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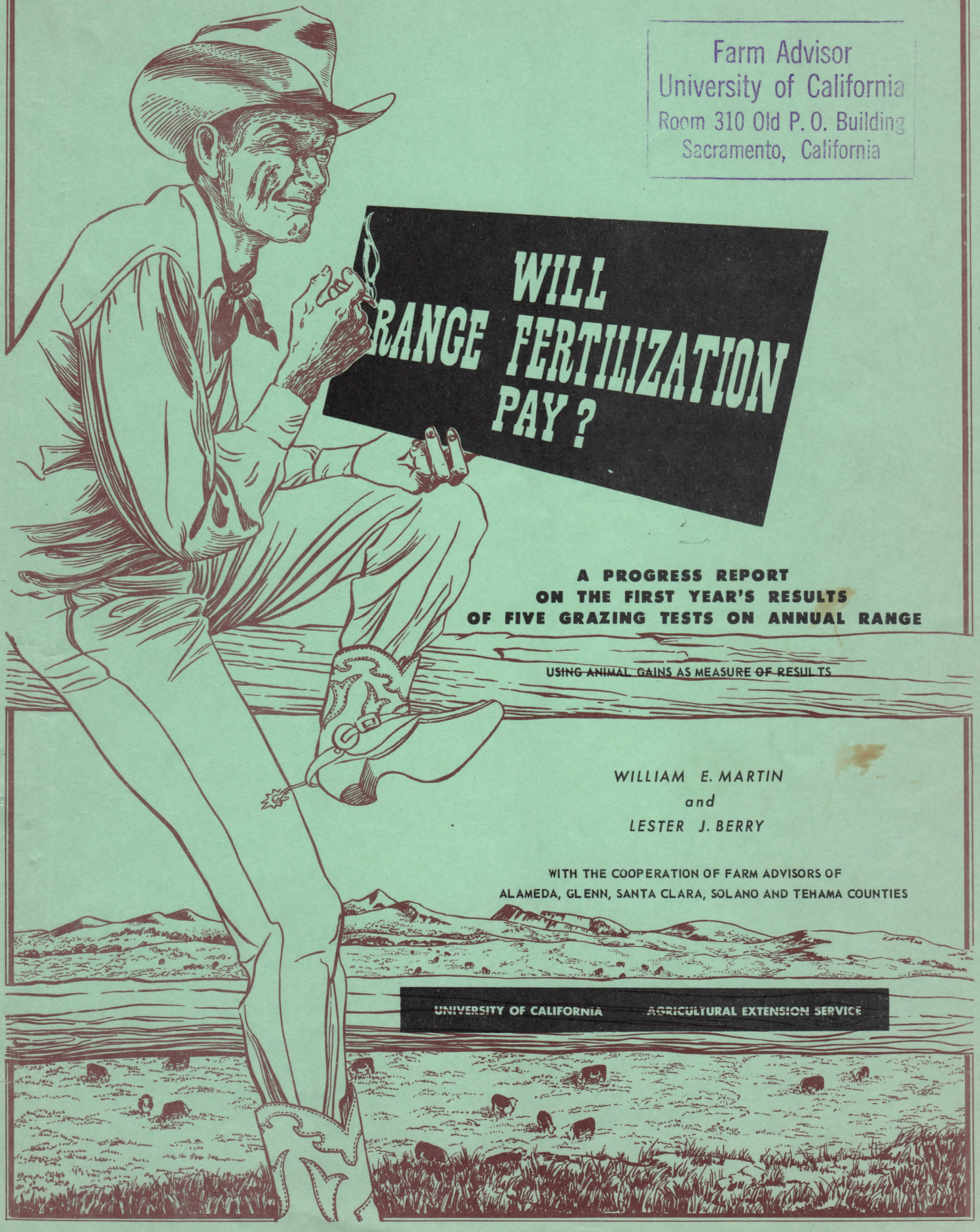

WILL RANGE FERTILIZATION PAY?

A PROGRESS REPORT ON THE FIRST YEAR'S RESULTS OF FIVE GRAZING TESTS ON ANNUAL RANGE

USING ANIMAL GAINS AS MEASURE OF RESULTS

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UNIVERSITY OF CALIFORNIA AGRICULTURAL EXTENSION SERVICE

#1

THIS REPORT CONTAINS

I. A discussion of problems of forage production that may be altered by fertilization

   a) Shortage of early green feed
   b) Not enough total feed
   c) Poor quality forage

II. A description of the two approaches used in previous range fertilization work

   a) Legume fertilization with phosphorus or sulfur to increase spring feed and improve forage quality
   b) Direct fertilization of grasses with nitrogen fertilizers to increase total feed

III. A detailed description of five field scale fertilizer tests set up for the specific purpose of finding out whether nitrogen fertilizers could be profitably used on typical winter range. Actual meat production of 693 animals on 1118 acres was used to measure the results. These five tests showed:

   a) Earlier winter feed in the fertilized fields
   b) Fertilization brought about large increases in meat production

      On the best land, meat yields per acre were almost doubled
      On poorer range, production was increased almost five-fold

   c) The value of the increased production of meat during the grazing period equalled or exceeded the cost of the fertilizer in all four of the cattle tests. In the one sheep test production of lamb and mutton, though increased four-fold failed to pay the entire cost of the fertilizer the first season.

ACKNOWLEDGEMENTS

We wish to acknowledge the splendid cooperation of the ranchers who provided the animals and at extra expense provided the weighing facilities and especially fenced fields for these tests.

Grateful acknowledgement is also made to the companies whose gift of fertilizers made the tests possible. A total of 77 tons of materials were furnished by the following companies:

Balfour Guthrie & Co., Ltd.	--	Ammonium Sulfate and Ammonium Phosphate Sulfate
Best Fertilizers Co.	--	Ammonium Phosphate and Ammonium Phosphate Sulfate
Norsk Hydro of Norway	--	Calcium Nitrate and Urea
Shell Chemical Corp.	--	Ammonium Sulfate
Stauffer Chemical Co.	--	Superphosphate

WILL RANGE FERTILIZATION PAY?

First Year's Results of Five Tests Using Animal Gains to Measure Results

W. E. Martin and L. J. Berry

I. INTRODUCTION

Actual meat production by cattle or sheep on typical range will decide whether or not range fertilization can be economically feasible. Only by this means may we find out whether dollars spent for fertilization have returned value enough to justify the expense.

This report covers the first year's results from five field-scale cooperative tests laid out by the University of California Agricultural Extension Service on typical winter range in northern and central California. These tests represent as nearly as possible normal operations under actual range conditions. Gains in weight of 693 animals on 1118 acres measure the effectiveness of nitrogen and nitrogen-phosphorus treatments. Before discussing the results of these tests, it may be well to outline some of the problems of range forage production, and to review some of the fertilizer work already done on California rangeland.

II. THE PROBLEM

California range makes up somewhat over a third of the area of the state. It includes about ten million acres of open treeless range, plus about twenty-five million acres of oak-grass woodland and brushy areas used primarily for grazing. Much of this rangeland has been grazed by cattle or sheep for at least a century. Practically none has ever been fertilized. Present forage is composed principally of annual grasses, clovers, and alfilaria.

Most of the open range and low-lying portions of the oak-grass woodland are used for the production of green winter feed. At higher elevations and along the coast where rains continue longer, the range provides green spring and early summer feed. Late summer and fall feed is from the dry grasses and legumes produced during the spring months.

There are several problems of range forage production that may be improved by proper fertilization:

First, there is usually a shortage of green feed in the early part of the winter grazing season. Annual grasses and legumes grow slowly during the winter months, even though adequate soil moisture is present. The major production of forage comes in a great flush in the spring when soil and air temperatures have increased and soil moisture is still adequate. Feed dries up quickly in late spring as soon as the rains cease. This uneven seasonal growth makes for a feast or famine situation. Quickly available nitrogen or nitrogen plus phosphorus fertilizers greatly speed up growth of grasses during the cool winter months.

Second, total feed production is poor in many areas. Here the soils appear infertile and little forage is produced even when temperature and moisture conditions are favorable. Many such soils are known to be acutely deficient in phosphorus, sulfur, and nitrogen. Some soils are severely compacted from years of grazing and neither water nor plant roots penetrate readily. Growth is poor.

Third. Forage quality is often poor for animal use. Winter and spring-growing annual grasses make good feed while green or approaching maturity. Most of these same species are of low nutritive quality and some are unpalatable and even injurious when mature

and dry. Fertilizer treatments that increase the growth of legumes and desirable annual grasses, along with proper livestock management, will improve the quality of dry feed for summer and fall use. In some areas, annual grasses and legumes fail to extract the available moisture from the soil, allowing non-palatable summer weeds, such as star thistle and tarweed to become established. This further reduces the overall quality of the dry feed. In some cases the growth of summer weeds seems related to low soil fertility. Fertilization of desirable annual grasses and legumes has in some cases stimulated enough early growth to reduce the summer weeds.

III. WHAT HAS ALREADY BEEN DONE?

Two different approaches have been made to the problems of range improvement through fertilization. The first has been to stimulate native or introduced legumes by fertilization with phosphorus, sulfur, and other materials. The second has been the direct fertilization of grasses and other non-leguminous plants with nitrogen-bearing fertilizers. Both methods have much merit, but achieve different results.

Previous Work on Range Improvement Through Legume Fertilization:

The aim of legume fertilization has been, first, to improve current feed supplies, and second, to help build up soil fertility. A large number of small exploratory range tests have been set up throughout the state by the Agricultural Extension Service, in cooperation with Dr. John Conrad of the Department of Agronomy. These tests included phosphorus, sulfur, potassium, lime, and other materials. At many locations, phosphorus or sulfur-bearing fertilizers, alone or in combination, greatly increased growth of native or introduced clovers. In these areas, effective range improvement was achieved at low cost. The amount of spring forage was increased. The quality of feed, both green and dry, was improved by the greater proportion of high protein legume vegetation. A residue of organic nitrogen was left in the soil, which stimulated grass growth the following season.

Legume fertilization, though often effective in increasing spring feed, has serious limitations. First, it does not provide the early feed needed on many winter ranges. Second, in many areas, soils are well enough supplied with phosphorus and sulfur so that added fertilizers cause no growth increases. Third, some seasons, known as poor clover years, have temperature and rainfall conditions such that little legume growth is made regardless of fertilizer applications.

Previous Work on Range Improvement Through Nitrogen Fertilization of Grasses:

The aim in using nitrogen fertilizers has been to directly fertilize the grasses and thus increase forage production. Nitrogen treatments were included in many of the legume range fertilizer tests carried out by the Agricultural Extension Service and Department of Agronomy. In nearly every test, the grasses present responded to nitrogen. In a few cases, clovers responded.

In this series of exploratory tests, several patterns of nitrogen response on grasses appeared. On soils well supplied with phosphorus, nitrogen treatments alone made as good early and total growth as did nitrogen-phosphorus combinations. On soils acutely deficient in phosphorus, little benefit at any season was obtained unless phosphorus

was used with the nitrogen applied. Many soils showed a seasonal or winter deficiency in phosphorus. On these soils, nitrogen-phosphorus treatments gave large increases in winter and early spring growth. Here straight nitrogen applications showed little result in the winter but produced good grass growth in the spring after soil temperatures had increased. On some sulfur-deficient soils, ammonium sulfate applications made for better grass growth than equal nitrogen from ammonium nitrate.

The most striking and consistent response in this series of tests was that supplemental nitrogen fertilizers did stimulate early and continued winter growth of annual grasses. These responses took place during the cold season when little growth normally would be expected. Nitrogen appeared the key in making early growth but was effective only if adequate phosphorus and sulfur were present.

Recently a number of range fertilizer plots have been set up, both by the Soil Conservation Service and the University of California Agronomy Department.

At the Soil Conservation Service Sunol Nursery in Alameda County, 200 pounds of 16-20 Ammonium-Phosphate-Sulfate were applied for six successive years, starting in 1944. "Range readiness" was judged to be six weeks earlier where fertilized. Average seasonal forage as measured by clipped hay yields was increased from 1284 pounds to 4163 pounds an acre, at a fertilizer cost of $9.00 annually. The additional feed was produced for a fertilizer cost of approximately $6.25 a ton dry matter. A nitrogen-phosphate rate test carried out for four years at this same location showed that increased hay yields were primarily due to the nitrogen applied. Ammonium Sulfate alone gave 85-90% as much hay as did corresponding nitrogen plus phosphorus treatments.

At the Brown Ranch near Wilton in Sacramento County in 1948, the University of California Agronomy Department set up several range fertilizer tests on red, phosphate-deficient soils. Applications in March of 600 pounds 16-20 Ammonium Phosphate-Sulfate per acre produced 5505 pounds additional forage per acre the first season, with a carry-over of 1270 pounds the following year. The total, 6775 pounds of hay, as measured by clipping, was produced at a fertilizer cost of approximately $30.00, or $8.00 per dry ton. Further trials the following year showed fall applications to be more effective than spring applications.

At the University of California Hopland Range in Mendocino County, fall applications of ammonium sulfate were compared with ammonium phosphate (16-20) during the past season. Normally little winter forage is produced even though moisture is usually adequate. Sheep usually must be fed hay supplements during the winter months. Both nitrogen fertilizers hastened the growth of grasses. On January 5, only 240 pounds per acre of forage had been produced on the control plot. In contrast 83 pounds of nitrogen from ammonium sulfate gave 1535 pounds, while 83 pounds nitrogen plus 104 lbs. phosphorus (expressed as P_2O_5) from the 16-20 produced 2420 lbs. dry matter per acre. By March 30, the ammonium sulfate treatment had produced 3400 pounds more forage per acre than the control, in contrast to 5800 pounds of extra forage from the 16-20 treatment. This "out of season" winter feed was produced at a fertilizer cost of $7.58 per dry ton from the ammonium sulfate and for $8.00 from the 16-20 treatment.

The three groups of tests above illustrate the use of nitrogen and nitrogen-phosphorus fertilizers in making "out of season" winter feed and in increasing spring forage supplies on California ranges. Cost of this "out of season" feed is considerable. Supplemental feeding and hauling of hay to animals is likewise expensive. Often animals so fed gain little during the winter months.

IV. LAYOUT OF RANGE FERTILIZER GRAZING TESTS

Site Selection and Size of Experimental Fields:

Animal grazing tests on fertilized range were set up in five counties in the fall of 1953. They were set up for the specific purpose of finding out whether nitrogen fertilizer, with or without phosphorus, could be used profitably on winter range. Meat production during the grazing period was used as a measure of success. Tests were located in Alameda, Glenn, Santa Clara, Solano, and Tehama counties. All were field-scale trials carried out on lands selected as typical of extensive areas in each county. Some tests were on good productive range. Others were on poorer range depleted by years of heavy grazing. Some were selected in areas known to be deficient in phosphorus, while others were on soils reasonably well supplied with this nutrient.

The size of experimental fields was of necessity large, in order to get a fair cross-section of rangeland and to accommodate sufficient animals to obtain reliable results. Field size was also dictated by the size of suitable fenced fields that might be divided for treatment and also by the location of stock waterholes. In every test, the rancher cooperator had to build considerable new fence to provide suitable fields for treatment. Fertilized fields were approximately the same size in each test - usually 30 to 60 acres - while control fields were often somewhat larger. In the Glenn County test, the terrain was such that much larger areas were required. Here 133 acres were fertilized, as compared with an adjacent unfertilized field of 365 acres. The total acreage in all five tests was 1118 acres, of which 520 were fertilized.

Fertilizer Treatments of Experimental Fields:

The basic plan of these range fertilizer tests was to have three fields adjacent and comparable, one for the control, a second to be fertilized with nitrogen only, and a third receiving a nitrogen-phosphorus treatment. This design was employed exactly in the Alameda and Santa Clara County tests. In Solano County, a fourth field was available and an added treatment providing a nitrogen-source comparison was made. In Tehama County, on a soil known to be acutely deficient in phosphorus, no straight nitrogen treatment was made and instead, two nitrogen-phosphorus treatments with varying nitrogen application were set up to compare with the unfertilized area. In the Glenn County test, where only two large fields were available, one received a single nitrogen-phosphorus treatment.

Nitrogen fertilizers were applied at rates to furnish 40 to 60 pounds actual nitrogen per acre. Phosphorus rates were 80 pounds P_2O_5 per acre on soils known to be deficient in phosphorus, with lighter rates on soils with higher phosphorus supply. Nitrogen-phosphorus treatments were made in some cases by the use of Ammonium-Phosphates and at other locations by the addition of Superphosphate to the nitrogen fertilizer treatment used in the straight nitrogen field. A summary of the fertilizer treatment in all five tests is shown in Table 1.

Stocking of Experimental Fields:

Grazing was carried out as close to normal ranch operations as possible. Animals selected for uniformity were weighed into the fields when green feed had grown to a height of four to five inches on the fertilized areas. The untreated fields were stocked at rates selected by the rancher as the normal carrying capacity of the range. Fertilized fields were stocked more heavily, at rates estimated to approximate the available feed. Where necessary, extra animals were added to utilize the additional feed. No supplemental feed was supplied.

Animals were removed and the test terminated by mutual agreement with the rancher when nearly all of the green feed had been utilized, thus leaving enough growth to provide dry feed for normal fall use. Every effort was made to graze the fields so as to utilize the available feed but not to over-graze any of the treatments. The control and the fertilized fields were grazed during the same period.

All animals were weighed when placed in the fields and again when removed. Test weighings were made during the season to determine progress. At these times, stocking rates were changed if the condition of the range indicated it. By using this method of weighing and stocking, it has been possible to express results first, as total grazing days per acre; second, as average daily gains per animal; and finally, as pounds of meat produced per acre.

Forage Samples for Chemical Analysis:

Samples of forage were taken from all of the experimental fields in the five tests. They were collected as clippings from four or more ungrazed, fenced exclosures within each field. These samples were taken primarily to determine the effect of fertilizer treatment upon the chemical composition of forage.

Analysis of all samples was made in the Central Agricultural Extension Service Laboratory in Berkeley.

SUMMARY OF MEAT PRODUCTION IN FIVE RANGE FERTILIZER TESTS

The results of the five short-term grazing tests are most encouraging. In every case, there were large increases in meat production as a result of fertilization. Detailed description of the five individual tests will be made in the sections of this report which follow. The first year's results may be summarized as follows:

Earlier feed was produced in the fertilized field in every test. Nitrogen treatments alone produced as early feed as did nitrogen-phosphorus treatments in three of the four cattle tests. Only in the Santa Clara test did the combined nitrogen-phosphorus treatment produce earlier feed than nitrogen alone.

Meat production per acre was increased from nearly twice to over four times by fertilization. The meat yields in the unfertilized fields ranged from 21 pounds per acre in Glenn County to 109 pounds per acre in the Solano County test. Percentage increases due to fertilization were greater on the poorer lands.

Meat attributable to fertilization has been calculated by subtracting the meat yields of the control fields from the corresponding yields of the fertilized fields during the same grazing period. The value of the extra beef produced, calculated at 20¢ a pound, equalled or exceeded the fertilizer cost in all of the cattle tests. In the one sheep test, of only 62 days duration, the lamb gains failed to pay for all of the cost of fertilizer the first season. The figures on meat production, stocking rates, animal gains and fertilizer treatments are summarized in Table 1.

EVALUATION OF RESULTS

Definite conclusions should not be drawn from a single year's work. It seems clear that nitrogen and nitrogen-phosphorus fertilizers offer great promise as a means of increasing forage and meat production during the winter and spring green feed period.

Before a true evaluation of range fertilization can be made additional facts are needed. Carry-over effects of fertilizer treatments must be measured. Similarly, the effects of continued nitrogen application upon range condition must be known. Further trials are needed to establish the upper practical limits of nitrogen fertilization as well as the rates of phosphorus and sulfur necessary to make the nitrogen effective. With these objectives in mind the present program of field scale tests will be continued and enlarged.

SUMMARY OF RANGE FERTILIZATION AS MEASURED BY MEAT PRODUCED PER ACRE

County/ Ranch/ Grazing Period	Fertilizer Treatments		Stocking and Rate of Gain					Meat Produced & Profit from Fertilization				
	Materials lbs/Acre	Nutrients lbs/Acre	No.of Acres	No.of Animals	Acres/ Animal	Grazing days/Ac.	Aver. Daily Gain/ Animal	Total lbs/Ac.	Gain from Fertilization lbs/Ac.	Value of Gain	Fertilizer Cost $/Acre	Gross Profit $/Acre
Alameda Mulqueeney Cattle Dates: Jan.29-Apr.26 86 days	Control	-	45	15	3	28	1.42	40.7	-	-	-	-
	227 Amm. Sulfate	N_{45}	45	25	1.8	48	1.63	77.8	37.1	$7.42	$7.38	$ .04
	273 Am.Sul. 239 S.Super.	$N_{55}P_{47}$	37	25	1.5	58	1.81	105.3	64.6	12.92	13.35	-.43
Glenn Sevier Cattle Dates: Feb.3-May 12 98 days	Control	-	365	40	9.13	10.4	2.08	21.2	-	-	-	-
	108 Urea 126 S.Super.	$N_{48}P_{26}$	133	80	1.66	53.9	1.87	100.9	79.7	15.94	11.26	4.68
Santa Clara Nelson Cattle Dates: Feb.24-May 27 90 days	Control	-	30	12*	2.5*	22.9	2.30	52.7	-	-	-	-
	300 Am.Sulf.	N_{63}	30	20*	1.5*	60.0	2.50	150.3	97.6	19.52	9.39	10.13
	400 16-20	$N_{64}P_{80}$	30	30*	1.0*	93.5	2.40	224.8	172.1	34.42	18.00	16.42
Solano Lawler Cattle Dates: Jan.28-May17 108 days	Control	-	92	59*	1.56*	75	1.44	108.7	-	-	-	-
	300 Cal.Nit.	N_{46}	60	59*	1.02*	109	1.85	201.7	93.0	18.60	9.75	8.85
	249 Am.Sulf.	N_{40}	65	59*	1.10*	85	1.89	161.5	52.8	10.50	6.34	4.22
	273 Am.Sulf. 249 S.Super.	$N_{42}P_{47}$	66	59*	1.12*	97	1.78	172.0	63.3	12.66	9.39	3.27
Tehama Teisseire Sheep Dates:62 days Feb.24-Apr.6	Control	-	60	30**	2.0	31	.72+	23.8	-	-	-	-
	200 13-39	$N_{26}P_{78}$	30	30**	1.0	62	.67+	43.5	19.7	4.06	12.00	-7.94
	400 16-20	$N_{64}P_{80}$	30	45**	.67	93	.83+	104.0	80.2	12.76	19.00	-6.24

*Rate of stocking varied during test **Pairs = Ewe and single lamb +Average daily gain on lambs only

I. THE MULQUEENEY TEST

Walter Johnson, Farm Advisor, Alameda County

The Area Selected:

The area selected was near the village of Midway at the Junction of the Patterson Pass Road and the Western Pacific Railway, in the foothills of the Coast Range. The lands here have for years been devoted exclusively to grazing - for many years by sheep - but more recently exclusively by cattle. The range here is on rolling hills, with a few small valleys coming down from the upper foothills. The area is treeless except along water courses. The winter climate is mild and usually produces early winter and spring feed. The test was selected as typical of a large area of open range on the west edge of the San Joaquin Valley, where rainfall is light, usually not over twelve to fifteen inches.

The soils in the selected area were Linne adobe clay on the rolling hills, with some Ambrose clay in the valleys. The Linne has given a phosphorus response at some locations in the state, but earlier small plots on this ranch had shown response only to nitrogen.

Field Arrangement and Fertilizer Treatment:

Two adjacent pastures, of 45 and 82 acres, were selected near the scales and ranch corrals. The larger field was then split by building a new fence to provide two fields with about the same proportion of hill and valley land, and each provided with stock water. These latter fields, being on equivalent lands, were selected for a fertilizer treatment. The adjacent control field had perhaps a little better land than the fields to be fertilized.

The plan was to compare nitrogen alone, from Ammonium Sulfate, with equal nitrogen plus phosphorus from added Superphosphate. Materials were all applied in October before the rains. The actual rates of nitrogen differ slightly, with 45 pounds N per acre on the straight N field and with 57 pounds N and 47 phosphoric acid on the combined treatment.

Stocking the fields

The Mulqueeney herd of yearling heifers was carefully gone over, and 65 uniform animals selected for the test. All fields were stocked on January 29, 1954. Fifteen heifers were placed in the control field. This number was determined by the rancher as the number which would normally go on such land during the green feed period. Twenty five animals were placed in each of the fertilized fields. The animals were removed once for weighing on April 5, and returned to the fields for the balance of the season.

Forage Produced

Some forage started with the first rains in November and made much more rapid growth on the nitrogen plots. The nitrogen-phosphorus field appeared no different than the field receiving only nitrogen. During the late December and January drought the fertilized fields did not seem to suffer as much as did the control field. Much of the annual grass did not germinate in any of the fields until the heavy rains in late January.

Exclosures were installed in February, after grazing had begun, to check on the quality of the feed produced. The feed already present was clipped to two inches and the regrowth cut for chemical analysis on March 18.

Analysis of these forage samples showed higher crude protein in forage from the fertilized fields than from the untreated field. The percent phosphorus was relatively high in all forage, with slightly higher values from the nitrogen and nitrogen-phosphorus fields.

STOCKING AND FORAGE QUALITY

Mulqueeney Ranch - Alameda County

Fertilizer Treatments	None	Experimental Fields: Ammonium Sulfate 227 lbs/Ac.	Experimental Fields: Ammonium Sulfate - 273 lbs/ac. plus Superphosphate - 249 lbs/ac.
Nutrients/Acre	-	N_{45}	$N_{57}P_{47}$
Field Size	45 Ac.	45 Ac.	37 Ac.
Number of Heifers	15	25	25
Average weight in (Jan.29)	531 lbs.	531 lbs.	507 lbs.
Acres/animal	3.0	1.80	1.48
Forage composition from exclosures Clipped March 18			
% Crude Protein	13.9%	17.0%	20.0%
% Phosphorus	.33	.36	.41

How Much Beef from Fertilization?

All animals were weighed into the fields following an overnight stand without feed or water, at the start of the test on January 29. At the completion of the test, animals were weighed directly from the field in the early morning because of the unreasonably hot weather, and all final weights were shrunk 4%.

Higher daily gains (1.63 and 1.81) per animal were obtained on the fertilized pastures than on the control field (1.42 lbs/day). This is particularly significant since the animals on the control field had twice as much area for grazing per animal as did those on the heaviest fertilized field.

The yield of beef/acre on the control field was only 40.7 pounds, in contrast to 77.8 pounds on the Ammonium Sulfate field, and 105.3 lbs/acre where somewhat more Ammonium Sulfate plus Superphosphate were applied. In the latter case, we cannot say with assurance whether the results were due to more nitrogen or to the addition of phosphorus. It seems likely, in view of the high phosphorus content of all of the forage and soil, that phosphorus was not a factor.

Beef attributable to fertilization was calculated by subtracting production/acre on the control field from values from the fertilized fields. The fertilizer gains of 37.1 and 64.6 pounds/acre on the two fields, evaluated at 20¢/lb., were only sufficient to pay for the cost of the fertilizer used. However, if the phosphorus used was not effective, the higher nitrogen rate would have shown a gross profit of $4.05/acre.

The results of this test are encouraging. Earlier additional feed was obtained when feed was scarce, the animals gained more on the fertilized areas, and returns approached cost of materials. This is particularly encouraging in a dry season, when only 10½ inches of rain fell and only about eight inches were considered effective. The test had to be terminated several weeks earlier than planned since the feed dried up because of April drought.

BEEF BY RANGE FERTILIZATION

Mulqueeney Ranch - Alameda County

86 days grazing - January 29-April 26, 1954

Seasonal rainfall - 10½ inches

Fertilizer Treatment	Experimental Fields			
	Control	N_{45} Ammonium Sulfate	N_{57} P_{47} Ammonium Sulfate and Superphosphate	
Acres/Animal	3.0	1.80	1.48	
Grazing Days/Acre	28	48	58	
Average Daily Gain	1.42	1.63	1.81	
Beef/Acre	40.7 lbs.	77.8 lbs.	105.3 lbs.	
Fertilizer Gain	-	37.1	64.6	
Value of Gain @ 20¢/lb.		$7.42	$12.92	
Fertilizer Cost		7.38	13.35	N and P
			8.87	N only

II. THE SEVIER TEST

Glen Eidman, Farm Advisor, Glenn County

The Area Selected:

An area of typical commercial range land was chosen on the J. W. Sevier ranch ten miles west of Willows. The area included both open grassland and oak-grass woodland typical of the rolling rangeland on the west edge of the Sacramento Valley. In the experimental area, both hill and valley soils were present. The hill soils were principally Los Osos loam and the valley soils primarily Myers clay. Rainfall in the area is about sixteen inches annually. The range had been overgrazed in past years, but had been lightly stocked for the year preceding the test.

Field Arrangement and Fertilizer Treatment:

Two fields, of 133 acres and 355 acres, were available for this study. Both had adequate stock water and were fenced in such a way that the animals could graze normally from water holes without fencing obstructions, and thus utilize the feed efficiently and evenly. The smaller field was selected for fertilizer treatment. It included a slightly larger proportion of valley soil than did the control area.

A combined nitrogen-phosphorus treatment was applied to the treated area early in December, 1953. Because of the rough terrain, airplane application was used for all materials. Nitrogen was supplied, at 48 pounds per acre, from 108 pounds of Urea. Phosphorus was provided, at 26 pounds P_2O_5 per acre, from 135 pounds of Single Superphosphate. The Urea and Superphosphate were applied in separate operations. A total of seven tons of Urea and nine tons of Superphosphate were applied in five and a half hours, at a cost of $300.00, or $2.26 per acre.

Stocking the Fields:

Forty selected yearling cattle were put into each field on February 3, 1954. Two weeks later it was evident that the fertilized area was under-stocked. Forty additional animals were added, increasing the stocking rate to five and a half times that of the control field.

Growth Produced:

Growth in the fertilized area started several weeks earlier than in the control fields. This was particularly evident on the hill soils. Exclosures were set up to determine the effect of fertilizers upon growth and chemical composition of forage. These exclosures, 6.5 square feet in area, were placed in pairs on opposite sides of the central dividing fence. In this way, a comparison of the effect of fertilization was possible at four paired locations, each on similar soil type and terrain. Clippings were made on March 31 and again on May 9 from all of the exclosures. The green forage was dried and analyzed for its phosphorus and nitrogen content. Results of these clippings showed about 2.8 times as much forage on the fertilized area on March 31 as on the control. On May 9, a second clipping showed only one and a half times as much on the fertilized. Growth differences were greater on the hill soils than from the comparisons made on the better valley soils.

Analysis of the dried forage showed slightly higher crude protein content in the fertilized forage at the first clipping in March, with a lesser difference in the May clipping. The phosphorus content of both fields was high and showed no effect of the phosphorus applied. The total amount of nitrogen calculated to be in the two clippings was 51 pounds per acre greater from the fertilized than from the control area. These data are only from four pairs of small exclosures, but would certainly indicate that virtually all of the 48 pounds of nitrogen applied had been utilized in increased growth.

STOCKING AND FORAGE QUALITY

Sevier Ranch - Glenn County

Fertilizer Treatments	None	108 lbs. Urea / Ac. plus 135 lbs. Superphosphate/Ac.
Nutrients per Acre.	---	N_{48} P_{26}
Field Size	365 Ac.	133 Ac.
Stocking		
Number of Cattle	40	80
Av. Initial Weight	446	426
Acres per Animal	9.13	1.66
Yield and Composition of Forage		
Dry Matter per Acre (lbs)		
March 31	999 lbs.	2783 lbs.
May 9	652	1000
Total	1651	3783
Percent Crude Protein		
March 31	13.4%	14.6%
May 9	12.2	12.6
Percent Phosphorus		
March 31	.42%	.38%
May 9	.43	.42
Total Nitrogen in Forage		
Lbs/Acre in 2 clippings	34.1 lbs.	85.3 lbs.
Difference due to fertilizer		51.2
Nitrogen applied in fertilizer		48.0

How Much Beef from Fertilization:

All animals were weighed into the field following an overnight stand, at the start of the experiment on February 3. At the completion of the test on May 12 an overnight stand was not possible and all animals were weighed following a one mile drive and actual weights reduced by a shrinkage factor of 3%.

Average daily gains for the entire period were about two pounds per day in each field. In the first half of the experiment, gains were slightly greater on the fertilized area.

The yeild of beef per acre on the control field was 21 pounds per acre, in contrast to slightly over a hundred pounds per acre from the fertilized fields during the same test period.

Beef attributable to fertilization obtained by subtracting the yield of the control field from that of the fertilized field, was about 80 pounds per acre. This was evaluated at 20¢ a pound as being worth $15.93, or $4.60 more than the cost of the fertilizer, and $2.41 an acre more than the cost of the fertilizer and its application.

The results of this test were very striking. Growth and rainfall conditions were good throughout most of the period. A good profit from fertilization is indicated.

There is considerable question whether the phosphorus applied was actually needed. In applying the Superphosphate, a 100-foot strip across the entire field received no phosphorus, while an adjacent strip received double the phosphorus rate. Both received equal nitrogen. Neither strip was visible prior stocking, suggesting that phosphorus was probably not a factor, although the soil test prior to starting the experiment showed relatively low phosphorus. The fact that the phosphorus composition of the forage of both treated and untreated fields was very high, suggests further that phosphorus was not an important factor and that most of the growth response was due to the nitrogen applied. If this conclusion is correct, the net profit from fertilization, after deducting costs and application of Urea only, would be $6.12 per acre instead of 2.41 per acre for the combined nitrogen-phosphorus treatment.

BEEF BY RANGE FERTILIZATION

Sevier Ranch - Glenn County

98 Days of Grazing - February 3 - May 12, 1954

Seasonal rainfall - 18 inches

Fertilizer Treatment	Control	$N_{48}P_{26}$
Acres/Animal	9.13	1.66
Grazing Days/Acre	10.4	53.9
Average Daily Gain	2.08 lbs.	1.87 lbs.
Beef/Acre	21.22 lbs.	100.86 lbs.
Fertilizer Gain	-	79.64 lbs.
Value of Gain @ 20¢/lb.	-	$15.93 per acre
Less Fertilizer Cost		11.26
Less application cost		2.26
Net profit from fertilization		$2.41 per acre

III. THE NELSON TEST

M. S. Beckley, Farm Advisor, Santa Clara County*

The Area Selected:

The Nelson test was chosen as a location typical of the rolling hill lands along the western edge of the Santa Clara Valley. The lands have been used exclusively for cattle range for at least fifty years. The vegetation is composed principally of annual grasses and bur clover, with a few scattered oaks. The soils in the test area were mapped as Vallecitos clay loam, a neutral upland soil formed from shales and sandstone.

Field Arrangement and Fertilizer Treatments:

A 90-acre field was divided into three thirty acre plots. Each had access to stock water. On October 23, 400 lbs/acre of 16-20 Ammonium-Phosphate-Sulfate were applied to one field, and 300 lbs/acre Ammonium-Sulfate to another field. The third field was left untreated. This test provided a good comparison of the effects of nitrogen alone in comparison with equal nitrogen in a nitrogen-phosphorus fertilizer. Both of the fertilizing materials contained sulfur, so that differences between the two fertilized fields could be attributed to the difference in the phosphorus supplied.

Forage Production and Quality as Measured by Monthly Clippings:

At this location there were very striking effects of phosphorus in hastening winter growth of forage. Forage grew much earlier on the Ammonium-Phosphate-Sulfate plot than on the field treated with Ammonium Sulfate. The latter field produced feed far earlier than the control. Rainfall was poorly distributed. A good rain of 2.00 inches fell on November 15, but no rain at all fell in December, and not until January 17 was there a really effective rain of 3.10 inches. A total of 19.5 inches fell in the entire season.

Five fenced exclosures were set up in each fertilized field. These exclosures included the regular fertilizer treatment and also an adjacent strip that had been left unfertilized. Thus, at these ten locations, it was possible to get "point comparisons" showing the effect of the fertilizer applied. Clippings were made from 3x3 quadrats at monthly intervals.

* In cooperation with G. L. Thomas, District Conservationist, Loma Prieta Soil Conservation District. This test is one of a separate group of range demonstrations set up by Balfour-Guthrie & Co. Ltd. in cooperation with California Soil Conservation Districts.

The analysis of the forage samples gave a measure both of the forage produced and its crude protein and phosphorus content. The figures show no clear-cut effect of fertilizer treatment upon percent protein. The phosphorus content, however, was consistently increased by the addition of the 16-20 fertilizer, while material from the Ammonium Sulfate field showed reduced phosphorus content as compared to the unfertilized forage.

YIELD AND QUALITY OF FORAGE FROM CLIPPED EXCLOSURES

NELSON TEST - SANTA CLARA COUNTY

Clipping Date	Yield of Forage Produced, Pounds Dry Matter/Ac.			% Crude Protein			% Phosphorus		
	Control	Ammonium Sulfate N_{63}	16-20 $N_{64}P_{80}$	Control	Amm. Sulf. N_{63}	16-20 $N_{64}P_{80}$	Control	Amm. Sulf. N_{63}	16-20 $N_{64}P_{80}$
Feb.8	*	292	486	*	16.3%	19.3%	*	.16%	.38%
Mar.15	129	668	881	15.8	19.6	17.2	.26	.21	.41
Apr.19	625	924	926	14.8	15.8	11.8	.33	.27	.47
May 19	235	243	256	10.1	12.2	10.7	.29	.28	.35
				Lbs/Acre Nitrogen Uptake in forage			Lbs/Acre P_2O_5 uptake in forage		
TOTAL	989	2127	2549	21.9	59.4	62.9	7.1	12.3	23.8
Gain over Control	-	1138	1560	-	37.5	41.0	-	5.2	16.7
% Uptake of Fertilizer Nutrients Supplied					60%	64%		-	20%

* Not enough forage on control for chemical analysis on February 8.

Stocking the Fields and Rate of Cattle Gain:

The attempt was made to stock the fields in proportion to the feed available. Owing to the lack of rain in December and most of January, winter feed was much later than usual.

On February 24, yearling steers were put into the Ammonium Sulfate and 16-20 fields. The 16-20 field hadfar more feed and was stocked with 42 steers on 30 acres. It might have been stocked several weeks earlier. There was less feed on the Ammonium Sulfate field and it received only twenty steers. The control field had practically no green feed and stocking was deferred to thirty days.

On March 27, the 16-20 field was reduced to 30 steers, with the 12 removed going to the control field. The Ammonium Sulfate field remained with 20 animals.

On May 9, the stocking of the 16-20 field was reduced to 15, and the control plot to 10, while the Ammonium Sulfate field remained with 20 animals.

On May 27, the test was terminated after 90 days. At that time it seemed evident that the control and Ammonium Sulfate fields may have been somewhat under grazed as compared to the 16-20 field.

The rate of gains of the animals in each field was determined after each of the three grazing periods. No consistent differences related to fertilizer treatment were found. All gains were good. The control field showed an average daily gain of 2.3 pounds a day, the Ammonium Sulfate field, 2.5 pounds a day, and the 16-20 field, 2.4 pounds a day. Differences in beef production were then probably due to differences in earliness of feed and total feed produced, rather than to any quality superiority of the fertilized forage.

STOCKING AND CATTLE GAINS ON FERTILIZED FIELDS

NELSON TEST - SANTA CLARA COUNTY

February 24 - May 27, 1954 - 90 days

Grazing Period	Stocking and Average Daily Gain of Cattle		
	30 acres Control	30 acres Ammonium Sulfate	30 acres 16-20
Feb. 24 — 30 days — Mar. 27	No feed	20 steers* 2.23 lbs/day	42 steers* 2.41 lbs/day
Mar. 27 — 43 days — May 9	12 steers 2.33 lbs/day	20 steers 2.86 lbs/day	30 steers 2.40 lbs/day
May 9 — 17 days — May 27	10 steers 2.23 lbs/day	20 steers 1.94 lbs/day	15 steers 2.40 lbs/day
Grazing Days/Acre	22.9	60.0	93.5
Average Daily Gain for entire Grazing Period	2.30	2.50	2.40

* Average initial weight steers on 16-20 field 478 lbs.

on Ammonium Sulfate field 534 lbs.

How Much Beef was Produced by Fertilization:

The gains in the cattle when calculated on an acre basis give us a graphic picture of the results. On the control field, almost 53 pounds of beef were produced, in contrast to 150 pounds from the Ammonium Sulfate field, and nearly 255 pounds where 16-20 had been applied. Actually, the 16-20 field was so much earlier that 100 pounds of beef (value $20.00) were produced before any feed worth grazing had grown on the control field.

The fertilizer effect was measured by subtracting the production of the control field. This shows a fertilizer gain of 90 pounds per acre from the Ammonium Sulfate, in contrast to 172 pounds from the 16-20. These gains, evaluated at 20¢/cwt, less the actual cost of the fertilizer, show clear-cut profits from both materials, with $16.42 gross profit (not including application costs) from the 16-20 and $10.13 from the Ammonium Sulfate.

It seems clear at this location that Ammonium Phosphate Sulfate produced much earlier feed than the Ammonium Sulfate. This was probably due to a cold weather or seasonal phosphorus deficiency. If early feed is desired, nitrogen-phosphorus treatment would seem essential. If merely more spring feed is needed, applications of Ammonium Sulfate will probably return more per dollar expended.

BEEF BY FERTILIZATION

Nelson Test - Santa Clara County

Grazing Period - Feb. 24-May 27 - 90 days

Seasonal Rainfall - 19.5 inches

Fertilizer Treatment Pounds Beef/acre	Control	Ammonium Sulfate 300 lbs/Ac.	16-20 400 lbs/Ac.
Feb. 24-Mar. 27	-	46.3 lbs.	101.2 lbs.
Mar. 27-May 9	40.1	82.0	103.2
May 9-May 27	12.6	22.0	20.4
TOTAL 90 days	52.7	150.3	224.8
Gain from fertilizer	-	97.6	172.1
Value of gain @ 20¢ cwt.		$19.52	$34.42
Fertilizer cost/acre		9.39	18.00
Gross profit/acre		$10.13	$16.42
Return per fertilizer dollar spent		$ 2.08	$ 1.91

IV. JOHN LAWLER TEST

Arthur K. Swenerton, Farm Advisor, Solano County

The Area Selected:

The area selected was located 3 miles east of Fairfield, in an area of "flat lands" devoted almost exclusively to cattle or sheep grazing. Attempts to cultivate the land have failed in years past because of lack of suitable irrigation water and also because of the nature of the soil.

The soil here is mostly of the Antioch Series, with a small body of the closely related Olcott Series. These soils have a thick, impervious "clay-pan" layer beginning at about 18 inches. This clay layer prevents the growth of deep rooted crops by causing the soil to "fill up" with water in wet seasons, bringing about a waterlogged condition. Grasses, however, thrive if properly fertilized, since winter rainfall is usually good and the climate, being near the Bay, is mild. About 46,000 acres of this and similar soils occur in Solano County and are used primarily for grazing.

Field Arrangement and Fertilizer Treatments:

The Lawler test employed 4 fields arranged in the form of a square with water available at the central point. An additional 30 acres was included in the field used as a control plot, making 92 acres in this field in contrast to 60 to 66 acres in the fertilized fields.

The plan in this test was to compare an unfertilized field with a field receiving nitrogen alone, and this in turn with a field receiving nitrogen plus phosphorus fertilization. This was done by treating two fields of equal size with the same amount of Ammonium Sulfate and adding sufficient Superphosphate to the second field to give 29 pounds P_2O_5 per acre. These materials were applied in early December.

A fourth field was available for this study and a split application of Calcium Nitrate was made, to give a total of 47 pounds of nitrogen per acre. Half the material was applied in December and the balance in early March.

Stocking the Fields:

The Lawler herd of yearling steers and heifers was divided equally into 4 groups, and 59 animals (33 steers and 26 heifers) were placed in each field in January 28. The animals were thin, averaging only 360 to 380 pounds at the start of the test. They had been on dry pasture with some hay supplement until put into the experimental fields.

Forage Produced:

The forage grew much earlier in all of the nitrogen treated fields than in the control area. The nitrogen-phosphorus field showed slightly earlier feed than the fields receiving nitrogen alone, but the difference did not persist even until late January when the animals were placed in the fields.

Four exclosures were set up in each field to determine the effect of fertilizer treatments upon chemical composition of the forage. Little effect of fertilization was seen in the analysis of these samples. The crude protein values were virtually unaffected, with the highest average values from the control area. Similarly, the phosphorus content was not increased by fertilization. The lowest values from the Ammonium Sulfate field and the highest values from the control field. It would appear that the feed quality, regardless of treatment, was good both as to protein and phosphorus content.

STOCKING AND FORAGE QUALITY

Fertilizer Treatments	None	Split applications Calcium Nitrate December and March	Single applications - December Ammonium Sulfate	Ammonium Sulfate plus	Super-phosphate
Fertilizer Used	-	300 lbs/Ac.	249 lb/Ac	273 lbs/Ac	249 lbs/Ac
Nutrients per acre	-	N_{47}	N_{40}	$N_{42}P_{29}$	
Stocking					
Field Size	92	60	65	66	
Number of Animals	59	59	59	59	
Average weight in	359	369	363	386	
Composition of Forage					
% Crude Protein					
March 3 I.	15.5	13.0	13.0	13.4	
May 9 II.	13.0	11.5	11.6	11.8	
% Phosphorus					
March 3 I.	.36	.25	.19	.26	
May 9 II.	.32	.31	.27	.31	

How Much Beef Was Produced by Fertilization?

All animals were weighed into the field following an overnight stand and earmarking on January 28. At the completion of the test, animals were weighed directly from the field following a drive of about a half-mile, then final weights were shrunk by a factor of 3%.

Average daily gains of the cattle were good on all the fertilized fields and exceeded the gains on the control fields in every instance. The average daily gain on the control field was 1.4 in contrast to about 1.8 pounds per day on the fertilized fields, which were stocked somewhat more heavily.

The yields of beef per acre were good in all fields. The control field produced 109 pounds of beef per acre in the 108 day period. The greatest yield was from the field receiving split applications of Calcium Nitrate. The Ammonium Sulfate and Ammonium Sulfate plus Superphosphate fields produced about the same total yield of beef.

Beef from fertilization was calculated as in the other tests by subtracting the production figures of the control field from those of the fertilized fields. The value of these gains at 20¢ a pound exceeded the cost of the fertilizer applied in every case. The greatest profit was shown by the split application of Calcium Nitrate. The next greatest profit was from the Ammonium Sulfate. The field with Ammonium Sulfate plus added Superphosphate did not produce enough extra meat to pay for the additional fertilizer used.

The results of this test show clearly that on good range or pasture land the use of nitrogen fertilizers may greatly increase meat production. The greatest differences in production took place during the early portion of the growing season when feed was scarce without fertilization. It is of interest to note that the increased meat gain was almost in exact proportion to the nitrogen applied. While the highest yields were from the Calcium Nitrate field, the total amount of nitrogen applied in the split application was somewhat higher. It cannot be determined whether the result was due to a superiority of nitrate nitrogen applied in two applications, or to the higher nitrogen rate employed. It seems clear that the addition of a phosphorus fertilizer was not justified at this location.

BEEF BY RANGE FERTILIZATION

JOHN LAWLER RANCH, SOLANO COUNTY - January 28-May 17, 1954
(108 days)
(Season rainfall - 14")

Treatments	None	Split applications Calcium Nitrate December and March	Single applications December Ammonium Sulfate	Single applications December Ammonium Sulfate and Superphosphate
Nutrients/acre	-	N_{47}	N_{40}	$N_{42}P_{29}$
Grazing days/acre	75	109	85	97
Acres per animal	1.4	1.0	1.1	1.1
Average daily gain (lbs.)	1.44	1.85	1.89	1.78
Beef/acre (lbs.)	108.7	201.7	161.5	172.0
Fertilizer gain	-	93.0	52.8	63.3
Value of gain @ 20¢	-	$18.60	$10.50	$12.66
Fertilizer cost	-	$ 9.75	$ 6.34	$ 9.39
Gross profit from fertilizer	-	$ 8.85	$ 4.22	$ 3.27
Application Approximate cost (using plane rate of 80¢/cwt.)	-	$ 2.40	$ 1.52	$ 2.82
Net profit/acre	-	$ 6.45	$ 2.87	$ .60

V. TESSEIRE TEST

Leland S. Frey, Farm Advisor, Tehama County

Area Selected:

The area selected was on the gently rolling terrace lands approximately 4 miles west of Proberta, on the old Corning-Red Bluff Highway. Vegetation in this area is composed primarily of annual grasses and alfilaria. Lands here are regularly used as winter and spring range for sheep and are occasionally stocked to grain, usually about every fifth year. Normally sheep grazing is only for a period of ten to twelve weeks. The sheep are then removed to irrigated pasture or taken to the mountains.

The soils in the experimental area were made up primarily of the Corning and Hillgate series, both claypan soils typical of thousands of acres of winter sheep range lying below the rolling foothills on the west edge of the Sacramento Valley.

Field Arrangements and Fertilizer Treatments:

A field of 120 acres regularly used for sheep pasture was made available for this test. It was divided by cross fences into a 60-acre control field, and two 30-acre fields for treatment.

In an adjacent field, legumes in an irrigated pasture had given a clearcut response to phosphorus alone. Nearby fields on the same farm had shown striking responses to nitrogen plus phosphorus, but not to nitrogen alone when cropped to grain. Other areas of range on the same ranch had shown striking response of alfilaria and grasses to nitrogen plus phosphorus fertilizer.

It was decided that both fertilized fields should be treated with equal phosphorus but to vary the nitrogen rate. Accordingly, one treated field received 26 pounds of N and 78 pounds P_2O_5 per acre from 200 pounds of 13-39-0 Ammonium Phosphate. The second field received 64 pounds of nitrogen and 80 pounds P_2O_5 per acre from 400 pounds of 16-20 Ammonium Phosphate-Sulfate. Fertilizers were applied with an "Easyflow" ground applicator on October 15, 1953.

Growth Produced:

Forage started growth much earlier on both of the fertilized fields than on the control field. The high nitrogen treatment ($N_{64}P_{80}$) had grazeable feed several weeks earlier than the light nitrogen treatment with equal phosphorus ($N_{26}P_{78}$).

Five exclosures (2x2 feet) were set up in each field. These were clipped once on April 6, 1954, for growth and quality measurements. At this time the grass and alfilaria were relatively mature. Chemical analysis of these samples shows no difference in percent to protein and only slight increases in percent phosphorus in forage from the fertilized fields. Production of total forage, however, from these clippings, showed a 5-fold increase with the $N_{26}P_{78}$ treatment and an 8-fold increase with the higher nitrogen rate ($N_{64}P_{80}$).

YIELD AND CHEMICAL COMPARISON OF CLIPPED FORAGE FROM EXCLOSURES

Fertilizer Treatment	Control	200 lbs/Ac.13-39 Ammonium-Phosphate	400 lbs/Ac.16-20 Amm.Phos.Sulfate
Nutrients Applied	-	$N_{26}P_{78}$	$N_{64}P_{80}$
Dry Matter per Acre in Forage Clipped	245 lbs.	1357 lbs.	2034 lbs.
Chemical Composition of Dried Forage			
% Crude Protein	9.69%	9.38%	9.94%
% Total Phosphorus	.26	.29	.31

Stocking the Fields:

All fields were stocked with selected ewes and single lambs ("pairs") on February 24, 1954. The control field received 30 pair of ewes and lambs on 60 acres, or .5 pairs per acre. The low nitrogen field ($N_{26}P_{78}$) was stocked at the rate of one pair per acre. The high nitrogen field ($N_{64}P_{80}$) received one and a half pairs per acre. These rates were judged to approximate the normal stocking capacity of the unfertilized area and the available feed in the fertilized field, according to a group of farmers and technicians meeting at the experimental area just prior to stocking the fields. The same rates of stocking were maintained throughout the test, keeping the same animals in the same fields without rotation. This was contrary to usual local grazing practice. Several ranchers felt that higher gains would be obtained if the fields had been grazed periodically rather than continuously.

How Much Meat from Fertilization?

All lambs and ewes were weighed into the field at the start of the test on February 24. At the completion, on April 6, all lambs and ewes were again weighed. No shrinkage deduction was made either at the start or the completion of the test.

Average daily gains were highest on the high nitrogen field. Here lambs gained .83 pounds per day in contrast to .72 pounds per day on the control field, even though three times as many were present per acre. The lambs from the high nitrogen field weighed 8 pounds more than those from the control area. Rate of gain and final weight of lambs from the low nitrogen field were about the same as from the control field, though twice the stocking rate was maintained. Ewes in the high nitrogen field gained nearly three-tenths of a pound per day, while those in the control and low nitrogen field made virtually no gain.

The yield of lamb per acre on the control field was 22 pounds, in contrast to 77 pounds on the high nitrogen field and 41 pounds on the low nitrogen field.

Meat due to fertilization has been calculated, as in the cattle tests, by subtracting the production of the control field from the meat yields of the fertilized fields. These gains have been evaluated at 21¢ a pound for lamb. On this basis, the low nitrogen field produced $4.03 worth of extra lamb for a fertilizer cost of $12.00. The high nitrogen field produced 54.7 pounds of $11.49 worth of lamb for a fertilizer cost of $19.00. In this latter field, 25½ pounds of additional mutton were produced from the ewes. This may or may not be of economic importance, but at most could not be evaluated at more than 5¢ a pound of $1.27 per acre.

The results of this test show that lamb production may be increased over three-fold by fertilizer treatment. The value of the extra lamb produced by fertilization in this 62-day test did not pay the entire cost of the fertilizers applied. If the nitrogen in the fertilizer material were evaluated at 15¢ a pound, the lamb gains on both fertilized fields would almost exactly pay for the nitrogen applied. Substantial carry-over may be expected from the phosphorus treatment. The high nitrogen field might have been grazed a month earlier than the actual stocking date. The test was terminated at shearing time, since the fields were drying up for lack of spring rains. Late rains in May brought along additional feed on the fertilized field, which were grazed in May and June but no weight records taken.

LAMB AND MUTTON FROM RANGE FERTILIZATION

Teissiere Brothers - Tehama County

Grazing Period February 24-April 6, 1954 - 62 days

Field Size	60 acres		30 acres		30 acres	
Fertilization						
Fertilizer/Acre	None		200 lbs.13-39		400 lbs.16-20	
Nutrients/Acre	None		$N_{26}P_{78}$		$N_{64}P_{80}$	
Stocking						
Number Animals	30 ewes 30 lambs		30 ewes 30 lambs		45 ewes 45 lambs	
"Pair" Days/Acre	31		62		93	
"Pair"/Acre	.5		1.0		1.5	
Weights	Lambs	Ewes	Lambs	Ewes	Lambs	Ewes
Average in-weight/lbs.	25.5	136	26.8	128	26.8	139
Average out-weight/lbs.	70.0	139	68.3	130	78.1	157
Average daily gain/lbs.	.72	.05	.67	.03	.83	.29
Total gain/acre/lbs.	22.3	1.5	41.5	2.0	77.0	27.0
Fertilizer Gain	-	-	19.2	.5	54.7	25.5
Value of Gain (Lamb @ 21¢)	-	-	$4.03		$11.49	($1.27 - ewes @ 5¢)
Total Fertilizer Cost/Acre			12.00		19.00	
Approximate cost of N			4.00 N		11.00 N	
Approximate cost of P			8.00 P_2O_5		8.00 P_2O_5	

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