures.

Observations indicate 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 runoff and erosion.

The use of fertilizers to improve production of legumes is being studied. Field applications and pot-test assays are correlated with other fertility work at Hopland Field Station and with the Soil-Vegetation Survey.

What are the hydrologic implications of burning an herbaceous cover? A reburn should not be necessary for brush control but is an essential phase of the watershed study.

7. Field days: A public field day was not held at Hopland Field Station in 1957. However, Watershed 1-A was subject matter for a portion of the Farm Advisor's Training Conference in May and Soil Conservation Technicians' Tour in June. Visiting groups and individuals are frequently shown this experimental watershed.

HERBACEOUS INVENTORY, HOPLAND WATERSHED 1-A, 1957
Summary of Two Sampling Systems

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

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~~ Dec sample.

X Indicated not sampled.

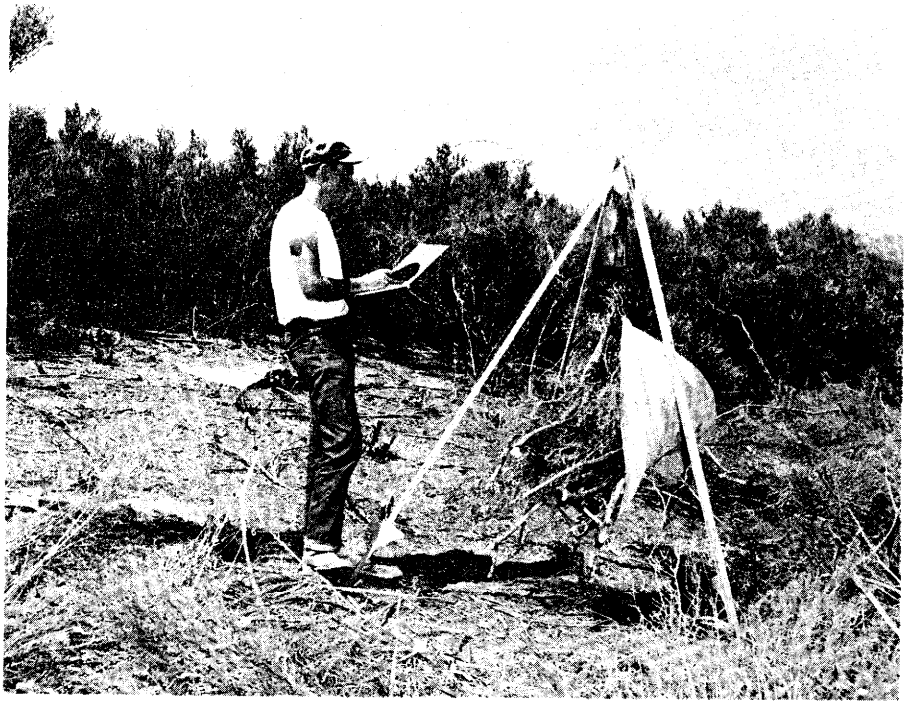
Piney Creek, Mariposa County

1. Description of area: The experiment is designed to study the influence of brush range improvement practices upon the runoff from a 2000-acre area of gentle slopes between elevations of 800 and 1,400 feet in northern Mariposa County. Dense chamise, unburned for about 25 years, predominates 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: About one-third of the brush was crushed by a crawler tractor dragging a 30-foot log. Brush crushing ensures a good burn in the event of cool damp weather.

The combined energies of Mariposa County Farm Advisor, Groveland-Coulterville Range Improvement Association, State Division of Forestry, Bureau of Land Management, Agricultural Stabilization and Conservation Committee and 18 land owners successfully control-burned 1,680 acres on August 24, 1957. All of the chamise cover in the experimental watershed was included in the burn. A total of 71 electric ignitors on three circuits were employed to aid in safe and effective burning. Ignition was planned to take advantage of a predicted shift in wind direction. Peripheral sections were burned prior to central drainage pattern ignition by electric ignitors and ignition by power flame thrower on the windward side.

Just prior to burning, standing shrub materials totalled 25,000 pounds oven dry material per acre plus 21.7 per cent moisture. Oven dry weight of dead wood material on the ground was measured to be 3,500 pounds per acre. The burn consumed nearly 100 per cent of fuels where brush was crushed and 49 per cent without crushing.



The brush cut and weighed just prior to Piney Creek Control-Burn varied from $8\frac{1}{2}$ to $17\frac{1}{2}$ tons per acre oven dry material with an average value of 12 tons. Dry dead wood materials gathered from the ground weighed 1 3/4 tons per acre.

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 $2\frac{1}{2}$, blando brome $\frac{1}{2}$, smilo 1 and rose clover 1. W. B. Sturtevant dragged approximately 200 acres following seeding. Lack of soil moisture delayed germination until December.

A ten-acre block was hand seeded to hardinggrass, smilo, Palestine orchardgrass and clovers. In preliminary fertilizer assays by pot tests rose clover responded to additions of phosphate and sulfur. Three acres of replicated plots were planted with the heavy duty range drill to test band seeding over various combinations of nitrogen, phosphate and sulfur. The plots also demonstrate advantages of various types of seed coverage. Nursery plantings include 23 species and strains of grasses and legumes.

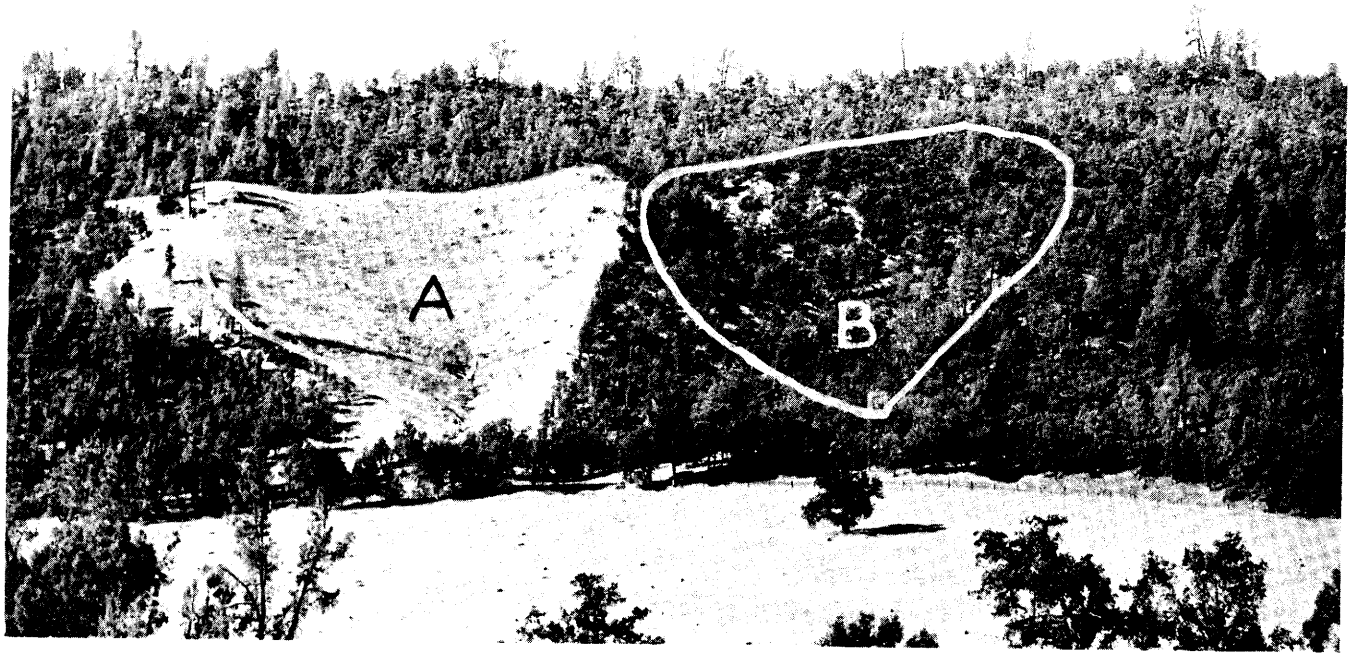
Future management: Unburned trees adjacent to the main watercourses will be poisoned before the summer of 1958. It is anticipated that portions of the chamise acreage will be sprayed for brush control this spring. A reburn in the near future should also be an item of future management.

Ono Watersheds

Two of four small 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 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 spraying the spring of 1958 will control a majority of sprouting brush.

Diamond Range Watersheds

Herbicide spraying of brush sprouts on the treated watershed in June of 1957 should control a majority of sprouting shrubs. Hardinggrass is abundant and tall fescue and rose clover appear in lesser amounts five years after planting.



Paired watersheds on the Diamond Range of western Tehama County. The blue oak and manzanita woodland-grass type as found on watershed B has been slashed, burned, sprayed, and replaced by a grassland cover on watershed A.

Tulare County Watersheds

The landowner declined to permit brush sprouts and seedlings to be controlled with herbicides. Although a fair stand of seeded and resident herbs was obtained, excessive grazing use has reduced density and soil stability.

Preliminary Studies in San Bernardino County

A great need for watershed studies similar to those described above has been voiced by the San Bernardino County Agricultural Extension Service. San Bernardino National Forest lands burned by wildfire are customarily seeded with annual grasses and mustard. The ensuing herbaceous cover is of unquestionable value for watershed protection especially by spring of the first growing season and during succeeding years. Density of cover is closely correlated with soil productivity. Dr. D. R. Cornelius of Agricultural Research Service has established plots of range species at three elevations. The reporting Range Demonstration Project has assisted with brush-control on these plots. Brush control rather than grass establishment is by far the more difficult to accomplish in this area. Investigation of chemical control of chaparral will be continued preparatory to availability of funds for watershed studies. The possibility of tremendous flood damage to agricultural, industrial and residential properties and increasing water values permits considerable per acre investments for watershed management.

Management could be directed toward continued concentration of effort to reduce wildfire occurance and spread. Total elimination of wildfire from the chaparral is virtually impossible. If high intensity rains occur following wildfire there are apt to be damaging floods.

An alternative objective of watershed management would be manipulation of the vegetation to a cover type that is less affected by fire. Ideally, disturbance by fire of this preferable cover would be slight and recovery rapid. Acute flood-risk conditions usually existing immediately after wildfire might be of lesser intensity and shorter duration. Although there may be no change in long term average rates of runoff and erosion, a reduction of flood peaks would certainly be an improvement.

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CHEMICAL CONTROL OF PLANT COMPETITION DURING SEEDLING ESTABLISHMENT

Seeding operations on annual rangelands with legumes and perennial grasses may often be doomed to failure because of intense competition for moisture and nutrients from resident annual grasses and forbs low in forage value. Measures used to prepare a good seedbed may be wasted by the inability of the seeded species to compete with the resident species during the seedling stage.

Many thousands of acres of annual rangelands support a cover of undesirable grasses such as medusa-head (Elymus caput-medusae) and goat grass (Aegilops triuncialus). A method is needed whereby these grasses and other weeds can be replaced with a palatable forage cover. Considerable time, effort and study is being made on the control of undesirable range plants but control must be followed by establishment of better forage plants. Thus, there is also a need for methods of replacing undesirable range plants, with palatable forage species high in productivity. The obstacle in such replacement is a lack of proper environment during seedling establishment.

The objectives of this trial are:

1. To screen six of the most promising pre- and post-emergent herbicides and soil sterilants for a suitable material for use on annual range plants.
2. To investigate minimum rates of chemical to apply for optimum results under the rainfall conditions of the study area.
3. To investigate the most successful time of seeding following application of herbicides and soil sterilants.
4. To assess species reaction to rates and kinds of herbicides applied in the fall of the year.

The chemicals used are E.P.T.C., C.D.A.A., C.I.P.C., Simazen, Dalapon, Monuron.

This is a cooperative project between Dr. C. M. McKell of ARS, Dr. Jack Major Botany Department, and B. L. Kay of the range demonstration project.

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LIME COATED CLOVER SEED FOR ACID SOILS

The use of lime coat on clover seed to induce nodulation is being tested on acid soils of pH 5.5 or lower. Observations in Australia indicate a "very marked

benefit has been obtained from a small amount of lime pelleted on the seed in overcoming the harmful effects of soil acidity on nodulation".

Trials are underway in Shasta, Humboldt and Mendocino Counties comparing lime-pelleted seed with seed placed in a band of lime, and seed without lime. Seed used is Mt. Barker sub clover. The trial is designed by Dr. Williams of the Agronomy Department. The pH of soils involved vary from 5.7 to 4.6.

Dr. Williams is conducting similar more intensive trials in additional counties.

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MISCELLANEOUS PLOTS WITH THE HEAVY DUTY RANGE DRILL

Range Demonstration Project personnel cooperated in using the range drill in plot work throughout the state on areas other than Demonstration Ranges. The drill was used by Farm Advisors in 8 counties on 13 ranches, the Hopland Field Station and Mendocino National Forest. Seventeen plots were established with an average of 4.2 acres per plot.

A variety of sites were included in these plots. Among these sites were cultivated plots, sprayed sagebrush, burned and unburned medusa-head, mechanically cleared areas, control brush burns, one-year-old broadcast seeding failures, and sudan fields. Wherever possible plots were designed and replicated to test the value of drilling as compared with broadcast seeding with and without seed coverage. In exploratory plots seeds were drilled with and banded over various rates and combinations of nitrogen, phosphorous and sulfur carrying commercial fertilizers.

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DEMONSTRATION PLANTINGS BY FARM ADVISORS

ASSISTED AND SUBSIDIZED BY RANGE DEMONSTRATION PROJECT

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

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.

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