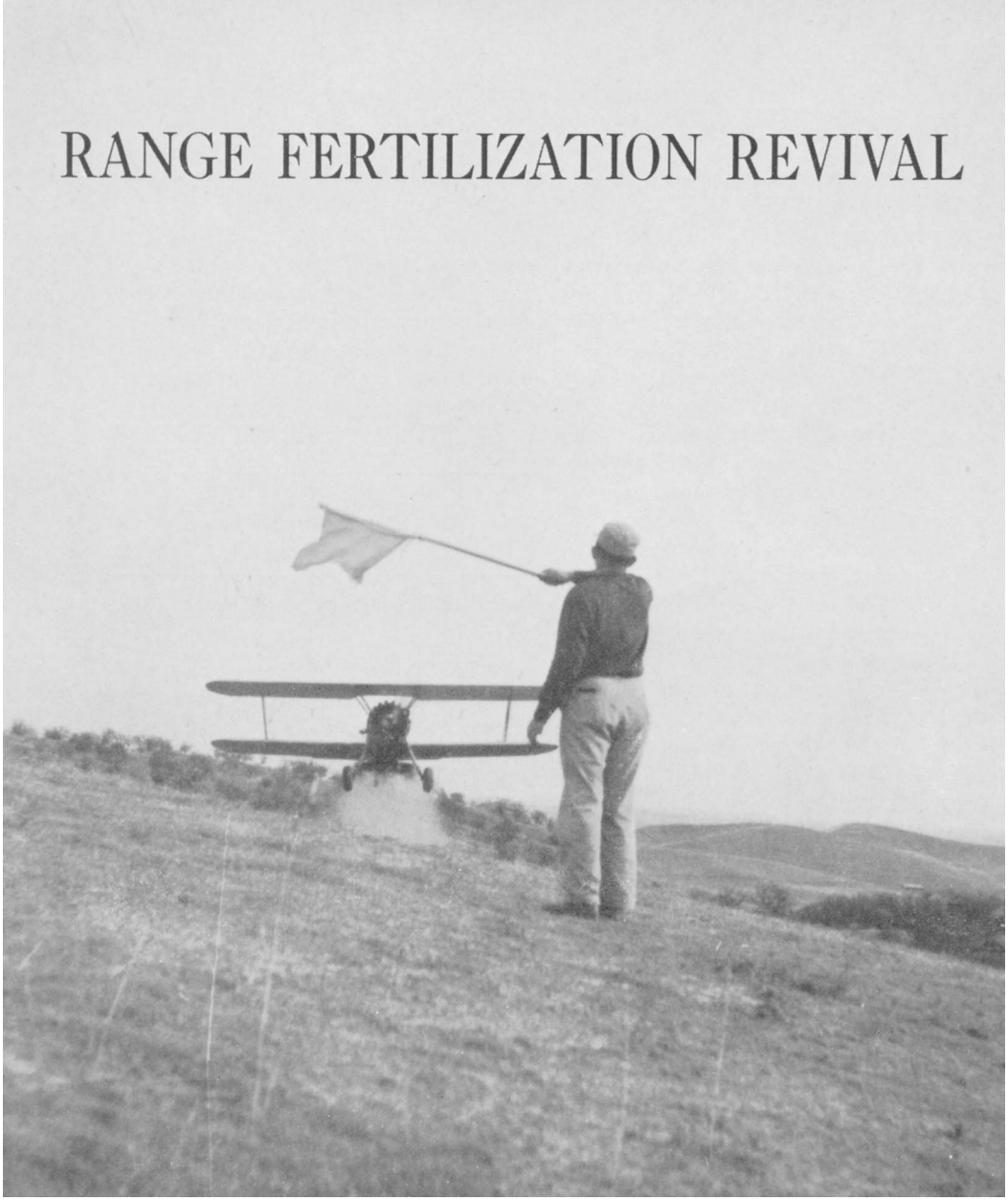
RANGE FERTILIZATION REVIVAL



The following conclusions were obtained from these experimental results and observations of commercial fertilizer applications on Glenn and Tehama County rangeland:

(1) Economical feed can be produced by fertilization with sulfur alone, or combined with nitrogen or phosphorus, on bur clover ranges in Glenn and Tehama Counties.

(2) Palatability of green and dry feed is increased with fertilization.

(3) Nitrogen stimulates early grass growth principally in the year of application.

(4) Sulfur stimulates bur clover growth over a period of three to seven years, depending upon the amount, source and seasons.

(5) During "clover years" bloat hazard may be increased by sulfur fertilization.

(6) If bur clover is not present for any reason—soil type, growing season, or grazing management—there is little or no response to sulfur.

(7) Coarse elemental sulfur is not readily available to plants for several years whereas fine elemental sulfur and sulfate sulfur fertilizers are effective the first season.

(8) An effective legume stand must be established on some soils before fertilization with sulfur or phosphorus is economical.

RANGE FERTILIZATION, once considered impractical and unprofitable by ranchers in Northern California, is now being revived in the foothills of Glenn and Tehama counties. The increased cost of owning rangeland and the resulting need to produce more from each acre, along with the increased availability and lower prices of fertilizers, have helped make range fertilization a feasible method of increasing range forage production. Field research in the two counties has helped answer many questions about fertilizer needs—questions about what kind of fertilizer to use, where to use it, and how much to use.

Early tests

As early as the 1940's, tests conducted by the University of California at the San Joaquin and Hopland Field Stations, and by the U. S. Soil Conservation Service at the Sunol Nursery showed that applications of commercial fertilizer to rangeland could be economical.

The first large-scale range fertilization work in Glenn and Tehama counties was begun in the winter of 1953–54. The Glenn County trial which lasted over a period of four years (table 1) showed a return of about $1.50 for every $1 spent on fertilizer. Average annual gain per acre of stocker steers on the field fertilized with nitrogen every other year was 59 lbs. The field fertilized every other year with nitrogen, phosphorus, and sulfur yielded an average of 77 lbs annually, compared with the 27 lbs of beef per acre from the control field.

The Tehama County trial was conducted on Corning soil with a stand of native clovers insufficient to provide a carry-over response to the sulfur and phosphorus.

From 1955 through 1965, a series of plots was established in Glenn and Tehama counties under the leadership of the State Cooperative Soil Vegetation Survey. The principal objective of this survey was to obtain basic information on kinds of upland soils and vegetation, their distribution, and their fertility status.

Nutrient trials

The nutrient trials were established on sites typical of a certain important soil series. Fertilizer treatments were applied to 10 × 20 foot replicated plots. A 4-foot square from each plot was harvested and the percentage of ground cover of various plant species was determined in the spring by the point step method. A summary of experimental results is given in table 2.

A follow-up trial was established in 1965 on a deep phase of Sehorn soil at the Rehse Brothers ranch to compare "more economical" rates of three commercial fertilizers: 100 or 200 lbs per

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Aerial photos were checked carefully before the planning of aircraft application of fertilizer to rangeland at the Sutfin Ranch, Tehama County.

TABLE 1. SUMMARY OF LARGE-SCALE RANGE FERTILIZATION TRIALS IN GLENN AND TEHAMA COUNTIES 1953–57

	Nye Ranch, Glenn County			Tessiere Ranch, Tehama County		
Soil series	Sehorn-Millsholm			Corning-Hillgate		
Primary vegetation	Annual grasses & bur clover			Annual grasses & Filaree		
Trial period	4 yrs., 1953–57 seasons			62 days, Feb.–March 1954		
Experimental animals	Stocker cattle			Ewes and lambs		
Acres/field	365	200	133	60	30	30
Nutrients/acre	0	$N_{63}P_{6}S_{0}$*	$N_{56}P_{10}S_{15}$*	0	$N_{26}P_{35}S_{14}$†	$N_{64}P_{35}S_{62}$†
Av. gain/acre lbs	27	59	77	24	44	104
Value @ 20c/lb	$5.40	$11.80	$15.40	$4.80	$8.80	$20.80
Cost of fertilizer	0	4.85	6.53	0	12.00	19.00
Value less fertilizer cost	$5.40	$ 6.95	$ 8.87	$4.80	$–3.20	$ 1.80

* Applied every other year.
† No carry-over observed.

TABLE 3. DRY MATTER YIELD COMPARISONS AND COSTS OF RANGE FERTILIZATION OVER A 4-YEAR PERIOD—REHSE RANCH

Harvest year	Control Yield†		Fertilizer Treatments* and Year Applied					
			100 S 1965	200 S 1965	300 PSO_4 1965	300 NSO_4 1965	300 NSO_4 1967	300 NSO_4 1967 1968
	lbs DM/Acre	%	%	%	%	%	%	%
1965	5278	100^{a}	101^{a}	97^{a}	114^{b}	149^{c}	–	–
1966	2641	100_{a}	109^{ab}	98^{a}	150^{c}	131^{bd}	–	–
1967	5664	100^{a}	120^{ab}	128^{abc}	127^{abc}	131^{bc}	147^{c}	147^{c}
1968	5276	100^{b}	116^{cd}	119^{de}	123^{e}	95^{a}	113^{c}	140^{f}
Total	18,859	100	110	113	126	126	121	127
Cost/acre‡		0	$3.60	$7.80	$8.15	$8.00	$8.00	$16.00
Cost/extra ton of dry feed/acre total		–	$3.96	$6.50	$3.39	$3.28	$3.98	$ 6.33

* Treatments: 100 S = 100 lbs. per acre beaded elemental sulfur 95% coarser than 100 mesh; 200 S = 200 lbs. per acre beaded elemental sulfur; 300 PSO_4 = 300 lbs. per acre single superphosphate (8.7% phosphorus, 12% sulfate sulfur); and 300 NSO_4 = 300 lbs. per acre ammonium sulfate (21% nitrogen, 24% sulfate sulfur).
† Yields in the same year bearing different superscript letters are significantly different ($P < .05$).
‡ Cost includes application cost, ASC payment not included.

acre of a very coarse (95 per cent coarser than 100 mesh) elemental sulfur (100 S and 200 S) and 300 lbs per acre each of single superphosphate (PSO_4) and ammonium sulfate (NSO_4). The plot was laid out so that one-third of the plot could be fenced every other year to allow measurement of carry-over yields after the plot had been recently grazed.

The plots were harvested by hand clipping at the end of each grazing season. Dry matter yield comparisons among treatments are shown as a percentage of the control in table 3. An excellent bur clover growing season in 1965 produced 5,278 lbs of dry matter per acre without fertilizer. The NSO_4 plot yielded 149 per cent and the PSO_4 plot, 114 per cent of either the control or elemental sulfur treatments.

An extremely short season in 1966 produced only 2,641 lbs per acre in the control plot. Again the NSO_4 plot at 131 per cent, and PSO_4 plot at 150 per cent, were the only treatments significantly higher than the control. The NSO_4 plot was not significantly different from the 100 S plot at 109 per cent.

Two additional plots were fertilized with 300 lbs per acre of ammonium sulfate in 1967, which produced a significant yield increase (147 per cent) over the control. Variation among replications of the treatments was large, probably because of the effect of the previous years' grazing. However, it was evident that the 100- and 200-lb elemental sulfur treatments were increasing growth (120 per cent and 128 per cent of the control) during this outstanding bur clover year. The original NSO_4 plot yielded 131 per cent and the PSO_4 plot 127 per cent of the control. The control yield was 5,664 lbs per acre.

In 1968 (a poor clover year because of a cold winter), ammonium sulfate was applied to one of the plots previously fertilized in 1967. The plot where ammonium sulfate had been applied in 1965 yielded significantly less than the control, whereas all other treatments yielded significantly more.

The yield reduction may indicate a depletion of phosphorus as well as sulfur and nitrogen in the soil because of the increased growth in previous years. A tissue analysis of bur clover in 1965 indicated adequate phosphorus levels in all plots, but there was a significant reduc-

Nitrogen stimulates early grass growth, as shown in this photo of a Soil Vegetation Survey plot on Sehorn soil.

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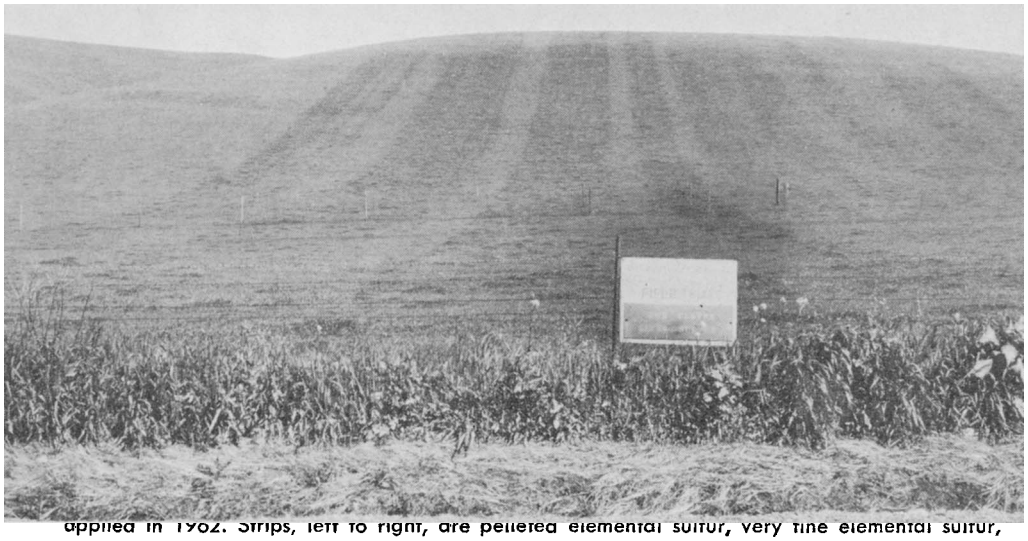
141



applied in 1962. Strips, left to right, are pelleted elemental sulfur, very fine elemental sulfur, gypsum, single superphosphate. Shorter strips to the right are carryover from single superphosphate applied in 1959.

tion in parts per million phosphate phosphorus in the NSO_4 plot (1725 ppm) compared with the control (3050 ppm).

Over the four years, an application of 300 lbs per acre of ammonium sulfate resulted in about a 50 per cent increase in dry matter over the control in the year of application, and a significant carry-over for two years. The most consistent increase over the four years was in the 300-lbs-per-acre single-super plots.

This again indicated some response to phosphorus. Total dry matter production over the four years was the same between the PSO_4 and the NSO_4 treatments, but the carry-over response was significantly greater in the single superphosphate plot in spite of the higher sulfate content in ammonium sulfate. There was a delayed response to the very course elemental sulfur of about two years.

The cost of extra feed was lowest in the 1965 ammonium sulfate plot, $3.28 per ton; followed by single-super, $3.39; 100 sulfur, $3.96; 1967 ammonium sulfate, $3.98; 1967 and 1968 ammonium sulfate, $6.33; and 200 sulfur, $6.50.

Ranchers Jamieson, Groteguth, Thompson, Briggs, Burrows, Millsap, Soeth, Scheeline, Gibson, Conway, Rehse, Stein, McNabb, Miller, Sutfin, Flournoy, and Tessiere are among the Glenn and Tehama County cattlemen and sheepmen who have fertilized rangeland. Their observations also confirm the experimental results reported here.

Lester Scheeline, Jr. fertilized 200 acres west of Willows with 300 lbs of ammonium sulfate per acre in 1966. In spite of the cold winter and dry spring, lambs gained faster on the early-growing fertilized range than the band which was also fed alfalfa hay on an adjacent range.

Fine elemental sulfur at a 100-lbs-per-acre rate was applied by aircraft on 2,000 acres at the Buckhorn ranch near Paskenta in the fall of 1965. Only a slight response was noted in 1966; however, clover response in the spring of 1967 was dramatic. Bur clover grew so luxuriantly that grazing cattle required careful management to minimize bloating. Grazing capacity was doubled. Bob Stein, ranch manager, considered the benefit in increased gains from the stimulated clover far outweighed cattle bloat problems.

On the Loren Miller ranch, west of Red Bluff, elemental sulfur was applied by aircraft to 1,700 acres in the fall of 1965. Again, no response to the sulfur was observed during the 1966 season. However, in 1967 Miller was able to stock the fertilized fields 25 per cent heavier than the unfertilized range. The additional cattle gain per acre during the 1966–67 grazing season paid for the sulfur with a $1.20 per acre "dividend."

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TABLE 2. SUMMARY OF FIRST YEAR EFFECTS OF NATIVE RANGE FERTILIZER TRIALS IN GLENN AND TEHAMA COUNTIES, AS RECORDED IN SOIL VEGETATION SURVEYS

Soil Series*	Fertilizer treatment	Yields, lbs/A oven-dry	Dominant plants and percent composition of forage by broad groups							
			Desirable grasses		Weedy grasses		Desirable forbs		Weedy forbs	
			Species	%	Species	%	Species	%	Species	%
SEHORN Series with similar potential: Altamont, Ayar, Contra Costa, Nacimiento, Walker. Associated alluvial series: Hillgate, Meyers, Tehama.	Unfertilized control	1600–2000	Soft chess Common wild oats	20–30	Ripgut Spanish brome Medusahead Annual fescue Foxtail barley	20–30	Bur clover True clover Red-stem filaree	10–15	Micropus Blow-wives Fiddleneck Foothill plantain	20–30
	Sulfur–100#/A	3000–3500	Same as control	5–20	Same as control	5–15	Bur clover	40–75	Same as control	5–15
	Nitrogen–150#/A	3700–4100	Same as control	60–70	Same as control	15–20	Same as control	2–5	Same as control	5–15
	Nitrogen–150#/A + sulfur–100#/A	5300–6000	Common wild oats	70–80	Same as control	10–15	Same as control	2–5	Same as control	2–5
MILLSHOLM Series with similar potential: Millsap. Associated alluvial series: Hillgate, Meyers, Tehama.	Unfertilized control	1200–1600	Slender wild oats Soft chess	15–20	Red brome Annual fescue	10–15	Mostly broadleaf filaree Some bur clover	35–45	Foothill plantain Navarretia	15–25
	Sulfur–100#/A	1500–2000	Same as control	15–20	Same as control	5–10	Some broadleaf filaree Mostly bur clover	50–65	Same as control	5–15
	Nitrogen–150#/A	3100–3500	Same as control	35–45	Same as control	5–10	Broadleaf filaree	50–60	Same as control	2–5
	Nitrogen–150#/A + sulfur–100#/A	4500–5000	Same as control	45–60	Same as control	10–20	Broadleaf filaree	30–40	Same as control	<2
NEWVILLE Series with similar potential: Corning. Associated alluvial series: Arbuckle, Pleasanton.	Unfertilized control	400–1100	Soft chess Slender wild oats	5–10	Mostly annual fescue Some medusahead and red brome	15–30	Broadleaf filaree	35–55	Smooth cat's ear Annual lupine Foothill plantain	20–40
	Nitrogen–150#/A	2000–5000	Soft chess Slender wild oats Common wild oats	10–30	Annual fescue Medusahead	15–40	Broadleaf filaree	20–60	Same as control	5–10
	Nitrogen–150#/A + sulfur–100#/A	2500–5500	Same as nitrogen	10–35	Same as nitrogen	15–40	Broadleaf filaree	15–60	Same as control	2–5

* Data in this table are for Sehorn, Millsholm and Newville soils only. Soils listed with similar potential occupy same general areas and from other observations would probably respond in a like manner to fertilization. Associated alluvial soils occupy rather narrow bands in stream bottoms, usually would not be managed separately, and probably would respond similarly to principal soils. Winter clipping or grazing reduced the clover-depressing effect of nitrogen in nitrogen plus sulfur plots.