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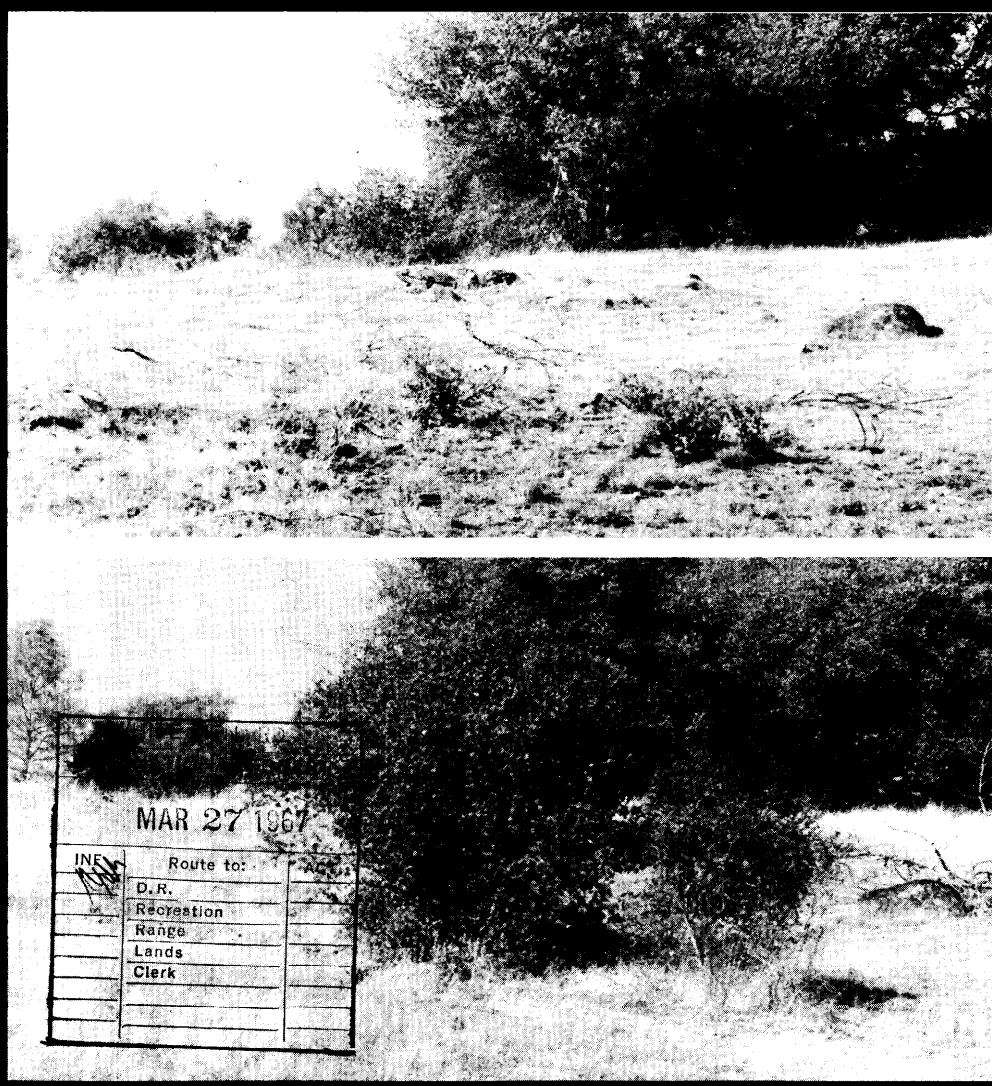

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The American Society of Range Management was created in 1947 to advance the science and art of grazing land management, to promote progress in conservation and sustained use of forage, soil and water resources, to stimulate discussion and understanding of range and pasture problems, to provide a medium for the exchange of ideas and facts among members and with allied scientists, and to encourage professional improvement of members.

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The Journal, published bi-monthly, is the official organ of the American Society of Range Management. The Journal aims to publish something of interest to the entire membership in each issue. The Society, however, assumes no responsibility for the statements and opinions expressed by authors and contributors.

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Post Office Entry. Second-class postage paid at Portland, Oregon, and at additional offices.

Manuscripts. Address manuscripts and correspondence concerning them to the Editor, Journal of Range Management. Instructions to authors appear in the March Journal. Copies are available in the Editor's office.

Reprints. Reprints of papers in the Journal are obtainable only from the authors or their institutions.

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BOOK REVIEWS

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LAND GRABBER

Dense growths of brush like juniper, mesquite and catclaw can rob your land of productivity. With more rangeland needed every day, now is the time to fight such thieves with mechanical brush control.

Now as never before, there is a need for food. To meet the crisis growing in countries throughout the world, many rangeland owners are moving to increase American farm production.

Idle lands are being put into use. And land now falling short is being brought up to its full productive potential.

Brush infested rangelands can play a major part in this program. In most cases, the key is mechanical brush control.

It was, for Beefmaster cattle breeder Leo Jasik. His 516-acre ranch near Pleasanton, Texas could only support one cow per 15 acres because much of it was brush-infested. Then he had 120 acres chained and rootplowed, and sprigged to Coastal Bermuda grass.

Within four months, Jasik was able to put 77 cows on the new pasture. Where one cow grazed before, six cows and their calves have all the grazing they need today. He maintains the same stocking rate year-round.

Beef yields have soared. The calf crop is up from 90% to 98%, calves average 100 lbs. heavier—and the Coastal Bermuda is 8 in. high, thick and spreading.

Jasik has since improved all 516 acres. He expects the full costs to be repaid completely within three years.

Mechanical brush control can help you, too. Prepare your land for tomorrow's needs—and for new profit opportunities for you.

See your Caterpillar Dealer or conservation contractor.

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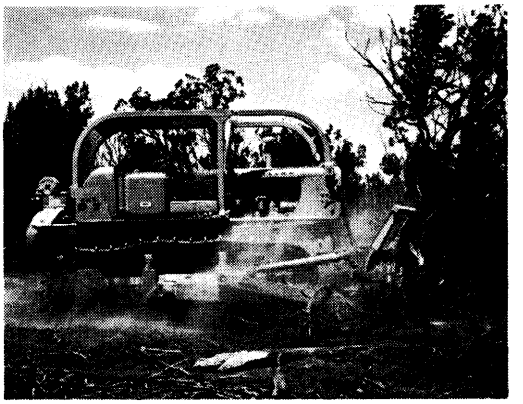

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Editorial

What Are We Going To Do About It?

Charles E. Poulton

Professor of Range Ecology, Oregon State University, Corvallis, and Member, Board of Directors, ASRM.

Dr. Charles E. Poulton

About what? The image of range resources and of range management in the viewpoint of the average citizen! I have just finished reading the chapters on "Grasslands" and on "Wild Animals" in Allen's and Leonard's third edition, CONSERVING NATURAL RESOURCES, PRINCIPLES AND PRACTICE IN A DEMOCRACY. This experience renewed my awareness of and concern about a chronic "disease" that I believe has infected all together too many of us in the Range Management "Profession". Could we call it defeatism or "don't-careitis"? We are not doing a sufficiently vigorous and dedicated job of selling the importance of this tremendous natural resource for which we are responsible, of building a greater appreciation for what modern range management is, of making "John Doe citizen" more aware of how society benefits from healthy, productive ranges and what the livestock industry has been doing to help improve this important natural resource, of stimulating a more widespread appreciation that healthy range resources are basic to the productivity of big game populations as well as the western range livestock industry. By these omissions, we make it harder for authors like Allen and Leonard to do a good job when they talk about *our field* and the resources with which we are concerned.

My first reaction upon reading the above chapters was one of great disappointment—almost of anger and disgust—that two knowledgeable people would cut range resources so short in writing a book widely used in conservation courses across the country. I was particularly concerned that the philosophy and attitudes they expounded do not represent the 1966 brand of range management which has seen conflict between the professional and the stockman evaporate like the morning fog on a sunny day—the kind of range management which is seeing great programs of resource improvement carried to successful conclusion, the kind of dedication by both professional and user that is seeing increase in Federal permits to livestock ranchers as a result of good management, research that is developing new technology for the improvement of important game ranges—the kind of range management that is cognizant of the multiple-use-management concept and is working hard to resolve old or fancied conflicts with forestry and with wildlife and to prevent conflicts with the rapidly developing recreational use of important range lands. No, I couldn't blame all these oversights on the authors of this widely used book.

If we had been doing our job thoroughly and talking range management instead of excusing it or hiding it under such misleading, politically expedient blankets as "wildlife habitat", its importance and nature would have been so clear to these authors that we might have seen two instead of one chapter on range. The presentation would have been up to date. It would have clearly established this resource as the food and cover base for *both* wildlife and domestic livestock populations and as the core of watershed protection and quality on millions of acres. The chapter might even have been titled "Range Resources". One can't ignore the obvious — you know when the sun is shining, if you're awake. More than just lovers are aware of a full moon but it is mighty easy for any of us not to notice the thin sliver of a new moon just peeking up or (I sometimes wonder) sinking over the horizon.

There is unrealized opportunity for qualified range people to write for the layman—to write voluminously about the wise use and management of range resources and what they mean to our national life and to the world. All you have to do is just introduce an elementary or secondary school teacher of Conservation or Biology to the true importance of range resources and you will hear exclamations like, "Oh! Why, I didn't realize . . . ; where can I get more information? Tell me more!" But, we are not telling the story of range resources and range management to one of our best allies and "evangelists"—the conservation teacher and textbook writer. We are denying them the tools with which to work. WHAT ARE WE GOING TO DO ABOUT IT?

Supplemental Protein Levels for Calves and Yearlings Grazing On Winter Bluestem Pasture[1]

E. F. SMITH, K. L. GNADT, C. V. DeGEER, D. RICHARDSON, F. W. BORDEN, AND G. F. KRAUSE[2]

Animal Husbandman; Graduate Student; Research Assistant; Animal Husbandman; Associate Animal Husbandman; Statistical Consultant; Departments of Animal Husbandry and Statistics, Kansas Agricultural Experiment Station, Manhattan.

Highlight

One lb/head daily of soybean oil meal pellets was adequate supplemental protein for yearling steers grazing winter bluestem pasture when followed by summer grazing that permitted the steers to compensate for low winter gains. Calves responded to additional supplemental feed, energy or protein with efficient gains.

Native bluestem pasture in Eastern Kansas is highest in nutritive value during the first two or three months of the growing season, May through July, and depending somewhat on environmental factors, steadily declines in nutritive value to a low in late winter, February and March. Traditionally, it has been used during the spring and summer when it is highest in nutritive value and has been used for winter grazing in only a limited way, but its winter use has steadily increased.

Cattle gains on bluestem pasture are much lower in winter than in the summer (Smith et al., 1960) and it is the usual winter custom to feed some type of supplemental feed to increase weight gains.

This investigation was to determine response to supplemental protein fed at different levels by young cattle grazing winter bluestem pasture.

Materials and Methods

The experiments were conducted from 1952 to 1964 at the Kansas Agricultural Experiment Station at Manhattan on native bluestem range six miles northwest of the campus. The vegetation is typical true tall grass prairie. Big bluestem *(Andropogon gerardi)*, little bluestem *(Andropogon scoparius)*, and indian grass *(Sorghastrum nutans)*, make up between 50 and 60% of the total vegetation on the ordinary upland and limestone break sites, as described by Anderson and Fly (1955). Each experiment is a summary of one or more trials and each trial included a winter supplemental feeding period and a summer grazing period when no supplement was fed. The winter period usually extended from November or December to April and the summer period, from April to August or September. During the winter when snow covered the grass, an average of 190 lb of grass hay was fed per animal per winter.

Experiment I — Forty-four Hereford heifer calves were divided into two treatment groups, one group was fed an average of 2 lb/head/day of soybean oil meal pellets (.92 lb of crude protein) during the winter grazing period; the other, 2 lb of ground sorghum grain (.23 lb crude protein). Each group received approximately the same amount of supplemental energy. Dicalcium phosphate was added to the supplements to equalize supplemental phosphorus intake at about 15 g/heifer/day; vitamin A, to supply 15,000 IU/heifer/day. Salt was always available.

Experiment II — Sixty-one Hereford heifer calves were used in three trials, two treatment groups per trial, with 10 to 11 heifers per group. During the winter grazing period one group got twice as much alfalfa as the other. Ground shelled corn was fed to the group receiving the smaller amount of hay to minimize the difference in energy intake. Crude protein intake for the doubled alfalfa hay was approximately 1.07/lb/head/day; from the corn and alfalfa combined, .76 lb. Salt and a mixture of equal parts by weight of salt and bonemeal were available during the winter period.

Experiment III — Three trials were conducted with three experimental treatment groups of steers per trial, 10 Hereford steer calves per group, or 30 steers per treatment. During each winter grazing period these supplements were compared (lb/head/day): 1 lb of soybean oil meal pellets (.46 lb crude protein), 1 lb soybean oil meal pellets and 1 lb ground shelled corn (.56 lb crude protein), 2 lb soybean oil meal pellets (.92 lb of crude protein). Salt and a mixture of salt and bonemeal (equal parts by weight) were available during the winter grazing period.

Experiment IV — Three trials were conducted with two experimental groups of yearling Hereford steers per trial, 10 steers per group, or 30 per treatment. During the winter grazing period in each trial one group of steers was fed 1 lb/head/day of oil seed meal pellets; the other, 2 lb (Soybean oil meal pellets were fed in trials 1 and 3 and cottonseed oil meal pellets in trial 2). Approximately .42 to .46 lb/head/day of crude protein was supplied to the group at the lower level of supplementation depending on whether cottonseed or soybean oil meal was fed, while the intake of supplemental crude protein for the other group was twice that much. The steers were rotated on pastures during the winter to minimize pasture differences. During the winter period a mixture of equal parts by weight of bonemeal and salt and also salt alone were available.

---

[1] *Contribution No. 335, Department of Animal Husbandry, Kansas Agricultural Experiment Station, Manhattan.*

[2] *G. F. Krause is now Associate Professor, University of Missouri, Columbia.*

Results

Experiment I — A highly significant ($P<.01$) increase in weight gain was obtained during the winter grazing period and for the combined winter and summer period ($P<.01$) by winter supplemental feeding of soybean oil meal pellets compared with ground sorghum grain (Table 1). Summer gains were higher for steers fed sorghum grain, but not significantly so.

Table 1. Protein and energy winter supplements (2 lb/head/day)[1] for heifer calves on winter bluestem pasture.

Item	Ground sorghum grain	Soybean oil meal
No. of heifers	22	22
Initial wt, lb	429	432
Daily gain, lb		
Winter (146 day)	.06	.45**
Summer (147 day)	1.54	1.33
Total (293 day)	.80	.89**

[1]Dicalcium phosphate was added to equalize phosphorus intake at 15 gms. per head daily; 15000 I.U. vitamin A per heifer daily was included; salt was always available.
**=$P<.01$

Experiment II — Differences in weight gain between heifers fed an average of 7.3 lb/head/day of alfalfa hay and those fed 3.7 lb of alfalfa hay and 2.2 lb of ground shelled corn were not significant, although those fed the combination tended to perform slightly better (Table 2). The .76 lb of supplemental crude protein supplied by the grain and alfalfa combination was adequate protein for the calves.

Experiment III — During both the winter supplemental feeding period and the combined winter and summer grazing period, steer calves receiving 1 lb of soybean oil meal pellets gained significantly ($P<.05$) less than either steers receiving twice that quantity of soybean pellets or those receiving a combination of pellets and corn (Table 3). The .56 lb of crude protein supplied per steer daily by the combination of soybean pellets and corn provided adequate protein supplementation to the winter grass.

Table 2. Results from feeding two levels of alfalfa hay (in lb/head/day) to heifer calves on winter bluestem pasture (summary of three trials).[1]

Item	3.7 lb alfalfa hay 2.2 lb gr. shelled corn	7.3 lb alfalfa hay
No. of heifers	30	31
Initial wt, lb	488	492
Daily gain, lb		
Winter (127 day)	.54	.34
Summer (108 day)	1.80	1.82
Total (235 day)	1.12	1.02

[1]A mixture of equal parts by weight of salt and bonemeal was available during the winter. Salt was always available.

Experiment IV — The weight gains of yearling steers fed two levels of winter supplemental feed while grazing bluestem pasture are presented in Table 4. For the winter feeding period the steers fed 2 lb of oil seed meal pellets gained significantly ($P<.05$) more than those fed 1 lb. There was no significant difference in weight gain during the summer grazing period although the steers fed at the lower level gained more. For the combined winter and summer period the two treatments gave no significant difference in weight gain. Each steer was graded at the close of the test, using U.S.D.A. Feeder Cattle Grades, with no significant difference in grades between the two treatment groups.

Discussion

The larger quantities of protein fed, as the 2 lb/head/day of soybean oil meal (.92 lb of crude protein) and the 7.3 lb of alfalfa hay (1.07 lb of crude protein) seemed excessive since calves receiving lower quantities of protein with about the same amount of energy gained just as well.

Results were measured on the basis of weight gain only; higher

Table 3. Results from indicated levels of protein and energy (in lb/head/day) for steer calves grazing winter bluestem pasture (summary of three trials).[1]

	1 lb soybean meal	1 lb soybean meal and 1 lb corn	2 lb soybean meal
No. of steers	30	30	30
Initial wt, lb	505	507	508
Daily gain, lb			
Winter (126 day)	.35*	.51	.60
Summer (109 day)	1.88	1.89	1.87
Total (235 day)	1.07*	1.16	1.19

[1]A mixture of salt and bonemeal (equal parts by weight) was available during the winter and salt was always available.
*=$P<.05$

Table 4. Results from indicated levels of supplementation for yearling steers on winter bluestem pasture (summary of three trials).[1]

	Oil seed meal pellets head/day[2]	
	1 lb	2 lb
No. of steers	30	30
Initial wt, lb	689	687
Daily gain, lb		
Winter (143 day)	.45	.71*
Summer (110 day)	2.16	1.95
Total (253 day)	1.20	1.25

[1]A mixture of salt and bonemeal (equal parts by weight) was available during the winter, salt was always available.
[2]Oil seed meal pellets were soybean in two trials and cottonseed in one.
*=$P<.05$

Table 5. Composition of feeds in percent.[1]

Item	Moist.	Protein (N X 6.25)	Crude fiber	N-free extr.	Ca.	P.
Soybean oil meal pellets	8.63	45.93	5.01	29.90	0.33	0.59
Cottonseed oil meal pellets	7.95	41.63	11.80	28.49	0.16	1.14
Ground shelled corn	12.04	10.08	1.93	70.72	0.01	0.33
Alfalfa hay	8.61	14.71	33.03	35.65	1.20	0.39
Ground sorghum grain	11.39	11.75	2.81	69.49	0.03	0.36
Bluestem pasture[2]						
June		9.37	32.67	47.40	.38	.14
August		8.00	32.12	49.57	.45	.09
October		4.79	32.62	51.99	.53	.06
December		4.10	35.67	49.62	.46	.05
February		3.10	34.58	51.12	.46	.08
April		2.98	33.60	50.00	.51	.07

[1] Analyzed according to A.O.A.C. methods. (1955).

[2] Bluestem pasture grasses, composite, moisture free basis.

protein levels may not be excessive for such functions as reproduction, stress, or longevity. Turman et al. (1964) pointed out that feeding low supplemental levels may be false economy for developing females. Where 2 lb/calf/day of sorghum grain was fed, supplying only .23 lb of protein, no winter gain was obtained. However, the summer gain was large and compensated partially for the lack of winter gain. The combination of 1 lb of soybean meal and 1 lb of corn, supplying a total of .56 lb of crude protein, and the combination of 3.7 lb of alfalfa hay and 2 lb of corn, supplying a total of .76 lb of crude protein gave results as good as did higher levels of protein. McIlvain et al. (1955) has recommended 1 lb/head/day of cottonseed meal for calves on winter range in western Oklahoma. Bohman et al. (1961) reported that energy and protein supplements increased gains of beef calves on a semi-desert range and that the protein supplement (1 lb/head/day of soybean meal or the equivalent) increased gains more than did energy (1 lb of barley). Yearling steers in Experiment IV gained just as well on 1 lb of soybean oil meal as 2 lb where performance was measured by combined winter and summer gain.

Chemical analyses of the grass (Table 5) indicate that additional feed may be used to advantage as the winter progresses and nutritive value of grass declines markedly. Extremes in weather as well as grass quality, condition of the animals, and future animal use suggest varying the level of protein to fit local conditions.

Summary

Four experiments were conducted with young growing beef animals to determine response to various protein levels in winter supplement feeds. All experimental animals were on native bluestem pasture for a winter and summer season, but supplements were fed only during the winter period.

Heifer calves gained more during the winter supplemental period and for the year when fed 2 lb/head/day of soybean oil meal pellets than when fed ground sorghum grain. They gained as well on 3.7 lb of alfalfa hay and 2.2 lb of ground shelled corn as when fed 7.3 lb of alfalfa hay. Steer calves gained less when fed 1 lb of soybean pellets than when fed 2 lb, however 1 lb of corn and 1 lb of soybean pellets were just as effective as 2 lb of soybean pellets.

Yearling steers gained just as well when fed 1 lb/head/day of such protein supplement as soybean oil meal pellets as when fed 2 lb when the winter grazing period was followed by a summer grazing period that permitted low winter gains to be offset.

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Economics of Selected Alternative Calving Dates

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Highlight

Shifting calving dates from present early spring to fall or late spring dates offers an opportunity to increase income to range-based cattle operations in north central or northeastern Washington. Lower death losses and better marketing opportunities more than offset higher winter feed costs. Fall calves also make more efficient use of abundant spring ranges in this region, and dry cows make more uniform use of mountain summer ranges.

Ranchers have limited opportunities to adjust or inovate practices which will increase their income. An important part of this restriction can be accounted for by the fact that many of the costs of operation are "fixed", and not subject to change by adjusting numbers of brood cows. Expenses related to depreciation of buildings, equipment, and bulls, as well as cash items such as insurance, mortgage, interest, and property taxes do not vary with level of stocking on a given ranch so are known as fixed costs. Thus, if a ranch is not operating at or near capacity, the cost per unit of beef produced will likely be higher than necessary.

Recent studies in Washington have shown that 50 to 80% of the costs in range based cow-calf operations fall in the category of fixed costs (Mueller, 1966). This situation has stimulated some ranchers to seek alternative practices, in addition to full stocking, to increase the margin of profit. One such possibility is to shift calving from the traditional early spring date (February-March) to fall (September-October) or late spring (April-May).

It is not possible to determine the economic feasibility of such changes by comparing incomes to actual ranch operations under the different systems because there are too few ranches practicing the proposed changes. It is feasible, however, to construct a hypothetical "model" ranch operation and compare "budgets" for this model when the changes have been incorporated. It is the purpose of this paper to report our analysis of the economic opportunities of these different calving seasons.

Procedure

An "average" 170 brood cow ranch was synthesized, based on data obtained in a survey of actual operations in the region (Mueller, 1966). Six budgets were calculated for the model, showing income for three early spring calving operations at differing calving percentages, two fall calving operations and one late spring calving operation. The two variations in fall calving considered were (1) a 96% calf crop, and (2) a 10% increase in brood cow numbers, to adjust for increased grazing capacity using this system.

In this paper, interest on the investment has been omitted from calculation of total expenses because ranchers are generally willing to forego this income in return for other difficult-to-evaluate income items such as land appreciation, income tax advantages, and the value of ranching as a "way of life" (Martin and Jefferies, 1965). Hired labor has been included in operating expenses. Operator and family labor was assigned a wage of $1.50/hour.

Results and Discussion

Table 1 presents synthesized budgets for a model ranch operating at full capacity (170 head) on a program of early spring calving. In Budget 1, annual net income above cash costs, depreciation, and the charge for labor is $1,435.00 with a total cost/lb sold of 20.68¢. This favorable return is due primarily to the relatively high weaned calf crop of 92%.

Budgets 2 and 3 depict the same operation, but with 80 and 70% weaned calf crops. These smaller calf crops are projected on the basis of experience with higher mortality in early spring due to bad weather, calf scours, and other causes. Scours is particularly contagious at this season because the herd is usually confined to a congested feed yard under wet, cold, and unsanitary conditions.

Initially, the prices projected for cattle were the same in all budgets. However, it was noted that livestock prices are often at a seasonal low in the fall when spring calves are usually marketed. An investigation of seasonal price fluctuations for the past 10 years at the Spokane and Portland markets revealed that April-May calf prices (when fall calves are sold) were frequently 5¢/lb higher than September-November prices. Thus, in calculating the relative economic advantage, fall-dropped calves were conservatively given a 2¢/lb price advantage.

Budget 4 shows the relevant figures for the ranch operation when changed to fall calving. Cash costs increased due mainly to increased winter feed purchased. No excess capacity in terms of spring and fall grazing was required. Some costs decreased slightly, such as hired labor at calving time and veterinary supplies. Overall, the increased feed costs were more than offset by the decreases noted above, plus additional income generated by the increase in pounds sold. A total calculated cost/lb sold of 20.60¢ shows a slight advantage over early

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Table 1. Summaries of budgets—170 cow unit with changes in calving dates.

Item	Budget 1 Data	Budget 1 TCLb¢[1]	Budget 2 Data	Budget 2 TCLb¢	Budget 3 Data	Budget 3 TCLb¢	Budget 4 Data	Budget 4 TCLb¢	Budget 5 Data	Budget 5 TCLb¢	Budget 6 Data	Budget 6 TCLb¢
Calving Season	ESC[2]		ESC		ESC		FC[3]		FC + 10[4]		LSC[5]	
Calf crop %	92		80		70		96		96		94	
Lb. beef sold	80,650		72,610		64,900		86,300		96,650		84,950	
Lb. beef sold/cow	474		427		382		508		517		500	
Total Revenue	18,112		16,169		14,298		20,569		22,945		20,232	
Operating Expenses	9,581	11.88	9,581	13.20	9,581	14.76	10,686	12.38	11,985	12.40	10,892	12.82
Income net/cash costs	8,531		6,588		4,717		9,883		10,960		9,340	
Depreciation	2,596	15.10	2,596	16.77	2,596	18.76	2,596	15.39	2,846	15.35	2,596	15.88
Income net/cash costs and depreciation	5,935		3,992		2,121		7,287		8,114		6,744	
Labor, operator & family	4,500	20.68	4,500	22.97	4,500	25.70	4,500	20.60	4,500	20.00	4,500	21.17
Income net/cash costs, depreciation, and family labor	1,435		−508		−2,379		2,787		3,614		2,244	
Total Cost/cow		98.10		98.10		98.10		104.60		103.27		105.81
Total Cost/cow no labor		71.63		71.63		71.63		78.13		79.31		79.34

[1]TCLb¢=Total cost/lb beef sold (¢)
[2]ESC=Early spring calving
[3]FC=Fall calving
[4]FC+10=Fall calving, 10% increase in brood cows to 187
[5]LSC=Late spring calving

spring calving. The 96% weaned calf crop in Budget 4 reflects fewer calving difficulties encountered in fall calving.

In Washington and some other western states many ranchers have an excess of spring and fall grazing. The publicly-owned summer range is often the resource limiting the size of the cow herd. With fall calving, some ranchers are now producing calves weighing 400 lbs or more for sale by late May. This is usually just before turnout on the publicly-owned range. By selling the calves in late May and breeding in late fall, the load on summer range is reduced by two factors: (1) no calves are grazed, and (2) bulls, approximately five percent of the herd, won't have to be turned out with the cows until breeding time in late fall after the cows have been removed from the public range. This reduction in summer grazing load, through fall calving, might appeal to both rancher and public administrator. If the summer range is in poor condition, the reduced grazing pressure would help improve range condition.

If, however, a given rancher's public range allotment is in good condition, he might increase his cow herd to utilize the excess grazing capacity made available by removal of calves and bulls. It is estimated that fall calving could enable ranchers to increase cow herds by at least 10%. This is particularly true in Washington where excess spring forage is available on low altitude annual grass ranges and fall forage is available as aftermath in grain and hay fields.

An additional advantage in utilizing the grazing capacity would be realized because dry cows are more easily distributed over rough ranges, making more efficient use of the entire forage crop. The grazing capacity of a unit is the capacity of the key grazing areas plus whatever forage can be taken from remote and secondary areas. Lactating cows tend to be poor travelers, returning to find their calves and to drink water to keep milk production up. An increase of five to 10% in grazing capacity could be realized on this factor alone. A group of Forest Service administrators confirmed this estimate in conversation with the authors. The results of a 10% increase in the cow herd on the model ranch is given in Budget 5. Annual net income has increased approximately $800 and total cost/lb of beef sold declined to 20¢.

Fall calving might also allow increased use of artificial insemination in beef herds. Since breeding is between November 15 and January 15, the cattle are close to the ranch buildings better enabling the operator to detect heat periods. Artificial insemination allows a reduction in bull numbers to only a few for cleanup purposes. When considering artificial insemination, each rancher has to evaluate closely all costs associated with keeping bulls, in addition to determining if the timing is feasible.

In many areas fall calving is not feasible because of the poor quality of fall grazing. However,

some ranchers in these areas are calving later in spring. This practice enables them to obtain a higher weaned-calf crop than earlier calving and to have salable calves for the higher calf prices in February and March. Budget 6 summarizes costs and income for late spring calving on the sample model ranch. The net income of $2,244.00 in Budget 6 compares favorably with Budgets 1 and 4 and greatly exceeds Budgets 2 and 3.

Conclusions

Under the conditions imposed in the model ranch of this study, fall calving offers an economic advantage to early spring calving. The advantages of fall calving include: (1) lower death losses leading to higher percentage weaned calves, (2) higher prices for spring marketed calves, (3) closer correlation between season of green feed and the calves' ability to utilize forage, (4) the possibility of increasing brood cow numbers on public summer ranges, and (5) the opportunity to use artificial insemination procedures. Late spring calving, followed by winter marketing, offers a second alternative which may be more profitable than early spring calving.

Marketing flexibility is highly dependent upon available grazing. In any given year the outlook for heavier-weight calves for summer or fall sale may be more favorable than for lighter weight calves in spring (Miller, 1963). The rancher who fall calves has additional flexibility because he can hold his calves for the possibility of more favorable prices, thus adding the option of a cow-yearling operation.

A natural way to shift to fall calving would be to breed replacement heifers and some cows to calve in the fall. In five successive years following such a practice the entire herd could be shifted. In this way the rancher can test the advantages and disadvantages of fall calving without committing the entire herd. In essence, he may practice split calving for about five years, which may in the end turn out to be a better method of operation for him than either spring or fall calving.

All the public land policy implications imposed by fall calving have not yet been determined. However, public land administrators should welcome the opportunity to decrease the grazing pressure on ranges which have traditionally been overstocked.

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Effects of Herbage Removal on Seedling Development in Cane Bluestem

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Highlight

A single harvesting of as much as 60% of current herbage at any stage of seedling development did not significantly depress root and herbage production of cane bluestem plants grown in a greenhouse. Ninety percent removal was detrimental to subsequent root and herbage growth.

The major objective of range management is to obtain maximum sustained animal production consistent with perpetuation of the natural resources. It is important, then, to know the degree to which plants can be grazed without permanent injury. Little is known in this regard concerning seedling grasses. Criteria are needed for judging the grazing readiness of grass seedlings, especially those which can be related to stages of plant development that can be identified in the field. The research reported here sought to identify and relate such stages to the effects of herbage removal on subsequent root and shoot development.

Review of Literature

A number of related studies have been conducted to determine the effects of removing shoots from grass plants on the subsequent growth of roots. Most of these studies showed that cropping (clipping or grazing) will reduce subsequent plant growth, especially root growth, if the cropping is either frequent or excessive. The initial response to grazing or clipping is the interruption of root elongation (Parker and Sampson, 1931; Crider, 1955). Continued defoliation reduces the number and depth of penetration of grass roots (Jacques, 1937; Albertson et al., 1953; Ruby and Young, 1953; Cook et al., 1958). The amount of reduction is directly related to the intensity and frequency of defoliation (Graber, 1931; Thaine and Heinrichs, 1951; Albertson et al., 1953; Thaine, 1954).

According to Crider (1955), a single clipping that removed most of the foliage caused roots

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to stop growing for periods ranging from 6 to 18 days. When these clippings were repeated periodically, as in a system of rotation grazing, root growth of all grasses stopped for periods that ranged from 25 to 45 days during the growing season. The percentage of roots with interrupted growth was proportional to the amount of the foliage which was removed. Schuster (1964) found that, in general, the reduction in root systems of individual forage species on ponderosa-pine-bunch-grass ranges was proportional to the amount of use. Heavily grazed plants had roots with progressively fewer, more sparse and shorter branches.

The effects of clipping frequency on development of seedling grasses was reported by Robertson (1933) and by Thaine and Heinrichs (1951). Robertson found that clipping reduced the growth of both roots and shoots in seedlings of *Bouteloua gracilis, Bromus inermis, Sorghum sudanensis* (Robertson's *Holcus sorghum sudanensis), Koeleria cristata, Poa pratensis* and *Stipa spartea.* Of these, *Koeleria cristata* was least affected. He concluded that removal of the aerial parts of grass seedlings has an immediate injurious effect which was manifested both above and below ground; and that the extent of injury depended largely upon the nature of the species and frequency of the treatment. Thaine and Heinrichs showed that the total yield of roots on Russian wildrye (*Elymus junceus* Fisch.) declined progressively as the number of clippings increased.

Procedure

The study was divided into two parts. First, the ontogenetic expressions were determined for plants of cane bluestem, *Andropogon barbinodis* Lag., grown from seed. Second, the clipping studies were correlated with designated stages of plant development as expressed morphologically.

In the second phase, cane bluestem plants were grown in a greenhouse during the spring and early summer of 1965. This phase pertained to various clipping intensities within the pre-, 4-, 8-, and 12-tiller stages which were clipped to remove 30, 60, or 90% of the above-ground herbage. Data were subjected to an analysis of variance for a completely randomized design with 10 replications for each treatment. An additional 10 plants were allowed to reach maturity with no clipping. Anthesis of the inflorescence of the primary culm was used as the criterion for maturity. The control plants were purposely confounded and could not be included in the analysis of variance of the clipped plants. Mean comparisons of the clipped and unclipped plants were subjected to the Student's "t" analysis.

The various intensities of cropping were designed to remove assigned percentages of foliage (leaf and stem) weight, and are referred to as degree of use, percent use, or utilization. The stubble height corresponding to each degree of use was determined from height-weight clipping studies on five additional plants grown to the designated stage of development.

Each plant except the control was clipped to the designated stubble height and was not clipped again. Data collected at the time of clipping included oven-dry weight of clipped leaves and culms, number of tillers, length of plants, and number of nodes and leaves on the principal culm. The roots and all above ground vegetative material were harvested for all plants at maturity of the control plants.

In both phases, the plants were grown in one-gallon cans filled with a potting mixture consisting of equal parts of sand, peat moss, and perlite. Each can was planted with several caryopses. The emergent plants in all pots were selected for uniformity, and each pot was thinned to leave one seedling. The pots were watered equally with a 20% solution of 10-52-17 fertilizer. The harvested plant material was dried for 8 hr in a forced-draft oven at 60 C prior to weighing.

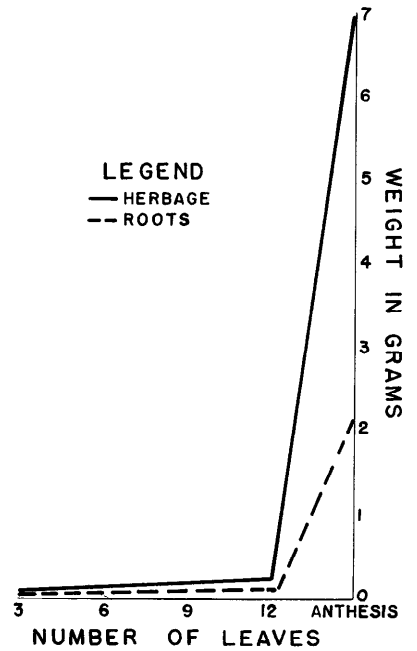

FIG. 1. Root and herbage production of cane bluestem plants from seedling emergence to maturity.

Results and Discussion

The first phase of the study revealed that the seminal root grew rapidly until three leaves were unfolded. Beginning at this time, the increase in root weight was very slow until the plant had 12 leaves, after which the initiation and extension of roots proceeded very rapidly. The first tiller buds at the base of the main stem were not evident externally until nine leaves had unfolded. The number of secondary stems increased rapidly, and their development generally proceeded concurrently with the rapid increase in root production (Fig. 1). It would seem that any reduction in photosynthetic tissue prior to the time second-

Table 1. Characteristics of cane bluestem plants harvested by clipping at different intensities at various stages of seedling development and compared to unclipped plants.

Tiller Stage	Days between Clippings	Percent removal	Number of tillers	Herbage weight grams[1]	Root weight, grams
PRETILLER	0	90	13.6	12.01	2.13
		60	14.8	16.99	2.65
		30	14.3	15.74	2.74
4	11	90	15.4	11.41	2.34
		60	16.8	15.57	2.52
		30	15.7	18.28	3.29
8	11	90	15.4	11.41	2.34
		60	16.8	15.57	2.52
		30	13.6	16.69	3.17
12	13	90	16.4	9.99	2.00
		60	14.8	13.50	2.22
		30	17.7	17.69	2.98
CONTROL	16	0	14.0	15.34	2.93

[1] Sum of weight of above ground vegetative material removed at maturation plus weight of material removed at clipping. Oven-dried at 60 C for 8 hr.

ary culms were produced would be harmful to the plant.

The effect of clipping on subsequent root production varied with the intensity of the clipping and the stage of development at which the clipping was done (Table 1). An analysis of variance of the clipped plants revealed a significant difference at the .05 level in root development due to intensity of use, regardless of the stage of development.

The analysis indicated a decline in root production with successively greater intensities of use. However, when the amount of root production from plants clipped to different intensities of use were compared with the amount of roots produced by the unclipped plants, only the 90% degree of use significantly reduced root growth (Table 2).

Light use appeared to stimulate root production as compared to no use, but this could not be demonstrated statistically. Average root production for the control plants was 0.95 g greater than that of 90% use; 0.38 g greater than 60% use; and 0.12 g less than 30% use.

Herbage production from plants subjected to varying degrees of use followed the same pattern as root production (Table 1). Although the light degree of use appeared to stimulate herbage production, only the plants which were clipped most severely differed significantly from the unclipped plants in yield of herbage (Table 2).

Table 2. Comparison of mean values (g) between control and different clipping intensities as to their effect on root and herbage development (all dates).

Development and Treatment	Clipping intensity, % 30	60	90
Roots			
Control	0.12	− 0.38	− 0.95*
30%	——	——	− 1.07*
60%	——	——	− 0.57*
Herbage			
Control	1.79	0.23	− 5.18*
30%	——	− 1.56	− 6.97*
60%	——	——	− 5.41*

* Significant difference at 95% probability level.

Even though an interaction between intensity and tiller stage could not be statistically demonstrated, it appeared that 90% use at the 8-tiller stage depressed the yields of both root and herbage more severely than clipping at any other stage of development (Table 1). This may be related to the ontogenetic development of seedlings. Root and shoot development were slow until 3 or 4 tillers were initiated (Fig. 1). Development of both was concurrent and rapid after this stage. Therefore, excessive removal of photosynthetic material during this period could have a very adverse affect on subsequent development. The effects of herbage removal prior to this stage could be offset with sufficient time to recover and removal after this stage could be partially offset with greater root and herbage development prior to clipping.

This study has shown that if further development of grass roots is interrupted for 6 to 18 days, as recorded by Crider (1955), this interruption is not reflected in total production after post-harvest intervals ranging up to 51 days except with removal of 90% of the herbage. Both Robertson (1933) and Thaine and Heinrichs (1951) demonstrated that repeated harvesting of seedlings was detrimental. The results from this study indicate that seedlings can be harvested judiciously the first year without damage, provided the harvesting is neither excessive nor prolonged.

This study has shown that as much as 60% of the herbage can be removed from new plants at any stage of development without depressing the production of either roots or herbage. Although it was not demonstrated conclusively, there was some indication that a single harvesting of 30% of the herbage might stimulate subsequent growth.

Summary and Conclusions

The effects of removing 30, 60, and 90% of the herbage at several stages of development (pretiller, 4-tiller, 8-tiller, and 12-tiller stage) was studied using first-year plants of cane bluestem. Subsequent growth of both

roots and shoots were compared with production from undisturbed plants under greenhouse conditions.

It was concluded that:

1. Removal of 90% of the current herbage at any stage of plant development was detrimental to further root and herbage growth.
2. Removal of as much as 30 and 60% of the current herbage at any stage of plant development was not detrimental to subsequent root and herbage production when compared with yields from unclipped plants.

From this study, the effects of herbage removal on first-year plants of cane bluestem are related to the degree of utilization, but show no definite correlation with the stage of development.

This study was conducted in a greenhouse under more or less optimum growing conditions. Further testing under field conditions may introduce considerations not evident here. Nevertheless, it demonstrated that, under the conditions specified, first-year plants of cane bluestem could withstand herbage removal of as much as 60% at very early stages of seedling development as well as later without undue harm to the plant and subsequent growth.

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Germination of Range Plant Seeds at Alternating Temperatures[1]

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Highlight

The germination behavior at alternating temperatures of range plants suitable for seeding semi-arid range was consistent with their behaviour at the fixed temperatures of the alternation cycle, but not with weighted mean daily temperature. Unfavorable temperatures produced a greater retardation of germination than would be expected from their relative influence on the weighted mean. Alternating temperatures did not stimulate germination in the species studied. These data support conclusions from previous work regarding low seedbed temperatures as a factor in the failure of semi-arid range seeding operations.

[1]*This research has been financed in part by a grant made by the U.S. Department of Agriculture, under P.L. 480, contract No. A10-CR-45. Contribution from the National and University Institute of Agriculture, Rehovot, Israel, 1966, Series No. 1017 E.*

In the first part of this investigation (Ellern and Tadmor, 1966; hereafter referred to as part I), germination behaviour of pasture plants at fixed temperatures under laboratory conditions was interpreted in the light of soil temperatures recorded in the field.

In the semi-arid Negev, diurnal temperature fluctuations in the seedbed zone of shallow seeded range plants normally reach an amplitude of about 20C on bright dry days and about 10C during cloudy and rainy periods (Tadmor et al., 1964). The bluegrasses (*Poa* spp.), orchardgrass (*Dactylis glomerata* L.), Bermuda grass (*Cynodon dactylon* L.) and others have been shown to respond to such fluctuations and to germinate only or better at alternating temperatures (Harrington, 1923; Morinaga, 1926; Lehmann and Aichele, 1931). The question therefore arose whether the species investigated also respond in this way; whether their germination at alternating temperatures is consistent with that at fixed temperatures; to what extent germination is a function of hour-degrees and how it is affected by the amplitude between temperature extremes. Investigations at fixed temperatures only might be insufficient to explain plant establishment in the field.

The contributions of Harrington (1923) and Morinaga (1926) to this topic as well as Lehmann and Aichele's (1931) comprehensive review of work on gramineae are still of importance today. Stotzky and Cox (1962) and especially Cuddy (1963) and Nakamura (1962a, b) working on pasture species, employed alternating temperatures along with other techniques primarily as a means of forcing germination, rather than of investigating their role as an environmental factor. Went (1949), Juhren, Hiesey and Went (1953), and Hylton and Bement (1961) have made comprehensive studies of germination and early growth of range plants, conducting parallel trials in the field and in a variety of fully controlled environments; these investigations however do not include many of the species and environmental conditions investigated in the present study.

Table 1. Summary of germination behavior at fixed temperature of range plants: Adverse effect of temperature extremes as indicated by days to onset, to full germination, and final germination percentage at low (4-10C) and high (25-30C) temperatures. Minus = adverse effect; plus = no adverse effect.

Species	Susceptible to adverse effect of:					
	Low temp. (4-10C)			High temp.(25-30C)		
	onset	full	final	onset	full	final
1. *A. desertorum* (Fairway)	−	−	−	+	+	+
2. *A. desertorum* (Nordan)	−	−	+	+	+	+
3. *Phalaris bulbosa*	−	−	+	+	+	+
4. *Oryzopsis holciformis*	−	−	−	+	+	−
5. *Hordeum bulbosum*	+	−	+	−	−	−
6. *Avena sterilis*	−	−	+	+	−	+
7. Barley (Beecher)	+	+	+	+	+	+
8. Wheat (Florence Aurore)	+	+	+	+	+	+
9. *Medicago hispida*	+	+	+	+	−	−
10. *M. truncatula*	+	+	+	+	−	+
11. *Trifolium purpureum*	+	+	−	+	+	−

Methods and Materials

Experimental procedure — Temperature alternations were within the temperature range commonly encountered in the seedbed zone (2-5 cm soil depth) during the winter (sowing) season in the semi-arid Negev. They included most of the possible combinations between temperatures of 4, 8, 10, 15, 20 and 25C and were applied by transferring petri dishes containing seeds to and fro between humidified incubators, representing "day" (8 hr) and "night" (16 hr) temperature. All seeds were kept in the dark except for daily counts, and "day" or "night" in this paper refers to periods of 8 hr and 16 hr only. The methods and the seeds employed were identical with those used in part I: the perennial grasses, *Agropyrum desertorum* (Fisch.) Schult. (crested wheatgrass, vars. Fairway and Nordan—1962 harvest); *Phalaris* bulbosa L. (hardinggrass, local ecotype, 1962 harvest); *Oryzopsis holciformis* (M. B.) Hack. (hairy ricegrass, 1962 harvest) and *Hordeum bulbosum* L. (bulbous barley, 1963 harvest); the annuals, *Triticum aestivum* L. (wheat var. Florence Aurore, 1963 harvest); *Hordeum vulgare* L. (barley var. Beecher, 1963 harvest); and *Avena sterilis* (animated oats, 1963 harvest); the annual legumes *Medicago hispida* Gaertn. (bur medic, 1962 harvest); *Medicago truncatula* Gaertn. (barrel medic, 1962 harvest); and *Trifolium purpureum* Loisel (purple clover, 1963 harvest). The work was done in the summer of 1964 when afterripening was expected to be complete. Germination was regarded as complete when both radicle and coleoptile had emerged, except with *Hordeum bulbosum* and *Avena sterilis*, where a radicle size of 2 mm was taken to indicate germination.

Presentation and analysis of data — Three parameters were chosen for analysis: a) days to "onset" of germination, defined as the day on which 10% of "final" germination was reached under any one temperature regime, b) days to "full" germination (80% of "final" germination), and c) "final" germination, defined as the cumulative germination percentage reached on the 30th day on which counts were usually terminated. These parameters have been fully discussed in part I (Ellern and Tadmor, 1966).

The diagrammatic presentation was adapted from Harrington (1923), Morinaga (1926), and Lehmann and Aichele (1931). Adverse temperature regimes show as peaks of time and/or as troughs of percentage. Weighted mean temperature (W.M.T.) has here been calculated as

$$\frac{\text{"day" temp.} + 2 \cdot \text{"night" temp.}}{3}$$

Results

The germination responses to fixed and alternating temperatures for the eleven species studied are presented in Fig. 1-11. For Fig. 3-11, only the data relating to "day" temperatures of 4, 15, 25 and 30C are shown; those for 8, 10 and 20C have been omitted. Results obtained with the same species in Part I have been summarized in Table 1 for comparison. Weighted mean temperature (W.M.T.) corresponding to each temperature alternation is shown for Fig. 1 and 2 only.

Onset and full germination.— In the species sensitive to low fixed temperature (the perennial grasses, nos 1-4 in Table 1 and Fig. 1-4), the time required for onset and full germination shortens as "night" temperatures rise in each set of

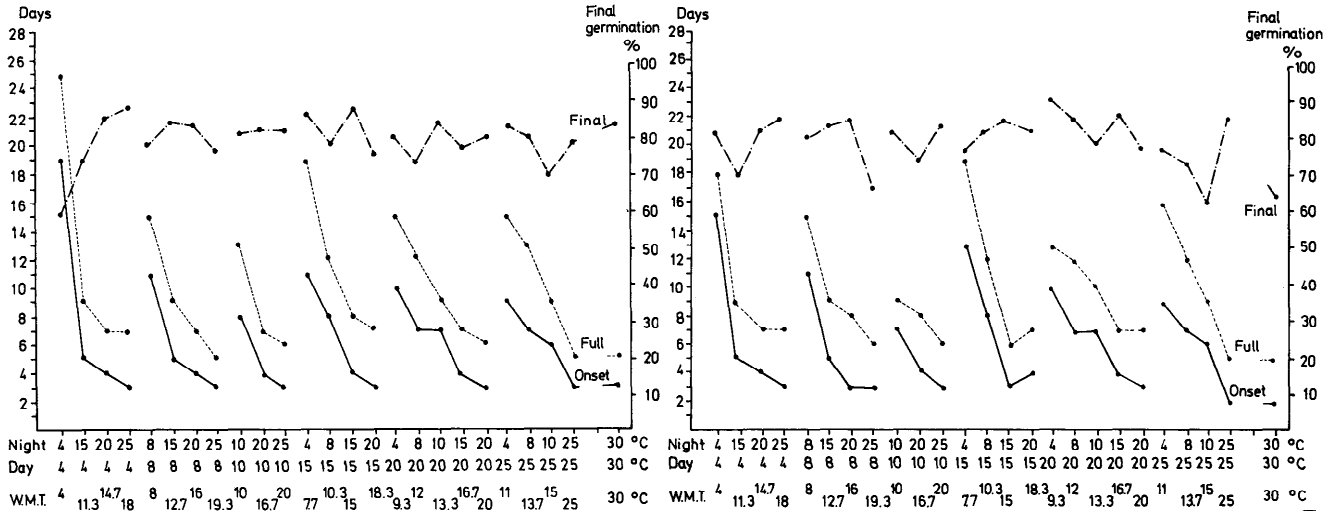

FIG. 1 and 2. Days to onset and to full germination and final germination percentage of *Agropyron desertorum* (var. Fairway), *left*; and *A. desertorum* (var. Nordan), *right* at fixed and alternating temperatures. Abscissa scale in °C. "Onset" = 10% of "final". "Full" = 80% of "final". "Final germination" = percentage reached on 30th day.

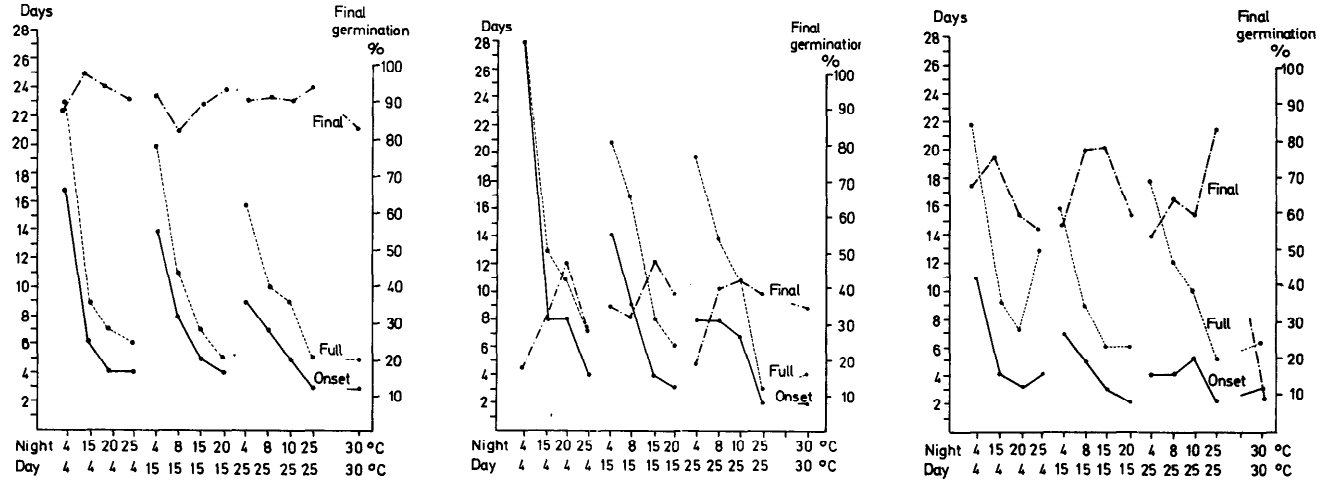

FIG. 3, 4, and 5. Days to onset and to full germination and final germination percentage of *Phalaris bulbosa, left; Oryzopsis holciformis, center;* and *Hordeum bulbosum, right* at fixed and alternating temperatures.

alternations having the same day temperature. Almost irrespective of the "day" temperature (4-25 C) severe retardation of germination is caused by the 16-hr night period at 4C and germination is fastest with 25C night period.

The annual grain and legume species—barley, wheat and *Medicago hispida* (Fig. 7-9) — least sensitive to fixed low temperatures were least retarded. *Avena sterilis, Medicago truncatula* and *Trifolium purpureum* (Fig. 6, 10 and 11) were somewhat more delayed and these species thus occupy an intermediate position between the least sensitive crop plants and the cold-sensitive perennial grasses.

The sensitivity of *Hordeum bulbosum* and *Medicago* spp. to high temperatures is less readily apparent. Comparing Fig. 5, 9 and 10 with the others, however, reveals retardation between the 20C and 25C 16-hour thermoperiods (left side of figures) where these alternate with the 4C 8-hour one. The increasing retardation for the 15, 20 (not shown), and 25C day temperatures when alternated with the 4C night temperature is another indication of the high temperature sensitivity of the *Medicago* spp.

The differential between days to onset and to full germination, i.e. the slope of the cumulative germination curve (not shown), actually measures the uniformity of the seed lot regarding time to germination (Heydecker, 1965). This is comparable to Koller's (1957) "percent per day" concept, and seems to be faster

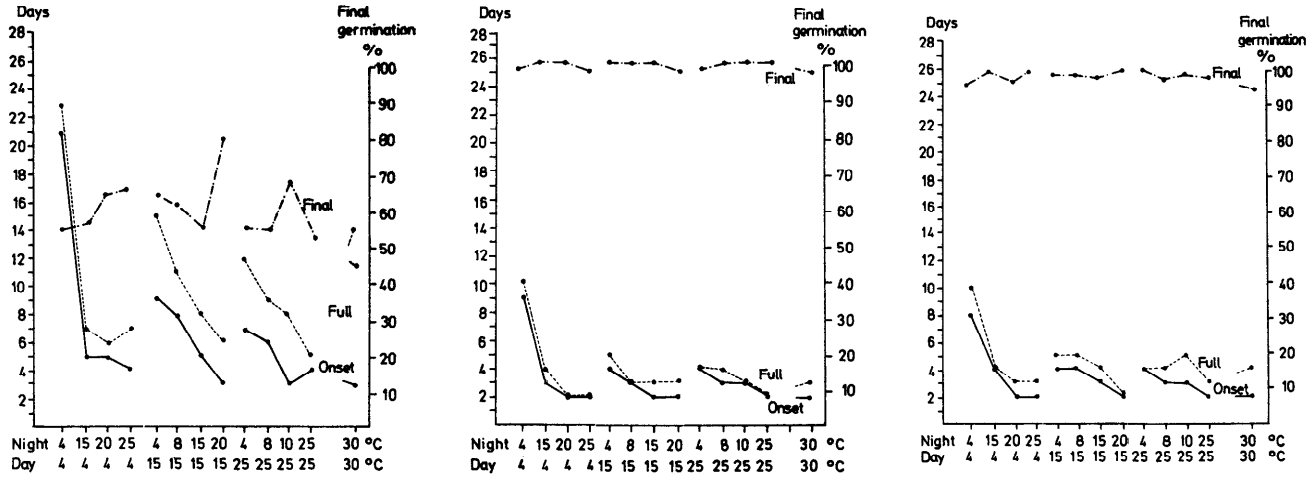

FIG. 6, 7, and 8. Days to onset and to full germination and final germination percentage of *Avena sterilis, left;* Beecher barley, *center;* and Florence Aurore wheat, *right* at fixed and alternating temperatures.

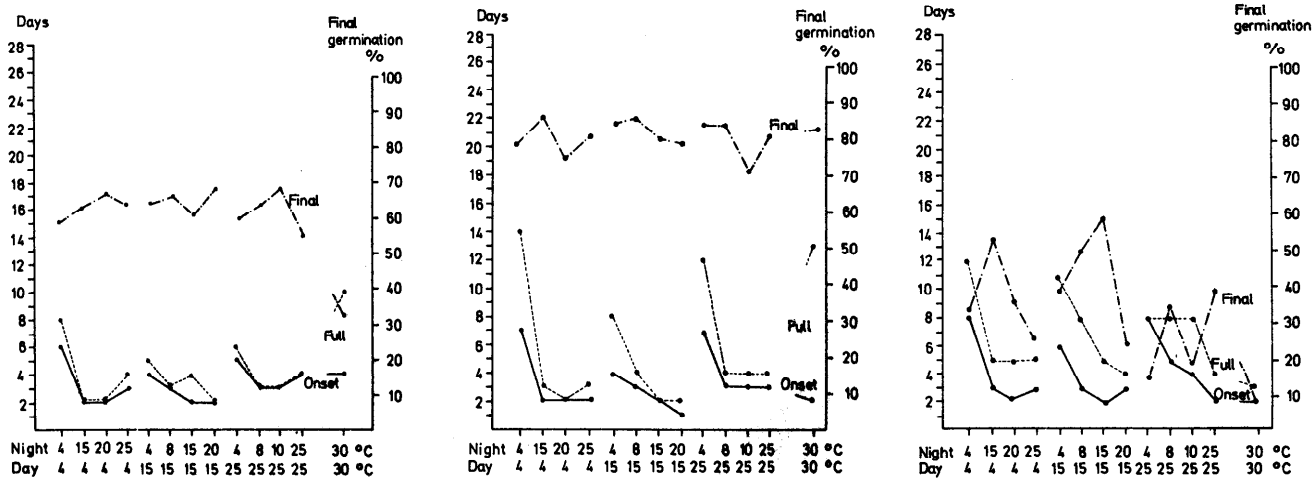

FIG. 9, 10, and 11. Days to onset and to full germination and final germination percentage of *Medicago hispida, left; M. truncatula, center;* and *Trifolium purpureum, right* at fixed and alternating temperatures.

in the species less sensitive to one or both temperature extremes (barley, wheat, *Medicago hispida* and *Phalaris;* (Fig. 3, 7, 8 and 9) than in the more sensitive species (*Oryzopsis holciformis* and *Hordeum bulbosum* (Fig. 4 and 5). However, some legumes (Fig. 10 and 11) do not conform with this trend. It is also faster at favourable temperature alternations (troughs) than at unfavorable ones (peaks) although this trend is less definite.

Final germination percentage.—Final germination, though not consistently related to temperature alternations, generally exhibits wider fluctuations in species sensitive to temperature extremes (e.g. *Oryzopsis holciformis, Hordeum bulbosum* and *Trifolium purpureum;* Fig. 4, 5 and 11) than in the less sensitive species (e.g. wheat, barley and even *Phalaris;* Fig. 3, 7, 8). Those sensitive only to high or low fixed temperatures occupy an intermediate position (e.g. Fairway wheatgrass or *Medicago trunctula;* Fig. 1 and 10).

Discussion

Response of species to alternating temperatures.—From the data presented in Fig. 1-11, it is clear that none of the species studied showed a favorable response to alternating rather than fixed temperatures as regards speed of germination (days to onset and full germination), final germination percentage, or to effect of amplitude between lower and higher temperature. Whereas in the data presented by Harrington (1923) and Morinaga (1926), germination at fixed temperature is much inferior to that at alternating temperature, in the present data the fixed temperatures fit into the overall pattern of germination response. The germination behavior of the

range plants investigated is therefore unlike that of the bluegrasses and other species in that they do not evince any response to alternating temperatures.

Relation of germination to weighted mean temperature — Germination does not appear to be a function of the weighted mean temperature (W.M.T.) of each alternation i.e. of hour-degrees. While rising W.M.T. was generally associated with increased speed of germination, the data show no consistent direct relationship between speed of germination at alternating temperatures and W.M.T. The retardation effect of adverse temperatures seemed to be stronger than would follow from their relative influence on the weighted mean of the alternation. The data are consistent with Harrington (1923), Went (1949), Wilsie and Shaw (1954), Wang (1960), and many others, who pointed out the dubious value of strict reliance on mean temperatures or day-degrees in bioclimatic work, especially as regards cyclic temperature fluctuations or alternations. No alternations with 30C and 35C were used in this work, since such temperatures are of less practical interest in the winter sowing season. This may explain why rising weighted mean temperature had, generally, a favorable effect.

Other points. — Germination response of the species to alternating temperatures was remarkably consistent with the response of the same species to the two fixed temperatures making up the alternation (Table 1). Unfavorable temperatures in the alternation reduced germination speed, but final or total germination percentage was comparatively unaffected. Adaptation of the species studied to survival in a natural environment is shown by the remarkable lack of effect on total germination of widely differing temperature alternations within the amplitude encountered in the field during the rainy season. At the same time, the data for alternating temperatures support the conclusion, arrived at in part I (Ellern and Tadmor, 1966), that low temperatures are a major underlying factor in the failure of range seeding operations in the semi-arid winter rainfall environment described, where the speed of germination rather than germination percentage is the critical factor for establishment of pasture plants. The absence of any consistent relationship between the data for germination speed (onset and full germination) and final germination percentage is in agreement with the findings of Hepton (1957), Harrington (1963), Cuddy (1963), and others.

The effect on germination of temperature alternations has here only been analysed qualitatively. Harries (1943) made an interesting study of the rate of acceleration in the time of embryonal development of insect eggs exposed to alternating temperatures, as compared with values calculated from the time required at fixed temperatures; Kotowski (1926) made a similar comparative analysis on the germination of vegetable seeds. Attempts made to subject these data to a comparable quantitative treatment will be reported separately.

Summary and Conclusions

Nine species of range plants, with wheat and barley for comparison, were germinated in darkened humidified incubators in petri dishes at seven fixed and 16 alternating temperatures, including most combinations between 4, 8, 10, 15, 20 and 25C liable to be encountered in seedbeds in the semi-arid south of Israel during the winter sowing season.

In none of the species was there a more favorable germination response to alternating than to fixed temperatures. The application of alternating temperatures is therefore not a requirement in studying the temperature dependence of germination in these species.

While rising weighted mean temperature (hour degrees) was generally associated with increased speed of germination and, less consistently, with increased germination percentage, germination behavior at alternating temperatures seemed to be related to the separate effects of the two component temperatures and the time of exposure to each, rather than to be a direct response to hour-degrees such as W.M.T.

The results support conclusions reached in the first part of the work regarding low seedbed temperatures as a major factor in the failure of range seeding in semi-arid areas.

Acknowledgements

Grateful acknowledgement is made to Miss Ruth Hofbauer for her help in the laboratory; also to Dr. W. Heydecker, of the University of Nottingham School of Agriculture, for commenting on the manuscript.

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Aerial Photography and Statistical Analysis for Studying Behaviour Patterns of Grazing Animals[1]

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Highlight

Measurements and their statistical analysis are suggested and tested in the study of sheep distribution in an arid part of Australia. The use of aerial photography and an electronic computer make the job possible and relatively cheap. The possibility of predicting the condition of a range from patterns of grazing behaviour is suggested.

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[1] *The work would not have been possible without the generous help and personal interest of Mr. Tedd Marr, the owner of Mt. Murchison and Messrs. Frank and Brian Clark, owners of Kayrunnera. We wish to acknowledge also, the skilful photography of Mr. C. Totterdell and precision flying by Mr. H. Debney of Barrier Air Taxis Ltd. Messrs. I. G. Bush and H. Simpson, and Mrs. R. Jarasius are thanked for technical assistance.*

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In the study of animal behaviour certain individualistic aspects such as maternal behaviour, dominance and aggression must be studied at close hand. However, the organization, dispersion and movement patterns of grazing animals are difficult to study at close hand. They are also dynamic in nature. These aspects of behaviour are particularly important to range management in arid areas.

Arnold and Baas Becking (unpublished) have used cinephotography to study the causes of dispersion and movement patterns. The camera on the ground, however, can only record a limited area and cannot quantify distances between individuals or between groups.

There are two problems involved, firstly to obtain a vantage point from which the organization, dispersion and movement can be seen and secondly, to record the relevant data. This second point is extremely difficult because what is relevant is often unknown until some analyses have been done.

Attwood and Hunter (1957) used a telescope to plot positions of sheep on a hill face. This has obvious limitations. The obvious vantage point is an aircraft and the tool a camera to take vertical photographs. Measurements can be made on the photographs. The advent of computers overcomes the major problem of handling and storage of large quantities of data from which relevant information can be extracted.

Most of the aerial survey work reported in the literature, e.g. Grzymek and Grzymek (1960), Newsome (1965) and others, has been aimed at the evaluation of population size in relation to area, habitat or movement indices. Photographic sampling was generally regarded as unsuitable for the purpose. However, Crofton (1958) used aerial photographs for the detailed study of sheep orientation under intensive grazing.

The use of a light aircraft, a camera, and a digital computer was investigated as a technique for the quantitative evaluation of dispersion of sheep within various environments. Criticism by range managers and researchers of the validity and importance of the approach is sought.

Methods and Materials

Experimental Areas. — Two properties in northwest New South Wales

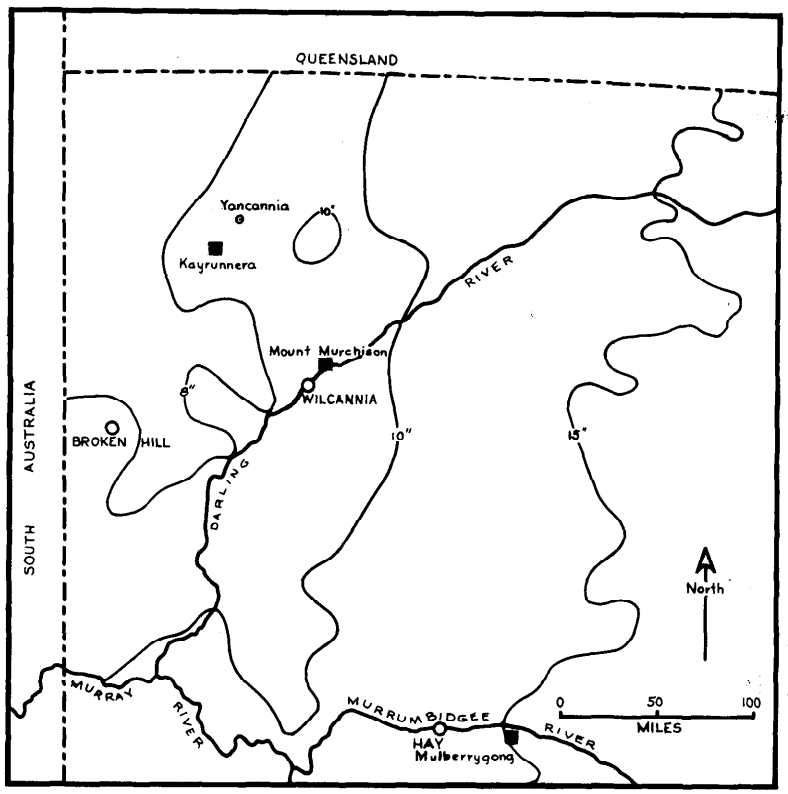

FIG. 1. Map of north western New South Wales with properties sampled and rainfall isohyets.

were chosen for the work. These were: Kayrunnera, about 120 mi northeast from Broken Hill and Mt. Murchison on the River Darling near Wilcannia (Fig. 1). Another property, Mulberrygong on the Murrumbidgee near Hay, was chosen but few results were obtained because of heavy rain at the time of the first survey.

Kayrunnera (100,000 acres, 8 in. rainfall) on gibber country (facetted pebbles or stone pavement) is similar in many ways to Mt. Murchison (123,000 acres, 10 in. rainfall) on flat country. The main associations at both are *Kochia pyramidata—Kochia sedifolia* (Beadle, 1948). At Mt. Murchison there was some old man saltbush *(Atriplex nummularia)* and some herbaceous plants. Mulberrygong (15 in. rainfall) on the other hand, is on the riverine plain and has little bush in the natural grassland *(Danthonia caespitosa* grassland, Williams, 1961). These habitats are illustrated in Fig. 2. The properties chosen all had airstrips and the sheep were conditioned to airplane shadows and noise. The sheep surveyed were all South Australian Merinos remaining on pasture yearlong with no salting or supplementary feeding. Ewes and rams were kept separate except for an eight week mating period. Animals were mustered twice a year for shearing and crutching, which was the only contact the sheep had with man. The rest of the management was limited to maintenance of fences and maintenance and control of water, latter mostly by means of a light aircraft.

Kayrunnera carries 28.8 sheep/mi^2, Mt. Murchison 39.8, and Mulberrygong 512.0. A map of each property, showing paddock sizes and shapes and position of waterholes, was available. The sex, age, and number of sheep in each paddock was known. (Table 1). Two paddocks each with ewes and lambs from 5-8 months old, and two with wethers were used on each property for the surveys. Two surveys were carried out, one in August and the other in November, 1965.

Photographic Methods.—A Cessna 205 light aircraft was used. It is a high-wing craft permitting full visibility. One of the 3 doors can be removed to allow vertical photography. All the photography was done with a Hasselblad 500C camera. The lens was a Zeiss Planar with a focal length of 80 MM (3.14 in.). The resultant scale at negative stage is 1:2600. The actual image dimensions on the negative are 2⅛ x 2⅛ in.

The crew consisted of the pilot, the guide (owner or manager of the station), the photographer and senior author.

Ground observations of type and availability of feed were made. A few observations of the sheep grazing were made but they could not be approached closer than 400 yards.

Experimental Design.—An attempt was made to minimize "local" climatic effects on behaviour by choosing a period when weather forecasts predicted similar weather over a large area for several days. The survey could only be carried out by completing one property at a time.

The basic design could be described as factorial. Four photographs per paddock were taken. There were two paddocks per sex. Replication in time was provided by one morning and afternoon flight on two consecutive days, i.e. 4 (photographs): 2 (paddocks): (2 sexes): 2 (am., pm.): 2 (day 1, day 2): 2 (stations) = 128 observations for generalizations over two stations. In addition at Mt. Murchison there was a paddock of young ewes and limited data from Mulberrygong.

In November 1965 the design was basically the same as the first survey except that five photographs per paddock were taken at Mt. Murchison. (For alteration of paddocks and sheep sampled, see Table 1).

The factorial design then was: 5 or 4 : 2 : 2 : 2 : 2 : 2, except for the afternoon flight on the second day at Kayrunnera which was prevented by a dust storm.

The idea was to photograph at fixed times after dawn and midday drinks. This was based on the individual grazier's knowledge of his sheep. The actual times of day and weather conditions are shown in Table 2.

Photographic Sampling. — The sequence of paddocks was arranged randomly for each flight. Paddocks were photographed so that each quarter was represented by at least one photograph, if possible. This was not always achieved because sheep were not uniformly distributed within paddocks. Sheep in the proximity of water holes and fence cor-

FIG. 2. Close-up photograph of typical vegetation at the three properties surveyed: *Top*, Kayrunnera; *Center*, Mt. Murchison; *Bottom*, Mulberrygong.

ners were avoided. When a flock of sheep was spotted, the altitude was checked or corrected to 700 ft.; the aircraft banked steeply; and a vertical photograph was taken. Location of the flock, and the corresponding negative numbered for identification, was mapped. Each photograph would cover 5.35 acres at 700 ft. However the error was probably considerable and no measure of it was obtained.

Computational and Statistical Methods. — Each photograph was a statistically independent unit when the sheep were isolated into small groups as they were in these surveys at Kayrunnera and Mt. Murchison. The photographs were enlarged to 10 x 10 in. A grid of the same size with 0.25 in. spacings was superimposed. Each sheep was located (Fig. 3) and its coordinates punched in relation to the grid into Hollerith card. A computer program was developed which calculated the punched information from the photograph.

The parameters thus obtained were (1) total numbers of sheep per photograph = flock, (2) mean number of sheep per cell of the grid (theoretically 12 x 12 ft but would vary with errors in height), (3) mean distance of every sheep from the others, the variance and distribution of these distances and the index of spread (SD of distance distribution/$\sqrt{N}$ where N is the number of sheep per flock). Standard analyses of variance were done on these parameters or their transformations.

The distance between sheep within a cell = 0. This produces multimodal distribution of distance from individual sheep from each other if there are several sub-flocks in a photograph. Increasing cell size would give different indices of spread and tend to unimodal distribution.

No movement of stock between paddocks took place at Kayrunnera between the two surveys. Both surveys, therefore, are comparable except for the morning and afternoon contrast. The latter comparison became non-orthogonal (unbalanced) because of a dust storm which prevented photography on the afternoon of the second day. At Mt. Murchison some changes took place (Table 1). Strictly speaking, no balanced comparison in the orthodox statistical sense could be made. However, there is no doubt that, with some qualifications, the general difference between the two surveys can be discussed.

Results

Patterns at Kayrunnera.— Mean number of sheep per occupied cell for the whole station

Table 1. Names and sizes of sites sampled with type and numbers of sheep within sites.

Kayrunnera August and November Survey				Mt. Murchison August Survey				Mt. Murchison November Survey			
Name of Paddock	Size in acres	Type of sheep	No. of sheep	Name of Paddock	Size in acres	Type of sheep	No. of sheep	Name of Paddock	Size in acres	Type of sheep	No. of sheep
Hilton	10,000	Wethers	500	MacIntyre A	8,800	Wethers	975	MacIntyre	17,600	Wethers	1,072
Ocean Down	10,000	Wethers	500	MacIntyre B	8,800	Wethers	975	Back Penanda	10,880	Wethers	1,235
Woolshed	12,000	Ewes with Lambs	500	Coonaro	20,275	Ewes with Lambs	1,934	Seawood	11,675	Ewes with Lambs	1,578
Gilbys	10,000	Ewes with Lambs	500	Seawood	11,675	Ewes with Lambs	1,578	Coonaro	20,275	Dry Ewes	1,700
				Tallandra	10,137	Young Ewes	1,465	Curlewee	6,800	Young Ewes	1,476

Table 2. Average times of aerial sampling and weather conditions.

			Mean Time of Sampling	Weather Conditions during Sampling	
				DAY 1	DAY 2
KAYRUNNERA	August	a.m.	8.50	Cloudy, calm	Cloudy, calm
		p.m.	3.55	Cloudy, calm	Cloudy, light N.W. winds
	November	a.m.	8.00	Sunny, calm	Overcast, windy
		p.m.	4.35	Overcast	Dust Storm
MT. MURCHISON	August	a.m.	8.00	Light Cloud	Very High Cloud
		p.m.	3.30	Overcast	Overcast, light N. winds
	November	a.m.	10.00	Light rain	Cloudy
		p.m.	4.35	Overcast	Sunny and Windy

was 1.18 and 1.09 for August and November respectively. There were no significant differences due to postulated variables nor, generally, between surveys.

The mean flock sizes, and indices of spread for the two surveys are plotted for different paddocks in Fig. 4. The analyses of variance are in Table 3.

In August flock size was large in the morning ($P < 0.05$) but in November this was reversed. In the combined analysis this interaction is significant ($P < 0.05$). There was also a significant ($P < 0.05$) decrease in flock size from 5.85 to 5.10 from August to November. One striking difference was that of flock size in the two paddocks of ewes.

The significant differences in index of spread were that ewes with lambs were more widely spread than wethers. There was also a significant difference between the two wether paddocks. The mean difference between two surveys is almost significant at 5%.

Patterns at Mt. Murchison. — Flocks were classified into types as wethers, ewes and lambs and young ewes in August and wethers, ewes and lambs, ewes (young or dry) in November.

The mean number of sheep per cell was 1.18 and 1.13 in August and November respectively — very similar to Kayrunnera. There were no differences due to any of the postulated variables.

The mean flock sizes and indices of spread for the two surveys are plotted for different paddocks in Fig. 5. The analyses of variance are in Table 4.

Flock size was about twice that of Kayrunnera. There were only two significant effects in the flock size data, both in August. These were an interaction between type of sheep and time of day and a difference between two ewe paddocks.

Index of spread effects were also limited to August where there was a significant interaction between type of sheep and time of day.

Discussion

Behaviour patterns are dynamic and cannot be described from random sampling. Sampling must be related to the variables influencing behaviour. In this work we were not attempting to describe any behaviour pattern in detail but were assessing the technique by the precision with which it detected variability in certain behavioural characteristics. We knew from previous observations that the variables causing sub-grouping of a sheep flock were age, breed, topography, vegetation distribution and water locations.

Of the behaviour characteristics studied, flock size and index of spread can be justified biologically; that of number of sheep per cell is more difficult. As yet there is no biological basis for it as used with sheep in this work. It it known that the closeness of sheep to one another decreases as feed availability decreases (Arnold, unpublished). The only reliable data from Mulberrygong, with its higher sheep carrying capac-

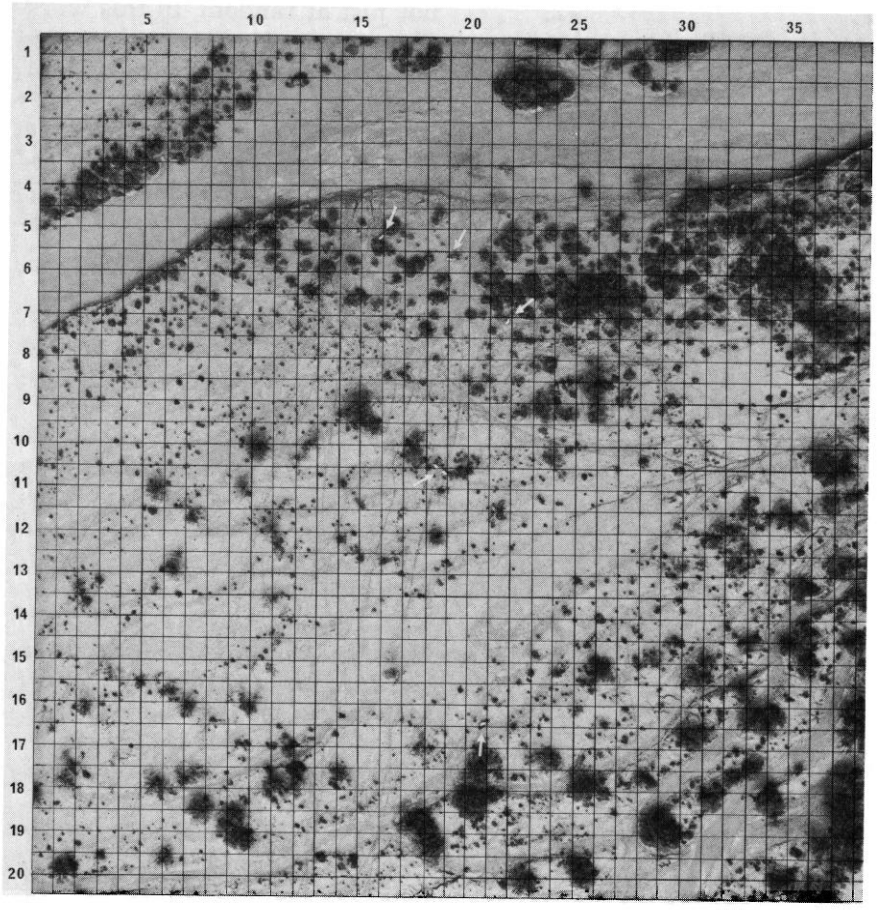

FIG. 3. Sample of an aerial photograph from 700 feet with 40 x 40 grid superimposed, Kayrunnera Sta., Gilby's Paddock, 4 Nov., 1965, morning, 6 ewes and lambs, 5 acres, Sprd. Ind. 29.98.

ity, was on number of sheep per cell. This was 1.66 which was significantly higher ($P < 0.001$) than at the two other properties. On the other hand it did not vary significantly at all on a property or between Kayrunnera and Mt. Murchison.

It is now appreciated that mean distance to nearest neighbour would be a more satisfactory and direct measure of contiguity of individual animals than mean number of sheep per occupied cell, and could be programmed from coordinates or measured directly with dividers. The convenience of recording position as at the centre of cells also has its disadvantages, and some compromise in cell size to avoid serious errors of grouping is necessary. Greater accuracy would be achieved by use of fine coordinates and abandonment of recording by cell frequencies. The property mean values for three behaviour indices were as follows: Kayrunnera for August and November, Number per Cell 1.18, 1.09, Flock Size 5.9, 5.1, Index of Spread 17.6, 22.1 respectively. The same for Mt. Murchison were 1.18, 1.13; 12.0, 13.3; and 18.0, 17.9.

In Table 5 we compare significant differences in one characteristic (flock size or index of spread) with the difference in the other. Clearly there is no close relation of these two characteristics as one would logically expect. In some cases this could be explained on vegetation distribution which could concentrate a few sheep into a small area. In other cases the subgrouping of sheep in the flock could give a large index of spread for a large flock. However, differences over pooled data indicate that these two characteristics are basically independent.

The average population sample was small—24 sheep of 500 at Kayrunnera; 50 sheep of 1500 at Mt. Murchison at each run on each paddock. However the lack of day to day interactions at any time for either flock size or index of spread suggests the differences recorded were real and

Table 4. Mt. Murchison analysis of variance of Log Flock Size and Index of Spread.

AUGUST			NOVEMBER		
Source	DF	M.S.	Source	DF	M.S.
Log Flock Size					
Type of Sheep	2	.014	Type of Sheep	2	.172
Type x Time of Day	2	.308*	Type x Time of Day	2	.043
McInt. "A" v. McInt. "B"	1	.006	McInt. v. B. Penda.	1	.124
Coonaro v. Seawood	1	.553*	Coonaro v. Curlewee	1	.002
Pooled Error	72	.085	Pooled Error	92	.074
Index of Spread					
Type of Sheep	2	.7	Type of Sheep	2	2.0
Type x Time	2	274.9*	Type x Time	2	2.4
McInt. "A" v. McInt. "B"	1	59.8	McInt. v. B. Penda.	1	91.3
Coonaro v. Seawood	1	.3	Coonaro v. Curlewee	1	75.7
Pooled Error	72	86.7	Pooled Error	92	59.4

* = $P < 0.05$

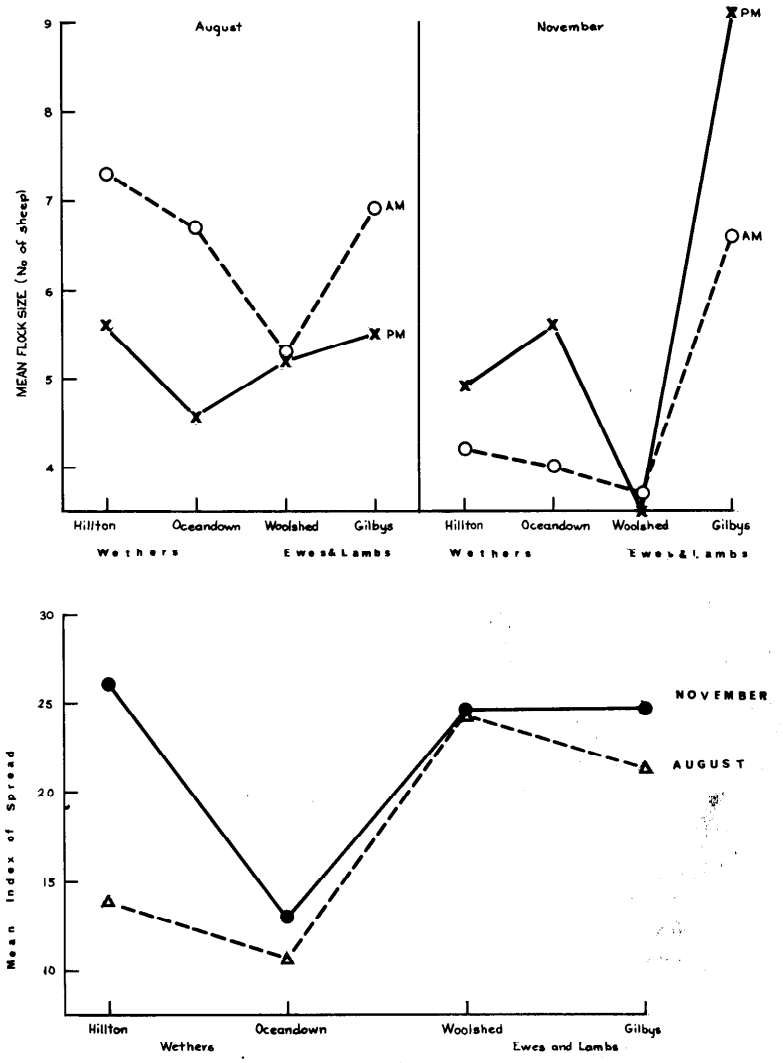

FIG. 4. Mean Flock Size and Index of Spread at Kayrunnera.

Table 3. Kayrunnera analysis of variance of Log Flock Size and Index of Spread.

LOG FLOCK SIZE									
	August		November		Combined		Interactions with Surveys		
Source	DF	M.S.	DF	M.S.	DF	M.S.	Source	DF	M.S.
Type of Sheep	1	.007	1	.056	1	.008	Type x Survey	1	.054
Time of Day	1	.143*	1	.091	1	.018	Time x Survey	1	.215*
Type x Time	1	.025	1	.000	1	.016	Type x Time x Survey	1	.009
Hilton v. Ocean Down	1	.031	1	.001	1	.014	(Hilt. v. OcDn) x Survey	1	.018
Woolshed v. Gilby's	1	.042	1	.531***	1	.399**	(Wool.v. Gilb) x Survey	1	.175*
Pooled Error	58	.037	42	.040	100	.038	Pooled Error	100	.038
							SURVEYS	1	.184*
			INDEX OF SPREAD						
Type of Sheep	1	1823.6 **	1	297.2	1	1898.0 **	Type x Survey	1	222.7
Time of Day	1	0.2	1	151.5	1	45.9	Time x Survey	1	105.8
Type x Day	1	160.1	1	25.6	1	54.9	Type x Day x Survey	1	130.8
Type x Time	1	444.0	1	165.1	1	606.3	Type x Time x Survey	1	2.8
Hilton v. Ocean Down	1	89.5	1	1041.6*	1	799.8*	(Hilt. v. OcDn) x Survey	1	331.4
Woolshed v. Gilby's	1	70.0	1	0.1	1	37.9	(Wool v. Gilb) x Survey	1	32.2
Pooled Error	57	155.5	41	202.2	98	175.0	Pooled Error	98	175.0
							SURVEYS	1	568.8*

* = P<.05, ** = P<.01, *** = P<.001

not just at random. In this work there were 64 observations for main comparisons, i.e. type of sheep, days, time of day. In order to detect a significant difference ($P < 0.05$) in flock size or index of spread would require a 25% difference between means. Increased numbers of photographs would decrease this.

The technique, as described, would need modification to study specific problems. For example to map the population as a whole; to measure distances between sub-groups on single photographs. Further study has to be done of situations where each photograph is not a statistically independent unit, i.e. when the animals are in a single flock in a paddock. The basic technique could be widely adapted to analyze both animal and vegetation population distribution patterns when quantitative measurements between individuals are wanted. However, its main use seems to lie in animal behaviour patterns and the environmental factors that influence them.

Conclusions

It is felt that aerial photography and the use of digital computers provide extremely valuable facilities for studying patterns of animal behaviour. By its very nature, the material is characteristically variable. On the average, a 25% difference, to be significant, should be based on about 100 independent observations. These can be collected and stored at the expense of not more than $400-500 including aircraft and travelling expenses for personnel. The economy of sampling, i.e. the speed of collection and analysis of results, considering the salaries of personnel, compares rather favourably with any surface investigation. The precision of information on stored photographs is probably better than that from the lengthy ground observations. With the

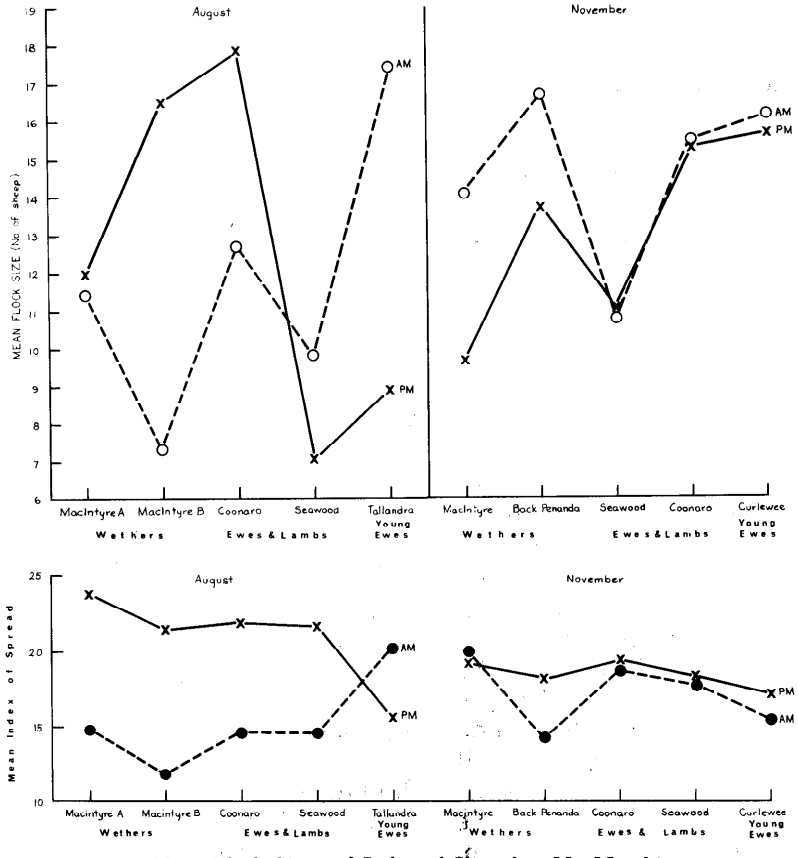

FIG. 5. Mean Flock Size and Index of Spread at Mt. Murchison.

aid of an electronic computer, conversion of photographs into quantitative indices can be achieved in seconds.

Since indices of behaviour are sensitive to environmental changes, the possibility of predicting the condition of a range from patterns of behaviour can now be seriously considered.

Considering simulation programs, the method we hope, has potential in evaluating parameters for arid-zone grazing strategies.

Table 5. Comparison of Mean Indices of Behaviour.

Comparison			Flock Size	Index of Spread
		AM	11.7	15.2
				**
August	Mt. Murchison	PM	12.4	20.9
		Ewes	5.7	22.9
				**
August	Kayrunnera	Wethers	6.1	12.3
		Woolshed	3.6	24.6
			***	
November	Kayrunnera	Gilbey's	7.8	24.7
		Hillton	4.5	26.2
				*
November	Kayrunnera	Oceandown	4.8	13.0
		Coonaro	15.2	18.2
			*	
August	Mt. Murchison	Seawood	8.3	18.0

Difference Between Means Significant at * = $P < .05$
** = $P < .01$
*** = $P < .001$

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USDA Reports Drop in 1966 Grasshopper Infestations—Less than 11.4 mil. acres of rangeland were found severely infested in survey of 17 Western States conducted last fall by USDA's Agricultural Research Service. This is about 5.2 mil. acres less than 16.6 mil. acres found economically infested previous fall, but still well over 8.7 mil. acres found infested in these States in 1964.

The Journal has received notice that copies of the 1966 Annual Report of the office of Water Resources Research are available from the OWRR, Department of the Interior, Washington, D. C. 20240. Limited numbers of the 1965 Annual Report containing background information on this new cooperative program are also available.

Umpqua National Forest Supervisor Promoted—F. Leroy Bond, supervisor of the Umpqua National Forest at Roseburg since January of 1965, has become an assistant regional forester for the Forest Service's Southwestern Region, Albuquerque, New Mexico.

Bond is in charge of timber management on the National Forests in Arizona and New Mexico. He assumed the position on February 12.

Yield and Mineral Composition of Grass Species Grown on Acid Grassland Soils[1]

F. P. GUERRERO[2], W. A. WILLIAMS, AND W. E. MARTIN

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Highlight

The objective was to study the use of various grass species, two liming materials, and phosphorus as means of improving very acid, unproductive, grassland soils. Phosphorus applications increased yields of all 10 species at all levels of liming. Liming with a mixture of calcic and magnesium limes increased yield more than either alone. The outstanding performance of veldtgrass was associated with its calcium-foraging ability, which resulted in the highest tissue concentrations of calcium. These guidelines point toward the use of phosphorus and small amounts of limestone, containing both Ca and Mg, with calcium-foraging species for successful forage establishment in acid grassland soils.

A group of dark-colored, strongly-acid, grassland soils that are high in organic matter but are very poor forage producers, occur in California. The soils are situated both in moist mountain meadows and in the well-watered foothills of the north coast. They are often prairie-like, but support a vegetation dominated by worthless forbs or bracken fern. Desirable grasses and legumes are almost completely absent and are difficult to introduce by current techniques.

These unproductive soils occupy positions where abundant forage would be of great value. The mountain meadows are needed for summering livestock and for the rapidly growing number of pack stock used for recreational purposes. The occurrence of these soils along the coast is ironic because the climate is ideally suited to forage production on adjacent better soils.

Two acid soils were selected for greenhouse experiments. The objective was to study the use of various grass species, two liming materials, and phosphorus as means of improving their forage production.

Experimental Soils and Methods

Wilder Variant Series. — The Wilder Variant Series occurs on flat, smooth, high alluvial terraces, and developed from sandstone and graywacke sedimentary rock alluvium. Gravels of sandstone exist throughout the profile. The soil is very strongly acid (pH 4.9), very friable, and high in organic matter. The soil site sampled for the experiments is in the Petrolia area where the annual rainfall is about 60 in. The climate is classified as Mediterranean cool summer with fog —Csbn (Durrenberger, 1960). In its virgin state the soil supports a vegetation dominated by western bracken (*Pteridium aquilinum* var. *lanuginosum*), silver hairgrass (*Aira caryophyllea*), and sheep sorrel (*Rumex acetosella*). On adjacent soil series such as Kneeland, plants of high forage value, including California oatgrass (*Danthonia californica*), soft chess (*Bromus mollis*), and slender oat (*Avena barbata*) are common. Hence, the poor quality of the vegetation on the Wilder contrasts sharply with the vegetation on the adjacent soil series.

Sixmile Series. — The sampling site is a meadow in the Sierra Nevada Mountains near Emigrant Gap, at an elevation of 5,500 ft. Average annual precipitation is about 60 in., most of which falls during November through March as snow. The climate is Mediterranean highland and is warm and dry during the summer, but cold and wet in the winter (Dsb). The parent material of the Sixmile soil is alluvium derived from andesitic breccia, and it is quite similar in chemical characteristics to the Wilder (Table 1). The higher, better-drained portion of the meadow has a very sparse vegetation consisting principally of low forbs, such as pussy paws (*Calyptridium umbellatum*), sheep sorrel, and a few other depauperate annuals. The more poorly drained areas contain meadow genera such as *Carex* and other Cyperaceae. Lodgepole pine (*Pinus murrayana*) is the main woody species surrounding the meadow; it appears to be encroaching on the better-drained areas.

Samples of soil from the surface 6 inches of each soil type were sifted through a 0.25-inch screen to remove rock and gravel. Three pH levels were obtained, 4.8, 5.8, and 6.8, by using the untreated soils and two lime

Table 1. A comparison of characteristics of Wilder and Sixmile soils.[1]

	Wilder	Sixmile
Cation exchange cap. me/100 g	30.0	23.1
Organic-matter-free cation exch. cap. me/100 g	11.1	9.4
Exch. Na me/100 g	0.4	0.3
Exch. K me/100 g	0.4	0.2
Exch. Ca me/100 g	0.8	0.5
Exch. Mg me/100 g	0.4	0.3
P (H_2O) ppm soil	0.12	0.25
P (HCO_3) ppm soil	6.0	14.0
Exch. Fe me/100 g	0.2	0.7
Mn (Ex. + sol.) me/100 g	nil	nil
Extract. Al me/100 g	4.8	4.0
N %	0.43	0.33
C %	6.40	4.10
Fe_2O_3 %	2.86	3.06
Organic matter %	10.9	7.0
pH sat. paste, dist. H_2O	4.8	4.7

[1] Supplied by Soils Extension Laboratory and the Department of Soils and Plant Nutrition, University of California, Davis.

[1] *From a thesis submitted by the senior author in partial fulfillment of the requirements for the M.S. degree in Range Management.*

[2] *Present address: Department of Pomology, University of California, Davis. The authors gratefully acknowledge many fruitful discussions of the work with P. G. Ozanne, Principal Research Scientist, CSIRO, Australia.*

levels, 1,750 and 5,500 ppm CaO (reagent grade). The amounts required were the same for both soils. The lime and soil were mixed thoroughly and then placed in 5-inch pots lined with polyethylene sleeves which permitted drainage. The pots were arranged in a stratified randomized block design with three replications. Soil moisture was determined gravimetrically, and the pH values were determined on a saturated paste of each soil.

Experiment 1. — The rates of lime were used in combination with phosphorus ($NaH_2PO_4.H_2O$) added at the rate of 0 or 105 ppm P for the Wilder and 0 or 125 ppm P for the Sixmile series. Ten species of grasses were planted on December 10, 1962 and later thinned to 10/pot. All pots received 100 ppm nitrogen as NH_4NO_3, half at 10 days and half at 41 days after planting. The species of grass were:

1. Cereal rye
   Secale cereale
2. Hardinggrass
   Phalaris tuberosa
3. Intermediate wheatgrass
   Agropyron intermedium
4. Kentucky bluegrass
   Poa pratensis
5. Orchardgrass
   Dactylis glomerata
6. Perennial ryegrass
   Lolium perenne
7. Redtop
   Agrostis alba
8. Smooth brome
   Bromus inermis
9. Tall fescue
   Festuca arundinacea
10. Veldtgrass
    Ehrharta calycina

The above-ground portion of the plants was harvested on February 17, 1963 by clipping at the soil surface and dried at 100 C for 3 days.

Experiment 2. — The Wilder soil was limed with CaO, MgO, or a mixture of equal parts CaO and MgO at the same rates as in experiment 1, with the MgO applied on an equivalent neutralizing basis. Two levels of phosphorus, 0 and 100 ppm P, were used, with Na_2HPO_4 as the source. All pots received 100 ppm nitrogen as NH_4NO_3, half at 35 days and half at 50 days after planting. Colonial bentgrass (*Agrostis tenuis*), hardinggrass, orchardgrass, and veldtgrass were seeded July 2 and harvested September 17.

Plants from both experiments were analyzed for phosphorus, aluminum, manganese, calcium, and magnesium.

Table 2. Effect of calcic lime and phosphorus on mean yield and mineral concentrations of 10 grass species grown on acid soils.

Nutrient Treatment	Wilder soil Lime applied Nil	Low	High	Sixmile soil Lime applied Nil	Low	High	LSD 5%
Yield g/pot							
None	0.24	0.48	0.48	0.39	0.78	0.80	0.18
Phosphorus	1.36	2.04	2.14	1.12	1.95	2.07	0.29
Phosphorus %							
None	0.13	0.10	0.13	0.16	0.13	0.14	N.S.
Phosphorus	0.20	.20	.20	.25	.26	.24	0.03
Aluminum ppm							
None	400	210	180	430	200	310	N.S.
Phosphorus	220	220	160	220	300	260	N.S.
Manganese ppm							
None	490	350	330	290	250	260	58
Phosphorus	470	240	250	250	180	190	40
Calcium %							
None	0.33	1.09	0.90	0.34	0.69	0.88	0.28
Phosphorus	.24	.71	.75	.35	.63	.77	0.16
Magnesium %							
None	0.22	0.32	0.33	0.34	0.36	0.36	N.S.
Phosphorus	.27	.26	.28	.29	.35	.34	N.S.

Results

Lime and Phosphorus (Experiment 1).—The average yield for the ten species was markedly increased by the application of phosphorus on both soils at all levels of liming (Table 2). Lime applied at the low rate (pH 5.8) resulted in a substantial increase in yield on both soils, with or without applied phosphorus. However, the increases were less than those resulting from the phosphorus treatment. The yield from the pots treated with the high rate of lime (pH 6.8) was essentially the same as from the pots treated with the low rate of lime on both soils.

Yields of the individual species from untreated pots ranged from 0.7-1.6 g/pot with cereal rye and veldtgrass to essentially nil with Kentucky bluegrass and hardinggrass (Fig. 1). Cereal rye and veldtgrass responded strongly to applied phosphorus, but they were unresponsive to liming on either soil. Hardinggrass responded strongly to liming in the presence of applied phosphorus. Responses of the other species were intermediate.

The variability of the data on the mineral composition of the individual species makes difficult the interpretation of differences in composition. However, some results of significance are evident from the data averaged for all species. Application of phosphorus increased the average concentration of phosphorus in grasses by 66% on the Wilder soil and by 56% on the Sixmile soil (Table 2). Concentration of aluminum in plant tissue was not affected measurably by the treatments. However, scatter diagrams of yield of individual species—treatment combinations plotted against aluminum concentration in tissue — indicate that high yields on either soil were obtained only at values less

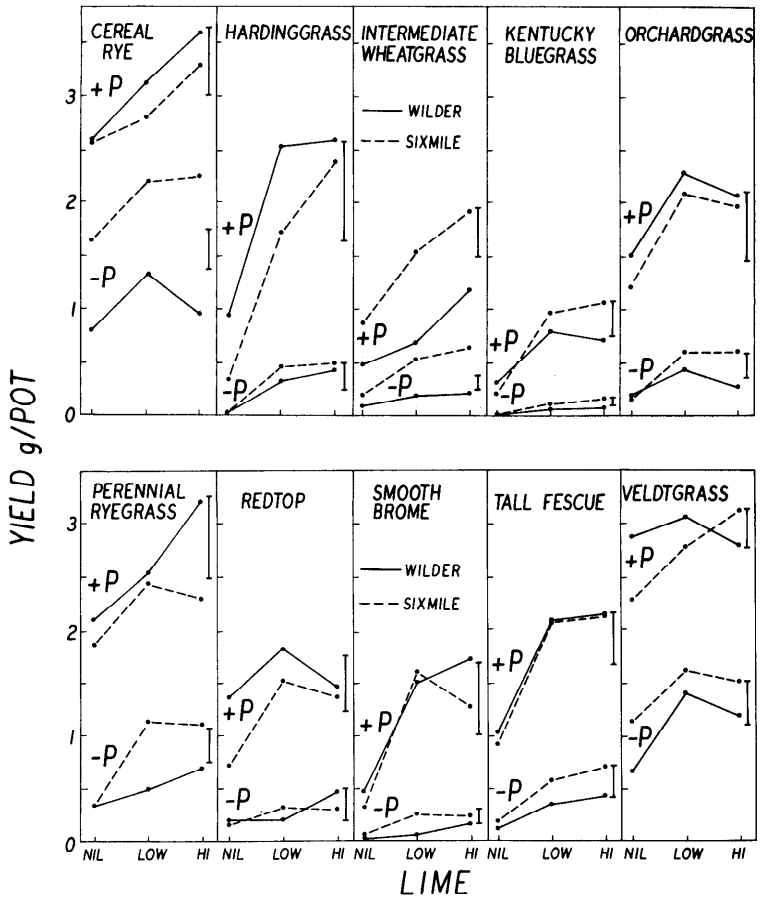

FIG. 1. Yields of 10 grasses as affected by applications of calcic lime and phosphorus on acid soils.

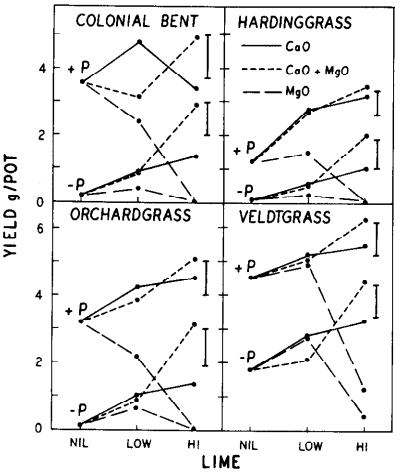

FIG. 3. Yields of four grasses as affected by applications of calcic and magnesian limes and phosphorus on Wilder soil.

than 400 ppm aluminum (Fig. 2).

Manganese in plant tissue was decreased substantially by the low amount of lime applied at either level of phosphorus. The high rate of lime caused no further decrease. Calcium in plant tissue was increased by the low rate of lime; the high rate of lime did not result in a further significant increase. Magnesium in plant tissue was not affected measurably by either the lime or phosphorus treatments. The soil pH, averaged for all species and phosphorus treatments, declined 0.9 units on Wilder soil and 0.6 units on Sixmile soil in the lime treated pots during the course of the experiment (Table 3).

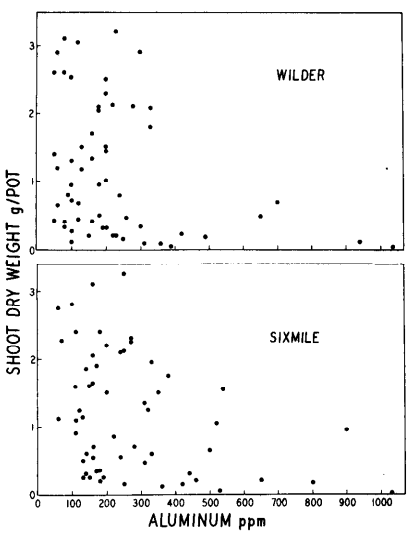

FIG. 2. Relation of yield of 10 grasses to their tissue concentration of aluminum.

Calcic vs Magnesian Lime (Experiment 2). — The grasses increased in yield from calcic lime and phosphorus applications in essentially the same manner as in experiment 1, i.e., generally major responses to phosphorus and minor responses to calcic lime (Fig. 3). The substitution of magnesian lime for half of the calcic lime, on an equivalent neutralizing basis, resulted in major yield responses from all four species in the absence of applied phosphorus. However, magnesian lime alone was deleterious at the low rate, and it was toxic at the high rate both with and without applied phosphorus.

Veldtgrass was the most productive of the four species on the untreated soil. The concentration of calicum was substantially higher in the veldtgrass than in the other species, where grown

Table 3. Effect of rates of calcic lime on soil pH at beginning and end of experiment 1 (averages over all species and phosphorus treatments).

	Lime applied						
	Wilder soil			Sixmile soil			LSD
pH	Nil	Low	High	Nil	Low	High	5%
Initial	4.8	5.8	6.8	4.7	5.8	6.8	.....
At harvest	4.3	4.9	5.9	4.4	5.2	6.2	0.1
Decrease during experiment	.5	.9	.9	.3	.6	.6	.....

Table 4. Effect of amount and kind of lime on concentrations of calcium and magnesium in four species of grass (averaged over two phosphorus treatments).

Lime Amount and Kind	Calcium %					Magnesium %					Mean Ca:Mg ratio
	Bent-grass	Harding-grass	Orchard-grass	Veldt-grass	Mean	Bent-grass	Harding-grass	Orchard-grass	Veldt-grass	Mean	
Nil	0.32	0.41	0.28	0.61	0.40	0.24	0.22	0.30	0.18	0.24	1.7
Low Ca	.44	.78	.60	1.24	.76	.23	.18	.34	.12	.22	3.5
High Ca	.70	.96	.88	1.68	1.06	.22	.20	.34	.36	.28	3.8
Low Mg	.21	.49	.41	.45	.39	.52	.46	.56	.70	.56	0.7
High Mg	—	—	—	.65	—	—	—	—	1.87	—	0.3[1]
Low Ca + Mg	.36	.60	.57	.78	.58	.38	.34	.54	.54	.45	1.3
High Ca + Mg	.36	.78	.60	1.20	.74	.44	.54	.58	.64	.55	1.3
Mean	.40	.67	.56	.94		.34	.32	.44	.63		
LSD 5%		0.18			0.22			0.10		0.13	

[1]For veldtgrass, the only surviving species.

on the unlimed soil (Table 4). Veldtgrass tolerated the high magnesian lime treatment better than did the other species, making some growth even though the concentration of magnesium in the tissue was 1.87%. Concentrations of aluminum and manganese did not vary significantly among species or treatments, and levels were of the same order as in Experiment 1.

Discussion

The two range species that were most productive on the untreated soils, veldtgrass and perennial ryegrass, were very responsive to applied phosphorus in the absence of lime, but responded inconsistently to applications of calcic lime. Hardinggrass, tall fescue, and smooth brome responded strongly to the application of low calcic lime in the presence of applied phosphorus, but did very poorly on the untreated soils.

The yield responses obtained on the untreated soils indicate that substantial variation in tolerance to strongly acid soils exists among the forage grasses commonly used in California. Other recent work has shown that there is also a within-species variation, in tolerance to acid soil, in ryegrass (Vose and Randall, 1962) and in wheat and barley (Foy et al., 1965). These researchers demonstrated an association between growth on acid soils and aluminum tolerance among varieties. We found a general association among our species-treatment combinations between yield and concentration of aluminum. As pointed out by Magistad (1925), there is very little aluminum in solution around pH 5; however, at pH 4 it is possible to have sufficient aluminum in solution to cause toxicity in most plants. The post-harvest determinations of soil pH indicate that the pH was sufficiently low in the present studies for aluminum to have existed in a soluble form. Although the plant analyses (shoot only) did not show any correlation between concentration of aluminum and yield, this does not necessarily rule out the possibility that aluminum may have been present in toxic quantities, since excess aluminum may have been retained in the roots (Wright, 1937). The fact that cereal rye and veldtgrass did relatively well in the untreated soil also supports the likelihood of aluminum toxicity, since this may have been due to their aluminum tolerance (established for cereal rye by McLean and Gilbert, 1927). All the other grasses did poorly in the untreated soils.

Unpublished work (W.E.M.) has indicated that the Wilder soil is deficient in magnesium. Evidence from experiment 2 verifies this observation, since all four species selected for this study responded in yield to the substitution of magnesium lime for half of the high rate of calcic lime. Where phosphorus was applied, magnesium response was largely masked. However, the high rate of magnesian lime alone was toxic, being fatal to bentgrass, hardinggrass, and orchardgrass. The veldtgrass survived, but its yield was strongly depressed.

Further evidence of the uniqueness of veldtgrass among the forage grasses tested is indicated by the mineral composition data from experiment 2. As an average of all treatments, calcium in veldtgrass was 74% greater than the mean concentration of the other three species (Table 4). Veldtgrass did not differ markedly from the other species in concentration of the other mineral elements considered, however.

Calcium: magnesium ratios, averaged for the four species, were calculated from tissue concentration data from experiment 2. A ratio of 1.3 resulting from the treatments with the lime-mixtures was associated with best growth of the grasses (Table 4). Ca/Mg ratios of 3.5 and above, resulting from the calcic lime treatments, were less favorable. Ratios of about 0.7 resulting from the magnesian lime applications were associated with even poorer plant growth as calcium-magnesium imbalance in the other direction resulted.

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Voles Damage Big Sagebrush in Southwestern Montana

W. F. MUEGGLER

Plant Ecologist, Forest Service, U.S.D.A., Intermountain Forest and Range Experiment Station, Forestry Sciences Laboratory, Bozeman, Montana, maintained in cooperation with Montana State University.

Highlight

Extensive destruction of big sagebrush in southwestern Montana in the winter of 1963-64 is attributed to a sudden irruption of the population of voles. Such extensive sudden destruction of browse species over wide areas concerns both ranchers and game managers because it can affect production of browse and forage for several succeeding years.

Outbreaks of voles, *Microtus* spp., are not uncommon historically. Such plagues averaged about three per century in Europe and caused much destruction of crops (Elton, 1942). At least two severe outbreaks have been recorded for the Western United States since 1900. In 1907-08, mountain vole *(M. montanus)* generally infested parts of Nevada, Utah, and northeastern California, but was most damaging in the Humboldt Valley, Nevada (Piper, 1909). Populations of mountain voles irrupted again in Nevada, northern California, southern Oregon, and western Idaho in 1956-58 (Jellison, et al., 1958). Concentrations as high as 3,000/acre in November 1957 suffered at least 90% mortality by the following April (Spencer, 1958). Normal populations of mountain vole on Sierra Nevada meadows do not usually exceed 10/acre (Jenkins, 1948). Aumann (1965) thoroughly reviewed the literature on population densities of voles and other microtine rodents.

Most reports of vole damage pertain to girdling of fruit trees and destruction of cultivated crops. However, Murray (1965) noted that voles barked some sagebrush, and Hubbard and McKeever (1961) mention girdling of bitterbrush during the 1957-58 outbreak in northern California.

Rodent damage to valuable browse species such as bitterbrush concerns both ranchers and game managers. On the other hand, damage to sagebrush could benefit grass production for livestock in many areas by reducing competition, but could also be undesirable where sagebrush provides important browse for either livestock or big game. A single year's severe damage can affect forage production on an area for many succeeding years.

An outbreak of voles in southwestern Montana in 1962-64 demonstrated the possible effect these infestations could have on stands of native shrubs. I first noted this infestation immediately following snowmelt in the spring of 1963, evidenced by moderate bark stripping on big sagebrush *(Artemisia tridentata)* in a natural grass-sagebrush community. By the spring of 1964, damage to big sagebrush was so severe that I surveyed surrounding areas to document the extent and severity of the infestation.

Methods

I contacted federal land managers throughout southern Montana to obtain preliminary information on the extent of increased rodent activity on shrubs. I then visited areas where damage had been reported. Although several different shrub species showed stem barking, damage was most pronounced on big sagebrush, which grows in relatively dense stands and over comparatively large areas. Quantitative data on the effect of barking was collected from eight of the more heavily damaged stands of big sagebrush. These stands are located as follows:

Area 1, Wapiti Creek (Sec. 19, T.9S., R.4E.)

Area 2, lower Taylor Fork (S. 8, T.9S., R.4E.)

Area 3, upper Taylor Fork (Sec. 10, T.9S., R.4E.)

Area 4, Call Road (Sec. 15, T.8S., R.2W.)

Area 5, Antelope Flat (Sec. 19, T.13S., R.2E.)

Area 6, Tepee Creek (Sec. 17, T.13S., R.1W.)

Area 7, Divide Creek (Sec. 7, T.12S., R.3W.)

Area 8, Antone Station (Sec. 20, T.12S., R.5W.)

The effect of barking was assessed by estimating the percent of crown mortality on individual big sagebrush plants. If 100% of the crown was dead, the plant was recorded as killed (big sagebrush does not sprout from the base). Plants were classified on the basis of size and vigor prior to bark stripping as follows: young—crown 4 to 12 inches in average diameter; mature —crown larger than 12 inches in diameter and vigorous; decadent —crowns larger than 12 inches in diameter and obviously lacking vigor prior to barking. The sample excluded plants having less than 4 inches crown diameter.

Shrub mortality and canopy kill were measured on a 2-acre

FIG. 1. Big sagebrush stem and branches barked presumably by voles; the section shown here is approximately 20 inches high.

FIG. 2. More than 80% of the big sagebrush plants in this dense 300-acre stand (Area 1) were killed—presumably by voles.

plot selected as typical of conditions within each stand sampled. Thirty-two sample points were located by restricted randomization; the closest shrub in each quadrant surrounding each point was then selected for measurement. A total sample of 128 shrubs was thus obtained for each stand. Size of each affected stand was estimated and general site conditions were noted.

Results and Discussion

Extensive bark stripping was either reported to me or seen by me at scattered locations throughout southwestern Montana on the following shrubs: big sagebrush, silver sagebrush *(A. cana)*, skunkbush sumac. *(Rhus trilobata)*, antelope bitterbrush *(Purshia tridentata)*, curlleaf mountainmahogany *(Cercocarpus ledifolius)*, Saskatoon serviceberry *(Amelanchier alnifolia)*, and common chokecherry *(Prunus virginiana)*. The latter four species are especially desirable browse for either big game or livestock, or both. The most severe damage was concentrated in Gallatin, Madison, and Beaverhead counties. All stem barking was similar in appearance, but differed in degree. Damage to big sagebrush was by far the most impressive because of the intensity of stripping and the amount of sagebrush affected.

Evidence that voles were responsible for stripping the bark from the shrubs is largely circumstantial. The type of damage noted (Fig. 1) was typical of that described by Bailey (1900) for voles: ". . . in the spring, when the snow disappears, trees and shrubs are found stripped of their bark for a wide space near the ground. The marks of tiny teeth remain in the hard wood, and little piles of dry outer bark, mixed with characteristic pellets of excreta, show what animal has been at work. . . . Shrubs and small trees are often stripped of their bark and killed." The damage apparently took place during the winter when snow covered much of the vegetation.

R. B. Finley, Research Biologist for the Fish and Wildlife Service, Denver, Colorado, determined by trapping that meadow voles *(M. pennsylvanicus)* occurred on Area 1. He attributed sagebrush damage to voles primarily because of the appearance of runways, burrows, and grass nests above ground under the bushes. Both meadow voles and mountain voles are common to southwestern Montana. Meadow voles prefer a wet meadow habitat, but mountain voles prefer drier grasslands (Findley, 1954). Either or both of these species could have stripped the bark from the sagebrush. Trapping was not attempted on the other areas, but the shrub damage was identical.

The eight big sagebrush stands sampled were at elevations between 6,800 and 7,600 ft. They were typical of the sagebrush-bunchgrass communities in mountainous areas of southwestern Montana. The sagebrush canopy, from 1 to 3 ft tall, covered 50 to 70% of the ground. The most prominent species in the understory were: Idaho fescue *(Festuca idahoensis)*, wheatgrasses *(Agropyron* spp.), lupines *(Lupinus* spp.), prairie-

Table 1. Percentages of big sagebrush, by age classes, apparently killed by vole damage in southwestern Montana, observed in 1964.

Area no.	Approx. area (acres)	Canopy kill				Total plant kill
		Young	Mature	Decadent	All classes	
1	300	89	98	96	97	84
7	800	38	86	85	78	66
3	50	24	87	91	76	66
6	350	38	68	78	70	51
8	150	24	72	66	56	35
2	50	26	64	65	55	30
5	1,200	8	46	64	50	23
4	20	8	22	35	23	10

smoke *(Geum triflorum)*, cinquefoil *(Potentilla* spp.), and sticky geranium *(Geranium viscosissimum)*. Grasses and forbs covered from 60 to 80% and litter covered from 10 to 30% of the ground surface. Approximately 10% remained in bare soil. Affected stands occupied streamsides, benches, slopes as steep as 20%, and the various aspects. The soils were fairly deep, and had small to moderate amounts of rock. All sites were in areas where snow pack had been continuous during the winter.

The damaged areas ranged from approximately 20 to 1,200 acres. Damage was generally restricted to stands in isolated drainages, and was by no means continuous. Most big sagebrush stands in southwestern Montana grow intermittently with timber and herbaceous types.

On the areas sampled, from 10 to 84% of the big sagebrush had been killed (Table 1). On the most heavily damaged areas, mortality exceeded 90% on some spots smaller than an acre. Usually the amount killed within a single stand varied with location and site productivity. Damage appeared to be greatest in the more lush, productive spots.

The greatest canopy kill, approximately 97%, was measured on Area 1 (Fig. 2 and Table 1) in a large, dense stand of big sagebrush. Plant mortality in this stand averaged 84%. Interestingly, canopy kill on the mature and decadent shrubs was far greater than that on the young shrubs. Voles often stripped the bark from both the main stem and larger branches of the mature shrubs, but seldom completely girdled the stems of young shrubs on the same area.

On Areas 1, 2, 3, and 7, numerous stems were barked prior to the winter of 1963-64. Comparative weathering of the girdled scars and lack of deterioration of dead twigs suggest that much of this damage had occurred in the previous winter, 1962-63. Some shrubs may have been damaged even earlier. Thirty-two percent of the canopy kill on Area 1 was attributed to bark stripping before 1963-64, as was 22% on Area 2, 20% on Area 3, and 14% on Area 7.

Vole populations can increase tremendously within just a few months (Frank, 1957). Population peaks are usually followed by extremely rapid declines (Elton, 1942; Spencer, 1958). On these four areas, however, the buildup apparently lasted over at least a 2-year period, somewhat similar to the Pacific Northwest outbreak in 1956-58 (Spencer, 1958). Vole numbers very likely reached their peak in the winter of 1963-64 on Areas 1, 3, and 7—if amount of bark stripping is a reliable indication. This may or may not be true for the areas where disturbance was less severe, especially since damage prior to 1963-64 was not generally apparent on these areas. If population peaks were not reached on certain areas, damage to native shrubs could be even more severe than these data show.

The herbaceous understory did not appear to have been damaged by the outbreak of voles. Some foliage may have been eaten, but root systems remained intact. Production of grasses and forbs on these areas should benefit by reduction of competition from big sagebrush.

Rodents continually influence the establishment and growth of native vegetation, but this influence is not generally apparent. This influence usually appears as isolated damage to individual plants, or as collection and destruction of seed. As this outbreak has shown, however, small rodents, which are usually unobtrusive, occasionally cause spectacular changes in native shrub stands.

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A Step Toward Automatic Weighing of Range Cattle[1]

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Highlight

A battery-operated electronic scale recorded range cattle weights accurately on oscillograph charts without disturbing the animals. With refinement, the system could operate automatically.

The purpose of this study was to develop a cattle-weighing system that would operate under field conditions without affecting the animal's rate of gain. The weighing system was designed for research on such questions, as: When do cattle gain or lose weight? How are gains or losses related to vegetation, rainfall, temperature, or other factors? And, how do gains and losses correlate with the quantity, chemical composition, and digestibility of forage eaten by the animals?

The system was also designed to answer such practical questions as: When do calves or yearlings reach their peak weights? and, how are these peak weights related to the end of the spring or summer growing seasons, the drying of the perennial grasses, maximum and minimum temperatures, etc? Answers to these questions will help ranchers determine when animal weights and market prices combine to give maximum returns.

The usual way to weigh range cattle is to round them up, sort them, and weigh them over conventional level-fulcrum scales. This procedure is adequate for determining the value of cattle bought and sold, but it has serious shortcomings for research either in range animal husbandry or range management. One obvious disadvantage is cost. Few research projects are well enough financed to afford several sets of corrals and scales and a full-time weighing crew of two or three men equipped with saddle horses and the means for transporting them. A second disadvantage of conventional weighing is that range cattle lose weight in the process, and may not recover fully for several days. Thus, frequent weighing by conventional methods may be expected to underestimate rates of gain and exaggerate rates of loss.

With these thoughts in mind, we set out to devise a system that would meet the following minimum requirements:

1. The basic system should consist of:
   a. An inexpensive platform which the animals would cross naturally to get to water or feed (identical platforms could be built at several locations).
   b. Weight-sensing devices and a remote recorder that could be quickly connected to any platform where animal weights might be taken.
2. The scale should weigh animals individually as they cross the scale platform.
3. Operation of the system must not disturb the normal routine of the animals.
4. The system must be operable at remote locations not served by central station electric power.

Design and Construction of the Scale

The design criteria allowed for one animal entirely on the scale at one time, and restricted the animal from turning around on the scale. The width dimension was taken from a large Hereford bull. The length was determined by measuring the tracks of a 900-lb cow walking through sand. With these measurements as a guide, a platform 42 x 90 inches and a supporting structure were built (Fig. 1). The supporting structure was constructed from 6-inch channel iron and a 3-inch I-beam. The platform was constructed from angle iron and 2 x 8-inch planks. The platform rests on the base or below-ground portion of the supporting structure, except when cattle are being weighed. Four links attached to the platform and supporting structure allow sufficient vertical movement of the platform but prevent horizontal movement.

Since one criterion of design was that the system weigh animals as they moved across the scale without stopping, an electrical method was considered most feasible.

Four electrical resistance strain-gage load rings were made up in the Department shop[3]. Each load ring was a 2-inch section of standard 5-inch-diameter black pipe with wall thickness of 0.258 in. Eyebolts were attached to opposite sides of the ring along one diameter for loading. Strain

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[1] *Submitted as Journal Article #1130, Department of Agricultural Engineering, University of Arizona, Agricultural Experiment Station.*

[2] *Central headquarters located at Fort Collins, Colorado, in cooperation with Colorado State University. Author stationed in Tucson, Arizona, in cooperation with the University of Arizona.*

[3] *The design, construction, and calibration of the load rings and completed system are described in "An automatic animal weight recording system," by Leroy Leonard Bashford. MS Thesis, University of Arizona. 1966.*

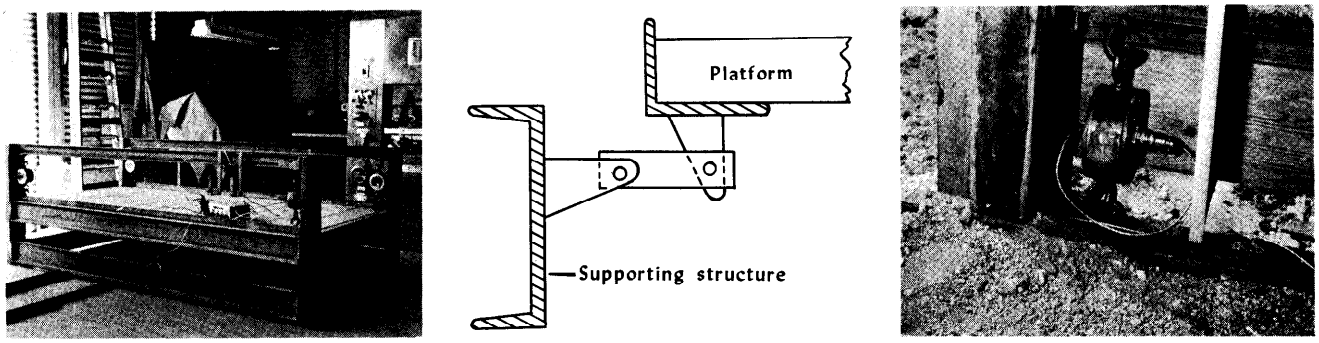

FIG. 1. To weigh cattle the scale is installed in a pit with the platform about 3 inches above the ground line. *Left*, the scale platform, supporting structure, and load rings. *Center*, link used to prevent lateral movement of platform. *Right*, single load ring in shade box after installation in the field.

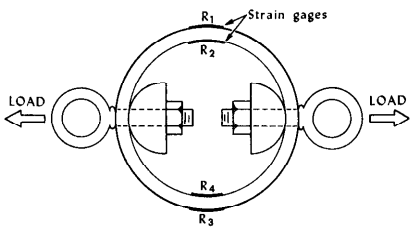

FIG. 2. Load ring showing the location of strain gages and direction of load.

gages were attached to opposite sides of the ring along a diameter perpendicular to the direction of load (Fig. 2). Hooks on the platform and on the underside of the top beam of the supporting structure permit the load rings to be easily inserted, thereby raising the platform off the base supports.

Adding weight to the platform stretches the strain gages on the inner surface of the load ring, compresses those on the outer surface, and changes the electrical output of the load-ring system. The magnitude of the electrical signal from the load rings is recorded on the oscillograph, and can be translated to weight by proper calibration[4].

In designing the load rings, it was estimated that the heavier range cows would weigh around 900 lb, but that occasional weights for bulls might approach 2,000 lb. The dead load of the platform was estimated at 400 lb. Thus, the total design load for the four load rings combined was 2,400 lb. To allow a safety margin of 200 lb. per load ring, each ring was designed to carry 800 lb.

Testing and Calibration

It was necessary that the sensitivities of the four load rings be as nearly equal as possible to insure that a given load applied at any location on the scale platform would result in the same signal output.

Before using the four load rings together in a system, they were labeled A, B, C, and D for identification, tested individually, and adjusted to approximately equal sensitivity by shaving metal off the ends of the less sensitive rings.

The four load rings were then electrically connected in parallel as they would be on the scale, and each ring was individually loaded to check its individual sensitivity as part of the weighing system. The individual ring sensitivities were within 3% of the mean of their sensitivities.

The completed scale was installed at the Campbell Avenue Farm of the University of Arizona for initial testing. The load rings electrically connected in parallel were used with a Sanborn 301 recording oscillograph[5]. Fifty-pound sand bags were used to load the scale in increments to 900 lb. When the platform was loaded at the corners, the sensitivity ranged within 1.57% of the mean. Thus, the position of the load on the platform had little influence on the reading

[4] *For a lucid discussion of strain gages see: Perry, C. C. and H. R. Lisner. 1962. The strain gage primer. McGraw-Hill, New York.*

[5] *Trade names are mentioned for the benefit of the reader; their use does not imply endorsement or preferential treatment.*

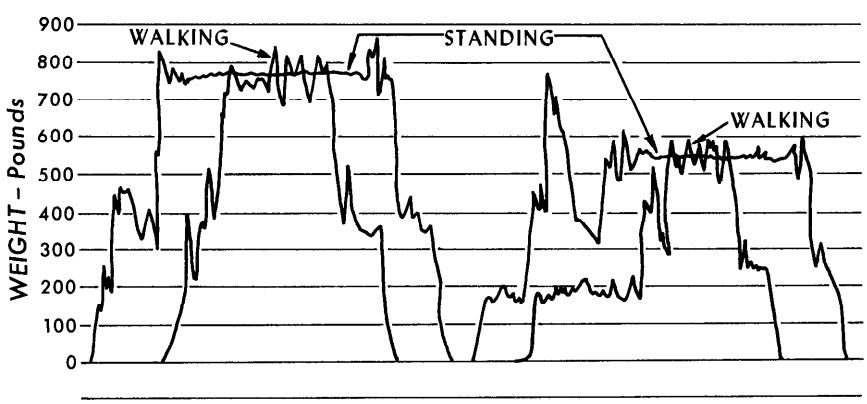

FIG. 3. Oscillograph traces taken from walking and standing animals, overlaid to demonstrate how charts can be interpreted.

obtained from the oscillograph.

Two steers of known weight were then led across the scale to observe the oscillograph traces that would be obtained with live loads. The true weight of each steer was obtained when it stood still on the scale. When their walking and standing oscillograph traces were overlaid, animal weights could be determined reasonably accurately by averaging the peaks and valleys of the oscillograph traces (Fig. 3).

The Completed Field Installation

After initial testing at the University of Arizona farm, the scale was set up at the entrance to a livestock watering place on the Santa Rita Experimental Range. A chute was constructed to force cattle to cross over the scale (Fig. 4). Trigger gates were built at the scale and at an alternate exit to force cattle to cross the platform in only one direction. The chute does not rest on the weighing mechanism and could be built narrower than 42 inches for smaller animals. At first the scale platform was covered with about 1 inch of soil so the cattle would not hesitate to cross the scale because of the wood floor. After a few days the soil was removed, and the cattle were given a few more days to become accustomed to the wood floor. When cattle were to be weighed, the load rings were installed and connected to the recorder, which was operated from a pickup truck parked about 50 ft from the scale. Since the cattle had little fear of the truck, it was not necessary to build a blind. The oscillograph was powered from the 12-volt truck battery through a convertor, which supplied 120 V, 60 c.p.s. current.

The calibration of the scale was checked again after it was moved to the Santa Rita Experimental Range. This field test was accomplished with five men and several 10-kg weights to provide a range in loads from 151 to 862 lb. The test showed that the weight, as interpreted from the oscillograph, was slightly but consistently higher than the applied load. The cause of the change in the sensitivity of the system was not isolated. This bias could have been eliminated by recalibrating the scale. For our purpose, however, satisfactory corrections were made by a regression formula computed from applied and observed weights.

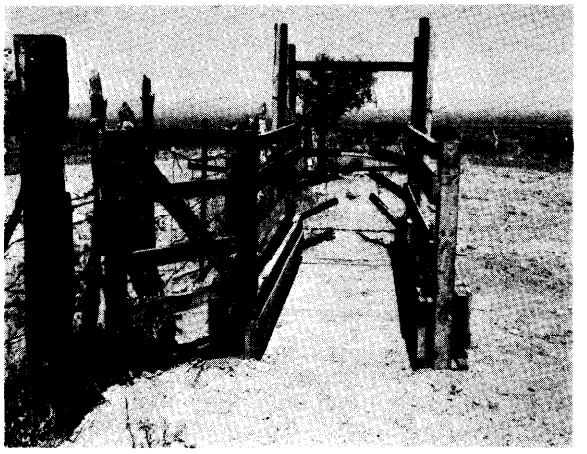

FIG. 4. The scale installed at the Santa Rita Experimental Range. Trigger gates keep cattle from recrossing the scale after watering.

When cattle were first weighed at the Experimental Range, some of the animals still hesitated to cross the scale platform. The charts for these animals were sometimes uninterpretable because the animals jumped or ran across the scale, causing extreme fluctuations on the oscillograph. These results indicate that longer conditioning periods are needed for some animals. Whether the nervous animals were excited by the wood floor, by the narrow passageway, by the presence of the truck and operator, by the faint hum of the recorder, or by a combination of these factors was not determined.

Most cattle weighed in the field crossed the scale more leisurely than those that were led across the scale during calibration at the Campbell Avenue Farm. Their oscillograph traces (Fig. 5) were less variable than those obtained by leading tame animals over the scale in the calibration studies.

Discussion

The results demonstrate that, by using load rings or equivalent

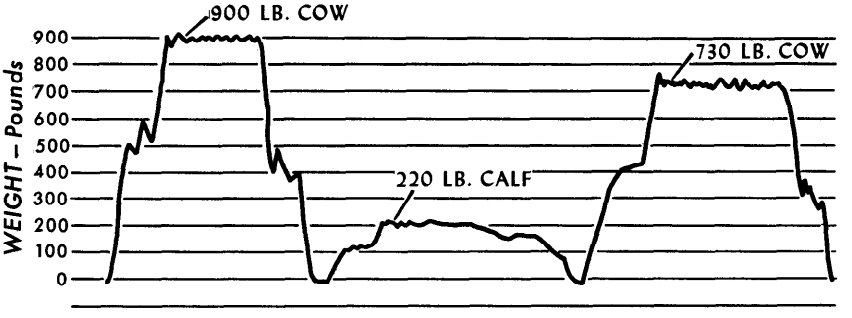

FIG. 5. Oscillograph traces obtained as two cows and a calf each crossed the scale.

transducers and a recording system, range cattle can be weighed without disturbing their normal routine. The weighing procedure does not require elaborate preparation. One person can insert the load rings and prepare the instrument for recording in about 30 min.

It should be stressed that the weighing system described here is a pioneer model, and that many refinements are possible. The use of commercially built load cells or transducers might well improve the performance of the instrument. For example, the experimental load rings must be shaded because they are not temperature-compensating, as most commercial units are. Adequate scale platforms can be built more cheaply from lighter weight materials. Some mechanical means of damping the scale, or a method to momentarily stop the animals on the scale, would eliminate some of the oscillating traces due to movement.

Cattle weights can be obtained with the experimental scale, but an operator is required. To fully automate the scale would require the following additional features:

1. A recorder with sufficient range to accommodate the full range of weights anticipated. The recorder we used required a change of attenuator setting for heavy animals.
2. Remote control of the chart drive, such that an animal would start the chart by stepping on the platform, and that the chart would run 1 or 2 seconds after the animal leaves, in order to establish the base or "no load" line. Since long intervals may elapse between animals, it is essential that the chart not run all the time.
3. Where individual animals must be identified, numbers could be painted on the animals. These numbers could be recorded by a camera tripped by the signal that starts the chart drive.

A scale with these additional features will soon be completed. If it is successful, we will proceed with tests to learn how to distinguish between gain or loss of tissue and changes in fill.

When perfected, the electronic scale will offer several cost advantages. One set of instruments can be moved about to obtain cattle weights on inexpensive, permanent platforms at several locations. Since cattle are not restrained, elaborate, expensive corrals are not needed. One man can set up and calibrate the system and record weights as animals cross the platform, or, he can set the system to operate automatically.

In its present stage of development, the system should work well where cattle visit a certain area regularly for feed or water. Weighing at water offers promise in the Southwest, where many animals drink daily during warm, dry weather, and where cool, moist weather is unusual. Until automatic operation is worked out, however, much operator time can be saved by closing the water the day before weighing, and allowing most of the cattle to gather before letting them cross the scale.

Comparison of Cage Methods for Determining Utilization on Pine-Bluestem Range[1]

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Highlight

Plucking herbage from caged quadrats to simulate grazing resulted in lower estimates of yield and utilization than did monthly or yearly clipping of herbage from caged and open quadrats. At the end of the grazing season, estimates of ungrazed herbage did not differ significantly by measurement technique. The overestimate of yield when herbage was clipped once a year was probably caused by greater growth on caged than on open quadrats.

[1]*Paper presented at the 20th Annual Meeting, American Society of Range Management, Seattle, Washington, February 16, 1967.*

When forage consumption is computed as the difference between herbage weight on protected and grazed plots, greater growth on protected plots may distort the estimate. The longer the period of protection, the greater the discrepancy is likely to become (Joint Committee, 1962). To assess the magnitude of this error, various measurement techniques were compared in a 2-year study on pine-bluestem range.

Procedure

The study was made in 1963-64 on a 570-acre range unit of the Palustris Experimental Forest in central Louisiana. Longleaf pine, *Pinus palustris* Mill., had been clearcut more than 20 years before. The woody cover now consists mainly of scattered second-growth pines, scrub oaks, *Quercus* spp., and southern waxmyrtle, *Myrica cerifera* L. Pinehill bluestem, *Andropogon divergens* (Hack.) Anderss. ex Hitchc., and slender bluestem, *A. tener* (Nees) Kunth, dominate the herbaceous cover. Herbage averages about a ton (oven-dry)/acre/year. Annual rainfall is about 58 inches.

Before the study, ⅓ of the unit was burned each April in a 3-year rotation. A cow herd grazed yearlong, and utilization averaged about 75% on the newly burned portions and 25% on the unburned. For 1963, the study site was a 190-acre area burned in April. To intensify use during

the second year, only 20 acres were burned in April 1964, and the grazing herd was kept constant.

Yield and herbage remaining after grazing were measured by three methods: stationary-cage, transient-cage, and plucked-quadrat. All are variations of what is called the difference method (Joint Committee, 1962) or cage technique (Brown, 1954), whereby herbage weights on protected plots are compared with those on adjacent, unprotected plots. Utilization at the end of the grazing period is computed, in percent, from differences.

Measurement units were replicated 20 times in a randomized block design because a preliminary survey indicated that this sampling intensity would be required for a sampling error of less than 20% on burned, moderately grazed range. All quadrats were 3.1 ft square; ungrazed guadrats were protected by net-wire cages 4 ft square. Original plots were installed immediately after sites were burned. Final measurements were made in the fall, after growth ceased; the growing season lasted slightly more than 7 months in 1963, but only 6 months in 1964. All clipping was to a 1-inch stubble height. Samples were oven-dried at 76 C.

Stationary-cage method.—A cluster of four quadrats, similar in herbage density and composition, constituted the measurement unit. One quadrat, randomly selected, was caged and left undisturbed throughout the growing season. The three remaining quadrats were open to grazing; preliminary sampling indicated that three open quadrats/cluster would minimize weight variation among herbage samples from grazed range. Herbage from open quadrats in each cluster was combined and the average weight subtracted from the weight on the caged quadrat.

This method, with the grazing and growing periods coinciding, is the simplest version of the difference, or cage, technique. Since caged quadrats are free of grazing influences throughout the growing season, however, growth on them may exceed that on open quadrats. As a result, yield and utilization estimates may be too large.

Transient-cage method. — The measurement unit was a series of quadrat pairs whose members were similar in herbage density and composition. The first pair was established immediately after the fire; one quadrat, randomly selected, was caged, the other left open.

After 30 days, both caged and open quadrats were clipped, and utilization was calculated for that period. Immediately before clipping, a second pair was located in which each member was as similar as possible to the open member of the previous pair. Open quadrats were limited to one/cluster to permit accurate matching. The sampling procedure was repeated monthly, and quantities utilized were totaled to determine utilization for the whole season.

Except for 30-day periods when yield-measurement quadrats were caged, all quadrats were subjected to cropping and trampling. Thus, transient-cage measurements should estimate yield and consumption more accurately than the stationary-cage. Because quadrats must be frequently relocated and adequately paired, however, personal bias in this method may exceed that of other methods.

Plucked-quadrat method. — The measurement unit consisted of three quadrat pairs. One quadrat/pair, randomly selected, was caged throughout the growing season; the other was left open to grazing. Three pairs/set were presumed necessary to sample grazed range adequately. At 30-day intervals, herbage on caged quadrats was hand-plucked to a height judged the same as on corresponding open quadrats. Herbage plucked from the three caged quadrats/set was combined and the weight averaged. After growth ceased for the year, all quadrats were clipped and weights averaged for both open and caged quadrats.

Caged quadrats were not trampled, but periodic plucking simulated cropping by cattle. Precision of this method depends to some degree on the observer's ability to pluck caged quadrats to the same height as their grazed models. Most of the immediate error arising from inaccurate plucking should be corrected when quadrats are clipped at the end of the season. Where plucking intensity consistently exceeds grazing intensity, however, growth on caged quadrats may be less than on the open; conversely, insufficient plucking may increase production on caged quadrats.

Because the plucked-quadrat method provided a direct measure of herbage removed by simulated grazing, it was considered the control for this study.

Because techniques differed in subsampling intensity and procedure for measuring yield, production and utilization variances were heterogeneous both years. Hence, a special analysis for comparing means was necessary (Snedecor, 1956, p. 285-288).

Table 1. Herbage yield and utilization (oven-dry basis), by year and method.

Year and Method	Herbage yield	Herbage util.	
	Lb./A	Lb./A	%[1]
1963			
Plucked-quadrat	1824	925	50
Stationary-cage	2212	1334	56
Transient-cage	2047	1135	54
1964			
Plucked-quadrat	1851	1154	62
Stationary-cage	2318	1643	69
Transient-cage	2194	1615	74

[1] Mean of 20 values/method.

Results and Conclusions

In 1963, utilization measurements by the three methods varied from 50% for the plucked-quadrat to 56% for the stationary-cage (Table 1). These differences were not significant at the 0.05 level. Estimates of herbage remaining on open quadrats after grazing were likewise similar. Yield measurements were significantly different; those by the stationary-cage method were highest. Despite similar measures of utilization, therefore, accuracy of the stationary-cage method was questionable.

In 1964, utilization measurements ranged from 62% by plucked-quadrat to 74% by tran-

sient-cage and differences were significant. As in the previous year, the techniques gave similar estimates of herbage remaining on grazed quadrats but measures of yield differed.

The stationary-cage method overestimated yield in both years and utilization in one. Greater growth on caged than on open quadrats probably accounted for the bias. Cassady (1953) found that undisturbed plots produced 33% more herbage than plots harvested at 4-week intervals.

Apparently, exaggeration of utilization by the stationary-cage technique is greatest under very heavy use and diminishes as utilization approaches zero. Findings show, however, that overestimation is not serious even when utilization is about 70%. Therefore, for general use—e.g., determining approximate utilization on lightly or moderately stocked range — this simple, economical method is probably adequate.

The transient-cage method consistently gave higher estimates of yield than did the plucked-quadrat. Moreover, its 1964 estimate of utilization significantly exceeded that by the plucked-quadrat. Measures of residual herbage by the two methods were similar in 1964; therefore, the high estimate of use was probably due to exaggerated yield. Reason for this overestimation is not clear. Since all quadrats were located by one observer, personal bias may have been responsible.

Where periodic and cumulative measures of production and utilization are needed, the transient-cage method or a modification of it must be used. However, its general usefulness is questionable. It was only slightly more reliable than the stationary-cage method and required seven times as much field work and much more computation.

Estimates of herbage remaining at the end of the season did not differ significantly either year. This suggests that the 1:1 ratio of open:caged quadrats sampled residual herbage as precisely as the 3:1 ratio. Thus, subsampling intensity for the stationary-cage and plucked-quadrat methods could have been reduced materially, without loss of accuracy.

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Commercial Fertilizers Influence Crude Protein Content of Four Mixed Prairie Grasses[1]

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Highlight

Nitrogen applied at 33, 100, and 300 lb/acre, alone and with phosphorus, increased crude protein content of blue grama, buffalograss, windmillgrass, and silver bluestem. Addition of nitrogen caused a retention of protein above the level recommended for wintering pregnant beef cows in blue grama, buffalograss, and windmillgrass. Phosphorus fertilization failed to significantly increase protein content or retention.

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The majority of studies involving fertilization of native rangeland have beeen conducted in humid areas. The increase in forage yield has been the established criterion for success in these fertility experiments.

Results of fertilizer experiments on the rangelands of the Great Plains of the United States have illustrated great variance in forage yield with environmental factors. However, in most studies, crude protein content of fertilized range grasses appeared to increase independently of yield and was apparently less affected by environmental factors than was the increase in dry weight (Clark and Tisdale, 1945; Kapp, Smith, and Potts, 1949; Williams, 1953; Carter, 1955; Rogler and Lorenz, 1957; Klages and Asleson, 1959; Klipple and Retzer, 1959; Huffine and Elder, 1960; Taylor and Rudman, 1960; Casper and Thomas, 1961; Mason and Miltimore, 1964).

Taylor and Rudman (1960) noted that nitrogen fertilization increased protein contents of forage throughout a portion of the winter. Other investigators have noted that weathering or leaching of protein from mature grass plants is a primary cause of low value winter forage (Fudge and Fraps, 1945; Williams, 1953).

This paper reports the influence of nitrogen and phosphorus fertilization on crude protein content of four mixed prairie grasses during the winter weathering period.

Methods and Procedures

Two replications of each of 10

fertilizer treatments were established on grass stands dominated by blue grama (*Bouteloua gracilis* H.B.K.), buffalograss (*Buchloe dactyloides* Nutt.), windmillgrass (*Chloris verticillata* Nutt.), and silver bluestem (*Andropogon saccharoides* Swartz) respectively. These four grass stands were common on the research area, the Texas Technological College Research Farm, Pantex, Texas, and represented large areas of rangeland on the Southern Mixed Prairie.

The 10 fertilizer treatments were:

N_1	33 lb N/acre
N_2	100 lb N/acre
N_3	300 lb N/acre
P_1	33 lb P/acre
P_2	100 lb P_2O_5/acre
P_3	300 lb P_2O_5/acre
N_1P_1	33 lb N
	33 lb P_2O_5/acre
N_2P_2	100 lb N
	100 lb P_2O_5/acre
N_3P_3	300 lb N
	300 lb P_2O_5

and a control plot receiving no fertilizer.

Nitrogen was applied as pelleted 33% ammonium nitrate. Phosphorus was supplied from granulated 20% superphosphate. Fertilizer was broadcasted over grass stands in June, 1963.

Leaves and culms of each grass were collected from each treatment on September 1, October 1, November 7, and December 29, 1963, and March 7, 1964. These samples were dried immediately and the protein content of each determined by the Kjeldahl method (A.O.A.C., 1950). Differences between treatments were tested by analysis of variance and Duncan's multiple range tests.

Results

Differences between grasses.—The four grasses selected showed a decline in crude protein content throughout the study period (Fig. 1).

Silver bluestem was significantly lower ($P < .05$) in crude protein content than the other plants studied. September content of 6.6% was significantly higher than the October percentage of 3.0%. The November and December percentages of 2.5% and 2.6% were significantly lower than the October percentage and the March content of 3.0%. The increase in the spring protein level was caused by green re-growth in protected portions of the grass clone.

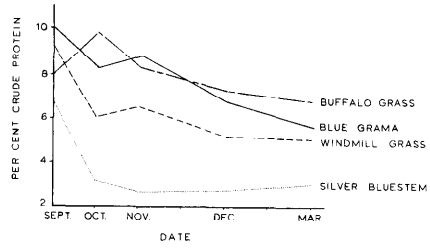

FIG. 1. Percent crude protein of four grasses September - March.

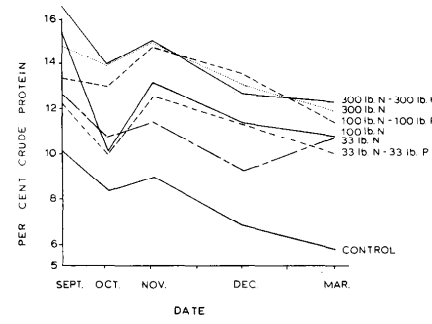

FIG. 2. Percent crude protein of treated blue grama from September - March.

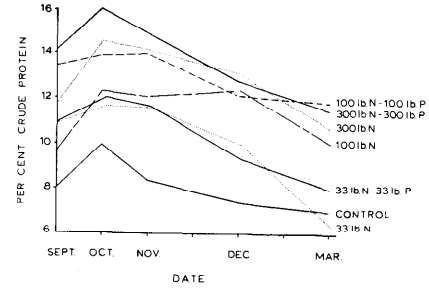

FIG. 3. Percent crude protein of treated buffalograss from September - March.

Windmillgrass varied from 9.3% protein in September to a low of 5.1% in March. The protein percentages in September, October, and November were significantly different ($P < .05$) from each other and were all significantly different from the December and March dates. However, there was no significant decline in protein content from December to March.

Buffalograss contained 9.8% crude protein in October, compared to lesser amounts in September, November, December, and March. The higher ($P < .05$) amount in October was due to a late rain on the buffalograss area. The protein contents at all other months showed a steady decline from the high in October until sampling was terminated in March.

Blue grama exhibited a steady decline from fall to spring. The crude protein content in March of 5.7% was significantly less than that in September, 10.0%.

Influence of fertilizers.—Nitrogen, applied alone and in combination with phosphorus, increased protein content of grasses studied. Phosphorus applied alone did not increase protein content of treated grasses over the control plants.

All levels of nitrogen fertilization increased crude protein content of blue grama over the control throughout the study (Fig. 2). At the end of the weathering period, the control forage had significantly ($P < .05$) less protein than that receiving 33 lb N, 100 lb N, and 33 lb N and 33 lb P_2O_5/acre. Plants receiving 100 lb N and 100 lb P_2O_5/acre, 300 lb N/acre and 300 lb N and 300 lb P_2O_5/acre contained significantly greater crude protein contents than any others in the test. All treatments showed a seasonal decline similar to that of the untreated plants.

Crude protein percentage for buffalograss followed a pattern similar to that for blue grama (Fig. 3). However, in the case of buffalograss, the 33 lb/acre rate of nitrogen, alone or in combination with phosphorus, did not increase crude protein content significantly. All other levels of fertilization increased protein con-

tent significantly over the low level, but were not different from each other. Seasonal trends in protein loss from treated buffalograss was not different from the controls.

Protein content of windmillgrass increased as nitrogen application increased (Fig. 4). At the spring sampling date, the protein content of control plants, 5.1% was significantly lower than those receiving 33 lb N/acre, either alone or with phosphorus. Treatments receiving 100 lb N/acre were significantly higher than those receiving 33 lb, but were significantly lower than those receiving 300 lb N alone or in combination with phosphorus. Protein content of plants on all treatments declined at a constant rate throughout the study.

Silver bluestem responded differently to fertilizer treatments than the other grasses studied (Fig. 5). The plants receiving 300 lb N and 300 lb P_2O_5 had significantly more protein than all other treatments through the December date. There was little difference between the other treatments. There was an increase in protein content of samples from all fertilizer treatments in March due to new growth in the lower portions of the grass clump. Plants receiving phosphorus in addition to nitrogen increased in protein more rapidly than those receiving comparable levels of nitrogen alone.

Discussion

Nitrogen fertilization increased crude protein content of mixed prairie grasses, but additional phosphorus failed to significantly increase protein percentage. The increase in protein content generally increased as nitrogen levels increased.

Nitrogen fertilization reduced the effects of winter weathering on crude protein content. In all species, crude protein content of fertilized grasses declined at the same rate as untreated plants.

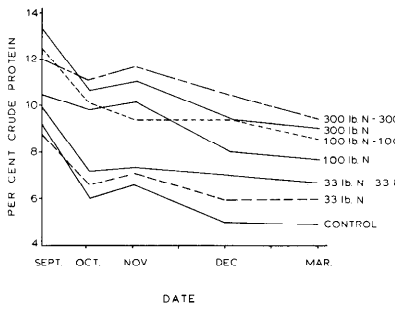

FIG. 4. Percent crude protein of treated windmillgrass from September - March.

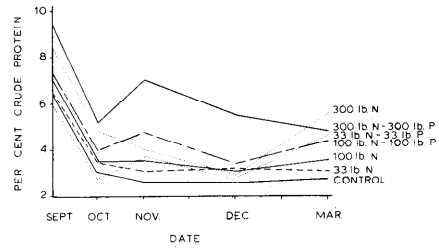

FIG. 5. Percent crude protein of treated silver bluestem from September - March.

Therefore, the main effect of fertilization was to increase the protein content of maturing plants. Although they lost about the same amount of protein to leaching, they remained higher in crude protein during the critical late winter grazing period.

Protein contents of blue grama, windmillgrass, and buffalograss from nitrogen treated plants remained above that recommended by animal nutritionists (National Research Council, 1958) throughout the winter and spring period. However, only those silver bluestem plants receiving 300 lb N and 300 lb P_2O_5/acre remained sufficiently high in protein to meet beef cow requirements for an extended period.

Although data on digestibility of the crude protein are lacking, range fertilization may offer a tool for increasing quality of forage and eliminating the need for winter supplementation of protein on mixed prairie ranges.

Summary

The influence of 10 fertilizer treatments on the protein content of blue grama, buffalograss, windmillgrass, and silver bluestem was studied on the Texas Technological College Research Farm, Pantex. These included nitrogen at 33, 100, and 300 lb/acre, P_2O_5 at 33, 100, and 300 lb/acre, and both nitrogen and phosphorus at the same levels.

All levels of nitrogen, either alone or with phosphorus, increased protein content over the controls. Phosphorus, at any level, when applied alone did not significantly influence protein content.

Nitrogen fertilization influenced protein content of grasses in the late winter through an increase in total protein. Buffalograss, windmillgrass, and blue grama remained sufficiently high in protein through March to meet wintering requirements of pregnant beef cows.

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Bitterbrush Seed Collecting— By Machine or By Hand?

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Highlight

Three methods of harvesting bitterbrush seed that yielded about 5,000 lb clean seed in 1963 were used by the Inyo National Forest. The most economical method of collecting the seed was by Forest Service crews collecting by hand; the most costly was by an experimental browse seed harvester; purchase from private seed collectors was intermediate in cost, but compared favorably with Forest Service crew hand collections. Cost ranged from $47/100 lb clean seed for certain hand collections up to $424 for some machine collections.

Bitterbrush is one of the most important browse species on many deer winter ranges in the Great Basin region of the Western States. It is also highly preferred forage for cattle, sheep, and other game animals. This browse has declined throughout much of its range owing to damage by fire, drought, insects, diseases, overgrazing, and in some instances by natural succession. To restore bitterbrush on the deteriorated ranges by reseeding requires an adequate supply of good quality seed.

The only source of bitterbrush seed is from native stands. The amount and quality of this seed vary from season to season and according to the species. Good antelope bitterbrush *(Purshia tridentata)* seed crop production may occur only every second or third year; good seed production is even less frequent for desert bitterbrush *(P. glandulosa)*. Date of seed maturity varies according to latitude and elevation and, secondarily, to exposure and seasonal climatic differences (Nord, 1963).

Bitterbrush fruit — a spindle-shaped achene—holds firmly on the plant and is difficult to dislodge until fully ripened. But thereafter the seed shatters easily and will literally "shower" from the plant when disturbed. When ripe, the entire seed crop can be cast from the plants when shaken by winds or thundershowers. Seed must therefore be gathered as soon as it matures; any delay can jeopardize both the yield and the quality of the collected crop.

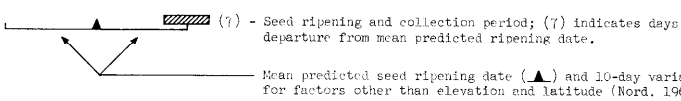
The year 1963 had been forecast as one in which a good crop of bitterbrush seed would develop because of favorable growing conditions the preceding year. We made plans to collect a large supply of this seed as a reserve for plantings in future years. Seed ripened 5 to 8 days later than was predicted by applying Hopkins' Bioclimatic Law (1918) to California conditions. Owing to seasonal variation and other factors, a 6- to 10-day spread from predicted dates can be expected; therefore, the ripening dates were within this range (Nord, 1963).

The prediction of a good seed crop proved correct — seed production in 1963 was unusually heavy. More than 13,700 lb of bitterbrush fruit were harvested by U. S. Forest Service and commercial seed collection at selected sites. This harvest yielded about 5,000 lb of clean seed. Collections were centered next to the Inyo National Forest, in Inyo and Mono Counties (Table 1). The broad elevation gradients there permitted seed collection to continue over a longer period than in most other areas. Seed was collected between July 14 and August 20, on eight sites that ranged from 5,500 to 7,800 ft elevation.

The abundant seed harvest provided the first opportunity to test adequately a mechanical browse seed collector designed and built by the U. S. Forest Service's San Dimas Equipment Development Center. It also enabled us to use other means of

Table 1. Bitterbrush seed collection dates in Inyo and Mono Counties, California, 1963.

Collection site	Latitude north	Elevation (feet)	Maturity dates: July 5 10 15 20 25 30 / August 5 10 15 20 25 30
McMurry Meadow	37° 08'	5,500	(7)
Georges Creek	36° 40'	6,000	(6)
Buttermilk	37° 20'	6,400	(1)
Black Rock Mine	37° 41'	6,050	(8)
Sherwin Grade	37° 31'	7,000	(5)
Mono Lake	37° 55'	6,800	(8)
Arcularius Ranch	37° 45'	6,950	(8)
Reversed Peak	37° 48'	7,850	(8)



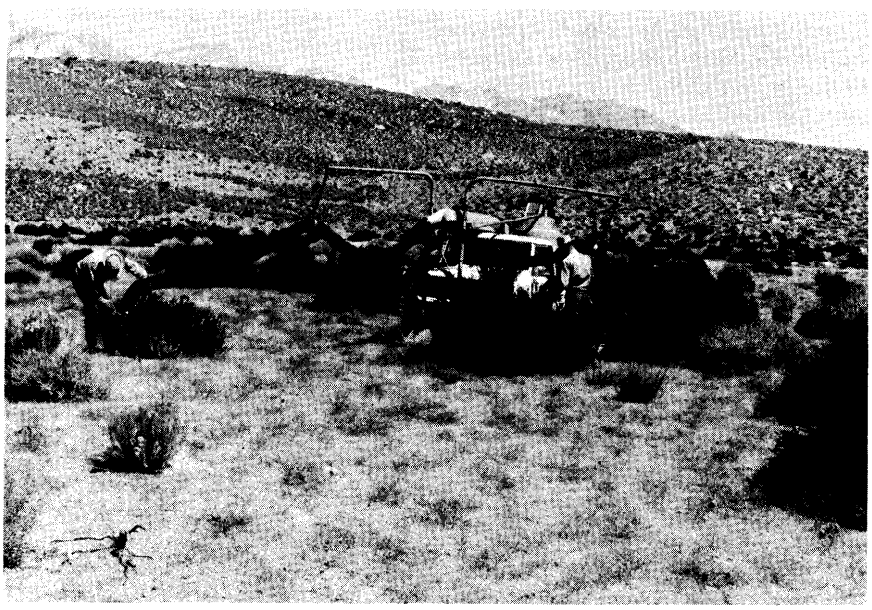


FIG. 1. Browse seed suction harvester collects bitterbrush seed. The two 20-foot hoses are supported by swinging booms.

harvesting and to compare relative costs of collecting bitterbrush seed. In this study the three methods of obtaining seed compared were: (1) mechanical, (2) Forest Service crews, and (3) purchase from private collectors.

Mechanical Collection

The browse seed collector is a vacuum-suction machine designed to be mounted on a 4-wheel drive pickup truck or jeep. Seed is sucked in at the end of two 20-ft-long hoses supported by swinging booms (Fig. 1). These hoses converge at the front of the vehicle into a rigid 10-inch duct. The duct leads to the collector separator, which is carried on the load deck of the vehicle. The separator is a 36-inch cyclone type with a 20-inch outlet into a large receiver-drawer. The entire unit weighs about 675 lb, and cost about $1,300 to build.[1]

It takes three men to operate the equipment — a driver, and two hose operators who work on either side of the vehicle. The hoses are slipped over and worked up and down the seed bearing branches. The operator can tell if the hose is collecting by the rattle of seed passing through. When one operator has stripped the seed from plants on his side, he swings over to the other side of the vehicle. Low seed-producing shrubs are skipped. The operators signal the driver when they are ready to move on.

The mechanical seed harvester was tested on native stands of both desert and antelope bitterbrush under different conditions, using one or two hoses, and in addition hoses of four different diameter classes. Most of the collection trials were made on bitterbrush plants that averaged about 4 ft in diameter and 3 to 4 ft in height.

In the field run, the mechanical seed harvester collected 826 lb of bitterbrush fruit, which upon processing yielded 231 lb of clean seed (Table 2). Manpower collection costs for field-run fruit of desert and antelope bitterbrush were 73 and 89¢/lb, respectively. After cleaning, costs totaled $4.24 and $1.90/lb seed of these two species. The high costs for collecting desert bitterbrush seed are not considered normal because they included charges for training personnel to operate the equipment, whereas the costs for collecting antelope bitterbrush do not include this item.

When working under almost ideal conditions, the mechanical harvester collected 42 lb in one run of 50 min, or an average of 16.8 lb fruit/man hr. But this

[1] *U.S. Forest Service Arcadia Equipment Development Center. Browse seed collector ED&T-1010, 4 pp., illus. 1963 (limited distribution).*

Table 2. Comparative costs of collecting bitterbrush seed by machine and by hand—1963.

Collecting Method	Amount of fruit (lb)	Amount of clean seed (lb)	Seed yield (%)	Collecting costs Fruit[1] (cwt)	Collecting costs Clean seed (cwt)
Antelope bitterbrush					
Machine	302	141	46	$88.71	$190.00
Hand-Forest Service	826	439[2]	53	46.50	87.70
Hand-purchase	715	379[2]	53	50.00	94.30
Sum or weighted average	1,843	960	52	—	—
Desert bitterbrush					
Machine	524	90	17	$72.88[3]	$424.30
Hand-Forest Service	386	208[2]	54	26.86	47.00
Hand-contributed	102	54[2]	54	—	—
Hand-purchase	1,311	705[2]	54	50.00	87.70
Sum or weighted average	2,323	1,057	45	—	—
All methods: Sum or weighted average	4,166	2,017	50	—	—

[1] Does not include overhead supervisory and vehicle rental charges, which amounted to $11.52 and $23.14/100 lb fruit and seed respectively, nor does it include costs for processing and cleaning seed, which are estimated to cost about $4.00/100 lb seed.

[2] Hand-collected material was composited and processed as a group—amount of seed and costs prorated on basis of fruit collected in these categories.

[3] Includes costs to train personnel in operating the equipment.

rate could not be sustained. During 7 days of operation, the collecting rate was only about 5.2 lb of fruit/man hr. Trials using hoses of 3- to 6-inches diameter sizes showed that the 6-inch hose collected twice as much seed as any smaller hose. Thereafter, the 6-inch diameter hose—the optimum size for this equipment—was used.

A comparison of complete stripping of seed from each bush with high-grading gave the following results:

	Lb per machine hr	Bushes per machine hr
Complete stripping	37.0	42.5
High-grading	26.0	84.6

The possible advantage of high-grading is apparently offset by the time lost in moving the equipment more often through the stands.

In comparing one-hose operation to two-hose operation under two conditions, we found that where bushes were completely stripped of seed, the one-hose operation produced only 20 lb field run material/machine hr, whereas the two-hose operation produced 41 lb /machine hr. In another trial, where run-of-the-mill high-grading was done, one-hose operation using a 2-man crew produced 22 lb/machine hr, whereas the two-hose operation with a 3-man crew produced 28 lb/machine hr.

This disparity in collecting rates between complete stripping and high-grading using two-hose operation is attributed to inefficiency of manpower under the latter condition. Two suction hoses could not be operated to the best advantage when high-grading. The distribution of bitterbrush plants with adequate seed supply was such that each man could not always operate on a bush by himself. If two men were gathering seed from the same plant, they tended to be in each other's way, or one man occasionally had to wait while the other was gathering seed just before moving the equipment. This situation did not appear with a two-hose operation when plants were completely stripped of seed; accordingly, this method was used in subsequent seed collecting.

Clean seed yields were higher in all instances from hand-collected materials than from machine collections. Hand and machine collections of antelope bitterbrush contained 53% and 46% clean seed, respectively (Table 2). Some of the disparity in the proportions of field collected material to seed yield of desert bitterbrush can be attributed to the large proportion (87%) of trashy material — leaves, stems, etc. — that was sucked up by the machine during the initial trials of this equipment. As the operators became more experienced in handling the machine, this proportion was reduced to 54% of such materials.

Forest Service Hand Collections

Most bitterbrush seed has been collected by holding a tray or a box under the out-stretched branches while flailing the bushes with a stick, paddle, or by sweeping the arms across the upper branches to loosen the seed, which then "showers" into the receptacle. The material collected is then gathered into larger containers placed nearby. It is then screened through a ¼-inch mesh and over a ⅛-inch-mesh hardware cloth to remove twigs and finer flower parts before weighing the fruit.

Commercial seed collectors often use large aluminum box-like trays, 30 to 40 inches wide and 6 to 10 inches deep, to collect the seed. The large trays can be used to collect seed from large plants, but they are cumbersome when collecting seed from small plants. And they are difficult for

FIG. 2. *Left*, "Inyo" seed collection tray proved adaptable for hand collecting bitterbrush seed; *right*, improvised equipment, such as a cardboard box, was used for seed collecting.

some individuals to hold under the bushes.

For collecting seed by hand, the "Inyo" tray[2] was developed. This aluminum tray is 20 inches long, 30 inches wide, and rounded at the bottom to a depth of about 8 inches. A handle is inserted along the long axis (Fig. 2). This equipment does not hold as much material as the larger trays used by commercial collectors, but it proved adaptable to local conditions and was readily accepted and used by untrained seed collectors.

Three Forest Service employees without any previous seed collecting experience collected a total of 1,212 lb field-run bitterbrush fruit at an average cost of $40.25/100 lb—about half the cost of machine collecting.

The average collecting rate was 8.9 lb/man hour during 17 man-days. The rate during a 1-hour test run was faster. Under excellent conditions, three men collected 54 lb, or 18 lb/man hr. We found that in an 8-hour period 70% more fruit was collected per man-hour by the hand method at 40% less cost than by machine (Table 3).

Table 3. Comparative rates and costs of harvesting bitterbrush fruit by machine and by hand.

Method	Man-hr prod.	Collection costs ($/cwt)		
	(lb)	Field	Over-head	Total
Machine	5.2	78.67	11.52	90.19
Hand	8.9	40.25	11.52	51.77
Differences	3.7	38.42	——	38.42

Some of the costs of testing the machine with different-sized hoses and training personnel to operate the equipment were included in the machine collections from which the averages were derived. However, any adjustments to compensate for these factors still would not bring the machine costs down to the level of the costs of hand collections.

Private Hand Collections

The third method used in this study was to purchase clean bitterbrush fruit at 50¢/lb from anyone interested in collecting the material. Initial response to this offer was light and indifferent. One group collected a few lb and then gave up. But after two members of the Forest Service collected nearly 200 lb fruit in one day, continued publicity by radio and newspapers brought an overwhelming response. Scores of collectors, using a variety of makeshift collection equipment, appeared and within a 10-day period collected more than 8,000 lb clean fruit. The Forest Service purchased more than 2,000 lb, and commercial seed dealers purchased the remainder.

The collection was screened through the hardware cloth, weighed, and composited with other hand collections of the same species for further processing to loosen the seed from the husks and for cleaning.

Cleaning Bitterbrush Fruit

Field-collected fruit, consisting of 2,323 lb desert bitterbrush and 1,843 lb antelope bitterbrush, was cleaned by running it through a hammermill to loosen the seed from the husks and a cleaning mill to separate and grade the seed according to uniform sizes. The dehulling and cleaning operation yielded more than 2,000 lb of clean seed or about 50% of the field-run materials collected by the Forest Service. Antelope

[2] *The "Inyo" tray was designed by A. S. Fausett, who until his retirement in 1962 was range staff officer, Inyo National Forest.*

bitterbrush seed yield was considerably higher than for desert bitterbrush. Good seed comprised 52 and 45%, respectively, of the materials collected of these two species. The average per bushel weights were 54.2 and 42.8 lb, respectively, of three lots of antelope and four lots of desert bitterbrush seed. This variation in volume weights is attributed to the differences in sizes and specific gravity of seed of these species, with antelope bitterbrush having the larger and heavier seeds (Nord, 1965).

We did not determine the costs of dehulling, cleaning, and grading the seed, but commercial charges generally range from $3.00 to $4.00 cwt when quantities of about 1 ton or more material are processed at a time. Higher processing costs may be expected if seed collections are trashy or when smaller amounts are to be cleaned because charges are based upon gross weight and not upon the yield of seed. In addition, there is a minimum charge—generally about $25.00—regardless of the amount to be cleaned.

Conclusions

Within the limits of available manpower, seed collecting by hand can be quickly stepped-up to meet prescribed needs, whereas the machine rate cannot be increased to any large extent unless more machines are available. The browse seed harvester is limited to use in relatively open stands and on gentle terrain; it cannot reach many productive bushes. Furthermore, it is subject to delays caused by equipment breakdown or other difficulties, such as the carrier becoming stuck in loose sand or hung up by rocks.

In some situations, the browse seed harvester may have some advantages over hand methods of collecting bitterbrush seed. Seed borne on low or prostrate shrubs can be collected best by this method. Along roadsides or in plantations where equipment and crew can operate efficiently, the machine probably could sustain higher and therefore more economical collection rates than were achieved under the test conditions.

The cost of contracting to purchase field-run bitterbrush seed as compared to the cost of other methods will depend upon local conditions. Contracting requires less supervision and may reduce overhead costs of payrolling, accident-reporting (including allergenic reactions to bitterbrush), and less record-keeping than other methods that hire personnel for this purpose. Experience has shown that contracting may be a means of recruiting a larger work force for a short period of time than is otherwise possible. However, there are drawbacks to this method that must be considered. Unless rigid specifications are prescribed, there may be less control over quality and location of the seed collected. In some instances, bid prices might be higher than if seed collectors were employed. Nevertheless, contracting should provide bitterbrush seed at a lower price than is otherwise possible.

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OBITUARY

Arthur W. Sampson, 82, professor of forestry, emeritus, in the University of California school of forestry, died Tuesday night (Feb. 7) in a Bay Area hospital after a month's illness.

Born in Nebraska in 1884—he would have been 83 in March—he attended the University of Nebraska, Johns Hopkins University and George Washington University, earning his doctorate in plant ecology and climatology in the latter school in 1917. He began his professional career with the U.S. Forest Service 60 years ago, after graduation from Nebraska.

Professor Sampson was a scientist, teacher, and author. He started some of the first research in range management and was first Director of the Forest and Range Experiment Station of the United States Forest Service at Ephriam, Utah. In 1922, he joined the University of California to teach the first course ever given in range management in that college of agriculture. He combined the highest teaching ideals with true friendship for his students. He continued teaching until his retirement in 1953, and was active as Professor Emeritus until his death February 7, 1967.

Professor Sampson authored three textbooks and many scientific articles. Because of his pioneer work in research, teaching, and writing, he has been referred to as "The Father of Range Management."

The California Section of the American Society of Range Management has initiated a memorial scholarship in honor of Professor A. W. Sampson.

Design Considerations for Small Pipelines for Distribution of Livestock Water on Rangelands

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Highlight

Rapid development of the plastic pipe industry has brought about a revolution in distribution of water on Southwestern rangelands during the past several years. This article discusses and illustrates several considerations important in the planning, designing, and installation of range pipeline systems for distribution of stored water.

Improper distribution of livestock and grazing on semi-arid Southwestern rangeland results from the poor distribution of watering places. For years, Southwestern ranchers have constructed ponds and dugouts to collect surface runoff and store it at strategic points over the range—but as years progressed, it was learned that at best this water was temporary or seasonal. In fact, in dry years when proper grazing distribution became even more important to the rancher, the water supply from natural runoff was usually depleted. In many areas of the Southwest wells are few and far between. Depth to water and drilling costs make exploration drilling unfeasible from an economic standpoint.

During the past several years a revolution has taken place on Southwestern rangelands as ranchers have begun to pipe water from central water sources to stock water tanks, called "tubs," located in areas where no permanent natural supplies of water occur. In many cases it has become necessary to pump the water considerable distance to reach a site suitable for a permanent storage tank which in turn supplies water which is carried by gravity through pipelines to drinking tubs at various locations on the ranch.

The development and popularity of this relatively new method of water distribution on rangeland was brought about by the rapid development of the plastic pipe industry. Flexible plastic pipe is particularly well suited to laying pipelines over rough terrain. There are several considerations that are important in proper planning, designing, and installation of range pipeline systems for the distribution of stored water.

Considerations

I. Water Quality. — Before water from any one source is piped over a considerable portion of a ranch, there should be an analysis of the water to determine suitability for livestock use. This is especially true if the source is relatively new and unproven. Some ground water in the West contains high concentrations of mineral salts. Reduced gains and in extreme cases even death loss may result from range stock drinking water containing high concentrations of sodium sulphate ($NaSO_4$), sodium chloride (NaCl) and magnesium sulphate ($MgSO_4$).

Studies in South Dakota indicate that 7,000 ppm of soluble salts cause no apparent harm to livestock, although they may drink less of the salty water. However, toxic effects can be expected from concentrations of 10,000 p.p.m. regardless of the type of salts.[1]

II. Quantity of Water.—Range pipeline systems usually have a large storage tank located at the source of supply (pump, windmill, or spring) or on a high point as near as possible to the water source from which the pipeline or pipelines serve adjacent sections of the ranch. The Soil Conservation Service recommends that this storage be large enough to hold at least a 7-day supply for the area to be served when a motor or engine driven pump is to be used, or a 14-day supply when a windmill is to be used. As an example: Assume that the maximum number of cattle and sheep in the area to be served by the storage is 100 and 500 respectively. Using 12 gal/day/cow and 1.5 gal/day/sheep as requirements, the storage would be (12 X 100 head) + (1.5 X 500 head) 7 days or 13,650 gal, assuming the use of an engine or motor driven pump. Flow quantities within the system depend upon the size of each drinking tub along the line. Recharge to each tub should be sufficient to prevent depletion when an entire herd waters at any given tub.

III. Line Routing and Placement of Drinking Facilities. — The pipeline system usually will include a storage tank, so initial routing will in most cases be from the well to this advantageous storage site. The site for the storage facility is at such an elevation that all points needing water can be watered by gravity flow through the pipelines with an absolute minimum number of booster pumps. From the central storage, pipeline routing depends on two fundamentals:

1. The location of points where water is needed, and
2. Topography of the land.

The location of drinking facilities along any given line depends on two factors:

1. Where tubs are needed, and
2. Where it is necessary to break the pressure in the pipeline.

Normally these two factors can be satisfied with one facility, saving considerable expense. See details under "V. Gravity Flow Determinations".

IV. Materials.—Usually a range pipeline is installed with one of four kinds of pipe:

1. ABS (Aerylonitrile-Butadiene-Styrene) plastic
2. PVC (Polyvinal Chloride) plastic

[1] *John F. Vallentine. 1960. Water for range livestock. Univ. of Nebraska Ext. Circ. 63-156. 16 p.*

3. PE (Polyethylene) plastic
4. Steel

The polyethylene is most commonly used for range pipelines. It is flexible and may be purchased in lengths to 400 ft, thus making it practical to place by mechanical methods. Polyethylene pipe is manufactured with three pressure ratings: 80, 100, and 125 psi. These are normally sufficient for range pipelines. When greater pressures are experienced either PVC or ABS plastic or steel pipe is used. Steel pipe if used should be zinc coated.

V. Gravity Line Determinations.—From the storage along a given line decreasing in elevation, the flow in the line is dependent on the elevation difference in the water surface at the source and the water surface at the delivery point. The elevation differential is known as the

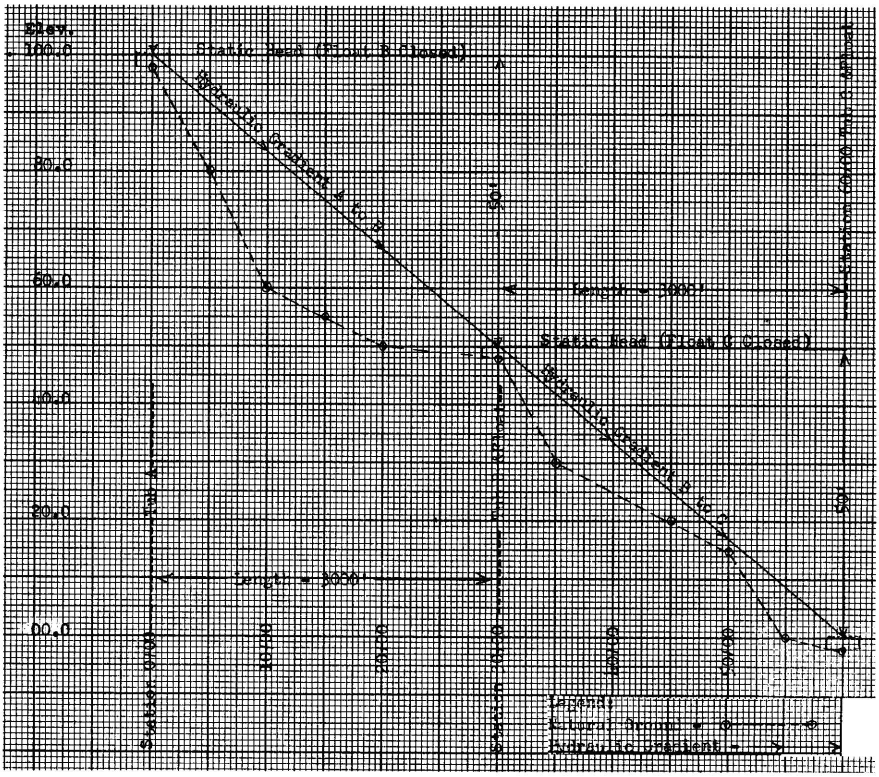
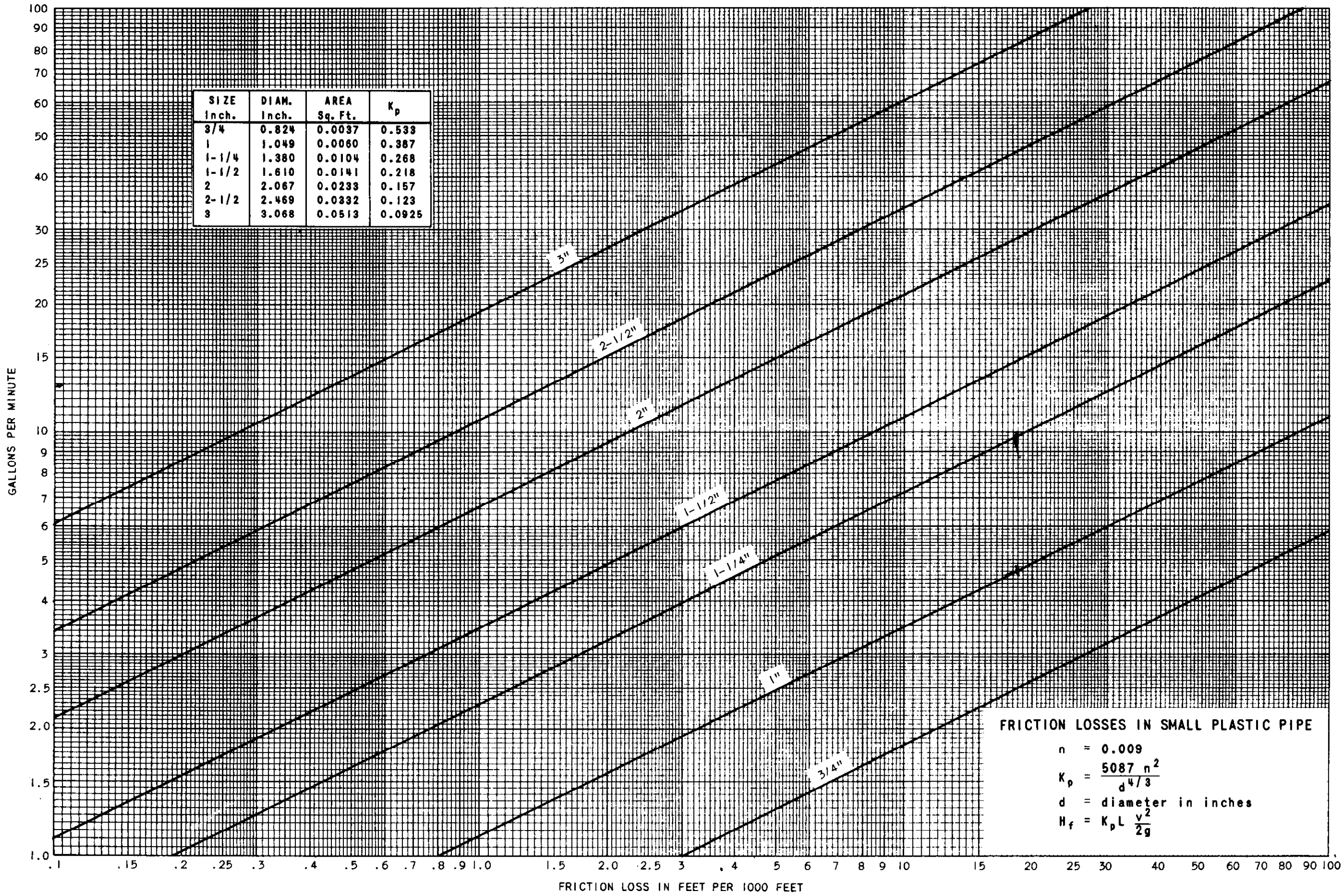


Fig. 1. Example of gravity system of water flow in small diameter plastic pipe.



SIZE Inch.	DIAM. Inch.	AREA Sq. Ft.	K_p
3/4	0.824	0.0037	0.533
1	1.049	0.0060	0.387
1-1/4	1.380	0.0104	0.268
1-1/2	1.610	0.0141	0.218
2	2.067	0.0233	0.157
2-1/2	2.469	0.0332	0.123
3	3.068	0.0513	0.0925

Fig. 2. Chart for estimating friction losses in small plastic pipe.

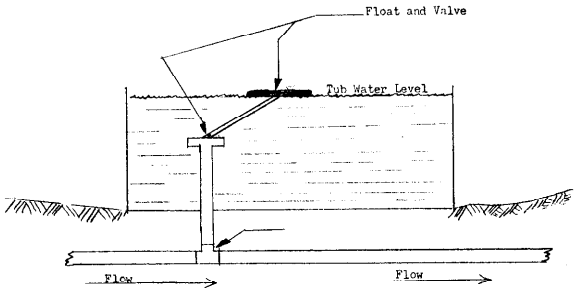


FIG. 3. Tub installation, maintaining line pressure.

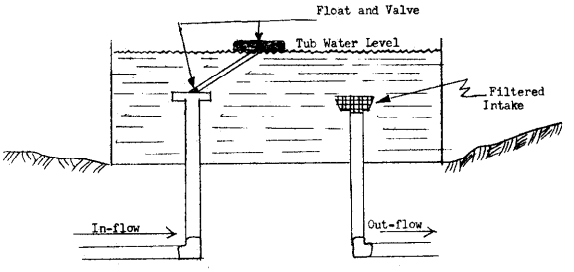


FIG. 4. Tub installation, breaking line pressure.

available head. It is equal to the head required to produce a given flow through a certain length of conduit. It is normal procedure in the design of range pipelines to neglect minor losses and consider only loss due to friction.

A Mannings "n" value for plastic pipe of .009 and for galvanized pipe of .012 is generally used in computing friction loss and determining pipeline capacity. An example of determining flow in small diameter plastic pipe using a nomagraph prepared by the SCS is shown below.

Assume that there is 50 ft of available head between the water surface in storage A and tub B shown in Fig. 1, and the distance AB is 3,000 ft. This means that there is 16.7 ft/1,000 ft of head available to overcome friction. The plan is to use plastic pipe and require a minimum of 5 gpm delivery. Flow in the line should be determined with the water surface at the bottom of the higher storage tank and static pressure determined with the tank filled.

Enter the chart in Fig. 2 at 16.7 ft/1,000 ft on the bottom scale and read vertically to the line representing a 1-inch pipe and the line representing 1.25-inch pipe.

From these two points reading horizontally, find that the 1-inch pipe will deliver 4.45 gpm and the 1.25-inch 9.2 gpm. Since 5 gpm was a minimum requirement, use the 1.25-inch pipe.

Referring back to Fig. 1, notice the static heads developed on the line as the floats at tubs B and C close. It can be determined that maximum pressure on gravity lines normally occurs not during flow, but when the system is *static.*

There are two methods of tub installation. Fig. 3 shows the connection when it is not desirable to break line pressure and Fig. 4 shows installation method to be used when it is desirable to break the pressure in the line. It is readily apparent that the tubs in Fig. 1 were tied into the line by the method shown in Fig. 4.

VI. Pump Line Determinations. —In gravity lines, pipe size and amount of fall determine the actual flow that will occur. In the

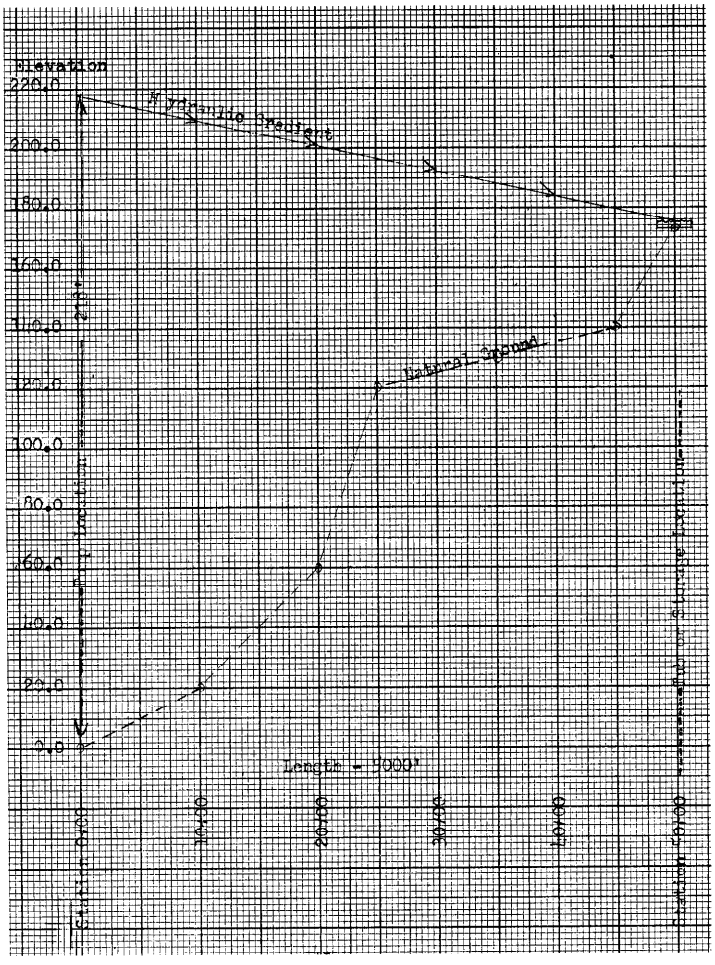


FIG. 5. Illustration of pressure system, showing locations of pump and storage or drinking tub.

design of pump lines for any given pipe size (providing the pipe would withstand pressure created) any given quantity of water may be pumped through the line by increasing or decreasing the power applied to the pump. Therefore, it may be readily seen (Fig. 5) that the maximum pressure on a pump line normally occurs at the pump or at a lower point in elevation along the pipe relatively near the pump.

For an example, using Fig. 5, assume the need to deliver 10 gpm to 50+00 through a 1.5-inch line. The elevation difference between 0+00 and the water surface in the tank at 50+00 is 175.0 ft. The friction loss in the 1.5-inch pipe flowing 10 gpm would be 8.6 ft/1,000 or 43.0 ft total for the 5,000 ft of pipe. Neglecting minor losses, the total head would equal the elevation difference plus friction loss, or 218.0 ft at 0+00.

On gravity and pump lines, the maximum pressure on any segment of the line should be checked. The maximum pressure occurs where the hydraulic gradient or the static head is a maximum distance above the center line of the pipe. This head in feet is easily converted to pressure in lb/in^2 (P).

$$P = \frac{62.4 \times \text{Head in ft}}{144}$$

VII. Pumping Plant. — Pumping water for livestock considerable distance against a high head normally requires only small pumping plants. Horsepower is an expression of the time rate of doing work. Work is defined as a force (lb) moving through a distance (ft). One horsepower is defined as 550 ft-lb/second or 33,000 ft-lb/minute. The first step in determining power requirements is to determine the water-horse power required.

When Q=Quantity of flow in gpm.

$$\text{Water HP} = \frac{8.33Qh}{33,000} = \frac{Qh}{3,960}$$

Referring back to the line in Fig. 5, it was determined the total pumping head was 218 ft. In this case Water Horsepower would be:

$$\text{HPw} = \frac{(10)\ (218)}{3,960} = .55 \text{ HP}$$

With a gasoline engine it may be safely assumed that an overall pumping plant efficiency of 50% could be obtained. This includes pump efficiency, transmission efficiency, and efficiency of the engine itself. In the sample problem an engine of 1.1 rated horsepower should be sufficient. Selection of a power unit for this system would probably be a 1.5 horsepower engine. Care must be taken in selecting pump and engine and matching them in respect to performance data. Performance data is available from the manufacturers.

TECHNICAL NOTES

Mortality of Rock Goldenrod in Sagebrush Stands Sprayed With 2,4-D

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Highlight

Rock goldenrod, an undesirable range plant, was sprayed with 2,4-D incidental to a sagebrush-control project on the Ashley National Forest. One-half to two-thirds of the rock goldenrod plants sprayed at the rate of 2 pounds per acre were killed. This application killed all mature sagebrush.

Sagebrush-control projects on the Ashley National Forest north of Vernal, Utah, provided an opportunity to determine if 2,4-D will kill rock goldenrod *(Petradoria pumila* (Nutt.) Green). Rock goldenrod is an undersirable range plant that grows in a wide altitudinal range (3,500-11,000 ft) extending from Wyoming and southeast Idaho, south into northern Arizona and New Mexico, and west to the mountains of California's Mohave Desert (Anderson, 1963). Rock goldenrod is not eaten by livestock or big game (U.S. Forest Service, 1964), nor is it a good soil binder because it has a taproot with few laterals near the surface.

Some cattlemen believe that rock goldenrod has increased in amount and distribution on the south slopes of the Uinta Mountains during the last decade. However, quantitative records are not available to confirm this belief. The form of rock goldenrod in this area is *P. pumila* ssp. *pumila* (Anderson, 1963). It grows with other forbs and with grasses in the understory of big sagebrush *(Artemisia tridentata* Nutt.) communities, and is most abundant on rocky ridges and other areas with shallow soils. It is also abundant in some areas on deep soils that have been cultivated and seeded to introduced grasses.

This paper does not report a "study" of the usual sort — merely some observations incidental to the sagebrush control projects mentioned above. Since rock goldenrod

Table 1. Density of rock goldenrod one year after spraying with 2,4-D.

Spray date	Site description	No. of 9.6-sq.-ft. plots	Av. no. plants per plot		Percent kill
			Live	Dead	
June, 1962	Scattered sagebrush shallow soil	20	2.6	4.4	63[1]
June, 1963	Scattered sagebrush shallow soil	40	3.6	5.4	60
June, 1963	Moderate sagebrush deep soil	100	4.2	4.4	51

[1] Counts 2 years after spraying showed 66% kill.

is often found in association with big sagebrush, there may well be some interest in the fact that 2,4-D may be used to control both plants simultaneously.

Methods

Two areas were sprayed with 2,4-D in an oil base at the rate of 2 lb/acre—one in June 1962; the other in June 1963. Both are on gentle, southeasterly-facing slopes at approximately 8,000 ft elevation.

On the area sprayed in 1962, live goldenrod plants were counted on 20 permanent 9.6-ft^2 plots just before, 1 year after, and again 2 years after spraying. The plots were on shallow soil with only scattered sagebrush plants. The rock goldenrod plants killed by the 1962 spray could be easily identified and counted in 1963. A slightly different technique was used to determine mortality of rock goldenrod on the area sprayed in June 1963. On this area, both live and dead plants were counted on 140 randomly located 9.6-ft^2 plots in 1964, a year after spraying. No count was made prior to spraying. Forty of the plots were on rocky, shallow soils with scattered sagebrush plants; the remainder were on deep soil with a moderate stand of sagebrush.

Numbers of live and dead sagebrush plants were also counted in the plots on both areas. Sagebrush plants were arbitrarily grouped into two classes: seedlings—4 inches or less in height, and mature—over 4 inches.

Results and Discussion

Rock goldenrod had reached its full vegetative growth, but had no flower stalks when sprayed in 1962. The sprayed plants produced a few distorted stalks without flowers later in the summer. Unsprayed goldenrod plants in adjacent areas flowered the first week in August 1962.

In 1963, 63 percent of the rock goldenrod plants sprayed the year before were dead (Table 1). Portions of many live plants also appeared to have been killed by the spray, and some of these plants died by 1964. Spraying killed all mature sagebrush, but one-fourth of the sagebrush seedlings survived.

In 1964, 60% of the rock goldenrod plants sprayed in 1963 were dead on shallow soils with little sagebrush cover; 51% were dead on deep soils with more sagebrush (Table 1). The spray killed all the sagebrush in the plots on shallow soil and 90% of the sagebrush on the deep soils. All live sagebrush plants were less than 4 inches in height, and many appeared to be seedlings that had sprouted after the area had been sprayed. The lower mortality of rock goldenrod and small sagebrush plants in the area that had the most sagebrush suggests that large sagebrush plants may have shielded some of these low-growing plants from the spray. On adjacent unsprayed areas, no dead rock goldenrod plants and only occasional dead sagebrush plants were observed in 1964.

Conclusions

Perhaps a greater proportion of rock goldenrod plants would be killed by (1) spraying at a heavier rate in June, (2) spraying all plants directly, including those under large sagebrush plants. Whether such a control program would be practical is not known.

Rocky ridges where rock goldenrod is most abundant are often excluded from areas sprayed for sagebrush control because the sagebrush cover is often quite sparse. If further study reveals that removing rock goldenrod increases grass yields, these rocky areas probably should be included in future spray programs.

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An Adaptation of the Grazed Plant Method for Estimating Utilization of Thurber Fescue

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Highlight

The grazed plant method of estimating utilization is some times inadequate because a large percentage of the plants may be grazed lightly. Utilization by weight may be no more than 40% when 100% of the plants are grazed. An adaptation of the grazed plant method aimed at overcoming this weakness has yielded very gratifying results for Thurber fescue in the Central Rocky Mountain area.

A vital factor in good range management is proper stocking. Proper stocking, in turn, is based on proper utilization of the key forage species. To maintain proper stocking then, a manager must have an efficient method for estimating utilization.

Several methods for estimating utilization of range plants have been described. The use of these methods has met with varying degrees of success and satisfaction to the user. For use on National Forest allotments, a

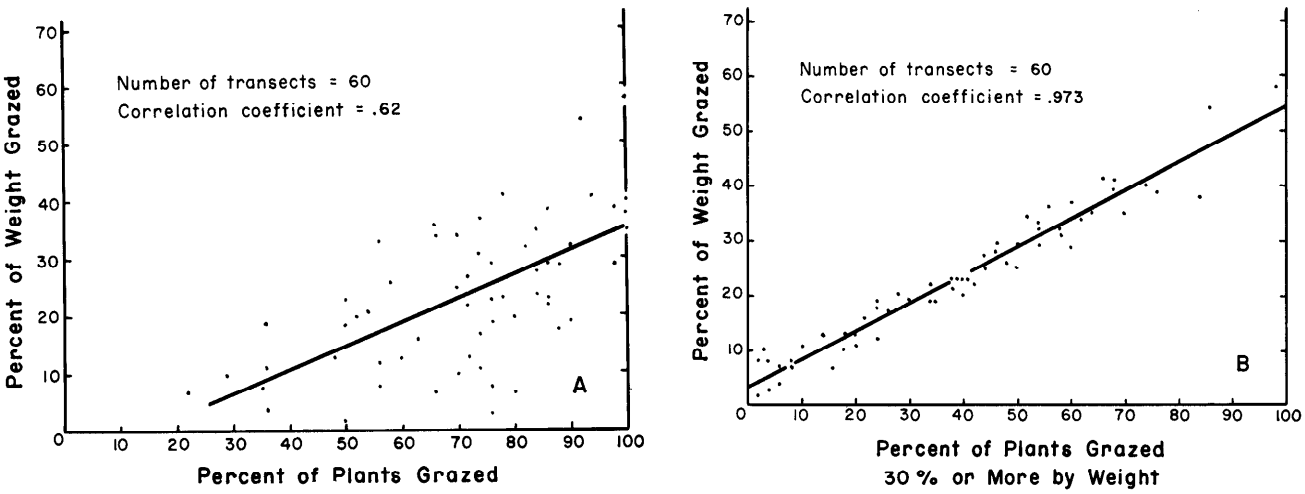

FIG. 1. Regression comparisons for utilization of Thurber fescue: *left*, percentage of plants grazed, and *right*, percentage of plants grazed 30 percent or more by weight.

method should be reasonably accurate, easy to use, and require a minimum of equipment.

Several methods of estimating utilization have been used in the Central Rocky Mountain area by the U. S. Forest Service. The grazed plant method described by Hurd and Kissinger (1953) and Springfield (1961), and the ungrazed plant method described by Roach (1950), are the most rapid and require the least equipment. These methods gave satisfactory results for some species in the areas where standards were developed. An attempt by the Forest Service to use them on other species and in other areas of Colorado and Wyoming has met with considerable dissatisfaction. Because not all forage species are grazed in the same manner from year to year, or in wet and dry periods, or in different areas, it was found necessary to develop standards for local conditions.

Height-weight utilization transects for Thurber fescue *(Festuca thurberi)* frequently contained numerous plants which were very lightly grazed. Therefore, data on percent of plants grazed and percent of weight grazed from the transects were analyzed statistically to indicate

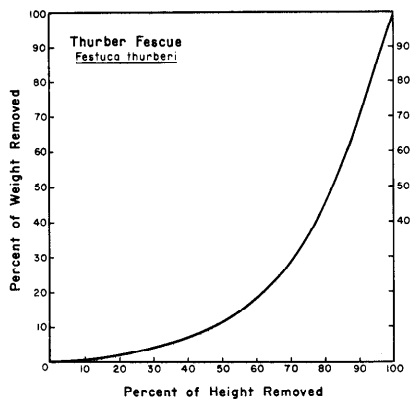

FIG. 2. Height-weight curve for Thurber fescue.

relationships. The relationships found are illustrated graphically by use of the regression equation $Y = a + bX$ (Fig. 1A). The wide scattering of values around the regression line, and the low correlation coefficient (.62) indicate that this regression line would not be satisfactory for estimating utilization.

To reduce that variability, plants that had been grazed very lightly were not included in the regression. This adaptation greatly improved the relationships described and the reliability of the method for estimating forage utilization for Thurber fescue (Fig. 1B).

Methods and Procedures

Utilization data were collected on 50-plant paced transects by the height-weight method. The height of 50 Thurber fescue plants selected by pacing on each transect was measured, and utilization for each plant was determined from the height-weight curve. Average utilization for the 50 plants of the transect was then computed.

The height-weight method for estimating utilization is described quite thoroughly by the National Research Council (1962).

The Thurber fescue height-weight curve (Fig. 2) was constructed from height-weight relations obtained by sectioning and weighing 30 randomly selected Thurber fescue plants in 1960. The curve was checked with two additional sets of data in 1963. The 1960 curve included seedstalks.

The 1963 data were from plants without seedstalks, but the curve for the two years were very similar.

Height-weight data from 60 transects made in 1962, from 70 transects in 1963, and 71 transects in 1964 were analyzed to determine correlations between percent of plants grazed 30% or more by weight and percent of weight grazed (Fig. 3).

Average percent of weight grazed and percent of plants grazed 30% or more by weight in each transect were determined from the transect data. In addition, the transect data were analyzed to determine if figures other than 30% or more by

weight for Thurber fescue would produce a variation in correlation. These analyses indicated that an optimum figure may be determined for each species, and it is expected to vary with different species. Additional studies of this feature are needed to determine the most efficient value for each species.

Besides Thurber fescue, other species studied were: Kentucky bluegrass *(Poa pratensis)*, Idaho fescue *(Festuca idahoensis)* in Colorado, western wheatgrass *(Agropyron smithii)*, tufted hairgrass *(Deschampsia caespitosa)*, mountain brome *(Bromus marginatus)*, and Arizona fescue *(Festuca arizonica)*. Correlation coefficients indicate that the method is also well suited to these species, and additional study is recommended.

Equipment required in the use of this method are: a ruler, transect recording forms, height-weight curves, and regression graphs for the species and area concerned.

The field procedure used in application of this method to estimate utilization for Thurber fescue is as follows:

1. Establish 50-plant paced transects through representative portions of the key and other areas of the range where utilization is to be studied.
2. At each pace, classify the Thurber fescue plant nearest the toe as grazed or not grazed; measure maximum seedstalk heights (or maximum leaf heights if seedstalks are not present) on ungrazed plants, and average stubble heights on grazed plants, and record in separate columns on the transect form. Stubble heights less than six inches should be measured to the nearest one-half inch.
3. Determine average height of ungrazed plants for the site concerned. A minimum of 20 ungrazed plants, selected at random, either along the transect or in the general vicinity of the transect should be used for this purpose.
4. Compute the stubble height which represents 30% of weight grazed. To do this:
   a. Observe from the height-weight curve (Fig. 2) the percentage of plant height that corresponds to the selected percentage of plant weight. For Thurber fescue, 71% of the height grazed equals 30% of the weight grazed.
   b. Apply the percent of plant remaining (29% in this case) to the average ungrazed height to obtain the stubble height needed. E.G., assuming an average ungrazed height of 36 inches, $36 \times 29\% = 10.44$. Plants grazed to a stubble height of ten inches or shorter are grazed 30% or heavier by weight.
5. Determine the percentage of plants on the transect that are grazed to, or shorter than, the computed stubble height.
6. Apply the percentage figure obtained in No. 5, above, to the regression graph (Fig. 3) to obtain an estimate of average utilization by weight for the transect.

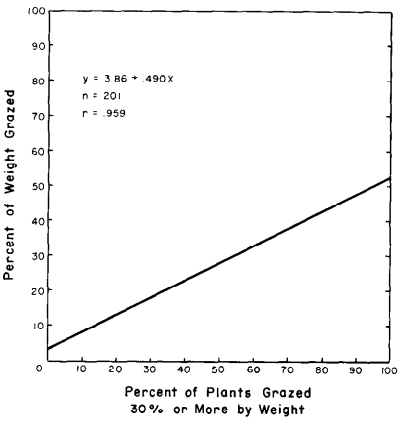

FIG. 3. Relationships between percentage of Thurber fescue plants grazed 30 percent or more by weight and percentage of herbage grazed.

Results and Discussion

Percent of Thurber fescue plants grazed 30% or more by weight was strongly related to average percent utilization by weight on 50-plant transects. Correlation coefficients of .973 for 1962, .972 for 1963, and .940 for 1964 show how closely the two measures are related. Differences between years are not significant. Combined data for the three years have a correlation coefficient of .959.

Utilization as determined by the method described herein compared very favorably with that determined by the height-weight system over a three year period. Analyses of utilization data for several other important grasses indicate that the method is suited to other species also.

For some species of grasses, height-weight relationships are different between seedstalk producing and non-seedstalk producing plants. This should be checked locally by constructing curves for both types of plants.

When one utilization transect has been read and all computations made for any given area, additional transects can quickly be installed in the same local area to provide a larger sample. In the case of the additional transects for Thurber fescue, use the stubble height from the first transect in that area which represents 30% by weight to alleviate need for extra computations.

Because average plant heights vary for a given species between areas and between years, stubble heights used in estimating utilization also vary. Measure ungrazed plant heights at each transect location each year to account for this factor.

This system should not be used beyond the limits of the data. Where utilization averages above 45 to 50% for Thurber fescue, for example, the method described herein will indicate that the utilization is heavy, but will not give an accurate estimate of the percent utilization. However, the examiner will know that utilization is heavy, and can compute utilization on the height-weight basis if all plants are measured and recorded.

All methods of estimating utilization require adequate sampling of comparable ungrazed plants as a control. On a heavily grazed range, it is difficult or impossible to obtain adequate ungrazed height data. Ungrazed plants protected by utilization cages, or in an adjacent pasture which has not currently been grazed heavily, should be used to

obtain the average ungrazed height.

Analyses of the utilization data indicate that there is an optimum value to use with a given species to obtain the highest correlations with percent of weight grazed. Additional study is needed to determine this optimum value for each species.

Summary

The percent-of-plants grazed method is a rapid and "easy-to-use" method for estimating degree of utilization, and it has given satisfactory results for some species in the areas where standards were developed.

Attempts by the Forest Service to use this system in the central Rocky Mountain area have been unsatisfactory for some of the important key grass species because of inconsistencies in the way livestock graze those species under different climatic conditions and between different seasons or years.

The adaptation of the percent-of-plants-grazed method described here has given satisfactory results over a 3-year trial period where data were gathered from various National Forests by several different examiners. This system, based upon utilization data from height-weight transects, accurately estimates percent utilization within the limits of the data.

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MANAGEMENT NOTES

Brush Control— An Unfinished Job

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The photographs in this note were the authors' prize-winning entry in the picture story contest at the ASRM Annual Meeting in New Orleans in 1966. The series of photos was started in 1952, when a study of rangeland brush control was started at the San Joaquin Experimental Range, near O'Neals, California. The Range is maintained by the Pacific Southwest Forest and Range Experiment Station of the Forest Service, U.S.D.A.

FIG. 1. Let's get that brush! A small tractor was brought in to do the job — July 1952.

FIG. 2. We'll get'er! It's a good thing the oak was small.

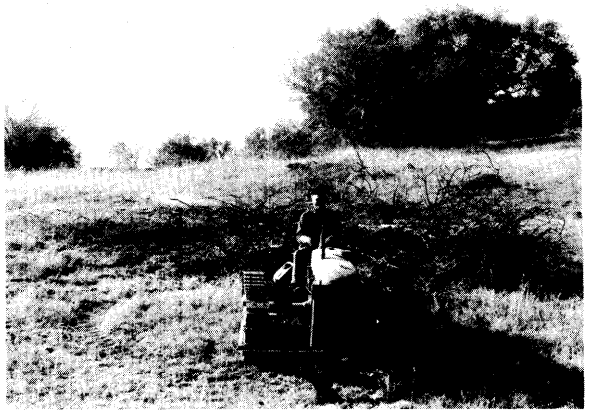

FIG. 3. We got'm! But a huskier tractor would have been better.

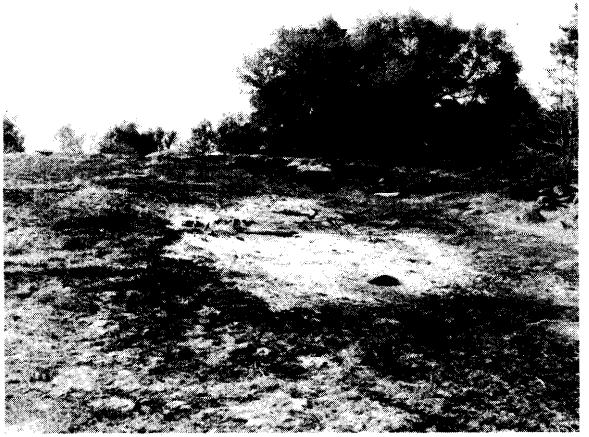

FIG. 4. Still July 1952 — the hot fire has left little but white ash.

FIG. 5. September 1953 — A few sprouts about right for the first spraying. This was the time to start spraying with a herbicide.

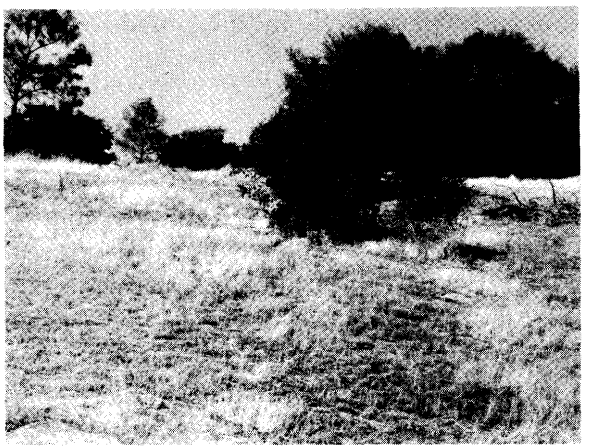

FIG. 6. October 1965 — Without followup control, a vigorous plant has regrown.

Some of the common brush and tree species found on the Experimental Range are: interior live oak *(Quercus wislizenii)*, blue oak *(Quercus douglasii)*, digger pine *(Pinus sabiniana)*, wedgeleaf ceanothus *(Ceanothus cuneatus)*, and deerbrush *(Ceanothus leucodermis)*.

In the illustrations, live oak is being treated. The first three photographs illustrate a common method of preparing brush for burning. In this particular demonstration, a small track-type tractor was used, but a larger tractor crushes brush more efficiently. The effectiveness of the July 1952 burn is illustrated in Fig. 4.

Brush that has the ability to sprout from the root crown, such as interior live oak, returns after a fire. By September 1953, the new sprouts were about 18 inches tall (Fig. 5). This was the year to start herbicide treatments — spraying in two or three consecutive years would have eliminated this live oak. The brush sprouts were not sprayed and the results are shown in Fig. 6, taken in October 1965. This photo illustrates a common fault with so-called brush control jobs—a good start but no follow through.

Livestock Grazing Under Multiple-Use Policy[1]

HUGH W. COLTON
Rancher, Vernal, Utah, and Chairman, Public Lands Committee, Utah Cattlemen's Association.

Highlight

Good range management is the price ranchers must pay for a place on the public lands. Stockmen must have a positive plan of action to improve the range and develop leadership in land management.

My livestock operation is entirely dependent on the use of public lands. The cattle operation I have today is based upon lands homesteaded by my parents in 1879 and has been used continuously since that time as a home base for livestock that graze approximately nine months each year on public range managed by the Bureau of Land Management and the United States Forest Service. In addition I have some public lands leased from the Utah State Land Board.

The last few years this operation has been on a non-profit basis but I hope this condition will soon change. However, with this base property and the use of public range lands, my father and mother reared a large family, from which has sprung nearly 400 descendants. I mention this to indicate how important this ranching business is in the growth of a community, a state, and a nation.

In order to appreciate the viewpoint of the livestock operator, we must remember the history of grazing. Prior to 1905 all of the forests were grazed without restriction, until 1934 all other public lands owned by the Federal Government were grazed without any control or regulation, and during this time the West was built, largely by the basic agricultural pursuits of raising cattle and sheep on public lands without charge.

Government regulation moved in on public range — generally speaking, the livestock operator has accepted these changes. The Taylor Grazing Act was sponsored, promoted, and passed through the efforts of the livestock men.

On June 12, 1960, The Congress passed the Forest Service Multiple Use Act. The Congress stated, "It is the policy of the Congress that the national forests are established and shall be administered for: 1) outdoor recreation, 2) range, 3) timber, 4) watershed, 5) wildlife and fish purposes." Here the traditional land policy was changed.

The livestock operator has lived with the multiple-use program throughout the years, so that grazing has been compatible with other uses for many years, and at this time must continue to be.

Most livestock operators feel Forest Service and BLM grazing permits are actually rights; however, the law does not yet say so, but they have all the earmarks of an established right. The mining law provides that the first locater obtains the right. The water law is based on the principle that he who first puts the water to beneficial use has the right to it. The homestead law provided that the right to the land went to the one who first filed upon it.

In many instances, special acts have been passed which provide that if a permit is taken away from a permittee, he will be paid the fair market value of the permit. This has always been done when a permit has been taken for military purposes.

Many prominent students of the range situation recommend that a law be passed making a Forest and BLM permit a right to guarantee tenure. If it were regarded as a right, it would eliminate much trouble. Then if a permit was to be taken away from a permittee for the benefit of the people, the permittee would be paid for it. Certainly if a large grazing area is retired from grazing for recreational purposes, to be used by the public, then why shouldn't the public pay the permittee? It is my opinion that this matter is a practical one and will, in the not too distant future, be settled by a grazing permit being recognized as a right. It appears we are merely fighting the problem to say it isn't. We all know permits are frequently bought and sold for substantial consideration.

The people who argue against this, generally speaking, are government range managers who say these lands belong to all the people. This does not appear to me to be a logicial analogy. Certainly the White House, by the same theory, belongs to all the people, but that doesn't mean all the people have the right to move in with the President.

Livestock operators must move forward with changing times and conditions. We do not feel that the establishment of the multiple-use policy changes the situation much. There has never been any conflict between the livestock operator and the lumbermen, who harvest the timber. I do not know of any case where the permittee has objected to the construction of dams and reservoirs for irrigation and power purposes. As far as wildlife is concerned, I feel confident in saying that the livestock operator has always cooperated with wildlife interests. For years, our own outfit has, in cooperation with the Fish and Game Commission, distributed salt for wildlife. There are times some hunters are inconsiderate of other users of the public lands, and particularly livestock. However, a closer look at the situation shows me that only a very small percentage of the hunters and other outdoor lovers disturb the livestock. Generally I have found hunters to be real gentlemen, if a gentleman is one who is considerate of the rights of others.

Outdoor recreation has become very prominent in the last few years and, undoubtedly, will demand more

[1] *Paper presented at Summer Meeting, American Society of Range Management, Logan, Utah, July 28, 1966.*

of the public lands in the future than it has in the past. However, many camp areas have been established in the heart of the grazing country, but where fenced properly, seem to interfere very little with the grazing of surrounding areas. Livestock grazing has been, and will be, compatable with wildlife grazing, hunting and fishing.

I feel confident the livestock operator can live with the multiple-use Act, which states, "The management of all the various renewable surface resources of the national forests will be so managed that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions and that some land will be used for less than all of the resources."

The viewpoint of the present livestock operators is that the smart thing to do is to develop and improve our forage production. We believe that a livestock operator is shortsighted and foolish if he overgrazes his private range or the public lands he is permitted to use.

I know many operators who have increased their net income by reducing the number of livestock grazed upon given areas. Today, the smart livestock operator is the one who makes proper utilization of his range but does not overgraze it. He knows that in overgrazing or by improper forage utilization, he is the loser.

Ranchers need to modernize their use of public lands or face further restriction. Public range administrators can be and have been of real aid by cooperating and encouraging stockmen to improve ranges and adjust to changing times.

We are informed the objective of range managers is to maintain or improve production of forage on land used to support domestic livestock and big game animals. Yet records show that too often, as management intensity on public lands has increased, total animal production has steadily decreased because of reduction in time or numbers.

Naturally, those who are concerned with maintaining a healthy livestock industry in the West view this trend with alarm.

Ranchers tend to defend their right to continue to graze public land on the basis of national meat needs, priority of use, moral principle, and the personal hardship which would result from reduction or elimination. Although each of these has a degree of validity, a stronger argument is that grazing belongs as a part of the multiple use of land and that it can be included without detriment to other legitimate uses. Early in the history of the West, land was abundant, sparsely occupied and used freely. The range livestock business was founded upon such conditions.

There is a great and understandable desire to own land; people are increasingly more aware of the value of public land and of their rights to use these lands.

Changing federal land policy is a product of public demand—not a cause. Most administrators, and especially those born and trained in the West, make an honest effort to keep Federal lands available for livestock grazing, despite the forces of millions of people demanding other land uses.

There is no need for alarming talk that changing federal land policy will wipe out the livestock business. True, a change is inevitable, but this need not mean elimination of the industry. But modernization is necessary. What happens in the future is largely up to the rancher.

The rancher cannot stand by and hope someone will protect his interest in the land. He must immediately and aggressively solve these problems. Livestockmen who approach the range manager in a spirit of understanding and a willingness to cooperate in putting together a workable multiple-use program on the land are the far-sighted ones. This requires that the stockmen have a positive plan of action to improve the range. Stockmen must develop leadership in land management. There is no reason to wait for others to develop the plans. Good range management is the price ranchers must pay for a place on the public lands.

I believe ranchers may now look forward to increasing, rather than decreasing, their grazing permits. This can be done on a large majority of our public ranges if stockmen and administrators really want it done. In 60 years of management on America's public ranges, we have not begun to exhaust the possibilities of increasing forage production. We have talked for years about getting this job done. It is time for action. Both stockmen and federal administrators have been slow in putting to use known information about improving ranges.

In conclusion, I want to emphasize the fact that the livestock operator who is permitted to operate his livestock on public lands can and must adjust his program to conform to the multiple-use policy. And that by proper planning and cooperation with the range managers, the future may well bring a more stabilized and profitable livestock industry.

Range Improvements and Returns to the Private Land Operator in the Intermountain Area[1]

DAN FREED

Vice President, Deseret Livestock Co., Salt Lake City, Utah.

Highlight

Ranchers are squeezed by spiraling inflation—yet the price for the meat they produce is the same as 20 years ago. Some means for meeting this problem are discussed, including range improvements and range management.

My formal education in Business Management and Economics left me lacking a schooling in Range Management, a lack that I have sincerely been trying to make up for during the last 25 years. But, with this background I have figured and figured and I still come up with the fact that ranching is the hardest way to make money of any way I know. It is a glamorous, historically fabled, or popular industry that is now trying to excuse its lack of return by saying that it is "a way of life" as though that excused it from having to make a profit or give a fair return on the money invested.

For the last few years, particularly, we have found the industry ever more invaded by the doctors, lawyers, and chiefs of industry who have made their money in other fields and are coming into the cattle business to "play cowboy"—coupled with the fact that they feel that ownership of land is the best hedge against inflation.

Despite a few, and I do mean very few exceptions, nobody in the livestock industry is making money although they are getting by and that's about the best you can say for it. Well, how are they gettting by? Some ranchers can carry on by living on their "fat" which means they do not do the maintenance and certainly add nothing new that they cannot pay for out of the immediate cash flow. It may mean refinancing over longer terms, despite higher interest rate. There are several good, old ranches that are carrying on because they have been able to refinance and spread their fixed payments over a longer time. Also, a lot of them are gradually going backward and for the first time they are starting to get operating loans that carry them through from year to year. Many of the ranchers see these operating loans as a regular thing now, and expect them to continue. Another way of getting by is to purchase additional range or permits on long terms. This increases their income, and although you can show with a pencil where this land may not be a good investment because of the poor return, it does let them pay for it over such a long period of time that they can get by. Some get along with no return on investment and very little return on their labor, if any.

Recreation has been helping them get by. This "fringe" income from hunters, fishermen or the like must not be discounted. In fact, some ranchers have found it so profitable, especially compared with their livestock operations, they have gone into the recreation business more and more. On the ranch with which I am now associated, we had a total of over 2,000 deer hunters last fall, that we charged $2.50 each. I wish I could tell you that this was net income but we did not break even. Coupled with the usual expense of having people come in like this and the vandalism, we have gotten a fine start of Canadian thistle throughout the range from bedding and horse feed brought in that I see no way of ever eliminating.

Agricultural Conservation Program payments which ranchers receive for specified conservation efforts must be considered a direct benefit. Another definite fringe item might be the fact that some ranchers are making a little money by selling horses — and some cattle ranches, who have never seen a sheep before, are now selling a few lambs to improve their income picture, and vice versa.

One way ranchers carry on is to sell parts of their land. The obvious sell-off is home sites for recreationists. Many of the old ranches are selling other speculative sites that they might have near urban areas whereby they recover some of their capital plus its appreciation. But, we must not overlook the fact that many fine ranches are being sold in their entirety because the economic factors are just too tough to buck.

Sadly, the way many ranchers have been able to carry on is by, frankly, a lower standard of living. There can be no doubting the fact that lots of our ranchers today live on an increasingly poorer standard. The obvious inequities of increased cost of labor, machinery, supplies and everything that is purchased along with the fact that the ranchers product, meat, shows no appreciation in the last 20 years has become the "Gordian Knot" that is facing everyone in the industry.

The opportunities to solve these problems are not too numerous despite all of the study and hard work that a rancher can do. Don't think the ranchers haven't tried to be up to date and progressive, but the problems of "cash flow" and raising capital to take advantage of the progressive things in life has nearly pushed them to the wall.

For example, the chances for improvement and profit in animal husbandry have been pretty well worked over. Performance testing has been utilized and is being utilized more all the time. It is well known and each rancher is trying his best to work it into his program. Nearly every rancher now has a health control program to reduce his losses. They start out with a comprehensive program of vaccination, cleanliness, and proper feed the year round to get the very most out of their livestock. Others use breeding programs such as pregnancy testing to eliminate the shy or non-breeders and systems of consistently calving two-

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[1]*Presented at the Summer Meeting, American Society of Range Management, Logan, Utah, July 28, 1966.*

year-olds rather than to go longer without some sort of income from the heifers. Many hire veterinarians on a consulting basis to come in and help them with these programs.

All of the things I have mentioned are obvious and sometimes desperate attempts to produce more pounds of meat, economically. However, it seems to me, that the one place that comparatively little has been done is in the field of *Range Management.* Frankly although this science is more difficult to demonstrate and requires more hard-to-get capital, the opportunities for economic betterment are larger than in any other field of ranching. Outlays for range improvement are not just "dead" capital outlays like machinery but they actually return more than any other ranch expenditure to-day.

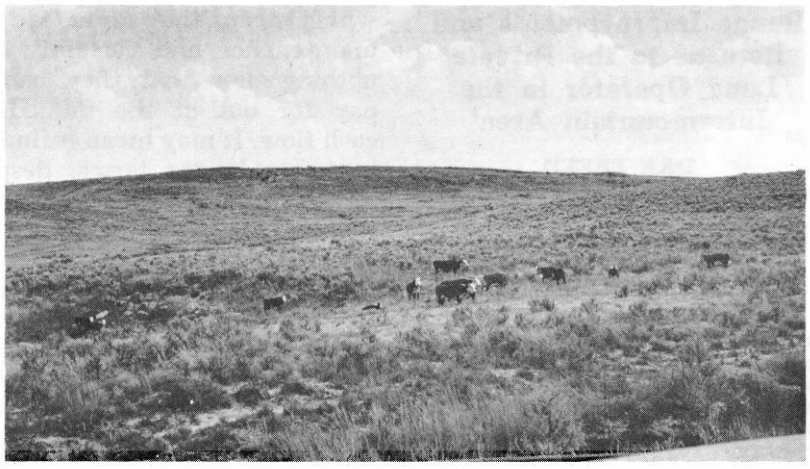

FIG. 1. Cattle grazing part of a tract of 20,000 acres sprayed for brush control, northeast Utah.

We may start by mentioning reseeding. This makes better feed at the weakest season on the ranch. In the Intermountain area we find the Spring and Fall ranges are probably the weakest and so most of the seeding in this area has been to crested wheatgrass, to extend the grazing season on both ends. Others such as Russian wild rye are good, too. By reseeding the depleted sagebrush areas, three to five times more feed is being produced on many of the ranges. On this ranch where I work, crested wheatgrass seedings are increasing the current production by more than 800 lb/acre at an out-of-pocket cost of $3.28 and year after year these continue to add pounds of meat to our production. The meadows are being improved in certain areas throughout the West the same way and probably just as dramatically.

Improving these ranges has enabled many of us to "flush" the stock and breed better and heavier livestock too. Another factor we have found that is of measurable benefit is our stock milk better when put on these seeded ranges. No doubt, one of the biggest improvements that will come in the years ahead is genetic changes in these grasses to match the productivity increases of hybrid corn and other cereals, because as you very well know, there has been comparatively little done with the grasses we have at hand to seed these ranges.

Another way of returning something to the range operator, and I have to admit it is my favorite, would be spraying. One of the little publicized uses of sprays is to kill poisonous plants such as death camas and larkspur, although the latter is much the more difficult to kill. In one small canyon, more than 500 sheep were killed while lambing due to death camas. After spraying, there has been no loss.

The great obvious benefit however, is to spray sagebrush to improve the grass cover. Over the last 9 years I have been intimately associated with the spraying of more than 35,000 acres and watching the change year by year. The improvement is so manifest and with such absolutely minor disadvantages it is hard not to get too enthusiastic over this method of increasing productivity for the private land operator today. For slightly over $2.00/acre out-of-pocket expenses, (plus small intangible costs, such as overhead and interest on the investment, and in some cases rent of additional pasture and the difficulties of operating that way for a year or possibly two), the rancher can "turn back the clock" to the by-gone days when the brush was not the problem it is today. Under the varied conditions I have seen, the feed improvement has been from 600 to 3,600 lb/acre and certainly a spray job is good for an absolute minimum of 10 years. In our country we have been averaging more than 800 lb of absolutely top forage per acre every year for 10 years. You just cannot let those opportunities go by.

If the rancher will set this up on a yearly basis to get his range sprayed under the Agricultural Conservation Program, half the $2.00 cost is paid by Uncle Sam. Using the figures I have just given, you will see that over the 10 years a rancher can get 8,000 lb of feed for a dollar of capital outlay—a ton for a quarter. Where can you equal that? This goes along with better feed to make more milk and less trailing. On many ranges we are noticing that the water is clearer in ponds and the springs run more freely where the brush has been killed.

This goes right into another range improvement that will make a valuable return to the operator—that is water improvement. This is simply looked at as the means of getting the most from what you have. Again, the stock do less trailing and there is less abuse around water holes. We cannot overlook the fact that the stock drinking water is better water, and something about which I have said very little is the fact that stock do better where all these improvements are made. This is an indefinable thing but operators know it for a very real benefit that goes along with better range management.

With all of the benefits I have mentioned is better control of our stock. All over the ranges in the west there is a great cry for more fencing, more herding, better salting and even fertilizing the range as means to better handle the stock. All of this is to get the stock on the best feed

at the best time. Now, that must mean best for the stock and best for the range—they must go hand-in-hand.

Many of my friends operating on the public domain who have suffered cuts in their permits in the last 30 years are now, at last, beginning to reap the benefits of these cuts. They are getting more pounds on their livestock as well as the fact that some of them are getting the return of some of these permits on ranges that are improved to a degree not believed possible. These benefits could not come at a more opportune time economically.

If I have sounded pessimistic and a little "hard-nosed" about this industry that I love, it is because I think we would be absolutely foolish to delude ourselves about such a vital thing. You men are close enough to the ranges of your acquaintance that you know we have to love this industry or we would not be in it.

Technical range managers have done much, and can do much more, to help the ranchers of the west to make a go of it. You can assist immeasurably by helping *sell* stockmen on the principles of range management and particularly the items that will make the most money for them. They certainly need your help.

Exposure May Influence Grassland Establishment

CLAUDE C. DILLON
State Range Conservationist, Soil Conservation Service U.S.D.A., Spokane, Washington.

Highlight

This example of the effect of exposure to grassland establishment can be useful to range management. South exposure sites in this climate will only recover to annual vegetation if perennial plants have been destroyed—that is, within a reasonable period of years. Reseeding would be an important consideration. Deferred grazing may not be beneficial on south exposure sites, but very desirable on north exposures where an excellent perennial grass stand could develop.

"After 64 years of nonuse, annual plants are the only vegetation on a steep south exposure; the comparable north exposure has a near climax plant community." Eveard Harrison, Soil Scientist with the Soil Conservation Service, brought this to my attention, and later helped me with soils information used in this article.

There is a long earthfill on a railroad track in southeastern Washington built in 1901—according to an inscription on the concrete culvert headwall. This fill is about 80 ft high, and 350 ft long. The railroad track runs due east and west, causing direct north and south exposures on the fill. The location is seven miles west of Prescott, Washington in Walla Walla County on the south side of State Highway 3 D.

The elevation is approximately 1100 ft above sea level; annual precipitation averages 9 inches, with warm dry summers and cool moist winters. Average January temperature is 28 F, July, 71 F, with a mean annual temperature of 49 F. Frost-free season is 140 days. The prevailing winds blow from the southwest.

The railroad fill was built with medium textured silt loam soils classified as Ritzville soil series. The slopes of the north and south exposures are about 65%, according to readings made with a hand level. Soil material was moved in from surrounding loess hills to construct the fill, so we can assume all the fill was made of the same soil in 1901. Soil color was checked on the top layer on both exposures, but no difference could be measured. The color-chart reading was 10 YR 3/2 moist and 10 YR 5/2 dry. Reaction was neutral (pH 6.9) on both exposures.

The vegetation was sampled and recorded by visual observation May 18, 1955, at 5:30 p.m. The air temperature was 82 F; and soil temperature at one inch depth was 93 F on the south exposure and 86 F on the north exposure. A light breeze was blowing from the southwest and the sky was partially cloudy. It was two inches to moist soil on the north, and six inches to moist soil on the south slope (moist enough to ball when squeezed tightly in the hand).

The vegetation on exposures was estimated in percent composition by relative weight by following a transect straight south, up the north

Table 1. Vegetation Percent by relative weights, north and south exposures.

Species	South	North
Beardless bluebunch wheatgrass *(Agropyron inerme)*		80
Sandberg bluegrass *(Poa secunda)*		10
Cheatgrass brome *(Bromus tectorum)*	60	T[1]
Rye *(Secale cereale)*	T	
Diffuse knapweed *(Centaurea diffusa)*	30	
Tumble mustard *(Sisymbrium altissimum)*	5	1
Common Russian thistle *(Salsola kali)*	1	
Common sunflower *(Helianthus annuus)*	1	
Tarweed fiddleneck *(Amsinckia lycopsoides)*	1	
Salsify *(Tragopogon* spp.)	1	
Fleabane *(Erigeron* spp.)		2
Common yarrow *(Achillea millefolium lanulosa)*		2
Lomatium *(Lomatium* spp.)		1
Milkvetch *(Astragalus* spp.)		1
Wooly Indianwheat *(Plantago purshii)*		1
Prickly lettuce *(Lactuca scariola)*	1	T
Tapertip hawksbeard *(Crepis acuminata)*		T
Rubber rabbitbrush *(Chrysothamnus nauseosus)*	T	2
Douglas rabbitbrush *(Chrysothamnus viscidiflorus)*		T
Total percent	100	100
Total yield, lb/acre, airdry	400	1000

[1]T=Trace.

slope, over the railroad and down the south slope covering a strip approximately 100 ft wide (Table 1).

Since 1901 the railroad right-of-way has been fenced and no livestock permitted. The area has been burned accidentally several times.

The soil is the same on both exposures. Perennial vegetative cover on the adjacent hills was originally bluebunch wheatgrass, with Sandberg bluegrass understory, a few perennial forbs, and occasional rabbitbrush. The seed source for the man-made fill was the same for both north and south exposure. Treatment has been the same for both exposures since 1901.

Factors that are different include soil temperature, moisture, and the resultant vegetation. Total moisture was not determined, but snow normally accumulates on north exposures and blows off south exposures to some degree. The effects of wind and temperature on the south exposure were most severe—apparently enough to have prevented establishment of desirable perennial vegetation and reduce total yields. South exposure soil has a microclimate apparently unsuited for seeds of perennial grasses and forbs to germinate and become established, and is still supporting primarily annual plants; while the north exposure has developed a perennial plant community to a near an original climax condition.

BOOK REVIEWS

Alaska—A Challenge in Conservation. By Richard A. Cooley. *The University of Wisconsin Press, Madison, Milwaukee, and London. 170 p. 1966. $5.50/42s.*

A challenge to conservation in Alaska might be thought of as coming from the exploitation of the fish, wildlife, timber, and other natural resources of that State. Some of these resources have been heavily exploited. The salmon fishery comes to mind. Earlier victims of excessive exploitation were the sea otter and the muskox. The last indigenous muskox was killed years ago. Still, a relative abundance of natural resources exists and the status of the not-so-abundant ones can be improved. How will the physical, biological, social, and economic forces within and outside of Alaska interact upon the resources and thereby affect the State's future? Therein lies a challenge to conservation.

The author approaches the subject by examining land as the primary resource commodity. Land, together with its uses and products, forms the central theme. Some facets of land management, protection, acquisition, and disposal appear in each of the ten chapters. (Land is a key word in the first sentence of every chapter). This approach to the conservation challenge in Alaska is informative but not very exciting reading.

Dr. Cooley is a resource economist, formerly Director of the Conservation Foundation's Alaska Research Center and now a faculty member of the Geography Department, University of Washington. He presents his material in 130 pages of narrative; there is a reference section of 14 maps, 12 tables, and 4 pages of bibliography. Eight pages of photographs show Alaska scenes but are unrelated to the text. The time period emphasized begins with the Statehood Act of 1958.

The significant part of that Act was the right given to Alaska to select 104 million acres from the Federal public domain — an area larger than California. In addition, there were other land selections that total 30 to 40 million acres. Hence, land selection, management, and disposal are major policy matters affecting the State today and that will extend into the future. In developing the theme of land as a commodity and a resource the author calls attention to some interesting points. For example: Because Alaska, unlike the 16 most western states, was not classified as a reclamation state, Congress provided that 90% of Federal revenues from leasable minerals should go to the State government. In turn, this has caused the State to critically evaluate the selection of mineralized land. Land selection, in general, is being reviewed by the State much more critically now than it was earlier when land acquisition was equated with immediate financial gain. The State has learned that land ownership carries certain responsibilities. Included here is fire protection now provided by the Bureau of Land Management on the unreserved public domain. Still another pertinent consideration of land selection is the consequent lowering of today's favorable 95:5 ratio for Federal highway matching funds as more land is taken from Federal ownership. When all factors are considered, the cost to the State of selecting an acre is an estimated 10 to 12¢ annually. Or, if 40 million acres are selected over 10 years with no subsequent disposal, the cost to the State would be approximately $27.5 million.

The concern for land and the natural resources it supports is found in the State's constitution which prohibits the State from selling, granting, or deeding its rights to renewable natural resources, but can only lease them with proper precautions for their conservation. In the words of the author, "It is the first provision of this type ever to be written into a state constitution, and it should help avert the destructive exploitation of resources that earlier occurred on the lands of many

western states." Nevertheless, the financial crisis confronting the new State government overshadows all other influences on State land policy. It is this pressure upon a new state with 250,000 people and an immense undeveloped area that contributes to the conservation challenge. Also, the Federal government, because of its huge land holdings in Alaska, plays an important role in the challenge to conservation. But, how do Alaskans view the future of their State and its resources?

Some see the State and its resources as another frontier to conquer and subdue in order to gain the industrialization benefits accruing to the Chicagos of the "lower 48"; these gains to be made with freedom of action and no holds barred. The other extreme prefer a wild and unsettled Alaska. To them, development has gone too far already. There are now too many junk yards, too many abandoned shacks, and too much clutter on the landscape. There are questioning voices occasionally raised; an example is quoted by the author:

"The progress (or development) complex has infected Alaska. We are caught firmly in its grip and cannot extricate ourselves. . . . Yet we cannot entirely shrug off the strange whisper that comes sometimes in the night and asks why we must continue to move onward from the peaceful, grassy knoll into an unknown future of dense and swirling population. Who has carefully considered the situation and decided that Alaska would be better with a million people or two million people, than with the present 230,000? In what way will it be better? Will it be better for you individually or for your friends and neighbors? Will you enjoy Alaska more then—its beautiful mountains and glaciers, its coastlines and tundra, its recreational opportunities? Will you find it easier to pay your bills? Will the State government . . . ?

"We cannot and would not halt the march of time, but let us to the extent possible, move forward with farseeing eyes, striving to guide the bandwagon instead of riding it blindly toward some strange place and condition that may not be as desirable, in truth, as where we are today."

Dr. Cooley believes the majority of Alaskans prefer this more cautious approach to the future. But this less vociferous group, although holding the balance of political power, has not yet entered the arena. "It is this group that must stir into action if Alaska is to use its great land patrimony wisely, for it is no play on words to say that development and conservation can and must move ahead together if the State is to carve out a future that encourages rather than destroys those natural and human qualities that now make Alaska unique among the 50 states."

Further elaboration upon the use of land as a central resource is contained in chapters entitled "Patterns of Settlement," "Conflicts in Resource Use," "Inter-agency Conflicts," "Planning and the Political Struggle," "A Conservation Ethic." As these headings might suggest, agricultural problems, road developments, cows and Kodiak (brown) bear, logging and salmon spawning streams, federal-state-local government relations involving coordinated planning, and a quantity-quality environmental conflict all receive attention.—*Richard M. Hurd,* Northern Forest Experiment Station, Juneau, Alaska.

Common Plants of Longleaf Pine-Bluestem Range. By Harold E. Grelen and Vinson L. Duvall. *U. S. Forest Serv. Res. Paper SO-23. Southern Forest Exp. Sta., New Orleans, La. 96 p. 1966.*

About 1945, several of us in southern range work pondered how to identify from vegetative and habit characteristics the common range plants of Louisiana, Mississippi, and east Texas. We finally formalized a study at the Alexandria Research Center, under John Cassady's leadership, which resulted in the publication in 1952 of the "Field Book of Forage Plants on Longleaf Pine —Bluestem Ranges", Southern Station Occasional Paper 127, by Langdon, Bomhard and Cassady. Photographs were by Walt Hopkins and wildlife food notes by Phil Goodrum. The booklet had detailed information on year-round field identification and forage values of some 75 species and mentioned a total of just under 100 species. In spite of limited coverage, the Hand Book was popular and the supply was soon exhausted.

This new booklet, on 8 x 10.5 inches paper, is a complete revision of the old Field Book. It contains details on more than 80 species and mentions a total of more than 150 range plants. Jane Roller's illustrated keys to the *Andropogons, Panicums, Paspalums,* legumes, and composites, and her drawings of many species make a very helpful and useful contribution. This version contains no photographs, but depends on the illustrated keys and descriptions to convey criteria by which a working range man may recognize species in the field. The writeup for each plant includes a botanical description, which should make the taxonomists happier with this edition than with the 1952 version.

The species are grouped under grasses, grasslike plants, forbs, and shrubs. Most of the species are eaten by livestock or wildlife, some are noxious, and others are of interest as prominent members of the plant community.

The booklet is complete with bibliography, glossary, and index of Latin and common names. For those who can really use it, the research paper is available from the Southern Station, T-10210 Federal Bldg. 701 Loyola Ave., New Orleans, La., 70113.—*R. S. Campbell,* Quincy, Illinois.

Them Were the Days. By Paul H. Roberts. *The Naylor Company, San Antonio, Texas. 134 p. 1965. $4.95.*

Western range men, Forest Service workers, and folks interested in western history will get a mild "bang" out of reading this little treasure chest of amusing experiences, history, and folklore of early day New Mexico and Arizona.

Paul Roberts was successively a range surveyor, grazing inspector, and forest supervisor in the Southwestern Region of the U. S. Forest Service between 1912 and 1931. He relates most experiences from memory but with library and personal research where necessary to insure authenticity. Historical incidents and amusing anecdotes are liberally interspersed in his factual account of personal experiences. All is couched in a colorful, folksy language of

which the title is somewhat suggestive. The variety in subject matter and lively and descriptive style of presentation make for entertaining and at times thrilling reading. In style and subject matter this little gem of a book rivals that of another eminent range man, "Longhorns and Apaches," by Will C. Barnes.

The shooting of several notorious outlaws near Magdalena, New Mexico, and Holbrook, Arizona, are sketched. Mr. Roberts goes into great detail in describing how long-line wagon teams were hitched and driven in early mining and hauling enterprises. Range men will especially enjoy reading about early day range and timber conditions in the Southwest: how range surveys were made on horseback, forest-fire protection and control methods were applied, timber sales were made, how stocking was adjusted to grazing capacity, and cattlemen and sheepmen disputes were settled.

The first-person relationships and close friendships this early resource manager developed with ranch and city folk in the mountain country of the Southwest when times were tough might serve as a model for modern public servants. It is evident from references to personal correspondence in the acknowledgment preface to the book that many of these friendships have been lifelong despite the author's having experienced the common "one or two dozen moves per career" standard associated with this public agency. He also paints brief word sketches of his bosses, close associates and some prominent citizens of his time. The following list of principals as well as their work one-third to a half-century ago should prove interesting since many are still living and some are still quite active in our Society: John Kerr, the author's first boss to whom the book was dedicated; J. H. Sizer, who has one of his poems reproduced; R. R. "Bob" Hill; W. R. "Chap" Chapline, former Chief of Range Research and still active in international range activities; the late Hugh Bryan; Ed Kavanaugh; M. W. Talbot, past President of the Society; Gus Becker and the Becker family of Springerville, Arizona; Harry Embach, Secretary to the Arizona Wool Growers Association; and Mrs. J. M. Keith of the Arizona Cattle Growers Association; and a great number of ranching families of the Southwest including many town dignitaries of Holbrook, Arizona.

Paul Roberts, in this his second book, displays much literary talent. In the finale to the book after describing his later experiences in the Northern Region of the Forest Service, he briefly and modestly writes: After Montana, we vanished into the misty shadows of retirement." Certainly such is the understatement of the year! After two literary gems a second successful career as historian and author seems assured. Moreover, the brief introductions made in this book concerning the work of the Forest Service causes the reviewer to respond to the author's fine efforts with a request for more along any one of a dozen lines suggested by the limitation of space in the present book. Certainly other stories about the great variety and abundance of natural resources in the Southwest, peoples' need for such, and the potentialities these have for making a greater civilization in the Southwest with wise use based upon sound management principles deserve to be told and Paul Roberts is just the person to handle this continuing assignment.—*C. H. Wasser*, Colorado State University, Fort Collins.

New Publications

Back volumes (1 to 26) of ECOLOGICAL MONOGRAPHS, unavailable in the original edition, have been reprinted by photo-offset—$25 each volume. Address orders and inquiries to Johnson Reprint Corporation, Dept. SL, 111 Fifth Avenue, New York, N. Y., 10003.

In their new book, WATER AND WATER USE TERMINOLOGY, J. O. Veatch and C. R. Humphrys offer the interested professor, student, lawyer, legislator, administrator, and layman a well-organized guide to the language of water and water use. The book is enriched by a wealth of information that goes beyond mere definition, and is recommended highly for all who have a special interest in water. Published in 1966 by Thomas Print. & Pub. Co., 724 Desnoyer St., Kaukauna, Wis. 54130. 375 p. $12.95.

The American Chemical Society has announced the monthly publication of a new journal, "ENVIRONMENTAL SCIENCE AND TECHNOLOGY," beginning January 1967. Social and political as well as technical aspects of water, air, and waste chemistry will be reported. The editor is Dr. James J. Morgan, Associate Professor of Environmental Health Engineering at the California Institute of Technology. $7.00 per year.

THE ANNUAL REPORT, 1965, OF THE GRASSLAND RESEARCH INSTITUTE, Hurley, Maidenhead, Berkshire, England, was presented for review in November 1966. Brief reviews of progress, with citations of 1965 publications, in Crop Production, Soils, Soil Microbiology, Plant Physiology, Crop Physiology, Animal Nutrition and Biochemistry, Animal Production, Ecology, and Biometrics give the reader an interesting synopsis of experiments in progress. The report also contains 5 essay papers. Members of ASRM should give special attention to their work on the developmental morphology of forage plants.

ANNUAL REVIEWS OF PLANT PHYSIOLOGY, Vol. 17. The subjects most immediately pertinent to range management are as follows: Plant Water Relations by J. R. Philip; Plant Antitranspirants by J. Gale; Biological Nitrogen Fixation by R. H. Burris; and The Physiology of Root Growth by H. E. Street.

The National Academy of Sciences-National Research Council has recently issued publication 1402, "THE SCIENTIFIC ASPECTS OF PEST CONTROL." This publication includes all papers presented at the public symposium held in Washington, D. C., February 1-3, 1966. Subjects such as "Monitoring wildlife for pesticide content" and "Biological magnification of pesticides" will be of interest to members of ASRM. Division of Biology and Agriculture, 2101 Constitution Avenue, Washington, D. C. 20418. 470 p. $5.00.

"PROTECTING OUR FOOD," the 1966 Yearbook of Agriculture, follows our food supply from field to table and describes every stage of protection from insects, rodents, contamination, and loss of nutrients. Senators and Congressmen have copies for free distribution. Supt. of Documents, Government Printing Office, Wash., D. C. 20402. 416 p., 105 photographs. $2.50.

NEWS AND NOTES

Material from many sources; not necessarily the opinion or position of the EDITOR or OFFICERS of THE AMERICAN SOCIETY OF RANGE MANAGEMENT

Third National Grassland Field Day

You can get a close-up look at what happens to your soil in a heavy rain at the Third National Grassland Field Day and Conference July 12-14, 1967, at Mead, Nebraska.

This is only one of many conservation exhibits and demonstrations being lined up, according to Dr. Donald Burzlaff, general chairman of the field day.

The event, carrying out the theme "100 Years of Change in Grassland Agriculture," will be held at the 9,400-acre University of Nebraska Field Laboratory near Mead, Nebraska.

It is co-sponsored by the University and the American Forage and Grassland Council and is being held in conjunction with the statewide celebration of Nebraska's centennial.

Laird Wolfe, assistant Nebraska state conservationist is chairman of the conservation exhibits committee.

Wolfe said the erosion control display will be operated by Agricultural Research Service and University of Nebraska researchers who developed the unique boom-type rainfall simulator.

In addition the Nebraska Game Commission is planning a living display that will feature either prairie chickens, animals, or fish.

The Soil Conservation Society of America will have a panel with lights and buttons on which people can test their skill in identifying grasses.

Each soil and water conservation district in the state has been asked to send in its best grassland conservation picture taken since 1956. This should make a display of 86 to 100 prime examples of grassland conservation, Wolfe said.

Others who will have exhibits but have not planned them yet include: Nebraska State 4-H Office, Forest Service, Agricultural Stabilization and Conservation Service, Soil Conservation Service, American Society of Range Management, Sandhills Cattle Association, Army Corps of Engineers, Fish and Wildlife Service, and Tennessee Valley Authority.

These are just early returns from invitations sent to half a hundred organizations, Wolfe said.

The displays are required to illustrate some aspect of conservation related to grassland farming.

Mariano Segura, formerly Acting Director of Agriculture Research, Ministry of Agriculture, Peru, is currently engaged in a Ph. D. graduate study program in range ecology at Oregon State University. Mr. Segura holds a M.S. in Range Management from Colorado State University. In addition to his numerous forage research and development activities in Peru over the past 10 years. Mr. Segura has held professorships in ecology, range and pasture management in five Peruvian universities. Working under a Rockefeller Scholarship at O.S.U., Mr. Segura will be conducting ecological research on one of the critical winter mule deer ranges in south-central Oregon.

Dr. Odell Julander retires from U.S. Forest Service—Dr. Odell Julander, specialist in wildlife management research, will retire from the U. S. Forest Service on December 30 according to announcements recently by Joseph F. Pechanec, director of Intermountain Forest and Range Experiment Station.

In 1962, he was transferred to Provo, where he has been Director's representative for Intermountain Station. He also was leader of research projects in wildlife-livestock relations and in restoration of big game ranges. He is author of numerous technical publications on both these subjects.

Dr. Julander and his family will continue to live in Provo, where he will teach classes in forestry and range management at Brigham Young University.

Radioecology

Of interest to ecologists will be the second National Symposium on Radioecology to be held May 16-17 at Ann Arbor Michigan.

The specific objectives of this Symposium will be to acquaint ecologists more precisely with the ways in which past problems arising from the release of radiation to the environment have been handled, to examine research findings dealing with radiation for their relevance to present problems of environmental contamination, and to provide the working ecologist with a better base for thinking about future radiation hazards in our environment. Emphasis will be given to freshwater and marine ecosystems as well as to terrestrial ones.

Further information and reservation material may be obtained from:
University of Michigan Extension Service
Conference Department
412 Maynard Street
Ann Arbor, Michigan 48104

Seminars

Four seminars will be held during the 1967 summer under the auspices of the Rocky Mountain Nature Association at Hidden Valley Lodge in Rocky Mountain National Park.

Beginning with a Geology seminar the week of June 19-24, on each of the three succeeding weeks there will be seminars on Field Identification of Plants, Mountain Ecology and Alpine Tundra Ecology. Registration for each seminar is limited to 25 persons.

Additional details may be obtained by writing: Mr. Glenn D. Gallison, Executive Secretary, Rocky Mountain Nature Association, P.O. Box 147, Estes Park, Colorado 80517.

Dunford-Holscher

Earl G. "Jerry" Dunford, Assistant Director for watershed, range and wildlife habitat research at the U.S. Forest Service Experiment Station in Berkeley will transfer to headquarters in Washington, D. C. effective January 30.

He will serve as acting branch chief for forest soil and water studies in the Division of Watershed, Recreation and Range research. That job is left by Clark E. Holscher, who is currently representing the U.S. Department of Agriculture in the Water for Peace program.

Agricultural Research Institute, Dr. Clair E. Terrill of the agricultural Research Service represented the Society at an October 10 meeting of the Agricultural Research Institute in Washington, D. C. He has this to say about it, "Reports of particular interest to the range management field included the paper by Minott Silliman, Jr., Soil Conservation Service, on the Land and Crop Basis for Animal Agriculture in the United States; G. K. Davis, University of Florida, on Modernization of Farming System in the Southeastern United States — Through Animal Agriculture; N. A. Konnerup, Army Institute of Research on The Outlook for Animal Agriculture in Africa; Milo Cox of the State Department in Animal Agriculture in Latin America; and T. C. Byerly, Cooperative State Research Service, on The Relation of Animal Agriculture to World Food Shortages. My general impression was that there is tremendous opportunity to increase animal production from the rangelands of the world by better range management. While this production may be a small part of the total it can be increased without detracting from the production of crops consumed directly by people.

"The proceedings of the meeting will be available soon from the Executive Secretary, Agricultural Research Institute, 2101 Constitution Avenue, N.W., Washington, D. C. 20418. I believe these will be of interest to many members of the ASRM."

FIRST CALL FOR PAPERS

21st Annual Meeting
American Society of Range Management, Albuquerque, New Mexico

The annual meeting of the Society is designed to give scientists, technicians, and ranchers an opportunity to report the results of their work and express new ideas. We would like to feature voluntary papers from people working in all phases of range land management.

Papers will be considered from all workers, whether a member of the Society or not. Papers from young scientists are especially encouraged. We would appreciate administrators calling this notice to promising people in their organizations with significant research to report.

Selection Procedure: Papers offered will be selected by the Program Committee based on review of (1) title, (2) 200 or less word preliminary abstract, (3) a separate supporting statement.

The supporting statement should indicate the significance of the paper. It should tell if the paper is new research, literature review, practical experience, philosophical, etc. It should also state the method of presentation (reading, slides, charts, etc.).

Deadline: Titles, preliminary abstract, and supporting statements must be in the hands of the Program Chairman by June 1, 1967. Preliminary abstracts for accepted papers may be revised later by authors for publication. Authors of accepted papers will be notified of deadline for final abstracts.

Selection of papers will be made by the Program Committee between June 1 and July 1, 1967. Notice of acceptance will be made by September 1, 1967.

Authors Note: File four copies of requested material by June 1, 1967 with:

Dr. Thadis W. Box
Program Chairman,
Range Management Section
Texas Technological College
Lubbock, Texas

Charles H. Stoddard, formerly chief of the Bureau of Land Management is now Executive Director of the Citizen's Advisory Committee on Recreation and Natural Beauty.

WITH THE SECTIONS

CALIFORNIA

Almost 200 years after the first domestic livestock were successfully introduced into the San Diego area, the California Section held its annual meeting in the same vicinity. In this setting at San Diego State College, 85 or more persons gathered for the Section meetings on November 17 and 18 to enjoy an exceedingly fine program of papers and pleasant entertainment that had been arranged by the program committee.

William D. "Pinky" Mathews, cattleman from Scott Valley in northern California, was selected "California Range Man of the Year" Mathews who is a member of the California Section as well as Secretary of the Scott Valley SCD and Chairman of the State Soil Conservation Commission was awarded a plaque and a "Trail Boss" belt buckle presented by Hal Hiller in recognition of this distinction.

The Section was uniquely honored with a plaque of the "Trail Boss" carved in bas-relief out of ancient bristlecone pine wood.

Section officers for 1967 installed at the banquet meeting were: Eamor C. Nord—President, Riverside; Robert Blanford — President-elect, Sacramento; Bill Templeton — Secretary-treasurer, Riverside; Bill Williams, Davis and John Stechman, San Luis Obispo — council members. Roche Bush, Berkeley and Ray Dalen, Santa Barbara continue to serve another year as council members.

The Bay Area Chapter of the California Section held its final meeting of the year on December 22, 1966 at the University of California Faculty Club at Berkeley. A "sherry hour," followed by a banquet, was enjoyed by 35 members and guests.

Chairman Everett Doman (Forest Service) gave a resume of the year's activities which included four Chapter meetings. Roche Bush (Soil Conservation Service) was elected Chairman for 1967. George Burma gave an excellent slide illustrated talk about his tour of northeastern Brazil following the 1964 International Grassland Congress.

FIG. 1. William D. "Pinky" Mathews, Scott Valley rancher (on right) accepts plaque and "Trail Boss" belt buckle from former President and awards committee chairman Hal Miller in recognition for being selected "California Range Man of the Year" at the San Diego meetings of the California Section. (Photo courtesy Collier Carbon & Chemical Co.)

FIG. 2. Fred Dunow, Sacramento, presenting the "Trail Boss" plaque to program chairman Eamor C. Nord at the California Section meetings in San Diego. The plaque design is carved in bas-relief on ancient bristlecone pine wood and framed or supported by bitterbrush, juniper, redwood, and wood of other plants. (Photo courtesy Collier Carbon & Chemical Company.)

NEVADA

The annual meeting of the Nevada Section was held in Carson City January 11 and 12.

Jack Artz, formerly with the Nevada State Division of Forestry, has replaced Mike Kilpatrick as Extension Range and Pasture Specialist, University of Nevada.

Artz inherited the Youth Committee of the Nevada Section and recently called a meeting of agency and Nevada Section representatives to formulate plans for the 1967 Nevada Range Camp. The 1967 Camp will be mobile, spending about half the time in the mountain area east of Ely and the other half in the Ruby lakes area. It will be held either the week of June 12-17 or June 19-24.

TEXAS

From left to right they are:

J. L. "Cy" Richmond, President-Elect, Area Conservationist with the SCS located at San Angelo, Texas.

Ben O. Sims, Rancher from Paint Rock is President.

R. B. Dooley, Secretary-Treasurer is Head of the Agriculture Department at San Angelo State College.

A MESSAGE FROM PRESIDENT SIMS. We are members of a unique professional Society. And no other society has a greater challenge than ours. Already the surpluses are disappearing and soon we may have to have maximum production from our land. And some of our land will have to have considerable work done on it if it is to reach its maximum potential. The job ahead is so great if I

were not so hard-headed, I would move to the city and get a job.

With the whole Section membership working together and those who are officers and committee members working a little harder, maybe we can make for some improvement of the rangeland. All those concerned with conservation must coordinate their efforts if we are ever to make the improvement that will have to be made, if the world as well as our nation is to be fed. Those of us who are members of breed organizations, Soil Conservation District Associations, Extension Service and other organizations must take part in forming the conservation policies of those organizations. The opportunities for leadership are unlimited. If we do no more than make suggestions and give guidance, we are contributing to the solution of a great problem.

SOUTHERN

The following are accomplishments and activities of the Southern Section during 1966:

The major activity in 1966 was hosting the national meeting held in New Orleans, Louisiana in February. Section members responded to the task in an excellent manner.

A long sought membership goal was achieved during 1966. Section membership went substantially above the 100 mark for the first time. The section had the fewest members and the lowest percentage of any section suspended for nonpayment of dues.

A successful and well attended annual meeting was held at Alexandria, Louisiana on September 7-8, 1966. A fine technical session and field trip was developed by the program committee.

The section voted to increase the Section Council by the addition of two Councilmen to better respresent the growing membership.

A two-year project was started in 1966 to revise "A Selected Bibliography of Southern Range Management" published in 1962 by the Section in cooperation with the Southern Forest Experiment Station of the US Forest Service.

Information for Authors

The JOURNAL OF RANGE MANAGEMENT is the official bimonthly publication of the American Society of Range Management. The aim is to publish in each issue something of interest to the entire membership of the Society and to others interested in grazing land management. Non-members may publish suitable articles in the JOURNAL upon approval of the Editorial Board. All manuscripts and correspondence concerning them should be addressed to the Editor: Dr. R. S. Campbell, RR 7, Quincy, Illinois, 62301.

High quality papers concerning technical and practical problems or practices of range management are suitable for publication. Review papers on selected subjects may be acceptable but are usually invited. Short articles concerned with research results, experimental equipment or techniques may be published as Technical Notes. Short papers dealing with any phase of applied range improvement or management may be considered for the Management Notes Section.

Papers should be based on new and adequate information. The introduction should state clearly and concisely the purpose of the report and its relation to other work in the same field. Unsupported hypotheses and rambling discussion should be avoided. Organization of the manuscript may vary to fit the content but the text should point out the application of the results to the range management problem considered. The paper should end with a brief summary of the outstanding points and their practical application. For general suggestions on writing and preparation of manuscripts, see "Style Manual for Biological Journals" (2nd edition, 1964), published by American Institute of Biological Sciences, 2000 P St. NW, Washington, D.C. 20036.

All papers will be critically reviewed by the Editorial Board or other subject-matter specialists designated by the Editor. Papers returned to the authors for revision should be handled promptly. Unsuitable papers will be returned to the authors with an explanatory statement. Prior publication of a manuscript or concurrent submission to another outlet automatically precludes publication in the JOURNAL OF RANGE MANAGEMENT.

Preparation of Manuscripts

1. Manuscripts must be typewritten, double-spaced with ample margins, on good-quality white paper, preferably 8½ x 11 inches with numbered lines. Use one side only of the paper and number all pages. Submit in duplicate, original and one carbon copy.

2. The title of the manuscript and name, position, and complete address of the author should be typed as distinct, well spaced entries on a separate page. Such a "title page" should also show running heads, i.e.: (1) author's surname, to be set at the top of each left-hand printed page and (2) key words (2 or 3) from title of the manuscript, to be set at the top of each right-hand page.

3. An introductory "Highlight", succinctly stating the purpose, major findings or conclusions, and their application, should accompany each manuscript. The Highlight should be only three to five sentences, typed double-spaced on a separate page.

4. Names of plants and animals must be shown in both common and scientific form the first time mentioned in the text. Authorities may be included at the discretion of the author. Further references should be to common names only.

5. Footnotes in the text should be used very sparingly and numbered consecutively throughout the article. All footnotes should be typed together, double-spaced, on a separate sheet.

6. Illustrations are desirable but should be held to a minimum. Glossy unmounted prints of photographs are desired. Protect these against damage in transit. Graphs should be prepared on white or blue-lined cross-section paper with neat lettering of a size suitable for reduction in printing. All figure titles should be typed together, double-spaced, on a separate sheet. Illustrations should carry an identification number.

7. Tables should be few and as simple as feasible. They must be typed, double-spaced, each on a separate sheet of regular-sized paper. Each table should carry its own separately numbered footnotes.

8. The Literature Cited section should begin on a new page. Citations should be listed in alphabetical order and referred to in the text by author and date, i.e., Jones (1949), or (Jones, 1949). Citations should be typed, double-spaced, in the style of the following examples:

PECHANEC, JOSEPH F., AND GEORGE STEWART. 1949. Grazing spring-fall sheep ranges of southern Idaho. U.S. Dep. Agr. Circ. 808. 34 p.

SPERRY, OMER E. 1949. The control of bitterweed *(Actinea odorata)* on Texas ranges. J. Range Manage. 2: 122-127.

Titles of journals should be abbreviated, following the Style Manual for Biological Journals (2nd ed., p. 82-87). Show total number of pages for books, bulletins, etc.

9. In general, papers should not exceed 4 printed pages including illustrations. Excess pages may be published at cost to the author of $35.00 per page. Illustrations and tabular material together are limited to 20 percent of the total number of pages. At cost to the author, this percentage may be greater.

10. When galley proof is received by the author, it should be carefully corrected and mailed within 48 hours to the Editor. An abstract of the article should accompany the corrected proof. An order for reprints will be sent the author after the paper has been paged. Costs of reprints vary with the size of the article and the number ordered. Covers cost an additional amount. Postage is also extra.

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