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Editorial

The Western Range and Changing Human Economy

IT IS an incredible thought that one short century ago the vast western terrain that comprises the major area of America's range lands was Indian country scarcely scratched by the trails of migrating pioneers. Today hundreds of prosperous cities dot the landscape, and paved highways, railroads and airlines have obliterated every vestige of those geographic frontiers known to our fathers. There remains no segment of our land to be explored or conquered, and few sizable acreages have escaped the exploitation of their mineral and agricultural resources. For us and for generations of Americans yet unborn, the frontiers of new wealth must forever lie in the more efficient and prudent use of the natural resources already known.

That the range resource was a major factor in the prosperous settlement of the West, History gives ample evidence. That the grazing industry must continue to serve a major role in our future economy, few would deny. The great question of the moment is "can this be done and how?" "Tis one and the same Nature that rolls on her course," and whoever ventures to anticipate the future in range management must occasionally retrace the past and consider well the present in range conditions and trends.

The history of the Western Range over the past century may roughly be divided into two periods of approximately equal duration. The first (1850–1900) was, in general, a period of settlement, expansion and unbridled exploitation. It was conceived under a national psychology of unlimited abundance and dominated by a pioneer spirit of boundless production. The completion of the trans-continental railroad in 1869 released the barriers to adequate markets for livestock, and initi-

DR. WALTER P. COTTAM

ated a boom in the grazing industry that was as spectacular in magnitude as it was short in duration.

The second period (1900–1950), a logical sequel to the first, began with a crash in the grazing economy that was widespread in extent, tragic in its consequences and shameful in its basic underlying causes. An attempt to assess blame would entail great injustices, for society as a whole was guilty. Young America liberated from Old World austerity was drunk with the idea of New World abundance. The science of ecology was in its infancy, and there were no yardsticks by which it was possible to measure or predict the consequences of overstocking. Worst of all, there were no sympathetic ears to listen even if all this had been known, for the settlers of the semiarid West were but newly transplanted from the humid cultures of New England and western Europe, where space was the chief limiting factor to copious agricultural production. A series of misguided land acts by Congress during the period of grazing expansion provided little incentive or possibility for livestock operators to acquire ownership of the lands they grazed; yet there was total lack of a national policy to provide Federal management of these pioneer grazing areas. All these factors were as certainly bound to incite war for forage as they proved to invite speedy disaster.

The past half century, so far as the grazing industry is concerned, has been a period of adjustment, investigation, and attempted rehabilitation of the range. We have learned much. The basic causes and effects of range deterioration have been experimentally verified, and the necessary practices leading to range recovery have been demonstrated. Today hundreds of competent scientists in the various services of the Federal Government and in private and state institutions are contributing valuable information to the many facets of the complex problems of land management. A partial list of these includes research in range management, range animal husbandry, forage utilization, range wild life and forest entomology; in range botany and range plant physiology; in natural revegetation and artificial reseeding; in watersheds, range economics, range weather and range soils.

This list of diversified research activities serves well to emphasize the fact that most of the problems confronting range management reach far beyond the limits of any one discipline of the natural and social sciences and point to the present and future needs for cooperative group investigations.

The practical results of our research programs over the past five decades would be more heartening if range recovery were at all commensurate with the scientific information at hand. But the fact remains that we know much more about what needs to be done in range management than we know how to accomplish it.

Among the several causes for this dilemma should be mentioned the practical difficulties of reducing stock numbers to range capacity, the recent phenomenal increase of big game over much of the mountain ranges, the tenacity with which many stockmen attribute reduction of forage to acts of God rather than to their own transgressions, and the reluctance of the public in general to realize their relationship to the land or to accept the practical values of range investigations.

An analysis of any or all of these deterrents to a more healthful range economy will finally and inevitably point to one and the same solution—the need for greater public enlightenment on the issues and problems that confront the range. If range management is to keep pace with

range research, urbanites as well as rural folk must come to realize that as populations increase and the complexities of civilization expand, the multiple use aspect of our wild lands assumes greater public importance and raises issues that strike at the root of personal and social liberties. The public must become acutely aware of the fact that no community can expand or survive without an adequate water supply and that well regulated streams or underground water sources are dependent on a properly managed soil mantle. The common man must realize that in order to protect watershed areas and at the same time to maintain grazing populations, the revegetation of potentially productive areas elsewhere is an urgent necessity. Greater recreational use of restricted lands is a recognized human need. And superimposed on all these problems is the issue of private vs. public control and ownership of the Public Domain.

There are some of us who, perhaps, honestly contend that the business of the scientist is to search for truth and not necessarily to publicly proclaim it. But surely if men who created the atom bomb consider it their moral duty to warn society against its use, can the ecologist or range manager logically shun his responsibility in warning society against the evil exploitation of the soil resource? There is in my opinion no more justification for a "public be damned" attitude for those of us who could well dedicate our efforts to conserve a resource, than there is for those who would selfishly despoil it. In the field of public education we should find opportunities to attain more quickly the goal of our research and certainly to attain new horizons in the service of mankind.

Walter P. Cottam, Department of Botany, University of Utah,
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GRAZING INTENSITY AFFECTS RUN-OFF

Knowledge of the effect of grazing intensity upon run-off and soil erosion is of vital importance in grazing management, especially on mountain watersheds. E. G. Dunford, at the Rocky Mountain Forest and Range Experiment Station, has recently reported results from studies on this problem in Colorado. The studies were made on Arizona fescue-mountain muhly range with a 17 percent slope at the Manitou Experimental Forest. Cattle were allowed to remove an average of 57 and 33 percent of the herbage on duplicated plots (0.01 acre in size) for heavy and moderate grazing. In addition, two plots were completely protected.

From 1942 to 1948 run-off was two and three times greater on moderately and heavily grazed plots, respectively, than on the ungrazed control plots. Soil erosion was not significantly affected by moderate grazing. However, heavy grazing caused 186 pounds of soil loss per acre compared to less than 100 pounds for the control. These data, indicate too heavy grazing lowers the absorption of moisture needed for plant growth. Increasing soil erosion on heavily grazed range strikes at the productive potential and watershed value of the site.—From Research Note No. 7, 1949. Rocky Mountain Forest and Range Experiment Station.

Summer Range Management Course on Wheels for County Agricultural Agents in Texas

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THE fourth annual summer range management course for Texas county agricultural agents closed on July 10, 1950. The class of 29 students told the instructors their college course was one of the best they had ever taken. They had just finished a course which required of them many hours of study, preparation of field notes, herbarium development, 1600 miles of travel, and the inspection of 22 ranches over a period of approximately three weeks.

Why did this field course, like the three previous ones, appeal to these experienced men although several of the group had taken no class work for a number of years?

The answer may in part be found in the following: First, the county agents had a real look at range problems both from the distance and close-up. They were convinced that something concrete must be done to save one of the largest and most important crops of Texas, namely the native grasses and forbs. Second, they recognized that text book information and field application can be correlated. Third, that the principles and practices of range management taught could in a large measure apply to most of the counties of the state although these are highly diversified in climate and native forage. Fourth, the agents also realized they did not have the answers for the many questions that ranchmen asked them concerning range management. Fifth, these men discovered that it was real fun to study and learn in an atmosphere of challenge. The challenge came not only from the members of the class but each challenged himself to increase his efficiency and knowledge from day to day.

The latter point was of considerable interest to the instructors because a number of the members of each course were in their forties and a few in their early fifties. This proved that age is no barrier to technical learning.

At the request of Vice-Director J. D. Prewit of the Extension Service, arrangements to teach the summer field range course were made with the Agricultural and Mechanical College of Texas, College Station, Texas during the spring semester of 1947. The Extension Service appointed a committee composed of district agricultural agents to work out with members of the Range and Forestry staff the overall program for the field course. As a result, the district agents were held responsible for transportation, registration and camp facilities, while the instruction was made the responsibility of the Department of Range and Forestry.

Dr. O. E. Sperry and the writer prepared a syllabus of the course. It was approved by the College Administration and the first range management course for county agricultural agents began on June 22, 1947 at Agricultural Substation No. 14 near Sonora, Texas. This Substation is located in the approximate center of the Edwards Plateau region.

Twenty-six agents representing counties rather widely distributed over the State reported for class. During the first meeting, the county agents, under

the supervision of a district agent, organized their camp program. The problem of food was solved by employing a cowboy cook and hiring a truck equipped for outdoor cooking. Each man brought his cot and bedroll and slept in the open.

The lecture room (for six days) was a machine shed. A semi-portable blackboard, a small teacher's table, three long rough board tables and board benches for seats comprised the class room furnishings.

The topics included in the course were with certain exceptions those that would apply to any group of agriculturally trained men without a technical background in range management. The lectures included both fundamental and applied knowledge relative to range management. The principal topics treated were:

1. The identification and classification of the important range plants of Texas.
2. Range types in relation to the climate, topography and soil of the State.
3. Proper utilization of forage plants in relation to regional composition.
4. Proper forage utilization as a guide to stocking rates on the basis of "key" species and "key" areas.
5. Management of ranges in relation to kinds of livestock, proper distribution, proper season of use, and indicators of both range abuse and range recovery.
6. Poisonous plants, their distribution and methods of control.
7. Control or eradication of noxious species of brush and the introduction of proper grazing practices on brush lands.
8. Range reseeding.
9. Pastures and their management as forage supplement for ranges.
10. Technical problems in relation to range management.
11. Range condition classes.
12. Range developments.
13. Applied range economics.

The periods and sequence of instruction at the Sonora Substation included from one to four hours of formal lecture daily, with field exercises on nearby ranches taking up the remainder of the day. The field exercises not only parallelled the lecture material but actually introduced new subject material for later lectures. This was made possible by the different methods of management found in the region where stocking combinations of cattle, sheep and goats are a common practice.

Forage plants were studied in relation to their environment as well as a means of determining their identification and classification. The county agents were taught how to prepare a field herbarium and how to mount and preserve plant specimens for educational purposes. Several of the agents later prepared a grass exhibit for display use in their offices. These were used to familiarize ranchmen with the species common to their ranges. They also added interest to the 4-H grass judging contests that have proved so popular over much of the State.

Survey techniques were introduced as a means of quantitative determinations in the various phases of range management. Cause and effect was readily brought to the attention of the students on several ranches where the poisonous bitterweed (*Actinea odorata*) was taking a heavy toll of sheep. Other poisonous species and dense stands of brush and prickly pear cactus occupied much of the native pastures in certain areas that once supported dense and nutritious vegetation. This condition was brought about primarily by overutilization of the better

grasses and forbs through the "common use" grazing of cattle, sheep and goats over a fifty year period.

Chemical and mechanical methods of controlling live and shinnery oaks, juniper (cedar) and other woody species were observed. It became apparent that the brush problem on native ranges was one that would require the best talents of all concerned. In addition, several of the major problems associated with range abuse throughout the State, were available for study within a radius of 60 miles of the Substation.

This crowded week of lectures and field exercises gave the students the background essential to move on to other areas in order to study range management practices under different environments.

July 2nd, 1947, the class left the Sonora Substation in private cars accompanied by the cook, a chuck wagon, a blackboard, and the instructors. The first major study was made at the Clark Hereford Ranch near San Angelo. Here were observed outstanding results obtained by fitting tobosa grass into a rotation system of grazing with other grasses.

The class next moved westward to the vicinity of Fort Stockton. The general region was experiencing a three-year period of drought. Here irrigated pastures and alfalfa fields were studied not only as to management but as a source of supplemental forage and hay for the ranges during drought periods. A study of the Puckett Ranch, in this general locality, revealed the importance of proper rates of stocking to maintain a profitable unit during a prolonged drought period.

A hurried trip was made through the 290 section E-L Ranch near Fort Stockton. In a small native pasture located in a corner of this great ranch, the highly palatable bush-muhly grass once fairly abundant but now almost extinct over western and southwestern Texas, was seen making a satisfactory comeback under proper grazing practices.

Sixty miles to the west, in the Davis mountains, the class visited the little college city of Alpine. The vegetation in this vicinity revealed for the first time on the tour zonal differences associated with altitude. Here different kinds of range management were associated with the zonation—something unusual for Texas. In this area and on the famous Kokernot Ranch, a dual management program of cattle, deer and antelope furnished valuable information on the role that native pastures play in balanced land use for the hunter and livestock producer.

Moving deeper into southwestern Texas, the class stopped at the Mitchell Ranch located near Marfa and in an area that is noted for Highland Hereford cattle. Here a practical engineering method of water distribution was studied. Seven windmills, within an area of less than five acres, are used to lift water from a canyon from where it is distributed to various points in this 17,000 acre ranch. Range economics was strongly stressed in this particular region. During the three-day stop at Marfa, first hand information was obtained relative to the effect of the drought and overutilization on the ranges of that area. The determination of range condition classes was quite stimulating to the class. The value of leaving sufficient plant stubble and residue on the range lands to protect the soil from the forces of erosion was evident from comparisons made in the region. In addition, these studies left a deep impression with the county agents as to the close correlation of the physiological and ecological relationships of the plants to their environment.

The eradication and control of poison-

ous plants in this general region was also a major consideration. Such poisonous plants as rayless goldenrod, woolly and Riddell senecio, woolly and narrow leaf locos, garboncilla, peavine, and others were causing considerable livestock losses on several ranches. Again an opportunity was presented for the class to correlate range abuse and the kind of vegetation with the practices used in areas studied elsewhere. They questioned each other as to the soundness of given management practices. Whenever the instructors felt it was desirable to stop for a lecture or to outline on the blackboard certain phases of the instruction, they did so. Lectures were held in such places as open native pastures (Fig. 1), under trees, or on the

FIGURE 1. Class assembled on open range for lecture and discussion following inspection of a comparatively large ranch unit.

that might increase or invade as a result. A hurried inspection of the poisonous plants laboratory brought to light the need for technical assistance and funds to combat the poisonous plant problem in Texas.

During the period of travel the county agents became more conscious of the importance of the overall range program and likewise became more inquisitive each day. They obtained valuable information first hand from livestock operators. Qualified personnel from the Soil Conservation Service and Extension Service willingly gave their experiences on the methods and programs necessary to make range conservation work.

The agents made comparisons of the several range management practices observed in a given area and attempted to show whether the results were correlated shady side of barns and once in a high school lecture room.

At the close of each lecture or discussion the instructor would leave a challenge that called for additional thinking on the part of the class. There was never an idle moment on the part of the student if he wished to follow all leads.

When the course terminated, the students as well as the instructors agreed that it was a great education for all. Many friends were made among the ranchmen, farmers, and townspeople as the class moved from place to place. The hospitality characteristic of Texas rural people, was extended wherever the class went. A number of barbeques were given, light refreshments were served, and other favors extended. The ranchmen gave freely of their time and counsel, asking no remuneration for their services

except that any worthwhile knowledge they imparted would be carried on to other ranchmen (Fig. 2).

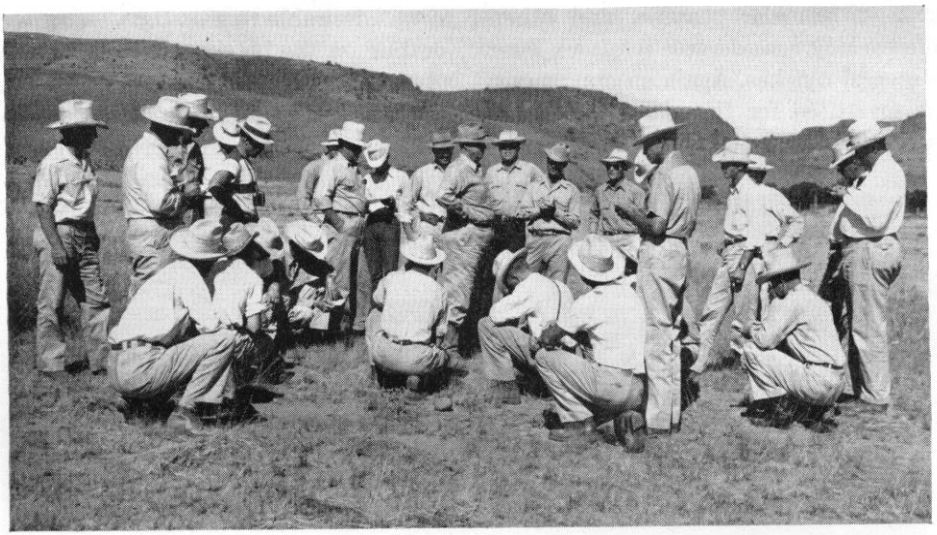

FIGURE 2. A rancher discusses the range problems on his ranch and general locality. The ranchmen were always very helpful in promoting range Extension conservation.

One might logically ask what the course accomplished that could be passed on by the county agents in their respective counties to promote better range management and stimulate rural people to become more range conservation minded. These are a few that stand out:

1. The introduction of a range management program for specific localities in a county that would assist ranchmen in initiating range conservation practices needed to obtain a sustained forage yield.
2. Range and pasture field day demonstrations have been organized and guest speakers invited to attend.
3. Ranchmen have been visited and encouraged to set up reduced stocking rates on over-utilized ranges.
4. Forage displays of outstanding native range plants have been placed in a strategic place in the county court house or in the office of the county agricultural agent.
5. Grass judging contests for 4-H boys have been expanded.
6. Last but not least the county agents have preached the gospel of range conservation to their neighboring county agents and advised them to attend the next summer range management course.

The results obtained by the county agents who attended the second course were equal to and in some respects better than those of the first group because the teaching staff through experience obtained during the first course was able to stress certain phases of the field studies to better advantage. Not only did these county agents introduce management practices suggested to the first group, but they substantially enlarged the plant judging program which was extended to many more 4-H clubs and counties. In addition grass and plant judging contests for 4-H and F.F.A. boys were introduced at county livestock shows, county fairs, the State Fair and finally regional contests where keen interest and competition has resulted. Adult grass identification

contests are also becoming popular at field day programs.

The county agents who completed the course the third year were equally as enthusiastic as the former two groups and were determined not only to carry on what had been introduced in the past, but to introduce additional phases of range management and conservation. Two members of this class soon after returning to their respective counties

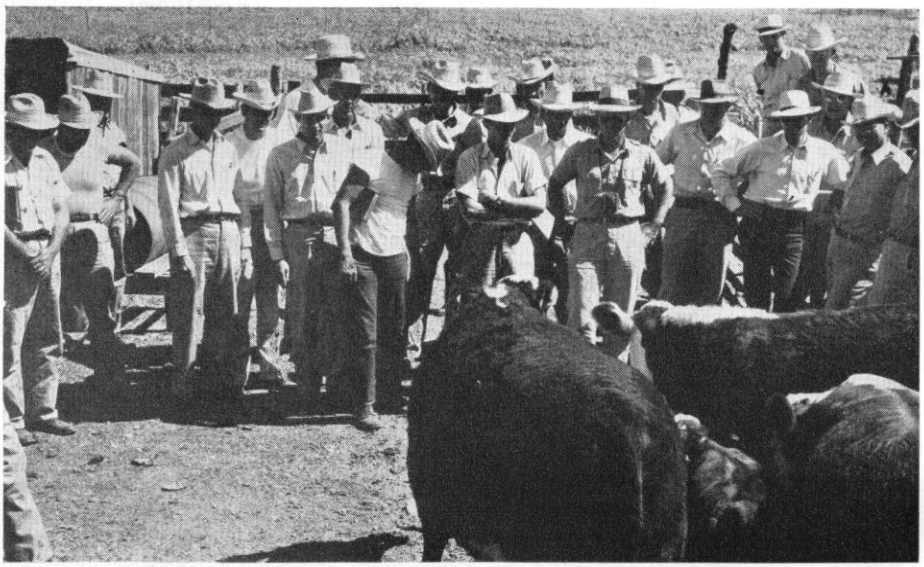

FIGURE 3. County Agricultural Agent W. T. Posey (second from right) discusses the value of 4-H calf club program and methods for show fitting with class. The large calf, *Judge Roy Bean*, on the left and owned by one of Mr. Posey's club members won the Grandchampionship at the Chicago International Livestock exposition in 1948.

successfully conducted range management courses for ranchmen and others interested in land conservation. Two other members began range management field contests among their 4-H clubs which will no doubt be greatly expanded in the future.

The members of the fourth class which comprised 23 county agents and 6 vocational agricultural teachers although less than a month out of the field range school are at this time reporting the organization of range programs for their counties and vocational agriculture classes.

The summary of the major contributions in range management obtained in the Extension Service in 1949 is included in a paper published by Extension Service Range Specialist A. H. Walker, entitled "Extension Range Work in Texas" (Journal of Range Management 3: 186–189, 1950; Table 1). Sixteen major activities are reported and each was well supported by 18 to 159 counties. However, all the activities listed and reported should not be attributed entirely to the influence of the summer range management field courses. The energetic action by those who did attend started the general program rolling, however. Mr. Walker who was appointed range worker September, 1947 was especially active in promoting the range program and his services were made available to any agent desiring assistance.

In conclusion, the experiences of the

writer in the field of range management now definitely indicate that ranchmen, farmers, business men and others are profoundly interested in the welfare of our native range lands. Much has been accomplished in range management research, but the results, published principally in technical bulletins, have been slow in arousing the ranchmen and farmers to action.

It is now too late to depend largely on literature to stimulate an interest in proper range management practices. Therefore, real action is necessary whereby the information must be brought to the landowner by representatives of the various agencies interested in range conservation by means of personal visits, organized meetings, field demonstrations and club work for boys (Fig. 3).

There should be at least one Extension Range Specialist in each of the 17 Western range states to assist the county agricultural agents with their range management programs. These specialists would help to keep the landowners in touch with results being obtained in range research. Not until every county agent, every Vocational Agricultural teacher, and every conservationist is spreading the gospel of proper range management practices will our native range lands be safe from exploitation.

PLANT GRASS AND SAVE SOIL

We must conserve our remaining natural resources. This applies particularly to our topsoil. It is not too late to save, and even improve, our soil. We can prevent the runoff of eroding rain water by adopting such practices as contour and strip farming and by putting greater emphasis on grass crops. Fortunately, increased demands for livestock products require more grass culture.

Only a small fraction of our farmers are as yet using the scientific knowledge now available. If that knowledge were universally applied, our food supply could be raised 50 percent.

Dr. Harold G. Moulton,
in The American Magazine

Control of Orange Sneezeweed with 2,4-D

CLYDE W. DORAN

Rocky Mountain Forest and Range Experiment Station[1]

RECENT tests by the Rocky Mountain Forest and Range Experiment Station in western Colorado show that orange sneezeweed (*Helenium hoopesii*) may be killed with 2,4-D at lower costs than by grubbing or by the application of soil sterilants such as borax or sodium chlorate.

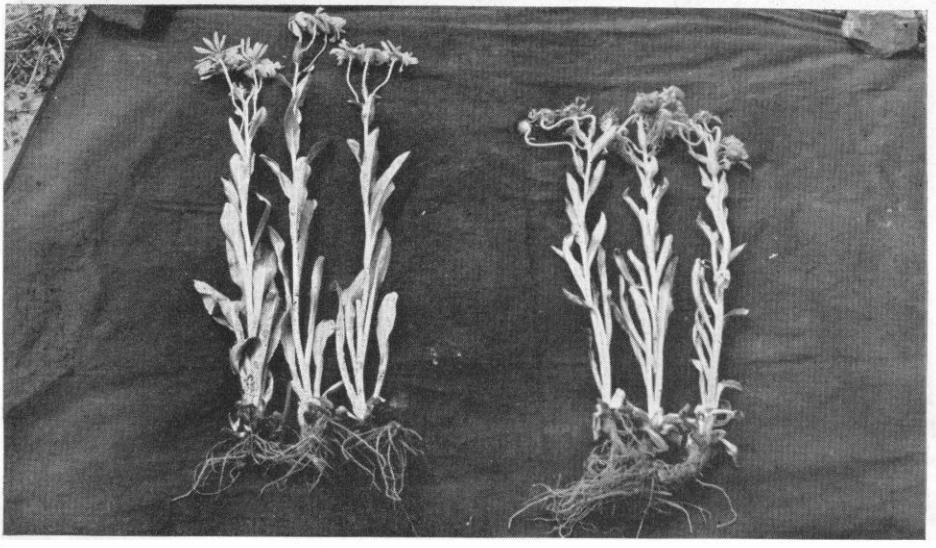

FIGURE 1. Sneezeweed is a yellow-flowered, glossy-leaved, perennial of the sunflower family. A normal plant (left) is compared with a plant recently sprayed with 2,4-D (right). Wilting and stem deformation follow spraying within a few hours, but several weeks may elapse before a plant is completely dead.

Sneezeweed (Fig. 1) is poisonous to sheep and unpalatable to cattle. Light to heavy infestations occupy more than two million acres of summer rangeland in the central Rocky Mountains. The plant reproduces prolifically by seed and by offshoots developed from adventitious buds on the taproots. Following overgrazing, sneezeweed spreads rapidly, and becomes a constant source of danger to range sheep. When sheep eat sneezeweed in quantity, they develop "spewing sickness" (*Marsh, 1924*), causing severe death losses and reduced lamb and wool crops. *Dayton et al, 1937* note that losses in Utah have been reduced by moving poisoned sheep to lower uninfested brush ranges until their condition improves. More recently a study in western Colorado (*Doran & Cassady, 1944*) has shown that if certain management practices are rigidly followed, sheep are able to utilize sneezeweed-infested ranges with very small losses. Recommended practices

[1] Maintained by the U. S. Department of Agriculture, Forest Service, in cooperation with Colorado A & M College, Fort Collins, Colorado.

include: (1) use of one-night bedgrounds and their location in uninfested areas, (2) light use of the range and avoidance of the most dense stands of this poisonous weed, (3) non-use of infested ranges in early spring or in late fall when desirable forage plants begin to dry, (4) open quiet herding, (5) uniform use of the range with as little trailing and "twice over" herding as possible, (6) never salting on bedgrounds until just before dark so sheep do not concentrate and graze with little chance of plant selection, and (7) careful culling of the flock at marketing time to dispose of all poisoned animals.

Although careful management of the flock will reduce poison losses, sneezeweed remains a problem on both sheep and cattle ranges because it produces little or no forage and occupies productive land that could and should be producing grass.

Many different methods of eradicating sneezeweed have been tried (*Doran & Cassady, 1944*). Grubbing and application of soil sterilants such as borax and sodium chlorate have proved effective, but costs vary from $15 to $30 per acre. Such costs are generally prohibitive on low-value rangelands and follow-up treatments are often required for complete control.

Good kills of sneezeweed have now been made with only one application of 2,4-D at a cost of approximately $8 per acre (Fig. 2). The development of cheaper or more effective herbicides and better methods of application may decrease costs in the future.

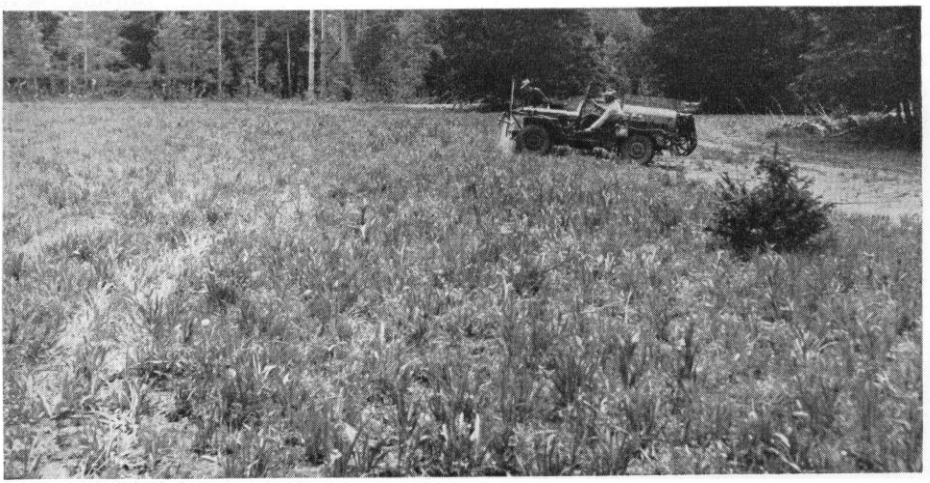

FIGURE 2. Spraying dense stands of sneezeweed with 2,4-D in mountain parks has been done efficiently with a low-pressure weed sprayer with 20-foot booms, mounted on a jeep.

Initial eradication tests with 2,4-D were made on the Uncompahgre, Grand Mesa, and White River National Forests in 1946. Hand-operated garden-type sprayers were used to apply the 2,4-D solutions to rod-square plots. Early spring, midsummer, and fall dates of application were tested, using 2,4-D concentrations of 1, 2, and 4 pounds of pure acid per acre. These initial tests showed that only the highest concentration of 2,4-D, or 4 pounds pure acid per acre, was effective in killing sneezeweed, and then only when applied in midsummer. Smaller amounts of 2,4-D or early-spring and late-fall applications

caused the weed to wilt and discolor, but the old roots produced new offshoots that quickly replaced the original stand.

In 1947 additional small plots were treated at three different dates during the midsummer period, conforming to different stages of sneezeweed development: (1) pre-bloom (2) early bloom, (3) full bloom. These stages occurred about two weeks apart. Three different commercial 2,4-D formulations (ester, amine, and salt) were tested in water solutions or carriers, and in addition the ester formulation was applied in a distillate or fuel oil carrier instead of water. Table 1 indicates the average density of sneezeweed before treatment, and six weeks, one year, and two years following treatments. These tests were made only on the Uncompahgre and Grand Mesa Forests.

All the 2,4-D formulations tested produced good sneezeweed kills when applied during this midsummer period, from the pre-bloom to full-bloom stage of sneezeweed development. The esters appeared to give the most consistently good kills throughout the different periods of application, while the amines and salts appeared to be slightly more effective

TABLE 1

Average percent density of sneezeweed before and after spraying with 2,4-D

FORMULATION	CONCENTRATION (POUNDS PURE ACID PER ACRE)	STAGE OF SNEEZEWEED DEVELOPMENT WHEN APPLIED	UNCOMPAHGRE				GRAND MESA			
			Before	6 weeks after	1 year after	2 years after	Before	6 weeks after	1 year after	2 years after
Water carrier										
Ester	4	pre-bloom	3.2	0.2	0.1	0.4	2.1	0.1	T	0.3
Ester	4	early bloom	3.2	0.1	0.1	T	2.2	0.2	0.1	0.2
Ester	4	full bloom	3.4	1.0	T	0.1	1.2	1.7	0.5	0.4
Ester	8	pre-bloom	6.7	0.2	0.1	0.2	1.8	T	0.1	0.2
Ester	8	early bloom	4.4	T	T	0.0	3.0	0.5	0.1	T
Ester	8	full bloom	2.9	1.1	T	0.1	0.9	0.2	0.1	T
Amine	4	pre-bloom	2.5	T	T	0.1	2.0	0.2	0.1	0.1
Amine	4	early bloom	4.3	2.6	0.6	0.6	1.6	1.3	2.2	0.3
Amine	4	full bloom	2.8	1.6	T	0.2	1.9	2.4	0.4	T
Amine	8	pre-bloom	4.6	T	T	T	1.4	0.0	T	0.1
Amine	8	early bloom	4.6	0.5	T	0.1	3.2	1.5	0.8	0.1
Amine	8	full bloom	2.5	0.6	T	T	1.6	0.5	0.1	0.2
Salt	8	early bloom	2.4	2.4	0.6	1.5	2.8	1.5	0.6	0.3
Salt	8	full bloom	3.6	3.9	T	0.3	1.2	1.4	0.4	0.1
Distillate (oil) carrier										
Ester	4	pre-bloom	2.5	0.4	0.1	0.1	1.2	0.4	0.7	0.1
Ester	4	early bloom	4.8	0.3	T	0.1	4.0	0.2	0.4	0.1
Ester	4	full bloom	2.0	0.4	T	T	2.2	0.5	0.3	0.3
Ester	8	pre-bloom	3.9	T	0.0	T	1.8	0.0	T	T
Ester	8	early bloom	1.0	T	T	0.1	1.0	0.0	T	0.1
Ester	8	full bloom	6.1	0.5	T	0.2	2.4	3.1	0.5	0.5
No treatment										
Check		pre-bloom	3.2	3.9	1.7	2.9	1.2	1.4	1.3	1.5
Check		early bloom	2.4	2.7	0.6	2.2	0.8	1.6	2.2	2.0
Check		full bloom	2.1	2.7	0.8	1.8	2.9	3.3	2.8	2.8

T = trace.

when applied during the pre-bloom stage. A water carrier was just as effective as a distillate or oil carrier.

Later tests on a larger scale have shown that the jeep ground-spraying equipment (Fig. 2) may be effectively used for spraying sneezeweed-infested ranges. Good plant coverage can be obtained using 50 gallons of water per acre as the 2,4-D carrier. In experimental tests the jeep, equipped with 20-foot booms and appropriate nozzles, traveled about 4 miles per hour and required 15 minutes to spray an acre. Table 2 shows the number

TABLE 2

Number of sneezeweed rosettes per acre before and 6 weeks after spraying with 2,4-D[1]

TREATMENT	AVERAGE NUMBER OF SNEEZEWEED ROSETTES PER ACRE (THOUSANDS)	
	Before treatment	6 weeks after treatment
Sprayed with 2,4-D		
Plot 1	378	34
Plot 2	234	38
Plot 3	415	64
Plot 4	458	27
Check (no treatment)		
Plot 1	274	352
Plot 2	372	318

[1] Number of rosettes per acre is based on counts of 20 random sample plots within each treated plot. Sample plots were 1/20,000 acre in size. One sneezeweed plant may consist of 1 to 20 rosettes.

of sneezeweed rosettes before and after spraying four ½-acre plots on the Uncompahgre Plateau with the jeep ground-spraying equipment. These plots were sprayed in early July during the pre-bloom stage of sneezeweed development. 2,4-D was applied at the rate of 4 pounds pure acid per acre in an ester formulation with a water carrier.

Spraying should be confined to the period just before the sneezeweed plants begin to bloom, when flower buds are formed and the plants are growing rapidly. At a 9,000-foot elevation in western Colorado, this period usually occurs in early July. 2,4-D should be applied on calm, warm, sunny days. If rain falls within a few hours after spraying, it is liable to wash away the 2,4-D before it is fully effective.

Killing sneezeweed with 2,4-D has some disadvantages and may create new problems. For example, most of the broadleaf plants that grow with sneezeweed are also susceptible to 2,4-D. Commonly occurring species that are killed or severely damaged by 4 pounds of pure acid per acre are as follows:

Western yarrow	Achillea lanulosa
Dandelion agoseris	Agoseris taraxacifolia
Painted cup	Castilleja spp.
Hairy goldaster	Chrysopsis villosa
Menzies larkspur	Delphinium menzeisi
Trailing fleabane	Erigeron flagellaris
Aspen fleabane	Erigeron macranthus
Richardson geranium	Geranium richardsoni
Aspen peavine	Lathyrus leucanthus
Mountain bluebell	Mertensia ciliata
Shrubby cinquefoil	Potentilla fruticosa
Cinquefoils	Potentilla filipes, P. anserina, P. glaucophylla
Buttercup	Ranunculus spp.
Niggerhead	Rudbeckia occidentalis
Groundsel	Senecio spp.
Decumbent goldenrod	Solidago decumbens
Common dandelion	Taraxacum officinale
Edible valerian	Valeriana edulis
American vetch	Vicia americana

When these plants are killed the forage crop is reduced and the soil may erode more rapidly.

Fortunately, 2,4-D sprays do not damage native grasses commonly found with sneezeweed. Native grasses tend to increase after being released from weed competition, but in many areas the grasses are so sparse that several years may elapse before they can thicken enough to provide an effective soil cover.

In spite of obvious disadvantages, 2,4-D sprays offer a promising method of controlling sneezeweed. Because of the aggressive nature of the weed, permanent control cannot be expected from a single application of 2,4-D. A good cover of perennial vegetation that will keep sneezeweed from re-invading must be established and maintained.

Studies have been initiated to determine how such a vegetation cover can be obtained and maintained most effectively and economically. Getting rid of sneezeweed is a difficult goal to attain; yet the benefits in increased forage production and reduced poison losses make the effort worth while.

Summary

Tests made by the Rocky Mountain Forest and Range Experiment Station in western Colorado show that sneezeweed can be killed with 2,4-D sprays. Sneezeweed is poisonous to sheep and unpalatable to cattle. When abundant, this noxious weed is a problem on summer ranges in the central Rocky Mountains.

A low-pressure weed sprayer with 20-foot booms mounted on a jeep, proved satisfactory for applying 2,4-D in mountain parks. Ninety percent kills were obtained at costs of approximately $8 per acre.

To be effective in controlling sneezeweed 2,4-D should be applied:

1. At the rate of 4 pounds pure acid per acre.
2. On calm sunny days, with no rain for several hours following application.
3. At the pre-bloom stage of sneezeweed development, when flower buds are formed and the plants are growing rapidly.
4. With a sufficient amount of carrier, water or distillate, to give good plant coverage.

2,4-D does not damage native grasses, but does kill most broadleaved plants commonly associated with sneezeweed. Sneezeweed rapidly re-invades treated areas, and control should be attempted only when provisions are made to restore a good cover of grass in a short time.

The author wishes to acknowledge the cooperation of Bruce J. Thornton, Seed Laboratory, Colorado Agriculture Experiment Station, Fort Collins, Colorado.

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New Grasses for Old Ranges

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THE organization of the American Society of Range Management is but one expression of the concern experienced by those interested in our national agricultural resources for the present condition of our grasslands. The millions of acres of abandoned farmland throughout the West added to the still more millions of acres of brush infested and badly depleted range land attest to an immense deterioration of our range resources. The problems presented are of staggering magnitude and can be solved only through diligent cooperation of all people interested in range management. One of the keys to the whole situation is the discovery, selection, or production of grasses suitable for range reseeding. Lack of research on the problem and little understanding of the fundamentals involved have led us to many blind alleys and misconceptions. Range management specialists are not yet generally aware of the great differences which may be found between varieties of a species of grass. Many instances of unsatisfactory attempts at reseeding can be ascribed to a failure to recognize varietal differences in both introduced and native grasses.

There is no question that some species of grasses are better suited to reseeding our rangelands than others. A few seem to be especially suited to broadcast seeding which means they can be used in airplane seedings on a large scale. The splendid results so far obtained from King Ranch bluestem (a strain of *Andropogon ischaemum*) in parts of Texas and the similar performance of caucasian bluestem (*A. intermedius caucasicus*) in Kansas and other states indicate that we may have found grasses suitable for our southern ranges which can be used as readily as crested wheatgrass in the northern ranges.

King Ranch bluestem was introduced to this country by accident and was not discovered nor exploited for many years after its chance establishment in southern Texas. If such grasses can be found accidentally, "what could we do on purpose?" It would be coincidence indeed if this strain should be the very best of all the great number of forms and types of the Eurasian complex to which it belongs. It seems absurd to suppose that of all the thousands of strains in this complex we have already come upon the types best suited to our purposes. If we are not so lucky, then strains and varieties of even greater value await us somewhere on the continent of Asia.

Systematic Forage Introduction Needed

Introductions, particularly of forage plants, have been brought to this country in a haphazard, unsystematic way. Most of the introductions consist of one small packet of seed which cannot even represent the local variation of the species. This would be equivalent to sending a small packet of side-oats grama seed to Australia to represent that species. Side-oats grama is native from Maine to Southern California and the number of

variant forms is legion. The difference in adaptation between strains of side-oats grama greatly exceeds the difference in adaptation between many species of lesser distribution. Thus a single packet introduction—or even a dozen packets—is a pitifully inadequate sampling of a species. The Eurasian bluestems are native from Hungary to China. The handfull of accessions so far grown in this country cannot represent a reasonable sampling of the material.

Other introductions of value have reached us in the same way. Weeping lovegrass (*Eragrostis curvula*) has at least a limited place in some portions of the southern plains. The standard strain now being used is low in palatability and returns low gains per head. This does not mean that other and superior strains might not be found were we to search for them. A number of strains of the species have been tested, most of which are not nearly so resistant to cold as the standard strain and have winterkilled at Woodward, Oklahoma. Two other species of lovegrass have shown much promise in the Southwest. Lehmann's lovegrass (*E. lehmanniana*) and Boer lovegrass (*E. chloromaelas*) are both very cold sensitive. Many accessions have winterkilled regularly at Woodward, yet a lot was received in 1948 which overwintered under severe conditions without injury. Of several accessions of *Andropogon intermedius* tested, only the *var. caucasicus* type has proved winterhardy.

Among these occasional and chance introductions we have found, and may find in the future, material of immense value. But such introductions are a poor substitute indeed for a thorough and systematic survey of the world's grass resources. As the writer can testify from personal experience, an adequate sampling of the genetic material of a geographic region is not easily obtained. A systematic collection program for forage plants over the world would need to be well organized and adequately financed. The results would certainly justify the effort.

Superior Native Strains

Many of our native species offer the same challenge and opportunity. The difference between strains is sometimes extraordinary. This seems particularly true of the warm season grasses. The striking differences in behavior and performance between northern and southern sources of native species have long been recognized by range management specialists. More recent, detailed inquiry into the problem has shown that differences nearly as great may be found between varieties from similar latitudes. One example of special interest here can be cited of the behavior of a complex of blue-grama strains in the Capitan mountains of New Mexico. Here we find types indicating mediocre performance intermingled with types showing excellent vigor and marked superiority. Collections made only one half mile apart show striking differences although the blue grama stand is nearly pure and continuous between the sources. A similar behavior is demonstrable in side-oats grama and further study will no doubt reveal an analogous situation in other native grass species.

It is evident, therefore, that even to obtain an adequate sampling of some of our own native species we must go through some areas with a fine toothed comb. How much more difficult it would be to obtain a good sampling of foreign species about which we know even less!

Another problem of prime importance to the range management specialist is brought out by our study of varietal dif-

ferences. How can we determine which species is the best for our conditions? The comparison of two species by accepted research techniques becomes a virtual impossibility. We can compare one strain of one species with one strain of another species. We may compare the best known strain of one species with the best known strain of another, but we have not the physical resources to compare one species with another. *The difference in performance between strains of one species is in many cases a far greater variable than the difference between species.*

Grass breeding, although much neglected in our national forage crop picture can play a vital and important role in our range reseeding problems. By the discovery or production of new and superior strains, the grass breeding program is a key to the utilization of a number of species in range reseeding.

DOES THE HORSE HAVE AN I. Q.?

The horse rates near the bottom among animals in intelligence, even lower than a pig, according to scientists of the animal-behavior section of the American Museum of Natural History, who have been giving I. Q. tests to various animals. We would like to hear, at a safe distance, the reaction of some old-time ranch hand to that statement.—*in* Country Gentleman, August, 1949.

A Symposium on Rotation Grazing in North America

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ROTATION grazing composed one of the panel periods at the third annual meeting of the Range Society held in San Antonio, Texas, in January, 1950. Several papers on the subject were read and lively discussions followed.

It soon became apparent that much diversity of opinion exists among both research workers and operators regarding the merits of rotation grazing. Some of these differences seem to stem back to confusion in terminology, as between rotation and deferred grazing; others to the more broadly accepted objectives of these grazing systems, still others to a combination of the two.

The importance of this subject prompted Editor Dr. R. S. Campbell to request the authors to prepare their papers for publication in the Journal, preferably in a single issue. He also proposed that the writer edit the series, prepare a brief review on the subject of rotation grazing, list the most pertinent references, and perhaps draw some conclusions on the merits and application of rotation grazing. All agreed to carry out these proposals.

Highlights on Rotation Grazing

Rotation Grazing Defined

Rotation grazing consists in shifting the livestock systematically at desirable intervals to different subunits of a range area or fenced subdivisions, and back to the first subdivision, *without specific provision for seed production.*

The objectives are essentially: 1) to avoid grazing the same subunit first in the spring of each year; 2) to maintain the plant cover over the entire range area in a high state of vigor with little or no decrease in animal production.

Strictly speaking, any prescribed delayed date for placing the animals on a range subunit may be regarded as deferred grazing; to avoid confusion the term as commonly used in this country, is restricted to imply *deferment of cropping until after seed maturity.* The acreage reserved must be large enough to carry all the animals from the ripening of the seed crop of the primary forage species to the end of the normal grazing season.

"Deferred-rotation" is a somewhat common combination term and seems to have a useful place in American range practices. The term is justified for any rotation system which envisages delaying grazing on some small portion of the range until after seed maturity for purposes of revegetation.

Where a range area or fenced pasture is merely divided into *two* subdivisions to improve the vigor of the vegetation or "condition" of the range, the system is properly referred to as alternate grazing. As a rule ranges which have been revegetated through deferred grazing are maintained in good condition by rotation or alternate grazing under proper stocking. Most rotation grazing systems as practiced on the western range are, in effect, deferred-rotation systems in which the primary forage plants have good conditions for setting seed and of getting the seed crop trampled into the mineral soil on one subunit each season. On cattle

range rotation grazing is carried out by appropriately dividing the area into subunits by fencing or taking advantage of natural boundaries; on open sheep range by herding so as to rotate the grazing at appropriate intervals from one subunit to another.

Resumé of Literature

Numerous studies have been undertaken throughout the world to learn the relative merits of continuous and of rotation or alternate grazing, with or without a planned deferment. These tests have been conducted on native as well as tame pastures, with either cattle or sheep, and under various degrees of stocking. Several plant physiological experiments have also been made to corroborate the results of the rotation grazing trials. The present review is limited to the native range lands of North America, but the bibliography on the subject is more inclusive. In general, the foreign workers have been primarily concerned with intensive management on tame pastures grazed by dairy stock or sheep. Some of these trials gave results favoring a rotation grazing system; in others continuous grazing proved the more practical. Much of the work in the United States has been with dairy cattle, but a limited number of studies have been conducted with beef cattle or sheep on native ranges.

As early as 1895, Smith (40) advocated improvement of natural ranges by dividing them into separate pastures to be grazed in rotation, thereby providing for the spread of forage plants by means of ripened seed. In 1913, Sampson (35) reported preliminary results of a system of deferred and rotation grazing based on the growth requirements of vegetation that would naturally reseed overgrazed portions of sheep range. This proposal was derived from a study in the Wallowa mountains of Oregon initiated in 1909 and described more fully by this worker (36) in 1914. Jardine (21, 22) in 1915 and 1919 discussed this proposed plan and recommended a system of deferred and rotation grazing where feasible.

About 1915 a study was initiated at Manhattan, Kansas to compare continuous and deferred grazing on native bluestem pastures. The primary objective was to increase the carrying capacity of the pastures. Anderson (3) reported on this study in 1940. The original deferment to September 1 did not give the desired results. But a deferment to July 1 improved the vegetation, gave greater livestock gains, and increased the carrying capacity over that of the continuously grazed pastures.

In 1919 a study of rotation grazing was begun at Mandan, North Dakota. It compared a three field seasonal rotation system with continuous grazing. In 1941 Sarvis (38) reported that the vegetation in the rotation pastures improved over that in the continuously grazed pasture, but that the cattle made greater gains on the properly stocked (7 acres/head) continuously grazed pasture. Clarke and associates (9) reported in 1943 essentially the same results from a 5 year study at Manyberries, Alberta, except that the weaning weights of the calves were greater in the continuously grazed pasture, and the cow weights were essentially the same for both the rotationally and continuously grazed pastures. Both Sarvis and Clarke suggested that the beneficial effects of deferred and rotational grazing appear to be most evident in the restoration of overgrazed pastures rather than in the utilization of ranges in a highly productive condition.

In the early 20's a study was set up at Ardmore, South Dakota, comparing a midseason alternational system with con-

tinuous grazing. As the rates of stocking were not consistent throughout the study, the results were somewhat confounded. In 1937 Black and associates (7) reported that during the last 3 years of the study when the pastures were stocked at about the same moderate rate, greater gains were made on the alternately grazed pastures. These workers recognized that when pastures of different grazing intensities are compared livestock gains alone are not the only measure of forage production or the success of the system. In 1942, a four year study, also at Ardmore, was reported by Black and Clarke (8), in which the alternate pastures were grazed for a 28 day period (28 days on—28 days off). Under moderate stocking the vegetation in the continuously and alternately grazed pastures appeared to be essentially the same, and there was no significant difference in the weights of the cattle.

Another study initiated in the early 20's near Fort Collins, Colorado, was reported by Hanson and associates (16) in 1931. The deferred-rotation system consisted of 3 pastures, two of which were opened to grazing May 1 and the third was deferred until August 15. This system was compared with continuous year long grazing. At the close of the study the vegetation on the deferred pastures was much superior to that on the continuously grazed pasture. Trampling effect was pronounced on the continuously grazed unit.

Frandsen (12) of the Soil Conservation Service has made a practical study of the application of various grazing systems as used in the Pacific Northwest. He points out the difficulty of obtaining uniform forage utilization under continuous season-long grazing without seriously injuring the more accessible areas of the range. The easy way to improve the forage cover, he points out, is by a properly applied system of deferred-rotation grazing, the hard way by a properly applied moderate continuous grazing system.

Several clipping studies have indicated what effect the time of use has on productivity of various range grasses. McCarty (27), working with mountain brome, concluded that some form of deferred and rotation system should be employed to insure sufficient carbohydrate storage in the perennial range grasses. In a later study McCarty and Price (28) found that the quantity of carbohydrate reserves in the plants at the end of the growing season was less influenced by frequency of clipping than by time and degree of defoliation. Sampson and McCarty (37) found that moderate grazing or clipping once or twice early in the growth cycle had little influence on the total herbage yield of *Stipa pulchra*. But herbage removal was harmful during the summer when the growth rate was most rapid—a period when carbohydrate reserves were lowest.

General Conclusions

The above incomplete resumé of the literature brings out two fairly distinct viewpoints among range conservationists and operators regarding the merits of rotation or deferred-rotation grazing. It becomes clear that regional and local conditions have much to do with the results achieved. Such factors as growth form (bunchgrass, sodgrass, stoloniferous, or rhizomatous), stocking rates, seasonal distribution of the rainfall, soil type, topography and the time factor between deferment periods, may greatly influence the outcome of the practice. However, most workers and operators seem to agree on the following points:

1. On bunchgrass range, deferment of grazing every three years or so is, as a rule,

highly beneficial to the vegetation. The grass tufts are enlarged measurably; roots penetrate more widely and deeply through the soil; the volume of forage is greater, and the larger seed crop has a higher viability; the added food reserves protect the plants against winter killing and induce earlier and more vigorous spring growth.

2. On predominantly bunchgrass ranges, especially mountain lands with abbreviated growing season, some form of rotation grazing is essential. On sodgrass range, especially at the lower elevations, moderate season-long cropping produces somewhat heavier livestock weights without apparent injury to the vegetation.

3. Natural revegetation of depleted mountain bunchgrass range of rugged topography is generally unsuccessful because of spotty over-grazing of the more accessible portions and too light cropping of the steeper slopes. Improvement of soil and cover, if any, is slow and costly.

4. Any system of rotation grazing should provide for shifting the animals so that no given portion of the range will be grazed at the same time every year—a point too frequently overlooked. This principle applies especially to early spring grazing.

5. The benefits of rotation grazing must take into account the economic returns in beef, mutton, and wool, including such costs as fencing, water development, and handling of the stock. These expenses are particularly justified on mountain bunchgrass ranges and other equally critical areas.

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BRIEFS

Everything comes to him who hustles while he waits.—Thomas Alva Edison.

I am a great believer in luck, and I find the harder I work the more I have of it.—Stephen Leacock.

Rotational Grazing Studies in Western Canada

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THE purpose of the study was to determine the effects of deferred-rotational grazing in comparison with continuous use of the range.

The Dominion Range Experiment Station, Manyberries, Alberta, where the study was made, is located approximately 60 miles northwest of Havre, Montana, and confined on the south by the International Boundary. It comprises some 27,000 acres of short-grass prairie. The topography is undulating to gently rolling with numerous coulees dividing the area. There is a pronounced microrelief formed by the eroded depressions or "burn-out" pits of the solodized-solonetz profiles.

The area used in the study is classified as short-grass prairie, and is characterized by blue grama grass (*Bouteloua gracilis*), which comprises over one-third of the total vegetative cover, and by needle-and-thread (*Stipa comata*). Other important grasses are western wheatgrass (*Agropyron smithii*), Junegrass (*Koeleria cristata*), and Sandberg's bluegrass (*Poa secunda*). Involute leaved sedge (*Carex eleocharis*) is abundant and niggerwool (*Carex filifolia*) is common. Frequent associates are fringed sagebrush (*Artemisia frigida*), dwarf phlox (*Phlox hoodii*), broom weed (*Gutierrizia diversifolia*), winter fat (*Eurotia lanata*), salt sage (*Atriplex nuttallii*), hoary sagebrush (*Artemisia cana*), and cactus (*Opuntia polyacantha*). Little club moss (*Selaginella densa*) is abundant throughout the area, but its effect on the vegetation is problematical. In general, the vegetation is highly nutritive and palatable, but of low productivity. The grasses usually compose less than 10 per cent, but forbs and weeds increase the total cover from 20 to 30 per cent.

The animals used in the grazing trials watered at a centrally located well operated by a windmill. The maximum distance to water was two miles.

The area selected for the study is typical of a large portion of the short-grass prairie. While the fields were not standardized, the vegetation, topography, and general grazing conditions were the same previous to fencing.

The test was run from 1932 to 1937 with a grazing season of seven months (average April 8 to November 3). The rotation made use of three fields of equal size for each intensity of grazing. The rates of grazing were 20 and 30 acres per head and each pasture was grazed for one-third of the season. The order of the rotation is shown in Table 1.

TABLE 1

Order of rotation, field designations by letters, and years grazed

SEASON GRAZED	FIELD DESIGNATIONS BY LETTERS, AND YEARS GRAZED					
	1932	1933	1934	1935	1936	1937
Spring	A	B	C	B	A	C
Summer	B	A	B	C	C	A
Fall	C	C	A	A	B	B

During the 6-year period each field had two seasons of spring grazing, two of summer, and two of fall use. This allowed the vegetation in each field to develop normally in two years out of six. The two years of protection during the entire grazing season came consecutively; thus

any seedlings produced in the first year of protection might become established before grazing began.

The fields used for rotational grazing were 66.6 acres and 100 acres for the 20 and 30 acres per head of stocking, respectively. These fields were adjacent to the continuously grazed fields.

Ten head of uniform good commercial grade yearling Hereford heifers were placed in each set of pastures in 1932, and the same animals were grazed in the same fields in subsequent years. The heifers were bred at two years of age, and in each succeeding year, so there were calves with cows in the fields during the years 1934 to 1937, inclusive.

similar quadrats in the continuously grazed field are presented for comparison.

While both the continuously and rotationally grazed fields suffered to some extent from heavy use, the detrimental effects were more pronounced in the continuously grazed pasture. Western wheatgrass was the only primary species that did as well under continuous as under rotational grazing. Sandberg bluegrass increased noticeably with overgrazing and is sometimes considered a range weed. The great increase of this grass on the continuously grazed pasture was regarded as a good indication of the depletion of the cover in that area. Sandberg bluegrass also increased under moderate grazing.

TABLE 2

Changes in plant cover under two different systems of grazing at the rate of twenty acres per head

NAME OF SPECIES	BASAL AREA OCCUPIED (PERCENT)					
	Rotational Grazing			Continuous Grazing		
	1931	1937	Diff.[1] (percent)	1931	1937	Diff.[1] (percent)
Bouteloua gracilis	3.34	3.22	−4	3.77	2.96	−21
Stipa comata	2.49	1.95	−26	2.62	1.86	*−27*
Agropyron smithii	0.82	0.72	−12	0.86	0.78	−9
Koeleria cristata	0.30	0.66	*+120*	0.50	0.90	*+80*
Poa secunda	0.17	0.52	*+206*	0.05	0.54	**+980**
Other grasses and sedges	0.15	0.40	*+170*	0.06	0.16	*+167*
Total	7.27	7.37	+1.3	7.86	7.20	−8.5
Artemisia frigida	0.43	0.21	*−51*	0.62	0.41	*−34*
Phlox hoodii	0.33	0.39	+18	0.78	0.70	−10
Selaginella densa	10.0	1.48	**+48**	15.0	20.0	**+33**

[1] Statistical significance of changes is indicated by use of italic and boldface figures for percentage difference. Italic figures indicate significant differences, (odds of 19:1 or greater). Boldface figures indicate a high degree of significance, (odds of 99:1 or greater).

Data were accumulated by area-list quadrats (each 1 sq. meter) and periodic weighing of the cattle. Table 2 presents a summary of the data obtained from 25 area-list quadrats established on the field grazed in rotation at the rate of 20 acres per head. The results of 18

Table 3 presents the results of the quadrat studies on the fields grazed rotationally at the rate of 30 acres per head. The data for the pasture grazed continuously at the same rate are presented for comparison. Thirty area-list quadrats were studied in the rotated

TABLE 3

Changes in plant cover under two different systems of grazing at the rate of thirty acres per head

NAME OF SPECIES	BASAL AREA OCCUPIED (IN PERCENT)					
	Rotational Grazing			Continuous Grazing		
	1931	1937	Diff.[1] (percent)	1931	1937	Diff.[1] (percent)
Bouteloua gracilis	3.16	3.03	−4	3.37	2.80	−17
Stipa comata	2.75	2.47	−10	1.79	1.41	*−21*
Agropyron smithii	0.70	0.91	+30	1.22	1.25	+2
Koeleria cristata	0.32	0.88	*+175*	0.43	0.69	*+60*
Poa secunda	0.12	0.39	**+225**	0.10	0.64	**+540**
Other grasses and sedges	0.36	0.46	*+31*	0.75	0.84	+12
Total	7.40	8.14	+10	7.66	7.63	−0.4
Artemisia frigida	0.53	0.22	*−58*	0.72	0.22	**−69**
Phlox hoodii	0.32	0.42	+31	0.49	0.61	+24
Selaginella densa	6.50	13.7	**+110**	12.0	18.0	**+50**

[1] Statistical significance of changes is indicated by use of italic and boldface figures for percentage difference. Italic figures indicate significant difference, (odds of 19:1 or greater). Boldface figures indicate a high degree of significance, (odds of 99:1 or greater).

TABLE 4

Average gains in weight of cattle under different systems and intensities of grazing

GRAZING METHOD AND INTENSITY	AVERAGE GAIN IN WEIGHT OF COWS, AND WEANING WEIGHT OF CALVES (POUNDS)[1]							
		1932	1933	1934	1935	1936	1937	Av.
Rotational at 20 acres per head	Cows	267	292	118	92	79	21	145
	Calves	—	—	355	369	293	307	331
Continuous at 20 acres per head	Cows	319	284	136	141	22	45	158
	Calves	—	—	339	389	322	363	353
Rotational at 30 acres per head	Cows	296	296	169	163	198	73	199.2
	Calves	—	—	347	360	347	358	353
Continuous at 30 acres per head	Cows	334	307	120	159	176	102	199.5
	Calves	—	—	405	425	359	390	395

[1] Minimum significant differences in average gain for the various lots of cows are as follows: 34 pounds for rotational versus continuous at 20 acres (also for rotational at 30 versus rotational at 20). For calves, the corresponding figures are 41 pounds for rotational versus continuous at 20 acres, 44 pounds for rotational versus continuous at 30 acres.

fields and 27 in the continuously grazed area.

Here, the vegetation responded even more in favor of the rotated fields. The main forage species, including both blue grama grass, needle-and-thread, June-grass, and western wheatgrass, did better under rotational use. Associated with the decline in valuable forage species was a marked increase in Sandberg's blue grass, especially on the continuously grazed pasture.

The quadrat data indicated that a system of deferred-rotational grazing was superior to continuous use in their effects on the vegetation. This was most evident

in pastures grazed at rates near actual carrying capacity, which is 33 acres per head for the 7 month grazing season. On fields grazed at 20 acres per head, there was less difference in the response of the plant cover under the two systems of grazing.

The animals used in the study were weighed individually at regular intervals during each year of the experiment. The summarized data are presented in Table 4.

At the 20 acre rate, there was no significant difference in the gains made by the cows nor in the weaning weights of the calves. At the 30 acre rate, however, the average weaning weight of calves in the rotated fields was significantly lower than on the continuously grazed areas. The average gains of the cows under the two systems of grazing at the 30 acre rate were identical.

From the results here reported, it would seem that the beneficial effects of deferred-rotational grazing are more evident in the restoration of overgrazed ranges than in the utilization of pastures in highly productive condition. This was pointed out by Sarvis (1941). The results of this experiment make it seem unlikely that benefits from rotation grazing on the plant association concerned would be sufficient to offset the increased costs of extra fencing and water development. Also there were certain weaknesses in the system when applied to the Manyberries pastures, particularly the very heavy use of the spring grazed fields which had to carry three times the normal amount of cattle one year out of three. Another weakness was that one field each year was not grazed until fall, causing a decline in both amount and quality of the forage. Also the rotation practice did not appear to be particularly effective in inducing natural revegetation. Reseeding occurred mainly during better than average rainfall years, and appeared to be affected more by the intensity of grazing rather than the system practiced.

In view of the good response of the plant cover to deferred and rotational grazing, particularly at the rate of 30 acres per head, it might have been expected that both cows and calves would thrive at least as well on rotated as on continuously grazed areas. One factor which may have affected adversely the response of the animals in the rotated fields was the small size of the pastures; they were only 66.6 and 100 acres, while the continuous fields 200 and 300 acres. The cattle in the small fields were restless and did much walking along fence lines.

In 1949, a two-field rotation was started using 30 acres per head. The objective is to test the information from clipping data obtained in 1935 to 1939 which showed that forage production can be expected to increase 25 per cent on the rotational plots over the continuously clipped plots. Two 150-acre fields and a 300-acre continuous field were fenced and stocked with yearling Hereford steers, 10 in the continuously grazed field and 10 in the rotation-grazed pasture. Field "A" of the rotation carried the steers from April 25 to June 20, and from September 26 to October 24. Field "B" was used from June 20 to September 26. The continuously grazed field was used from April 25 to October 24. Both groups of animals averaged 488 pounds on April 25. On October 10, the cattle on the continuously grazed pasture averaged 824 pounds, those on rotation 800 pounds. During the next two weeks both groups lost over 40 pounds, so the summer grazing season was terminated on October 24. Clippings were made in these fields every two weeks. The results showed a 12 per cent increase in forage production in favor of continuous grazing pasture.

At the same time, plots were clipped in an exclosure to simulate the actual livestock rotation experiment. The clipping studies showed that rotational grazing produced 10 per cent more forage than the continuously grazed plots.

From these results, it would appear that continuous grazing for the Manyberries region is the most practical means of range management.

Summary

From 1932 to 1937, inclusive, a deferred-rotational experiment was carried out to determine the effects of this system of grazing in comparison with continuous grazing on vegetation and livestock. Two rates of grazing were used, 20 and 30 acres per head, or approximately 2.9 and 4.3 acres per cow month. The area selected represents the short-grass prairie of Canada, a Bouteloua-Stipa association.

Area-list quadrats and periodic weighings of the cattle were the principal methods used in the study. Under the heavier grazing, the vegetation on both the rotated and the continuously grazed fields suffered, but most pronouncedly on the latter. At this rate of grazing there was no significant difference in the gains made by the cows nor in the weaning weights of the calves. On the moderately grazed fields the stand of the primary forage species was maintained better under rotational use. At a grazing rate of 30 acres per head the average weaning weight of the calves in the rotated fields was significantly lower than that of the calves in the continuously grazed areas, while the average gain of the cows was identical.

It may be concluded that conservative continuous grazing in the region concerned is the most practical method of pasture use.

Acknowledgements

The author is indebted to Mr. L. B. Thomson, formerly Superintendent of the Manyberries Station, for the livestock records. Thanks is also due to Messrs. J. A. Campbell, J. B. Campbell, S. E. Clarke, W. Hanson, N. A. Skoglund, and E. W. Tisdale for the forage information from 1932 to 1937 for various services. The Tables used are taken from Tech. Bul. 46 by S. E. Clarke et al (1943).

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Rotation-Deferred Grazing as Compared to Season-Long Grazing on Sagebrush-Bunchgrass Ranges in Oregon

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Purpose of Study

IN 1938 A study was initiated to determine the practicability of rotation-deferred grazing on semi-desert sagebrush-bunchgrass range in Oregon. It is a summer range utilized by cattle, and this report summarizes 11 years of records (1938–48, inclusive) and compares the results with those obtained on range grazed season-long.

Description of Study Areas

In this study four ranges were used, located some 40 miles west of Burns in southeastern Oregon on generally rolling lands. Big sagebrush (*Artemisia tridentata*) was the dominant shrub and juniper (*Juniperus* spp.) occurred in varying abundance. Bluebunch wheatgrass (*Agropyron spicatum*) and Idaho fescue (*Festuca idahoensis*) were the best forage grasses. Sandberg bluegrass (*Poa sandbergii*), though producing the greatest forage density was of secondary value. The pastures were approximately 2100 acres each. Distribution of grazing in each pasture was partially controlled by salting and watering.

[1] The Squaw Butte-Harney Experiment Station is operated jointly by the Bureau of Land Management, U. S. Department of the Interior, and the Oregon Agricultural Experiment Station of the Oregon State College, Corvallis, Oregon. This report published as Technical Paper No. 640 with approval of the Director, Oregon Agricultural Exp. Sta.

Methods and Procedure

Three of the experimental ranges were grazed under a rotation system. The 6 year rotation period included two years of consecutive spring use, followed by one year of partial deferment, two years of full deferment, and one year of partial deferment. The three grazing periods were of approximately equal length in number of days. Since the growing season usually begins April 1 and ends June 30, the partial deferment period of grazing was essentially full deferment.

The fourth range was grazed continuously throughout the grazing season—from approximately May 1 to October 1.

The stocking rate of 10 to 12 surface acres per animal unit month was approximately the same under both systems of grazing and from year to year. It resulted in heavier use under season-long grazing because the season-long range was in slightly poorer condition in 1938 than the rotation ranges.

The breeding cow herds were balanced as to age, size, grade, condition, calving date, and weight performance on summer range. Each year the cows were given a 10- to 14-day fill on surplus ranges prior to turn-in date. Cows and calves were weighed on the ranges after spending about 12 hours off feed but on water and following the same procedure, again at the close of each grazing period.

Livestock data was kept on an indivi-

dual animal basis, and birth dates of calves permitted the adjustment of each cow weight, eliminating weight attributed to pregnancy (unpublished procedure used on Squaw Butte-Harney Exp. Sta.). Calves were dropped during March through August, inclusive.

Bulls were grazed with the cows beginning about the first of June.

Permanent plots located on a 10 by 20 chain grid throughout the ranges were used for square-foot density estimates during 1938, 1944, and 1948.

Utilization data were taken yearly on each range after grazing was concluded.

Results and Discussion

Broadly considered, season-long grazing was more favorable to both cattle and vegetation, mainly because the rotation system resulted in serious over-grazing during the first foraging period. In practice, rotation did not provide all advantages expected. This study may serve as a guide in devising a system of rotation-deferred grazing which will provide more of the benefits consistent with the theories.

The experiments did not incorporate randomization or replication, so statistical analysis could not be applied to the data. Figures in the report indicating the differences between the two grazing systems can be accounted for by a composite of differences between the ranges, herds, and grazing systems. However, since the herds were balanced the writers believe that little difference existed between them; neither was there much difference between the ranges in potential forage production; therefore the greatest difference was attributed to the systems of grazing.

Weight Gains and Losses of the Cows

Since a desirable system of grazing should indicate consistent results from year to year, the adjusted cow weights (1944 to 1948, inclusive) were analyzed by variation in weight gains between years as well as net gain per animal. (Table 1).

TABLE 1

Average gain or loss in weight of cows under rotation and season-long grazing[1]

YEAR	GRAZING PERIOD	AVERAGE GAIN OR LOSS PER COW (LBS.)		DIFFERENCE (LBS.) SEASON-LONG MINUS ROTATION
		Season-long	Rotation	
1944	1	116	91	25
	2	68	76	−8
	3	−65	−60	−5
	Total	119	107	12
1945	1	136	137	−1
	2	42	45	−3
	3	−15	−28	13
	Total	163	154	9
1946	1	125	114	11
	2	45	33	12
	3	−57	−26	−31
	Total	113	121	−8
1947	1	133	91	42
	2	25	34	−9
	3	−62	−57	−5
	Total	96	68	28
1948	1	121	85	36
	2	77	98	−21
	3	−63	−50	−13
	Total	135	133	2
Average	1	126	103	23
	2	51	57	−6
	3	−52	−44	−8
	Total	125	116	9

[1] Cow weights were adjusted to compensate for the increase in weight directly attributed to pregnancy.

Cattle weights on the season-long range showed less than half the variation be-

tween years during the first grazing period, about the same variation during the second period, and nearly twice the variation during the third grazing period as on the rotation ranges. Also, cows on the season-long range gained 23 pounds more per animal during the first grazing period, 6 pounds less during the second grazing period, and lost 8 pounds more during the third grazing period. There was an average annual advantage in weight gain of 9 pounds per cow for the season-long range.

Forage Utilization

Utilization records permitted the division of each range into lightly, properly, and heavily grazed areas. The proportion of each of these use divisions indicated the distribution of grazing in that range. Fifty six percent of the rotation ranges was properly utilized as compared with 39 percent of the season-long range. The heavily utilized areas included 26 percent of the rotation and 37 percent of the season-long ranges. There was also a smaller percentage of the rotation ranges lightly grazed—18 percent as against 23 percent on season-long ranges. Also grazing was more evenly distributed in each range under rotation than under season-long grazing. During the study period the season-long range was overutilized by an average of 20 percent whereas the rotation ranges were overutilized by 10, 12, and 14 percent.

Vegetal Trends

In general, even though the season-long range was utilized more heavily than those grazed in rotation, vegetation made a net increase in density of 22 percent as compared with an average increase of 20 percent on the rotation ranges (Table 2). Since an increase in vegetation density may indicate either an increase or decrease in forage production, an analysis by groups of vegetation is important.

Of the 22 percent increase in vegetal density on the season-long range, almost 19 percent were grasses, 1 percent shrubs (mostly big sagebrush), and 2.5 percent forbs. Of the 20 percent increase on the rotation ranges, 11 percent were grasses, 1 percent shrubs, and 8 percent forbs.

To fully apprcciatc these changes a similar analysis of the three primary grasses will be helpful (Table 3).

Season-long grazing permitted the greatest increase in forage production. The increase in density of the two primary forage species (expressed in terms of total vegetation density at the beginning of the study period) was 2.4 percent under season-long grazing. This was more than twice the increase, 1.1 percent under rotation grazing. The increase in Sandberg bluegrass of 13 percent under season-long grazing as compared with 7.9 percent under rotation grazing, may also indicate greater increase in forage production on the season-long range, but primarily indicates retrogression.

Under rotation grazing the three primary grasses increased throughout the ranges; whereas under season-long grazing, bluebunch wheatgrass and Idaho fescue increased mostly on the area grazed lightly, and Sandberg bluegrass on the heavily grazed area. Because it is important to maintain as much forage as possible on the most accessible areas, rotation grazing may have much to offer range managers in distribution of grazing over a long period of time. There was an apparent change in dominance from bluebunch wheatgrass to Idaho fescue under rotation grazing that also occurred on the heavy-use area of the season-long range.

Objections to Rotation System

There was considerable difference in the vegetation trends on the rotation

ranges due to the respective position in the rotation order when range surveys were made. Trends in forage production were depressed following two years of consecutive spring use. Apparently the combination of two years of consecutive spring grazing, and close use during the growing season, offset the advantages gained through deferment as shown by livestock gains and losses (Table 1). The data may also indicate an unreliable nature of range surveys due to the difference between density estimates on grazed and ungrazed forage. Apparently the difference between the rotation ranges was primarily one of changes in plant vigor and size rather than in number of plants. Concentration of grazing on a single range for most of the growing season, seriously restricted regrowth of the forage, and storage of carbohydrates for the maintenance of plant vigor (McCarty and Price, 1942; Blaisdell and Pechanec, 1949).

In the use of a rotation grazing system the authors believe that attention should

TABLE 2

Net 10-year change in vegetation density (1938–1948) per 100-square-foot plot

VEGETATION GROUP	SYSTEM OF GRAZING	1938 SQ. FT. DENSITY	NET CHANGE	
			Sq. Ft. Density	% of Total Vegetation Density
Grasses	Season-long	2.289	1.358	18.8
	Rotation	3.495	0.889	11.2
Shrubs	Season-long	4.270	0.071	1.0
	Rotation	3.759	0.082	1.0
Forbs	Season-long	0.671	0.183	2.5
	Rotation	0.756	0.638	8.0
Total	Season-long	7.230	1.612	22
	Rotation	8.010	1.609	20

TABLE 3

Net 10-year change in density of the primary grass species per 100-square-foot plot

SPECIES	SYSTEM OF GRAZING	1938 SQ. FT. DENSITY	NET CHANGE	
			Sq. Ft. Density	% of Total Vegetation Density[1]
Agropyron spicatum	Season-long	0.403	0.019	0.3
	Rotation	0.456	−0.098	−1.2
Festuca idahoensis	Season-long	0.264	0.155	2.1
	Rotation	0.498	0.183	2.3
Total[2]	Season-long			2.4
	Rotation			1.1
Poa secunda	Season-long	1.354	0.942	13.0
	Rotation	2.063	0.630	7.9

[1] The average 1938 square-foot density of all vegetation on the season-long range was 7.23 square feet and on the rotation ranges was 8.01 square feet (see Table 2).

[2] Totals represent the combination change of *Agropyron spicatum* and *Festuca idahoensis*.

be directed to plant vigor rather than seed production. Such management will also result in larger seed crops.

Summary

1. The first grazing period under the rotation system included most of the normal growing season.

2. Season-long grazing resulted in: 1) less variation in animal gains between years during the first grazing period; 2) an average of 23 pounds more gain per cow during the first grazing period; 3) an average of 9 pounds more gain per cow per year; 4) a greater increase in both total vegetation density and density of the forage species.

3. Rotation grazing resulted in: 1) less variation in animal gains between years during the third grazing period; 2) 6 pounds more gain per animal during the second grazing period; 3) eight pounds less loss per animal during the third grazing period; 4) better distribution of grazing; 5) serious overgrazing during the first foraging period.

4. In the use of a rotation grazing system attention should be directed to plant vigor rather than seed production.

Acknowledgement

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A Twenty-Five Year Comparison of Continuous and Rotation Grazing in the Northern Plains[1]

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A GRAZING experiment was established at the Northern Great Plains Field Station in 1916 to determine the carrying capacity of native range. Pastures of various sizes were grazed with cattle continuously during a 150 day summer season from May 16 to October 13 at intensities that would result in degrees of use from over-grazing to under-grazing. In 1918 additional pasture was established to study a system of deferred and rotation grazing. This deferred and rotation pasture was grazed every year during the period 1918–45. The results obtained on this pasture are directly comparable with those from the continuously grazed pastures.

Sarvis (1923 and 1941) describes the plan of the entire experiment and gives the results from 1916 to 1940. Rogler (1944) gives the results from 1940 to 1943. This paper presents data needed to compare results obtained on the deferred and rotation pasture with those from two of the continuously grazed pastures, one of which was grazed heavily and the other moderately.

[1] Cooperative investigations by the U. S. Dept. of Agriculture, Agricultural Research Administration, Bureau of Plant Industry, Soils, and Agricultural Engineering, Division of Forage Crops and Diseases and the North Dakota Agricultural Experiment Station. J. T. Sarvis of the former Division of Dry Land Agriculture was in charge of the project under which these investigations were carried on from 1915 to 1941, inclusive. Most of the data presented in this paper were collected during that period.

Climate and Vegetation

The climate of the area under study does not differ greatly from that of other sections of the northern Great Plains. Temperatures reach extremes in both winter and summer, rainfall is limited, and high winds are not infrequent. Of all the climatic factors involved, rainfall most influences the production of native forage.

Normally about half of the annual rainfall comes in May, June, and July and the seasonal precipitation from April 1 to September 30 is about three-fourths of the annual. The average annual precipitation at the Northern Great Plains Field Station for the 1918–45 study period was 15.30 inches; the average seasonal precipitation 11.83 inches. For the first study period, 1918 to 1935, the average annual and seasonal precipitation was 14.73 and 11.34 inches. The seasonal precipitation varied from 6.40 inches in 1934 to 16.04 inches in 1927. During the year 1936 when no grazing comparisons were made, the seasonal precipitation was only 2.96 inches, the annual only 6.43 inches. During the second study period, 1938 to 1946, the annual and seasonal precipitation was 17.15 and 13.47 inches. The seasonal precipitation varied from 11.37 inches in 1938 and 1939 to 16.86 inches in 1941. It is evident, therefore, that the second phase of the study was carried on during a much more favorable period than the first.

The mixed prairie native vegetation in the pasture on which these studies were

made is typical of much of the surrounding area. The dominant plant species are blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), threadleaf sedge (*Carex filifolia*), and needle-and-thread (*Stipa comata*). Other common species are silver sage (*Artemisia frigida*), white sage (*A. gnaphalodes*), green sage (*A. dracunculoides*), silverleaf scurfpea (*Psoralea argophylla*), and prairie junegrass (*Koeleria cristata*).

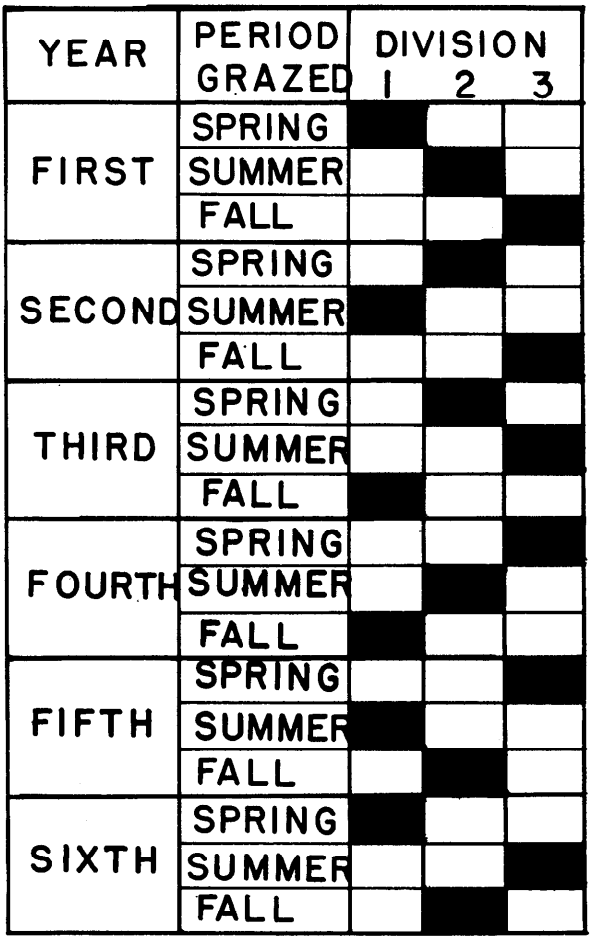

FIGURE 1. Diagram of the order of grazing the three divisions of the deferred and rotation pasture for a complete cycle. Grazing periods are shaded, rest periods unshaded.

PROCEDURE

The deferred and rotation system was set up in a manner similar to that suggested by Jardine (1915) and Sampson (1913). A 70-acre pasture was divided into three divisions and grazed as shown in Figure 1. Grazing on each division was deferred until fall during two successive seasons. This allowed production of seed on the fall-grazed division one year, and protection of the seedlings, if any, until fall of the next. Each division was grazed approximately one-third of the season each year.

The study was divided into two periods. Two-year-old steers were used during the first period from 1918 to 1934, and yearlings during the second, from 1938 to

1945. From 1935 to 1937 rotation and continuous grazing could not be compared because the heavy continuously grazed pasture was not used during that time. From 1918 to 1927 the number of steers on the pasture varied from year to year, averaging five acres per head. It was then determined that this pasture could be grazed at five acres per head without injury to the vegetation. In 1929 the location of the 70-acre rotation pasture was interchanged with a continuously grazed 70-acre pasture. Up to 1934 and during the 1938–45 period five acres per head were allowed until 1941 when the grazing intensity was increased to 3.85 acres per head. The pasture was cut in size from 70 to 50 acres in 1941 with a continuation of the same type of division and rotation grazing.

There were two continuously grazed pastures: one 70 acres grazed moderately and the other 50 acres grazed heavily. The 70-acre pasture was grazed with one head to 7 acres for the 1918–40 period, and with one head to 5.38 acres for the 1941–45 period. The 50-acre pasture was grazed at an intensity of one head to 5 acres from 1918 through 1940, and with one head to 3.85 acres from 1941 through 1945.

The 50-acre continuously grazed pasture did not carry the steers the full season every year. Grade steers were used, branded with serial numbers and weighed individually. Average 3 day weights were used at the beginning and close of the season. The second weighing was always made on May 31, and thereafter, weights were taken at intervals of 30 days to check monthly gains. The average starting weight of the two-year-olds was 748 pounds per head, for the yearlings 480 pounds.

Eighty permanent meter square quadrats were established in each continuously grazed pasture and in each division of the rotation pasture at the beginning of the experiment. Estimates and counts on these quadrats showed the effects of the different intensities and systems of grazing on the vegetation. To determine the amount of forage produced in the various pastures a series of clippings were made in the spring, summer, and fall when the cattle were moved from one division of the rotation pasture to the next, and also when the cattle entered and left each division. In addition clippings were made at 20, 30, and 40 day intervals, annually and biennially. Estimates were also made of the foliage removed by grazing on each pasture and on each division of the rotation pasture during and at the close of each season.

Results

Vegetation

It was evident by 1936 when the shift was made from two-year-olds to yearlings that an intensity of one head to 7 acres was approximately the correct grazing rate for a continuously grazed pasture carrying two-year-olds for the summer season. It provided enough forage to produce the maximum gain per head, and the vegetation was not adversely affected. An average of about 25 percent of the total foliage remained for a forage carryover to the next season. At this rate of grazing changes in the composition of the vegetation were influenced primarily by differences in precipitation. Species that tend to increase with over-grazing such as silver sage and blue grama either decreased or were maintained at about the same level. Species that decrease with over-grazing such as western wheat, needle-and-thread, prairie junegrass and silver leaf scurfpea were still abundant after 34 years of grazing. Much of the needle-and-thread was killed out during the drought years of 1934 and 1936 but was considerably recovered afterwards. Western wheatgrass also came in more abundantly after the drought years.

It was evident by 1940 that yearlings consumed about two-thirds as much forage as two-year-olds. The intensity of grazing was therefore increased by one-third on all pastures in 1941. The 70-acre continuously grazed pasture still provided a maximum of feed with plenty of carry-over forage. On the average only about half of the forage was grazed each year during the 1938–45 period when precipitation was especially favorable for the growth of grass.

The vegetation in the 50-acre continuously grazed pasture was definitely overgrazed at an intensity of one two-year-old to 5 acres for the 1918–34 period. Six times, the steers had to be removed before the end of the grazing season. The over-grazed condition was indicated not only by lower gains but also by an increase in silver sage, and a reduction of needle-and-thread, prairie junegrass, silver leaf scurfpea, white sage, and green sage. The density also decreased from an estimated 50 to 60 percent to 30 to 40 percent.

During the favorable 1938–45 period when yearlings were used, this pasture was in no year considered over-grazed. On the average there was a 30 percent carry-over of forage from one year to the next.

The rotation pasture was grazed at the average rate of one head to 5 acres during the 1918–34 period. The vegetation did not show the adverse effects evident in the pasture grazed continuously at the same rate. Under rotation, grasses benefited by the rest periods when they were periodically allowed to develop a normal growth and mature before being grazed. There was no evidence that the pasture benefited from any natural reseeding that took place in the fall-grazed divisions. The density of the pasture was so high at all times that old plants produced more competition than small seedlings could withstand. The vegetation was not affected when the pasture grazed continuously with one head to 7 acres was interchanged in 1930 with the rotation pasture grazed at 5 acres per head. This was true even though a greater amount of the foliage was utilized during each season in the rotation pasture after the change. The amount of foliage removed from each division of the rotation pasture was approximately the same each year. During the 1918–34 period, grazing removed a yearly average of 92 percent of the herbage; during the more favorable 1938–45 period, only 59 percent of the forage growth.

Gains

Comparative gains per head on the two continuous pastures and the rotation pasture for the 1918–34 period are shown in Figure 2. During this period there were only three years when the steers on the rotation pasture failed to gain more than those on the pasture grazed continuously at the same rate. The average gain of steers on rotation over continuous grazing at the same intensity was 33.9 pounds per head during 1927–34 when the steers on rotation were held at 5 acres per head; and 34.8 pounds for the entire 17 year period 1918–34 (Fig. 2).

In the comparison of the moderate continuously grazed pasture carrying one two-year-old to 7 acres and the rotation pasture grazed with one two-year-old to 5 acres, the continuously grazed steers gained more per head every year of the 1918–34 period—an average of 44.5 pounds per head. The average difference between gains on all pastures was statistically highly significant.

Comparative gains per head for the two continuously grazed and the rotation pasture for the 1938–45 period are shown in Figure 3. Since there was no shortage of forage in any of the pastures during

the period, even though the grazing intensity was increased in 1941, it appears permissible to average gains for all years. During seven of the eight years, gains per head were higher on the 50-acre pasture grazed continuously with 5 acres per head until 1941 and 3.85 acres per head thereafter than on the rotation pasture grazed at the same intensity. The 8-year average gain of 20 pounds per head more for the yearlings grazed continuously was statistically significant. Yearlings grazed continuously at the moderate rate of 7 acres per head for 3 years and 5.38 acres per head for 5 years gained more per head every year than those on the rotation pasture. The advantage for the continuously grazed pasture in this case was highly significant at 28.8 pounds per head over the rotation

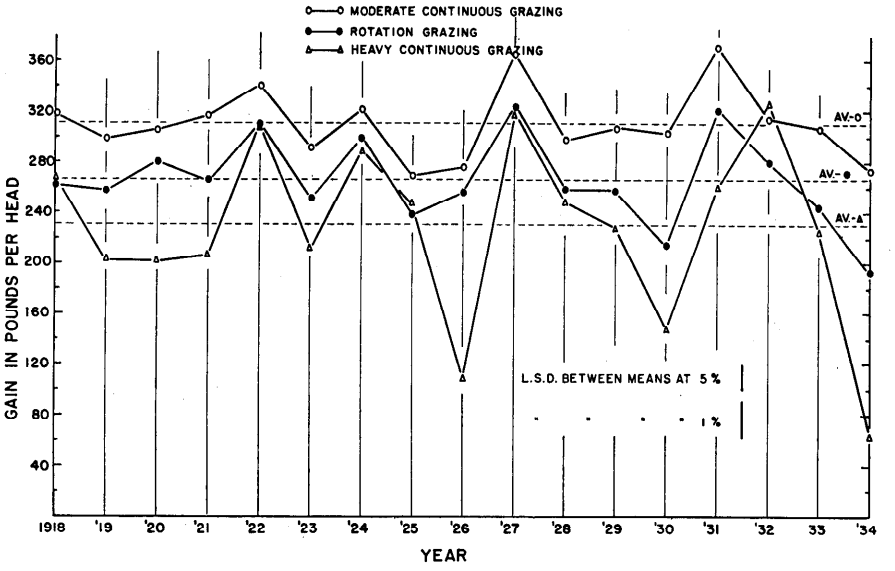

FIGURE 2. Seasonal gain of two-year-old steers on native pastures at the Northern Great Plains Field Station from 1918 through 1934.

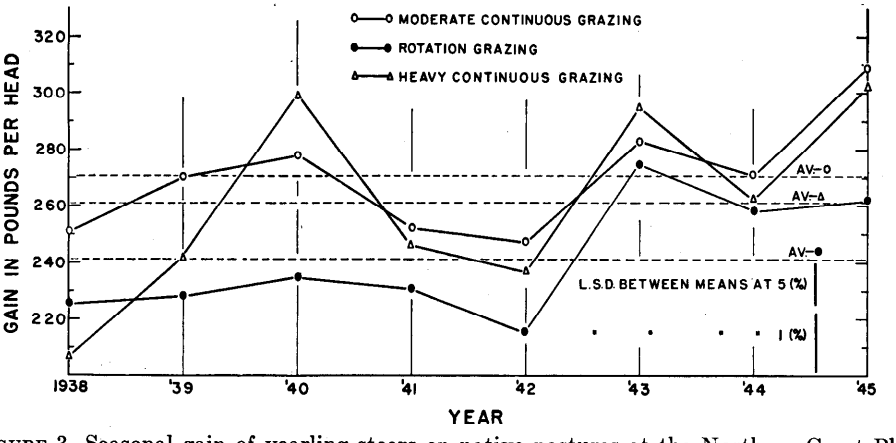

FIGURE 3. Seasonal gain of yearling steers on native pastures at the Northern Great Plains Field Station from 1938 through 1945.

pasture. As would be expected, because of the abundance of forage in both continuously grazed pastures, there was no significant difference in the average gain on these pastures.

Discussion

Under the conditions of the experiment, which are similar to those throughout the northern Plains, moderate continous grazing of native range is conducive to maximum gains per head. It cannot be expected that gains per head can be increased by changing to a rotation system when there is sufficient forage for continuous season-long grazing, with at least 25 percent carry-over of vegetation. Little benefit can be expected from rotation grazing where plenty of range is available. If enough native forage is available for cattle to put on maximum gains, no other system of grazing can be expected to show greater increases.

There would seem to be some merit in a rotation system for improving range that has been damaged by over-grazing. It is likely, however, that complete deferment until the range recuperates would be a more rapid and satisfactory method of improvement. If two-year-olds or older cattle are being grazed, a rotation system might be used when it is necessary to graze heavily during occasional years.

One of the apparent advantages of continuous grazing is that cattle have access to all the plants in the pasture when highest in feed value. Cattle grazed on rotation must crop each division closely before being moved to a new one. During this close grazing, gains are likely to be lower. If gains are lost they are generally not made up later in the season. Young cattle are less likely to gain under a rotation system because they do not utilize as well as older cattle the mature forage present in the summer and fall divisions. This is indicated by the fact that yearlings did not gain as well on the fall division of the rotation pasture as those on continuously grazed pastures during the same period.

Summary

1. A deferred and rotation pasture was established in 1918 as part of the long time grazing experiment at the Northern Great Plains Field Station. Results on the rotation pasture are compared to those on two continuously grazed pastures, one grazed moderately and one heavily.

2. The vegetation in both the continuous moderately grazed pasture and more heavily grazed rotation pasture showed no adverse effects from the cropping. The continuous heavily grazed pasture showed adverse effects of over-grazing.

3. For the 17 year 1918–34 period when two-year-olds were used, gains averaged 34.8 pounds per head more on the rotation pasture than on the continuously grazed pasture with the same grazing intensity. The steers on the moderate continuously grazed pasture during the same period gained 44.5 pounds more per head on the average than those on the rotation pasture.

4. Yearling steers for the 1938–45 period grazed continuously at both moderate and heavy rates gained more per head than those on rotation pasture. At the rate of 5 acres and 3.85 acres per head the continuously grazed yearlings gained 20 pounds more per head on the average than those on rotation pasture at the same intensity. At the rate of 7 acres and 5.38 acres per head the continuously grazed yearlings gained 28.8 pounds per head more on the average than those on the rotation pasture.

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NUTRITIONAL DEFICIENCIES IN BEEF CATTLE

Lack of sufficient total feed is probably the most common deficiency in beef cattle. In limited feeding on farms or overstocked ranges, low energy intake may be the sole deficiency, the results being slowing or cessation of growth (including skeletal growth), loss of weight, reproduction failure, and increased mortality. On ranges, low feed intake also commonly results in increased mortality from toxic plants and from lowered resistance to parasites and diseases. Very commonly, however, underfeeding is complicated by shortages of protein and other nutrients.

Richard T. Allman and T. S. Hamilton
in Nutritional Deficiencies in Livestock.
FAO Agri. Studies No. 3, 1949.

Eight-year Comparisons of Continuous and Rotational Grazing on the Southern Plains Experimental Range

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THIS paper presents experimental results of one form of rotation grazing on the semi-arid native rangeland of the southern Great Plains. The studies were conducted by the Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture, in cooperation with the Oklahoma Agricultural Experiment Station, Bureau of Animal Industry, and other agencies. During the growing season, the animals were rotated at regular or irregular intervals on two or three divisions of a dryland, native range. This rotation plan will be referred to as "divisional rotation." To prove its advantages over continuous grazing it must show superiority at the same stocking rate; otherwise results could be confused with a study of rate of stocking.

Recent Literature

Few well-rounded reports have been published in recent years on the subject of rotation grazing, and those available tend more to confuse than to clarify its practical application. Only an occasional paper reports results of experimental work on "divisional rotation." Many of the studies lack replication and proper controls, and some confound rotation grazing with other factors, such as rate of stocking, breed or species of stock, mowing practices, or fertilization. However, the concensus of literature on "divisional rotation" in humid regions shows that rotation grazing has some slight advantages over continuous use where grazing pressure is heavy and pasture production is high and comparatively uniform—Hodgson (1939), Moore (1946), Woodward (1938). But most investigators do not recommend rotation grazing because of the cost of fencing water development, or other factors—Hein (1937), Biswell (1947).

Area, Livestock, and Experimental Procedure

The Area. The experimental range is located in the northwest portion of Oklahoma near the 100th meridian. Annual precipitation is 23 inches, with 16 inches or 70 percent falling in the six summer months. During the period of this study—1941 to 1949—the annual precipitation averaged 26 inches, which is 12 percent above the 77-year average. The normal growing season extends from April 1 to November 1. The topography is gentle, and the soil is a sandy loam.

The vegetation consisted primarily of sand sagebrush, with an understory of blue grass and sand dropseed, and the pastures were selected for uniformity of stand, soil, and topography. The brush had an average foliage density of 75 percent while all grasses had an average basal density of 10 percent. About 15 tall and mid grasses constituted 20 percent of the grass density. Sand lovegrass, sand bluestem, little bluestem, and switchgrass were the most important tall grasses.

Average air-dry forage yield was about

1,300 pounds per acre of which 43 percent was blue grama, 25 percent tall grasses, 15 percent sand dropseed, 10 percent miscellaneous grasses, and 7 percent forbs. At the beginning of the study the density of vegetation was low as a result of the drought of the 1930's, but it increased over 100 percent from 1940 to 1949.

The Livestock. Good grade yearling Hereford steers were used. They were selected as weaner calves weighing 425 pounds, and remained under full control for an entire year. During this time they gained, on the average, 75 pounds per head in winter, and 300 pounds in summer. They were allotted to the pastures by an improved mechanical system which resulted in each animal in any one lot being matched by an animal of essentially the same weight, grade, and winter gain in every other lot.

Experimental Procedure. Comparisons were made on duplicate pastures where continuous and divisional rotation grazing at moderate and heavy stocking rates were carried out. Each heavily grazed pasture contained 50 acres and was cropped at an average of 4.3 acres per steer. The moderately grazed pastures were 75 acres, cropped at 6.3 acres per head. The rotational pastures were divided into three equal parts.

Pastures were grazed in summer during a period of 172 days, the average season started on April 15 and ended on October 4. The animals had free access to salt and water at all times, and were not given supplemental feed during the summer.

In 1942 the steers were rotated between divisions at two-month intervals, but both vegetation and cattle suffered greatly from the concurrent heavy cropping. Thereafter, the animals were rotated at monthly intervals—except in 1947 when the rotation interval was 15 days—to prevent too heavy grazing on the divisions during the latter part of each period.

Results were measured by effects on cattle gains, and changes in density and production of the vegetation. Three statistically accurate line transect studies of vegetational density were made of the experimental pastures. Forage production and utilization studies were made by both clipping and estimating forage inside and outside of movable exclosures.

Results

Steer Gains. Results of the 1942 rotation at two-month intervals were not included in the final summary of gains. It reduced steer gains 65 pounds per head at the heavy rate of use, and 30 pounds at the moderate rate. Gains during the second month were less than half of those recorded for the continuously grazed pasture (Fig. 1).

In 1947, at 15-day intervals rotation, the steers grazed at a moderate rate on the continuous pastures gained 16 pounds more per head than those rotated; on the heavily grazed rate they gained 12 pounds less than those rotated. Neither of these differences was statistically significant.

The results of the seven year study show no statistically significant difference between continuous and rotational grazed steers at either heavy or moderate rate. But continuous grazing at moderate rate did produce 10 pounds average annual advantage in gain per head. Steer gains under rotation were less than under the continuous system in spring and summer cropping, but slightly greater in fall (Fig. 2).

Vegetation. The data show no significant difference between the two systems of grazing. However, there was a statistically significant increase in density of blue grama due to rotation at the heavy rate (Fig. 3).

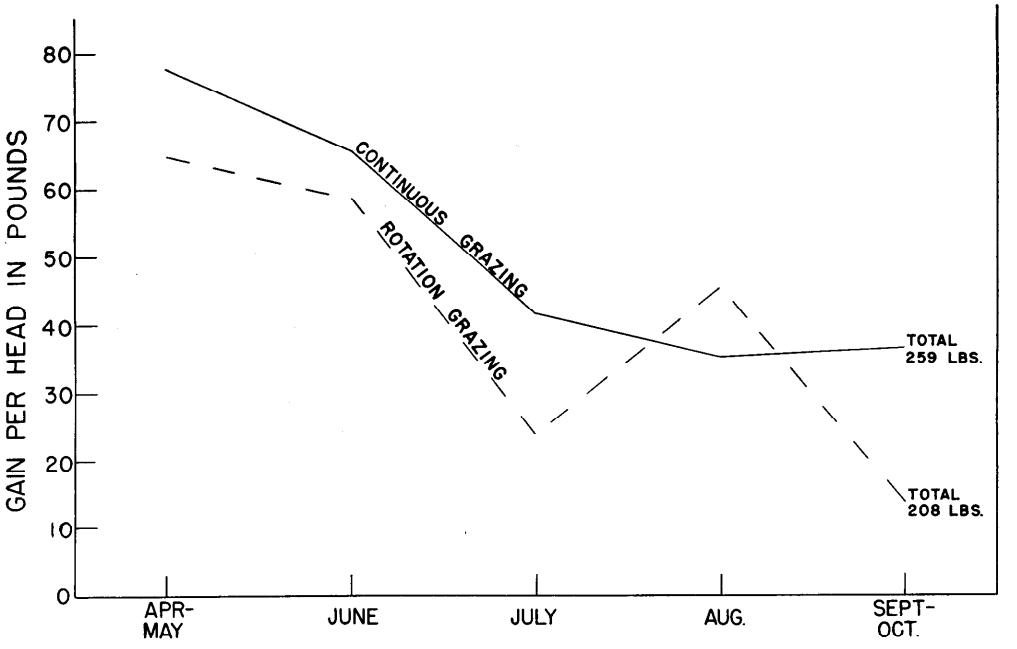

FIGURE 1. Average gain per head of yearling steers on four pastures continuously summer grazed in 1942 as compared with four 3-division rotation pastures, each division of which was grazed for a 2-month period in 1942, April-May, June-July, and Aug.-Sept.

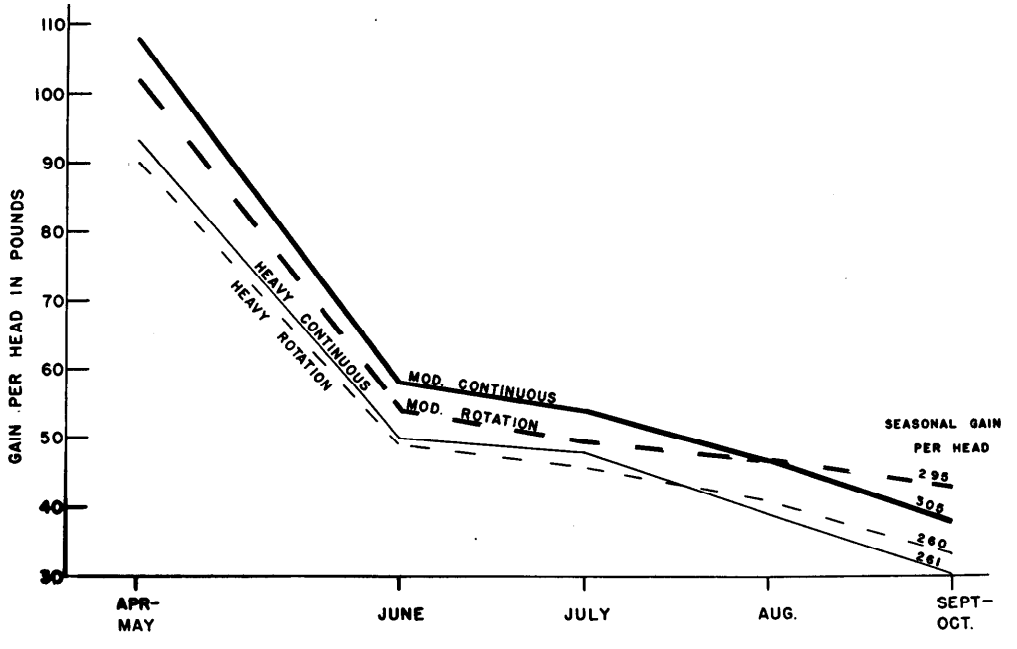

FIGURE 2. Average summer gains of yearling steers from duplicate pastures under four systems of management during 7 summers, 1943 through 1949.

Despite lack of statistical significance between comparisons of all species or classes of vegetation, except blue grama under heavy stocking, the density studies showed a slight advantage of rotation grazing. The tall grasses, such as sand bluestem, little bluestem, sand lovegrass, and switchgrass increased more under rotation at both grazing rates, while sand dropseed decreased slightly in density. The perennial forbs, most of which are fairly palatable to steers, decreased 50 and 67 percent, respectively, under moderate and heavy continuous use, and increased 20 and 33 percent under rotation at both grazing rates. All perennial grasses increased from 86 to 116 percent during the 8-year period regardless of the grazing management system employed.

The only consistent exception to the slight advantage of rotation grazing occurred in the class of miscellaneous mid grasses. Among these, side-oats, grama, Texas bluegrass, sand paspalum, fall witchgrass, and hairy grama increased most under continuous grazing. According to some authorities, sand paspalum, fall witchgrass, and hairy grama are "increasers" under heavy use. If this be true, then rotation grazing benefits the miscellaneous mid grasses more than continuous grazing.

Two other divisional rotations were studied at Woodward, both being tested in two divisional pastures. In the one study the steers were rotated back and forth at monthly intervals during the six months summer season. In the other study the steers were kept on one-half of the pasture for an entire year before being rotated to the other half for a corresponding period. Both tests showed that continuous grazing had a slight though insignificant advantage in gain per head, and a slight advantage in improvement of vegetation.

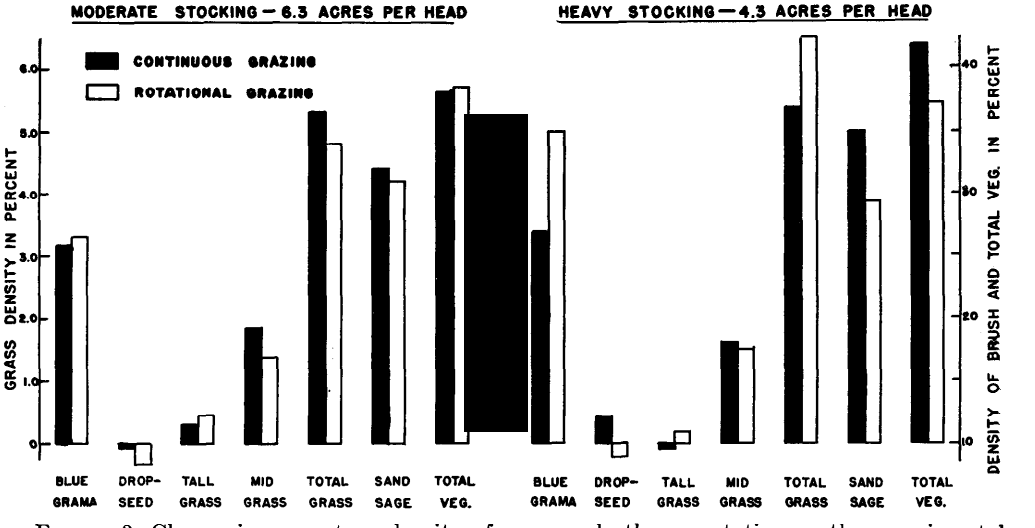

FIGURE 3. Change in percentage density of grass and other vegetation on the experimental pastures from 1940 to 1949, as determined by the line transect method.

DISCUSSION

What are some of the probable causes of failure of "divisional rotation"? Apparently the detrimental effects of heavy stocking on two-thirds of the pasture balances the beneficial effects of deferment on one-third. Cattle gains are less during spring and summer because the animals are denied access to each plant

species when it is most palatable and nutritious. Also the cattle make less gain while becoming accustomed to the new pasture. They usually spend some time trailing around the fence lines. Two-thirds of the rotation pasture was being more heavily grazed than the continuously cropped pasture, hence only one-third of the area would receive full benefit of seeding.

What is the probable answer to the paradox that rotation, though providing a rest period, does not significantly improve the grass stand? Evidence indicates the need of a reduction in stocking rate rather than in the rotation of the same number of stock to effect improvement through deferment.

Summary

Continuous and rotational grazing at moderate and at heavy stocking rates were compared on the Southern Plains Experimental Range since 1942. The studies were conducted in duplicate on eight native range pastures. Four of these were divided into three equal parts and grazed on a rotational basis in direct comparison with four undivided pastures. Other pastures were grazed on a two-divisional rotation system. The tests were designed to determine the advantage, if any, of dividing a dryland, native range pasture into two or three equal parts and rotating the grazing animals at regular intervals throughout the growing season.

Yearling Hereford steers of uniform brand, breed, age, size, and quality were grazed at the same stocking rates under the two systems. During the first summer —1942—the animals on rotation pastures were moved between sections at two-month intervals. Both vegetation and cattle were severely punished by this procedure. Since 1942, the animals were rotated at monthly intervals each summer except one when they were moved semi-monthly.

Results of the several tests at the end of eight years show no significant differences between continuous and rotational grazing in cattle gains, but continuous moderate grazing did produce an annual advantage in gain per head of 10 pounds, or 2.5 pounds per acre.

On the other hand, the density and vigor of grasses in the rotational pastures showed slightly more improvement, particularly under heavy stocking, though there were few statistically significant differences. The density of blue grama, sand bluestem, little bluestem, switchgrass, and sand lovegrass increased, while sand dropseed decreased, and more so under rotational than under continuous grazing.

The grass and other vegetation in the rotational pastures did not improve sufficiently during the eight years of grazing to justify the needed cross-fencing and water development, and to manage the cattle on a rotational basis. But the steers on the continuously grazed pastures made slightly greater gains per head and per acre. The detrimental effect of heavy stocking apparently overshadowed the beneficial effect of deferment. The cattle on continuously grazed range have access to all the grasses when they are most nutritious.

Since there are no important significant differences between the two systems in steer gains or in improvement of vegetation, divisional rotation grazing cannot be recommended over continuous grazing as an improved management practice on the sandsage vegetation of the southern Great Plains.

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PRODUCTIVE TYPES OF LIVESTOCK

The most productive types of livestock have been developed in regions where ample feed is produced and where temperate climatic conditions prevail. These regions are also those in which the economic status of the people is best and where considerable emphasis has been placed on research and extension or advisory activities designed to assist livestock producers in their efforts to improve their animals. In less productive regions, the limitations laid down by nature have prevented development, by the livestock producer, of animals highly specialized for meat, milk, wool, or work production. Generally poorer economic conditions have also hindered the development of highly competent research and extension services to assist the livestock owner.

Ralph W. Phillips
in Breeding Livestock adapted to Unfavorable Environments.
FAO Agri. Studies No. 1, 1949.

Continuous and Rotation Grazing on Buffalo and Tobosa Grassland

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ROTATION grazing trials were undertaken at the Texas Agricultural Experiment Station, Spur, Texas in 1942 to determine the value of using an intensive grazing period followed by a 2 month rest during the summer months to improve the productivity of native buffalo and tobosa grassland. These grazing studies were undertaken primarily because earlier clipping experiments of buffalo grass and blue grama at Spur indicated that these grasses produced the highest yields of forage when harvested at intervals of 8 weeks (Dickson, et al, 1948).

Description of Area

The land available for these grazing trials is located in the Southern Rolling Plains Region of Texas and is typical of gently rolling native grassland. The soils range from heavy clays to clay loams of the Abilene and Tillman series. The vegetation consists primarily of buffalo grass (*Buchloe dactyloides*), tobosa grass (*Hilaria mutica*), vine mesquite (*Panicum obtusum*), and minor amounts of purple three-awn (*Aristida purpurea*), side-oats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*) and trace amounts of other species. The principal woody plants, mesquite (*Prosopis juliflora glandulosa*) and lote (*Condalia obtusfolia*), were removed prior to the trials. Stock water of good quality from deep wells was available in all pastures. Salt was provided as needed and DDT was used at monthly intervals to control horn flies. No supplemental feed was used.

Methods and Procedure

A quarter-section of native grassland was divided into 16 ten-acre pastures and 5 of these pastures were used for a comparison between rotation and continuous use, while the remaining ones were used for other grazing experiments including intensity of use, different vegetative covers and contour furrowing. An ocular survey of vegetation and a soil survey map were made of the pastures and the information was used to select reasonably comparable pastures for each of the treatments. The grazing treatments for individual pastures were obtained by random sampling. Further detailed analysis of the vegetation in each pasture was made prior to the grazing trials by establishing 9 line transects, 10 meters long, at equidistant points in each of the pastures. Determinations were made of vegetal composition and basal density in April of 1942 and again in July of 1947, using the method developed by Parker and Savage (1940). Observations of the utilization of forage plants and grazing habits of the steers were made at monthly intervals throughout the season. Moisture penetration tests were also made following torrential rains at irregular intervals.

Good quality Hereford yearling steers, weighing an average of 550 to 750 pounds, were used to graze the pastures. They were weighed on two consecutive days and graded at the beginning and at the close of each grazing season. Single day weights were taken at monthly intervals. The grazing season generally began May 1 and extended to October 1, but length of season varied depending on the desired utilization and condition of the forage.

Results

The vegetation on the rotation grazed pastures had a somewhat higher content of tobosa and vine mesquite, but any desirable changes that occurred between the initial readings in April 1942 and July 1947 favored continuous moderate stocking. As shown in Table 1, there was very little change in the vegetal composition of the more desirable forage plants and an increase of only 2.7 percent in basal cover on the rotation pastures. There was a marked increase from 54.8 to 73.0 percent in buffalo grass and an increase of 6.5 percent in basal cover on the continuous grazed pastures from 1942 to 1947. Other grass species showed minor changes although some might be considered indicative over a longer period of study. There was also a marked tendency for the rotation grazed pastures to have a higher percentage of annual broomweeds and other annuals including sunflowers and Russian thistles.

TABLE 1

Composition of vegetation and basal density of principal species on rotation and continuous grazed pastures, 1942–1947

GRAZING TREATMENT	SEASON	NO. LINE TRANSECTS	AVERAGE PERCENT COVER BY SPECIES[1]									PERCENT BASAL COVER
			Bd	Hm	Po	Bc	Ap	Bg	Oh	Gs	Gd	
Rotation	1942	27	49.9	36.7	1.9	.6	1.2	.8	.5	.9	.2	15.6
Rotation	1947	27	53.5	35.0	2.2	.7	2.0	.9	.2	.2	.4	18.3
Difference			3.6	−1.7	−.3	.1	.8	.1	−.3	−.7	.2	2.7
Continuous	1942	18	54.8	16.4	11.10	T	3.5	2.2	.2	.4	.1	14.3
Continuous	1947	18	73.0	12.5	5.0	.4	2.8	1.2	.1	.1	T	20.8
Difference			18.2	−3.9	−6.1	.4	−.7	−1.0	−.1	.3	−.1	6.5

[1]

Species symbol	Scientific name	Common name
Bd	*Buchloe dactyloides*	Buffalo grass
Bg	*Bouteloua gracilis*	Blue grama
Ap	*Aristida purpurea*	Three awn
Hm	*Hilaria mutica*	Tobosa grass
Po	*Panicum obtusum*	Viney mesquite
Bc	*Bouteloua cortipendula*	Side oats grama
Oh	*Opuntia humifusa*	Prickly pear
Gs	*Gutierrezia sarothrae*	Perenniel broomweed
Gd	*Gutierrezia dracunculoides*	Annual broomweed

The rotation and continuous grazed pastures were stocked at a moderate rate for the season to utilize 50 percent of available forage.

The system of rotation grazing consisted of grazing each pasture intensively for one month and resting it for two succeeding months. By use of a three pasture arrangement the same steers were used each month on a pasture which had not been grazed during the two previous months. On continuously grazed pastures the same steers remained on each pasture for the entire summer grazing period.

Utilization records of forage plants at

TABLE 2

Depth of moisture penetration on rotation and continuous grazed pastures following a torrential rain of 3.33 inches, June 19, 1946

GRAZING TREATMENT	NO. SAMPLES TAKEN	RAINFALL, INCHES	DATE SAMPLED	AVE. DEPTH MOISTURE PENETRATION, INCHES	
				Buffalo grass	Tobosa grass
Rotation	27	3.33	July 12, 1946	8.43	20.10
Continuous	18	3.33	July 12, 1946	14.50	27.56

TABLE 3

Summary of gains of yearling steers on rotation and continuous grazed pastures during the summer months, 1942–1947

SEASON	GRAZING TREATMENT	LENGTH OF GRAZING SEASON	ACRES PER HEAD	AVERAGE GAINS, POUNDS		
				Steer	Acre	Daily
1942	Rotation	196	3.94	142	36	.73
1943	Rotation	160	5.20	183	35	1.14
1944	Rotation	117	3.94	173	33	1.48
1945	Rotation	160	5.02	107	21	.67
1946	Rotation	92	5.01	26	5	.28
1947	Rotation	151	10.30	143	14	.66
1948	Rotation	154	10.30	126	12	.82
1949	Rotation	181	10.30	171	17	.95
Average		151	6.02	132	22	.87
1942	Continuous	196	4.26	151	35	1.77
1943	Continuous	160	4.94	163	33	1.02
1944	Continuous	117	4.94	177	36	1.51
1945	Continuous	160	5.07	156	31	.97
1946	Continuous	92	5.07	34	7	.38
1947	Continuous	151	6.76	114	17	.76
1948	Continuous	154	10.14	138	14	.90
1949	Continuous	181	7.56	146	19	.81
Average		151	5.67	135	24	.90

TABLE 4

Average annual acre gain by months on rotation and continuous grazed pastures, 1942–1949

GRAZING TREATMENT	LENGTH GRAZING SEASON	AVERAGE ANNUAL ACRE GAIN, POUNDS BY MONTHS						AVE. ANNUAL GAIN	AVE. PERCENT UTILIZATION OF FORAGE
		May	June	July	August	September	October		
Rotation	151	11.03	1.38	4.11	3.07	1.49	.76	21.84	54
Continuous	151	10.73	4.18	4.18	2.61	.98	1.17	23.85	52

monthly intervals over the 5-year period strongly suggested that rotational grazing in a fixed plan may well penalize buffalo grass, side oats grama and other species with a long period of palatability when growing in close association with tobosa grass that has a rather limited season of palatability. Under good moisture conditions and during the early summer season the differential grazing of

steers was of only minimum importance but became increasingly more important as the season progressed, especially during periods of drought. In several instances, intensive use, coupled with a drought prior to a torrential rain, reduced the cover of the more palatable species on rotation grazed pastures well below that required for rapid absorption of rainfall (Table 2). From the data it is apparent that buffalo grass suffered the greatest reduction in moisture penetration under rotation grazing, although some loss occurred even from tobosa which usually has a good vegetative cover and litter left after heavy use.

From the standpoint of gains of yearling steers, continuous moderate grazing showed some slight advantage over rotation grazing (Table 3). These differences are relatively small considering the variation in length of grazing season due to drought and inherent variation in pastures. The lighter stocking rate used on rotation grazed pastures during the seasons of 1947 and 1949 was thought desirable to allow these pastures to recover following the severe droughts of 1947 and 1948.

An analysis of gains at monthly intervals during the grazing season indicates that a somewhat more uniform rate of gain was made by steers on continuously grazed pastures (Table 4). This data, however, is based on single day weights and cannot be considered too reliable under pasture conditions.

Summary

1. Rotation grazing of buffalo and tobosa grass growing in close association did not improve the vegetal composition or increase the desirable forage plants.

2. Rotation grazing brought about a marked differential use of buffalo grass and tobosa as the season progressed or in case of drought, and in some instances resulted in higher runoff and decreased moisture penetration on sites occupied by the more desirable species.

3. Gains of yearling steers were not increased by use of a fixed rotation grazing system when compared with continuous moderate use.

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Studies of Rotation Grazing in the Southeast

H. H. BISWELL

Associate Professor of Forestry, University of California, Berkeley, California

STUDIES of rotation grazing in switch cane (*Arundinaria tecta*) areas in eastern North Carolina were made over a three-year period. The chief objectives were to determine: (1) if a rest from grazing is beneficial to the forage plants in allowing them a period of undisturbed growth even though they must support more animals during the time they are grazed, and (2) to find the effects on cattle gains. The forage was studied as to vegetation density, species composition, and utilization; the cattle were weighed every 28 days and grazing habits observed. The pasture plan is shown in Figure 1. It consists of 12 pastures, each 15 acres in size. The pastures were stocked so that forage for the cattle was always sufficient and the areas were moderately grazed.

Two rotation systems were tested by comparing each with continuous grazing, making a total of three systems:

1. Mid-season rotation grazing. Each pasture was used about one-half of each grazing season, from May to November, and rested the other one-half.
2. 28-day rotation grazing. Under this system the animals were shifted between pastures every 28 days.
3. Continuous grazing. This served as a control or check group. The pastures were grazed continuously but with only one-half as many animals at any one time as on the other pastures. The animals were exchanged between areas every 28 days to simulate the changes of animals in the other groups.

The experiment was replicated once with steers used in one set of pastures and heifers in the other. Results showed no significant difference in gains of the steers and heifers. Twenty animals were used for each grazing system making a total of 60 animals on test each year. The steers and heifers were produced in the general area, hence they were accustomed to grazing on switch cane forage (Fig. 2). This study was made by the Southeastern Forest Experiment Station and the Bureau of Animal Industry, of the U. S. Department of Agriculture, in cooperation with the North Carolina Agricultural Experiment Station (Biswell and Foster, 1947).

Results

Forage.—The three systems of grazing gave about the same results. No appreciable differences occurred in forage density, species composition, or utilization as a result of the grazing systems. The principal results are contained in Table 1. The figures for 1941 were obtained previous to any grazing use.

In the various pastures, switch cane comprised 67 to 91 percent of the forage and warty panicum (*P. verrucosum*) a trace to 17 percent. Several less abundant plants also were found in the pastures and grazed to some extent.

Cattle.—No significant differences in cattle weight gains showed up under the three systems of grazing management. Average weights and gains of the cattle by 28-day periods are given graphically in Figure 3. Although the gains were not significantly different, the cattle under continuous grazing gained slightly more on the average than those under the 28-

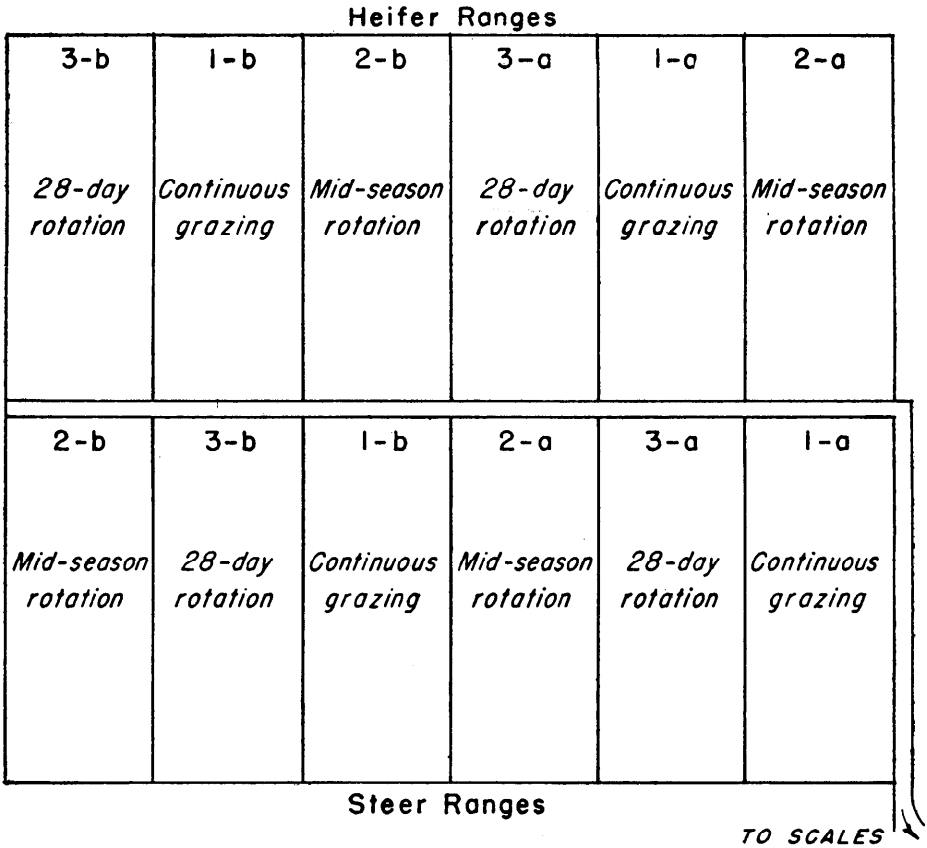

FIGURE 1. Diagram showing the plan of experimental pastures. The steers and heifers were handled independently of each other in the two sets of pastures.

FIGURE 2. Switch cane, fairly representative of that in the experimental pastures

day rotation system, and the cattle in each of these systems gained more than those under the mid-season system. The cattle weight gains for the three years averaged as follows: continuous grazing, 147 pounds; 28-day rotation grazing, 145 pounds; and mid-season grazing, 138 pounds.

Conclusions

There seems to be no advantage in rotation grazing in switch cane forage where the rotation plan requires a doubling up of grazing pressure during the time a range is used. If rotation grazing necessitates extra labor, fencing, and development of watering places, continuous graz-

TABLE 1

Forage Under Each System of Grazing Management

ITEM	MID-SEASON ROTATION			28-DAY ROTATION GRAZING			CONTINUOUS GRAZING		
	1941	1942	1944	1941	1942	1944	1941	1942	1944
Density of vegetation (%)	69	56	63	80	57	70	65	59	67
Main species in forage cover (%)									
Switch cane	47	69	43	53	70	48	47	67	42
Warty panicum	34	8	4	33	8	4	38	8	4
Degree of utilization (%)									
Switch cane	0	52	60	0	55	52	0	57	57
Warty panicum	0	60	80	0	60	77	0	60	78

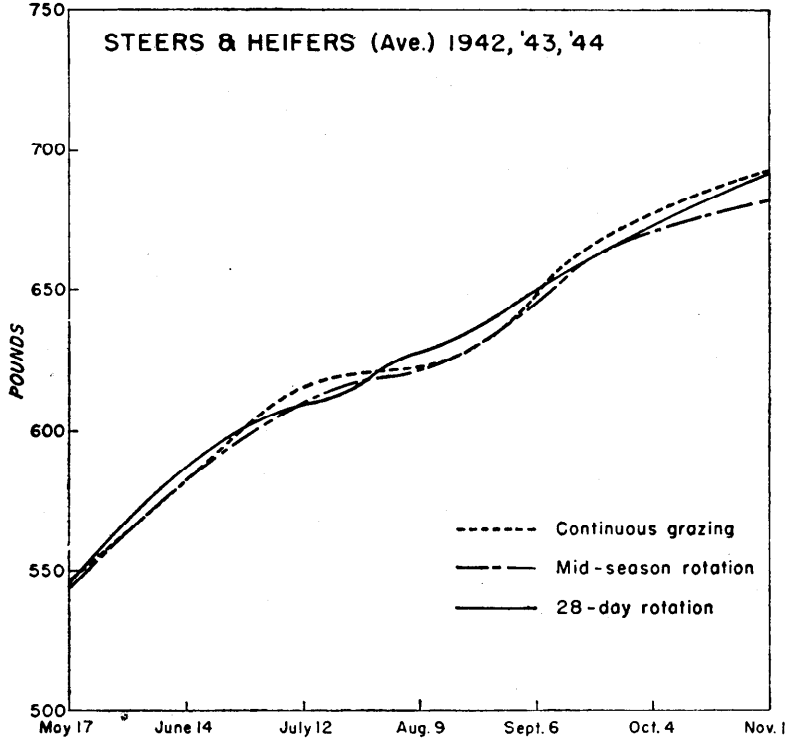

FIGURE 3. Average weights of cattle under the three systems of management at 28-day intervals for the three years, 1942, 1943, 1944.

ing is more practical. Therefore, one should be cautious about recommending rotation grazing here as a general practice. There are probably exceptions where rotation grazing, or at least deferred grazing, would be worthwhile. For example, following fires in switch cane areas it would seem desirable to defer grazing until as late in the season as possible to permit the switch cane plants to grow until they are less subject to damage by grazing, especially since young sprouts of switch cane are easily pulled by cattle.

The results from this study are essentially the same as those from studies conducted elsewhere, as listed under Literature Cited. Although results of other early studies vary somewhat, none have indicated marked advantages in rotation grazing.

Other studies in switch cane forage indicate that conservative grazing is important in maintaining vigor of the plants and grazing capacity; therefore, emphasis in management could well be placed on conservative use rather than on rotation grazing.

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BOOK REVIEWS

MONOGRAPH OF THE GENUS *Digitaria*
By J. Th. Henrard. 999 pp., illus. Universitaire Pers Leiden, Leiden, Netherlands. 1950. $16.00

Although primarily taxonomic this unusually large volume will offer much of use to many members of the Society. Obviously a labor of love and of many years patient compilation, the publication of which was postponed by World War II, the species of the fingergrasses (*Digitaria*) are for the first time treated (conservatively) on a world wide basis. Casualties of this type of treatment are *Leptoloma* Chase here treated as a subgenus of *Digitaria* and *Trichachne* Nees which is merely a section. The species are first treated alphabetically, with profuse quotations of original descriptions, and then are keyed. Most type specimens are illustrated.—*A. A. Beetle*, Dept. of Range Management, University of Wyoming, Laramie, Wyoming.

OF MEN AND MOUNTAINS

By WILLIAM O. DOUGLAS. 338 + xiv pp., frontispiece and maps. Harper Brothers, N. Y. 1950. $4.00.

This book is mostly about the author's adventures in the Cascades and Wallowas, and about the companions with whom he camped, tramped, rode, fished, and hunted. But it goes beyond these mountains into other wild places and into the story of his boyhood, and it includes elements of philosophy, geology, botany, zoology, camp cookery—and a bit of nonsense now and then. Truly a hunter's stew, thoroughly palatable to those with an outdoor appetite.

The author's purpose in writing the book is to encourage others to use the mountains in preparation for the adventure of life, and as a source of renewed faith:

> "I learned early that the richness of life is found in adventure. Adventure calls on all the faculties of mind and spirit. It develops self-reliance and independence. Life then teems with excitement. But man is not ready for adventure unless he is rid of fear."

Much of the best of the book treats, with the authority of experience, of self-discipline and the mastery of fear. The author feels that the mountains offer a way to a vigorous morality:

> "A people who climb the ridges and sleep under the stars in high mountain meadows, who enter the forest and scale the peaks, who explore glaciers and walk ridges buried deep in snow—these people will give their country some of the indomitable spirit of the mountains."

The thing that emerges most clearly from the book is the robust and yet sensitive personality of its author. He is already widely known and respected for his legal achievements, but this book will make him more intimately known and will add to the esteem in which he is held by people generally.

As literature the book is very uneven, some passages rising to heights of eloquence, others plodding and failing, we think, to reflect the experience adequately. Partly this may be because of a

lapse of many years between the experience and the account of it, partly it may be because sustaining interest through description is the most difficult skill of writing. Nor should the book be judged as science, for although the author has a tough, factual mind, characteristically using specific measures of distance, weight, and time, rather than generalizations, the fact remains that he is insufficiently trained to be a reliable guide in some of the fields of natural science into which he gallops with an amateur's abandon.

Consequently there may be little in this book for you if you read it as an ecologist, a geologist, a range or wildlife manager, or a forester. Read it as one human being becoming acquainted with another of warm, vigorous personality; read it to compare his reactions to the outdoors—to mountain ridges, forests, meadows, sagebrush plains, in storm, calm, daylight, or darkness—with our own reactions; and you will be well rewarded.—*Lincoln Ellison*, Intermountain Forest and Range Experiment Station, U. S. Forest Service, Ogden, Utah.

Financing the Farm Business

By I. W. Duggan and Ralph U. Battles. 354 pp. John Wiley and Sons, Inc. New York, 1950. $4.00.

This volume is the latest addition to the Wiley Farm Series and as such it is a useful addition to these basic aids to young agriculturalists. The authors state in the preface that: "*Financing the Farm Business* is designed to cover most of the important financial problems which confront young farmers."

The authors, officials of the Farm Credit Administration, U. S. Department of Agriculture, are well qualified to write about the field of agricultural finance and agricultural credit. I. W. Duggan is Governor, and Ralph U. Battles is Assistant Chief, Economic and Credit Research Division of FCA.

The book is divided into two parts, Part I, "Principles of Farm Financing," and Part II, "Sources of Agricultural Credit". The authors state a logical reason for Part I by writing, "Experience has shown that financial management is a phase of farm management that has not been given sufficient emphasis in the training of young farmers." To that statement this reviewer is in complete accord and would further state that this situation is also true for training in Range and Ranch Management.

The authors further express this same viewpoint, "The ability to finance a farm business on a sound basis is as important as the ability to produce and market crops and livestock efficiently." They point out that the use of credit is as much a tool to increased income as is greater yield and longer working days.

Other chapters in Part I are designed to give the reader basic information on capital requirements, use of capital, leasing systems, business transfers, types of credit, risk factors, interest rates and allied subjects. These chapters answer many of the questions a young farmer or rancher might wish to know. For the experienced farmer or rancher, much of this information may have been learned the hard way and for these individuals this treatment would be considered academic.

For the uninitiated, however, Part I of the book has much to offer. There he can find concrete information on transfer of properties, partnership arrangements, how to accomplish sound leases, equitable rental rates, financial statements, and

many of the myriad of details now necessary in the modern business of farming.

Part II is concerned with descriptive material about sources of agricultural credit and the many agencies in this field. Here we find some political history in the description of Federal and State attempts at aiding the farmer. The authors treat sources of agricultural credit such as commercial banks, insurance companies, and the Government aids, such as the Farm Credit Administration, the Federal Land Banks, and the many other divisions of FCA. Much of this is treated at length and in an interesting manner because of the authors' intimate association with the Federal system of credit to agriculture.

Although Part II does not have the concreteness of Part I, it makes interesting reading for persons who like historical and background material. This section informs on where credit is obtainable and why and how it happens to be obtainable. However it does not offer the same usefulness to the beginner as does Part I.

This reviewer feels that the basic purpose of the book is as a simple text for high school and freshman college courses. It does not require prerequisites in economics and finance to be useful. Each chapter is followed by a list of questions and exercises. This indicates a textbook application and enhances its use as a text for beginners in farming and for students seeking a basic knowledge of farm finance. —*H. R. Hochmuth*, Bureau of Agricultural Economics, Logan, Utah.

Water in the Physiology of Plants

By A. S. Crafts, H. B. Currier and C. R. Stocking. 240 pp., 59 illus. The Chronica Botanica Co., Waltham, Mass. 1949. $6.00.

Water in the physiology of plants is an excellent monograph intended primarily as a reference work. But the reading is not so tedious as to preclude its use in the classroom. The authors, in discussing the importance of water relations, point out that survey of modern literature proves that this subject still claims the attention of leading plant physiologists. "Viewpoints change; methods improve; still the underlying principles of water absorption and utilization challenge the researcher. Almost all plant functions involve water relations in some form or other; provision of adequate water for maximum growth of plants is the basis of successful agriculture in many parts of the world."

The field of plant water relations is one in which range men are vitally interested. Furthermore, it is one that most of us need to know still more about. A majority of range lands are in an arid region and available moisture there greatly affects plant distribution, growth, and grazing use of forage. In places the rainfall pattern largely determines the kind of vegetation a site supports. Range men are also interested in plant water relations in such work as plant breeding for drought resistance, range fertilization, impounding and distribution of flood waters, and general conservation of all supplies.

The monograph is concise. In its preparation the authors tried especially to do two things, first, to select from an immense literature the material relevant to modern concepts and problems, and, second, to present original work or synthesize new concepts from previous publications. This was done in ten chapters. The first one is short and covers the broader reviews. Subsequent chapters are more specialized, covering the structure of water and aqueous solutions, a review of the concepts of the mechanism of osmosis, consideration of the water relations

of individual cells, and finally, analysis of the functions of absorption movement, retention, and loss of water by organized plants.

At the end of each chapter, except for the first one, is a short summary of about one-half page to a page, bringing together the main points covered in the chapter. The authors did an excellent job in writing the summaries and they add a great deal to the monograph.

The book is written in the language of the present day botanist and plant physiologist. Several references are cited, however, that employ, almost entirely, the vocabulary of physical chemistry. The authors point out the need in plant physiology for more accuracy in the definition and use of technical terms; also the desirability of a universal language for all scientists. On the other hand, a book written for botanists using the language of physical chemistry probably would not be as useful as will be this monograph. With regard to this problem, the authors hope the book will serve two purposes: For the plant worker, it should develop an appreciation for the exact analytical methods of the physical sciences. For the physical scientists, on the other hand, they hope it will broaden, if need be, his view of the physical universe to encompass those many living systems upon which his very existence depends. There should be some common ground where these two may meet to work out their common problems for the mutual benefit of all. The field of plant water relations presents many problems upon which such cooperative effort may be profitably spent.

The monograph has a bibliography of 782 references and both an author index and subject index.

Technical range men will be interested to know about the monograph and many will want to see or own a copy of it. It is the 21st volume of the "New Series of Plant Science Books" published by the CHRONICA BOTANICA COMPANY. The authors are members of the Botany Department, University of California, Davis, California.—*H. H. Biswell*, School of Forestry, University of California, Berkeley, California.

CURRENT LITERATURE

Prepared by Grant A. Harris, *Range Conservationist*, Northern Rocky Mountain Forest and Range Experiment Station, 157 South Howard St., Spokane 8, Washington.

Members are invited to submit references for inclusion in the current literature section. The national periodicals are being covered. However, it seems desirable to include references in local, state, and regional publications. Attention should be given to correct spelling of authors' names, and correct enumeration of volume, number, and pages of the references. For proper form, note the references given in this issue. Send material to Grant A. Harris.

RANGE PLANTS: *Forage value, chemical composition, ecology physiology, systematics*

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when fields are usually abandoned, (2) its seeds are easily scattered by the wind, and (3) it germinates in the fall and grows through the winter. Aster dominates second because (1) horseweed seedling growth is inhibited by presence of decaying horseweed roots, (2) asters grow very large and give strong competition to small horseweed plants. Dominance of broomsedge is delayed by a lack of seed until the few early established plants produce and scatter their seeds. Once broomsedge is established it crowds the aster out through competition.

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gions are described, as well as a newly developed method for quantitatively expressing biological similarity between areas.

RANGE AND PASTURE MANAGEMENT: *Management plans, surveys, utilization, maintenance*

GALGAN, M. W., J. M. BELL AND E. Y. SPENCER., Variations in vitamin content with method of cure and stage of growth of alfalfa and oats and their utilization as forages by lambs. Sci. Ag. 30(7): 316–323, tabs., biblio. July 1950.—Oven-drying at 60°C (140° F) preserved vitamins to the greatest degree; loft-curing was intermediate and field-curing preserved the least. Forage cured at six stages of maturity showed a progressive decline in vitamin content except thiamine in oats. Carotene was affected most by curing and season. Gains of lambs fed oven-dried forage were greater than those receiving field or loft-cured forage.

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RANGE IMPROVEMENT: *Natural and artificial revegetation, noxious plant control, mechanical improvements*

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grass seed was greatly reduced by hammer mill treatment in an attempt to make it smaller and more stable in the mixture. A more successful method of keeping bromegrass seed in mixture is to dilute the seed mixture with chemical fertilizer. Storage of mixed seed in fertilizer previous to seeding did not seriously destroy viability when the storage period was less than six weeks.

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NEWS AND NOTES

The New Cover Design

Few men knew the early West as did Charles Marion Russell, the artist of "The Trail Boss" which, with this issue, appears as a permanent feature on the cover of the Journal of Range Management. Born in St. Louis, Russell went to Montana Territory in 1890 where he worked for years as a night wrangler and cow puncher for many of the big cattle outfits. Long known as "The Cowboy Artist", the authenticity of his work in pen and ink, water color, oil, and bronze has brought him recognition as one of the West's great historians, especially of the early range days before the plow "turned the sod wrong side up".

The cut, which is from the Russell collection of Past President Renner, was first used by the Society on the cover of the program for the 1950 annual meeting. The many favorable comments at San Antonio led to its proffer for use as a permanent "brand" of the Society, an offer which the Board of Directors enthusiastically accepted at their last meeting in Denver.

Natural Areas Approved

Last May the Chief of the Forest Service approved the establishment of the Signal Hill Natural Area on the Nebraska National Forest. Natural areas are established by the Forest Service to preserve special botanical and other biological values.

The Signal Hill Natural Area is located in the heart of the Southern Sandhills, 10 miles southwest of the town of Halsey, Nebraska. About 740 acres, lightly and intermittently grazed in the past, will be protected against livestock grazing in the future. The typical Sandhills climax grass species are present, as are the shrubs like redroot, prairie willow, and sandcherry, which have disappeared over large areas.

The Sandhills of Nebraska, comprising, perhaps, 12,000,000 acres of highly productive cattle range contain very few, small areas which have been ungrazed. The Signal Hill Natural Area, therefore, although small, should fill a distinct need. It will preserve in a more or less natural state a small segment of this distinct and unique grassland type for future study and comparison.

In Colorado, the establishment of the Mt. Goliath Natural Area was also approved. This area is at timberline on Mt. Evans, some 50 miles west of Denver. It includes both the upper fringes of forest and a segment of the alpine grassland or tundra above timberline. It is adjacent to a good road and should prove valuable in future studies of the alpine type under natural conditions.—*H. F Schwan.*

Savage on Range Mission to Uruguay

D. A. Savage, superintendent of the U.S.D.A. Southern Great Plains Field Station, Woodward, Oklahoma, left in October for a four-month study of pasture, forage, and range problems in Uruguay. The study mission, conducted at the request and with the help of the Government of Uruguay, was arranged by the Food and Agricultural Organiza-

tion of the United Nations in cooperation with the International Bank for Reconstruction and Development. The mission includes specialists in economics, dairying, soils and fertilizer, agricultural engineering, forestry, agricultural extension, cold storage, and pastures from France, Mexico, New Zealand, England, and the United States.

The general purpose of the mission is to survey agricultural problems and requirements in Uruguay and make recommendations for stimulating agricultural production, reducing cost of production, and improving marketing methods.

Savage's assignment includes a study of pasture production and management, both in extensive and intensive grazing areas, with a view to suggesting methods of improving pasture and forage production and utilization, through the use of improved varieties, fertilization and improved management practices, including the production and storage of hay and silage during periods of scant grazing. Particular attention is to be given to problems of range management, since feeding shortages during the dry season of the year are a continuing problem, and during severe droughts have a disastrous effect on the prosperity and stability of agriculture in Uruguay. The country is mostly in grass with about 95 percent of its exports consisting of livestock products.

Savage expects to return to Woodward about February 1 after spending about three months in Uruguay and a few weeks on trip reports in Washington, D. C. E. H. McIlvain is in charge of the Station during Savage's absence.

California Adopts Model Deer Policy

A management policy that might serve as a model for all states where over populations of deer exist or threaten has been adopted by the California Fish and Game Commission. In summary form, some of the highlights of the policy are:

1. To produce and maintain a maximum breeding stock of deer on all wild lands consistent with other uses of such lands.
2. To maintain the best possible range conditions in conformance with other interests and uses.
3. To manage deer populations on the basis of natural forage supplies.
4. To permit the harvest of all surplus animals, of either sex.
5. To work out with other interested parties an equitable allocation of forage for deer and livestock where conflict or competition exists, and thereafter to regulate the deer herd according to such agreements.
6. To inform the public concerning the mechanics of deer management and the requirements to maintain healthy and productive herds.—Outdoor News Bulletin.

The Range Management Society in Arizona

I believe that the existence of this Society is a wonderful thing and can do much good. The livestock men will be among its greatest supporters, for they must of necessity be the greatest conservationists. Without conservation they have no heritage and no future, but at the same time let us realize that it must be practical conservation.—*John Babbitt*, President, Arizona Cattle Growers' Association. *in* Arizona Cattlelog, July 1950.

Editorials

Did you notice the new Journal feature in the October issue—the Editorial? In

past issues we have had equivalents of editorials in the annual reports of retiring Presidents Pechanec and Renner. President Savage's report will be in the May 1951 Journal. Now, each retiring member of the Editorial Board is being requested to contribute an editorial as a fitting climax to his 3-year term of service to the Journal and to the Society. Each, because of his particular line of work and background of experience, will have a worth-while message.

Starting with Dr. Cottam's editorial in this issue, we are carrying a photograph of the author. Our next issue in March will have an editorial by Dr. Harold H. Biswell, the first editor of the Journal.—R.S.C.

SCIENTIFIC WRITING

The author should ask himself of any statement in his manuscript: Is it

1. Necessary?
2. Well placed?
3. Accurate?
4. Clear?
5. Brief?
6. Inspired?

Philip C. Wakeley
Southern Forest Experiment Station
New Orleans, La.

WITH THE SECTIONS

Arizona

The officers and council members of this Section, with Dr. R. R. Humphrey as chairman, met August 11 to formulate plans for a winter meeting. A two-day meeting was scheduled for December 15 and 16 at the University of Arizona at Tucson. George Glendening, U. S. Forest Service; Matt Baird, operator of the Ruby Star Ranch; and A. L. Brown, assistant range ecologist at the University of Arizona were appointed to draw up the agenda for the meeting. Range problems to be discussed include noxious plant control, reseeding, methods of rangeland appraisal, range forage plants, and range condition. A day of discussions and conferences was to be followed by an all-day field trip to view range problems and improvements in southeastern Arizona.

Members of the Section have been looking forward to the winter meeting as a follow-up to the interesting and educational meeting at Flagstaff on June 13 and 14.—*A. C. Everson.*

California

The members made a trip to the Eldorado County foothill area to observe brush clearance, water spreading, and other range practices in August.

The December meeting was planned to be held in the Bay Area. It was to consist of speeches and discussions on range management subjects of interest in California, ending with a banquet in the evening for members, wives, and friends. —*J. R. Bentley.*

Northern International Mountain

The first field meeting of this Section was held jointly with members of the Society of American Foresters at Waterton Lakes, Alberta, Canada on September 22 and 23. H. A. deVeber, Park Superintendent, extended a welcome with response by Section Chairman, Tom Lommasson, for the graziers and Clayton Crocker for the foresters.

Leaving Waterton Lakes by automobile at 7:30 A.M., our first stop was made at the Alberta Ranch. Members heard a discussion of ranch organization led by ranch owners F. E. M. Robinson of the Alberta Ranch, Frank Lynch-Staunton of Lundbreck, and George Chattaway of Nanton. Approximately 50 people made the trip. There were 14 cars in the caravan.

The Marquis of Lorne originally organized the Alberta Ranch in 1885 and named it for his wife, Alberta. The ranch includes approximately 16,000 acres. The province of Alberta was eventually named for this ranch. Much of the bottom land carries heavy stands of native timothy. Stocking totals about 1,000 head of cattle on a year-long basis; however, it will summer more stock than it can winter. Mr. Robinson made the point that "he liked to keep the grass ahead of the cattle instead of the cattle ahead of the grass," and the fine condition of his ranges showed clearly that this was what he was doing. Because of the proximity to Waterton Lakes Park, Robinson has considerable bear trouble and was forced to kill 16 of these animals last year and 9 this—about

⅓ grizzly and ⅔ black and brown. He reports an average feeding season of 75 days. The amount of hay fed per season varies widely but it is necessary to have two tons per head available at the beginning of the winter season in order to play safe. Cattle are moved to his summer range on May 15. This is an elevation of between 4,600 and 5,600 feet.

Frank Lynch-Staunton runs what he calls a small cattle operation with his breeding stock divided into three separate groups. He secures a 90% calf crop annually. He has a 150-head permit on the Forest Reserve from May to October but turns no breeding stock out on the Forest until after they have calved. He always grains his calves at weaning time and reports some wolf trouble.

George Chattaway is manager of the Maclay Ranch. This operation includes 1200–1400 head of cows that are divided up into small groups of 100–150 to a pasture, four bulls being provided for each 100 head. Fresh bulls are provided every two weeks during the breeding season in July and August. He reports an 80% calf crop on the average. He, along with several other ranchers, reported serious difficulty with pocket gophers. This year, they were so bad that they stopped his haying operations. He does not vaccinate yet for Bangs Disease.

On the northern outskirts of Coleman, we entered the Coleman-Kananaskis Forest road. This road has just been constructed and has opened up many acres of the Alberta Forest Reserve, formerly accessible only by horseback. This is a marvelous road with ideal alignment, surface and drainage—far superior to the average Forest Service road in the States. However, the outstanding point of interest in connection with it is the lengths to which the Alberta Forest people have gone in scrupulously cleaning up a broad roadside strip and treating the backslopes on the cuts and fills to prevent erosion. Various types of planting of both grass and browse species have been used. The following is an illustration of the sort of work they are doing to stabilize cuts and fills. Contour ditches were constructed at 3-foot intervals. In these, was placed a mat of browse species including Dogwood, Juniper, and Bearberry. This was covered over and then the entire slope seeded with grass—including timothy, various species of agropyron, alsike, and Dutch clover. Three-foot willow stakes were then driven into the bank horizontally at intervals. Most of these have sprouted. This planting was done on June 27 of the current year and so far shows good results.

A very delicious lunch was served the group at the Gap Ranger Station. Al Burrows of the Eastern Rockies Forest Conservation Board did a masterful job in taking care of this important item.

After lunch, we drove to the Waldron Ranch. Enroute we saw examples of both good and bad range—some of the latter on Ernst Creek, partially on private land and partially on the Forest. The Waldron Ranch is one of the oldest in Alberta. It was originally larger than at present and owned by a syndicate. It is now owned by Mr. Miller of Nevada, owner of the famous "101" ranch. Here we were met by Mr. Miller's foreman, Cody, and were later joined by Mr. Miller himself. We saw a number of the calves, progeny of Brahma bulls and Hereford cows. This project was started only two years ago and was described by Harry Hargrave of the Lethbridge Experimental Station. The ranch owns 15 Brahma-Hereford yearlings and the heifers at two years old will be bred back to a Hereford bull. The object of the experiment is to develop a larger animal that will dress out even better than purebred Herefords but will still have the stamina and "rustling"

ability of the Hereford. The Brahmas are free of udder trouble and pinkeye to which the Herefords are subject. It is hoped that the crossbreds will favor the Brahmas in these respects. The hump and dew-lap of the Brahma were very noticeable in the calves, as was also, in every instance, the white face of the Hereford.

The party returned to Waterton Lakes about 6:30 and at 8:00 o'clock, a banquet was served to about fifty people. Chairman Thomas Lommasson, U. S. Forest Service, Missoula, Montana, introduced the speaker of the evening, Ray G. Johnson, Grassland Expert of Montana State College, Bozeman, Montana.

Mr. Johnson gave an illustrated address on a trip which during 1943 and 1944 took him across India, up the Burma Road, into Tibet, Inner Mongolia and Turkistan. The long journey, mostly by caravan was taken in his role as Generalissimo Chiang Kai-Shek's advisor on livestock problems in West China, Tibet and Inner Mongolia. Great areas of Inner Mongolia were fertile irrigated lands 950 years ago but now are almost valueless eroded deserts because over-grazing and destruction of forests for fuel have destroyed the watershed. "We ourselves are going to have to pay attention to our grass and our watersheds," he warned the range management group.

Following the banquet, a Sectional Council Meeting was held and Chairman Lommasson selected committees to function for the balance of this year. It was agreed that our next Sectional meeting would be the first part of May in Missoula —one day to be devoted to a business meeting, election of officers, and the reading of technical papers, and the other day to be spent in the Bitterroot Valley examining various revegetation projects.

The country around Waterton Lakes, and elsewhere around Alberta, was superb from a scenic point of view and the weather was perfect for a field trip. Much credit should be given to the following members who were responsible for the planning and the carrying out of the fine meeting: W. R. Hanson, Del Steed, Al Burrows, Ed Burles, Ken Coppick, Del Hereford, Ron Peake, Harry Hargrave, Alex Johnston, "Scotty" Campbell.—*A. D. Moir.*

Pacific Northwest

A ranch run with the precision of a well oiled machine; grass seedings on skidways in a National Forest; grass seeding after a burn on a National Forest; reversal of the grass-to-sage cycle on a big meadow; half-blood Brahma calves; grass nurseries; weed control—these were some of the things seen on the successful and initial tour of the Pacific Northwest Section of the Society.

The tour was a two-day affair, August 18–19 of this year. It started in the center of Oregon's big beef cattle country, Grant County, and ended west of Burns, Oregon, in Harney County.

The first day was devoted mostly to the ranch operations of Joe Oliver of John Day, Oregon (Fig. 1). This ranch is a typical western outfit in one way—it combines low elevation, irrigated meadows in a mountain valley; adjacent cheat grass range; high elevation meadows; and adjacent Forest Service timber range. In these ways it is *not* typical:

1. A calf crop of 99 percent from over 600 cows;
2. A pen calving operation resembling in principle the best shed lambing operation;
3. Separation of forest allotment into 4 parts, with each fenced range used for a different class or age of cattle: aged cows, heifers, two-year old

steers, yearling steers. This gives a chance to watch each group and move them without disturbing the other groups; also a chance to watch the forage and lengthen or shorten the grazing period as the feed supply dictates;

4. On the meadows inside the forest, grass is mowed and raked in mid-summer. The cattle pay little attention to this until protein begins to run down in the other feed, when they rather suddenly turn to the windrowed, early cut hay and eat it almost completely. This is a system of protein supplements open to many but used by few. The early-cut hay is high in protein and so it is saved for late summer use. Naturally the method is not adapted to areas with heavy summer rains;
5. A big mountain meadow owned by Oliver is on its way back. He has thrown in a whole series of low-cost dams made with materials at hand and has made numerous furrows to lead the water around the edge of the meadow. Thus the channeling has been stopped, the old channels are filling in, the sage brush is dying, and the meadow is on its way back to grass;

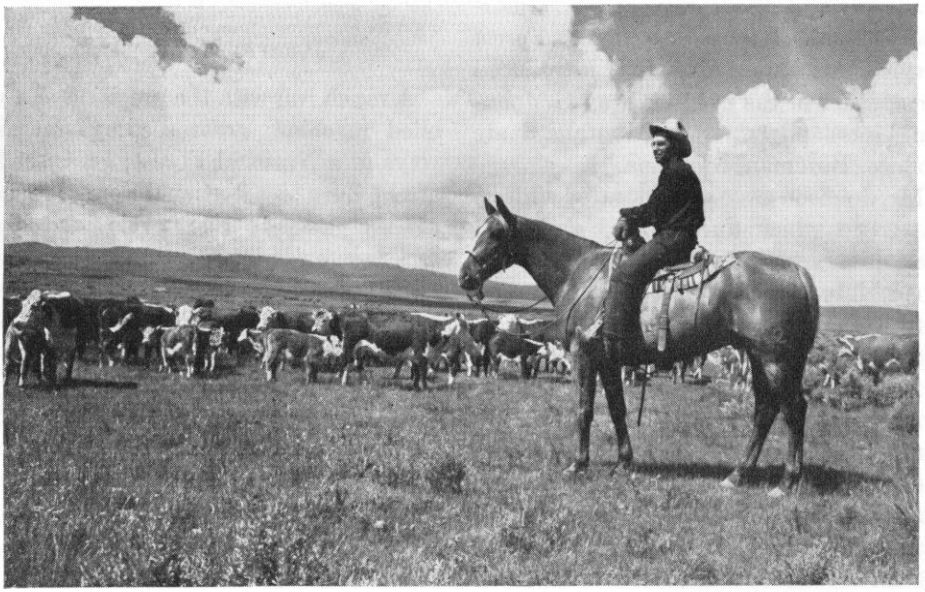

FIG. 1. Joe Oliver, John Day, Oregon looking over his range and cattle. In 1950 he branded 99 calves from each 100 cows. The brand on the horse, A2, is one of the old historic brands of Oregon used by Joe's grandfather.

6. The Malheur National Forest allotment used by Oliver was logged under the selective cut system and skid-ways seeded to grass;
7. Meadows are used as supplemental feed the instant the stock begins to lose flesh on range;
8. Heifers are kept growing.

Lunch was served at noon at a forest camp and there Herman Oliver, uncle of Joe, gave a colorful, intensely interesting discussion of the early days of cattle raising, the changes that have occurred, the development of the Oliver system of

ranch management, and some of the difficulties through the years and how they have been surmounted.

In the afternoon the crowd continued around the upper Oliver ranch in Bear Valley and made one stop at a grass nursery put in by Wm. Farrell, County Extension Agent. This is one of a series of nurseries covering the state of Oregon, mostly with seed provided by the Soil Conservation Service. Nurseries numbered over 300 at one time and there are still 150 of them. From them the Extension Service and other agencies make local recommendations for grass and legume plantings at all elevations and all rainfall areas.

One more stop was made in the evening and Cleon Clark, Malheur Forest Supervisor, showed the group a Forest Service grass seeding on an accidental burn. It is Forest Service policy in this area to seed all such burns in order to prevent erosion, reduce fire hazard, cut down weed and brush encroachment, and provide feed for livestock.

The night was spent at Burns and the crowd devoted the following day to the Squaw Butte Experiment Station, the only station operated by the Bureau of Land Management.

Oregon State College is a co-partner in the large range experimental plant and a committee of ranchers within the area helps in defining range needs and laying out the experimental program to supply answers to range problems. Art Sawyer, Superintendent of the station and his assistants, Don Hyder, Farris Hubbert, and Elmer Sniff told of the station's work. Dr. A. L. Hafenrichter, S.C.S., discussed in lively, interesting, and informative style the various grasses and legumes in the cooperative nursery.

To date the type of rotation grazing used on this station has been inferior to season-long use for both range and cattle. The range is divided into A and B areas and the same stocking rate is used on each, but B is divided into three parts and one part is deferred each year through a rotation grazing system. This results in putting three times as many cattle per acre on one portion of B as are on A during the spring in order to defer another part of B. The growing season is too short to permit the spring used part to recover from the close use given it. Bluebunch wheatgrass is disappearing on all parts of B and the cattle have averaged nine pounds less in weight than the cattle on A.

Brahma crosses with local beef strains, sage brush removal, and long-time nutrition and breeding experiments are underway at this station.

Joe Pechanec succeeded in getting down 128 names of those attending, together with their classification. This showed: Ranchers 36, Forest Service 31, State Game Commission 17 and Soil Conservation Service 9. Other groups or interests with six or less included: Indian Service, Extension Service, Bureau of Land Management, Oregon State College, Range Management College Students, Fish and Wild Life, Commercial Firms and Banks, Production and Marketing Administration, State Department of Agriculture, Livestock Press, and Bureau of Reclamation.

Of these 16 different occupations, of course, Oregon supplied by far the largest numbers, but there were also representatives from: British Columbia, Washington, Idaho, California and Colorado. There were 16 from Washington, most of them members of the Section.

The tour was a great success. Fred Kennedy, President of the Pacific Northwest Section, told of the work, aims, and hopes of the Section and the parent Society and John Chohlis took memberships from those who wanted to join. The

event sparked a demand for more field work by the Section.—*E. R. Jackman.*

Wyoming

This Section has grown until, in August, it boasted 123 members. Nearly 60 people attended a meeting of this Section September 30 at the Pole Mountain Ranger Station in the Medicine Bow National Forest. Those attending included the range management class and faculty members of the University of Wyoming, grazing permittees and forest service officials.

D. S. Nordwall, supervisor of the Medicine Bow spoke on correlation of range management and multiple uses of the Medicine Bow forest. Frank Knittle, president of the student section, gave a short talk on the activities of the range management class.

A demonstration of the work at the Pole Mountain grass nursery was given by the student group (Fig. 2). Those who put on the demonstration were George Manley, K. Johnson, Grant Smith and Dr. Alan A. Beetle. Outstanding was the demonstration work with Russian wild rye which was planted three years ago. From this planting, heavy seed was obtained in 1949 and again in 1950. Some of the seed was re-planted in 1950 in the nursery and the new grass is up to three inches in height and is firmly established. Work with the plant to date indicates a very favorable outlook with successive seed crops and is important from the standpoint that the plant is ordinarily a poor seeder.

Particularly interesting were the results obtained from seed from native Thurber fescue.

Following the demonstration at the nursery, District Forest Ranger Louis E. Coughlin conducted a "show me" trip to permit observation of water spreading and results of reseeding untertaken September 28, 1949, on granite type soil on South Crow creek project where success is indicated.

One of the members of the studen group present was from Turkey and another was from China.—*Alan A. Beetle.*

Fig. 2. Wyoming Section members watching demonstration of work done at Pole Mountain grass nursery, Medicine Bow National Forest.

SOCIETY BUSINESS

PROGRAM

Fourth Annual Meeting

THE AMERICAN SOCIETY OF RANGE MANAGEMENT

Northern Hotel, Billings, Montana
January 23, 24, 25, 1951

TUESDAY FORENOON, January 23

Registration

Greeting by Hon. John W. Bonner, Governor of Montana

President's address, D. A. Savage, Superintendent, Southern Great Plains Field Station, B.P.I.S.A.E., U.S.D.A., Woodward, Oklahoma

Business Meeting

TUESDAY AFTERNOON, January 23

Prize-winning student essay, and presentation of essay awards

The Range Situation in the Northern Great Plains and Adjacent Mountains

Chairman: Bruce Orcutt, Rancher, Beaverslide Ranch, Miles City, Montana.

Milestones of Development and Curent Range Problems of the Livestock Industry, William Denecke, Trustee and Past President, Montana Woolgrowers Assoc., Bozeman.

Range Animal Husbandry Problems of the Region, S. S. Wheeler, Head, Animal and Dairy Industry Dept., Colorado A. and M. College, Fort Collins.

Range Problems of Marginal Farm Lands, Mont H. Saunderson, Range Economist, Forest Service, U.S.D.A, Denver, Colorado.

WEDNESDAY FORENOON, January 24

Progress in Solving Big Game Problems of Range Lands

Chairman: Lowell Adams, Biologist, Fish and Wildlife Service, U.S.D.I., Missoula, Montana.

Elk in Montana and Wyoming, Robert F. Cooney, Director, Wildlife Restoration Division, Department of Fish and Game, State of Montana, Helena.

The Inter-agency Deer Study in Utah, Odell Julander, Range Conservationist, Intermountain Forest and Range Experiment Station, Forest Service, U.S.D.A., Ogden, Utah.

New Trends in Deer Management in California, William P. Dasmann, Game Range Technician, Department of Fish and Game, State of California.

Ecology and Utilization of sagebrush by Big Game Animals in Yellowstone National Park, Walter H. Kittams, Biologist, National Park Service, U.S.D.I., Yellowstone Park, Wyoming.

A Rancher's Viewpoint on Big Game, A. Stockman Panel.

WEDNESDAY AFTERNOON, January 24

Range Management in Western Canada

Chairman: J. Baden Campbell, Head, Range and Forest Division, Dominion Experimental Station, Swift Current, Saskatchewan.

A Range Land Rental System Based on Grazing Capacity and the Price of Beef, J. A. Campbell, Grazing Land Appraiser, Alberta Department of Lands and Forests, Edmonton, Alberta.

Community Pastures, Ray Youngman, P.F.R.A., Regina, Saskatchewan.

Timber Milk Vetch Poisoning on British Columbia Ranges, M. A. McDonald, Assistant, Dominion Range Experiment Station, Kamloops, British Columbia.

Range Resources of the Far North and the Reindeer Herd at Aklavik, H. J. Hargrave, Head of Animal Husbandry work, Dominion Experimental Station, Lethbridge, Alberta.

WEDNESDAY EVENING BANQUET, January 24

Master of Ceremonies: William G. McGinnies, Director, Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S.D.A., Fort Collins, Colorado.

THURSDAY FORENOON, January 25

Significant Developments in Range Management and Research

Chairman: W. R. Chapline, Chief, Division of Range Research, Forest Service, U.S.D.A., Washington, D. C.

New Management Developments Under the Taylor Grazing Act, Marion Clawson, Director, Bureau of Land Management, U. S. Department of the Interior, Washington, D. C.

Range Conditions in Eastern Washington 50 Years Ago and Now, G. J. Chohlis, Range Conservationist, Soil Conservation Service, U.S.D.A., Yakima, Washington.

Studies of Range Stocking at the Archer Field Station, O. K. Barnes, Project Supervisor, Soil Conservation Service, and R. L. Lang, Associate Agronomist, University of Wyoming, Laramie.

Some Effects of Range Condition on Livestock Production, J. S. McCorkle, Regional Chief, Range Division, Soil Conservation Service, U.S.D.A., Albuquerque, New Mexico.

Pasture Improvement in the Northeast, William Myers, Chief, Division of Forage Crops and Diseases, B.P.I.S.A.E., U.S.D.A., Washington, D. C.

Making the Most of the Research Dollar, E. J. Woolfolk, Chief, Division of Range Research, Northern Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S.D.A., Missoula, Montana.

THURSDAY AFTERNOON, January 25

How to Speed-up Progress in Range Management

Chairman: E. R. Jackman, Farm Crops Specialist, Extension Service, Oregon State College, Corvallis.

Teaching Range Facts—the Role of the Schools, Vernon A. Young, Head, Department of Range and Forestry, A. & M. College of Texas, College Station.

Selling Range Facts—What the Extension Services Can Do, Ray G. Johnson, Range Specialist, Extension Service, Montana State College, Bozeman.

Using the Facts—Views of the Practical Operator,

1. My Ranch Conservation Plan, Otto Wolff, Rancher, Rapid City, South Dakota.

2. Putting the Facts to Work, Alan Rogers, formerly Chairman of Public Relations Committee, American National Livestock Association; Walking T Ranch, Ellensburg, Washington.

Hotel Accomodations for Annual Meeting

We hope you have already arranged for your accomodations for the Annual Meeting at Billings, Montana, on January 23–25, 1951. But if you have not, the following information has been furnished by Bud Molohon, Chairman of the Local Arrangements Committee. All reservations will be on a first come—first served basis. We suggest you make yours now—its later than you think!

Hotels and rates available for advance Reservations:

1. Northern Hotel (headquarters hotel)
   $3.50—single with shower
   $4.00—single with tub
   $5.00 double with shower
   $6.00 double with tub
2. Grand Hotel (across street from Northern—rooms and service equal to Northern)
   Rates same as above.
3. For accommodations in motels or campgrounds—or if you are unable to get confirmed reservations in either of the above two hotels—write Billings Commercial Club, Attention: Convention Housing, Billings, Montana, and you will receive prompt service.

Highlights of Board of Directors' Meeting

August 4–5, 1950

Shirley Savoy Hotel, Denver, Colorado

August 4.

Present were: D. A. Savage, President; M. W. Talbot, Vice-President; H. R. Hochmuth, Treasurer; M. H. Deming; W. L. Dutton; F. G. Renner; J. S. McCorkle; K. W. Parker; and E. H. McIlvain, Secretary.

Also present were Section representatives: A. A. Beetle, Wyoming Section; and Darrol G. Born, Wyoming Student Section.

Meeting was called to order by President Savage at 8:50 A.M.

Minutes were read and approved.

A motion was passed that the constitution be amended as soon as possible to provide for a new office of Executive Secretary at a salary to be fixed by the Board of Directors; and on January 1, 1952 to abolish the offices of the Treasurer and Secretary and transfer their duties to the Executive Secretary.

A motion was approved to raise student dues from $2.50 to $3.00 per year starting January 1, 1951, to make them self-supporting.

Proposed changes submitted by Constitutional Revision Committee were discussed, modified, and approved for submission to membership.

Afternoon session. To the morning attendance was added Albert Reid, Herb E. Schwan, and Don F. Hervey of the Colorado Section.

Matters pertaining to the Natural Resources Committee were taken up, including discussion of the "platform." A motion was passed that the President appoint a representative to attend the Fort Knox meeting at other than Society expense.

Herb E. Schwan discussed questions of securing advertising for the Journal.

Motion was passed that the Society is not ready at this time to establish a "fellow" grade.

The Board disapproved exchange of complimentary subscriptions to the Journal.

The Board went on record against reduction of dues and subscription rates to international members because costs are higher for them than for members in America.

Mr. Allen Bell of Bell Publications discussed the program concerning advertising in the Journal.

The Board authorized Editor Campbell to order 300 reprints of the Society membership list as published in the October Journal and send them to Bell.

Alan A. Beetle discussed his committee's activities regarding establishment of a central depository of Society literature. The Board passed a motion for the Society to retain and file its own papers and affairs with the future Executive Secretary.

Utah State Agricultural College library was designated as central depository for storage of materials selected by the library committee.

Meeting adjourned at 5:30 P.M.

August 5.

The meeting was called to order at 8:10 A.M. by President Savage.

A letter was read from President Warren C. Whitman of the Grassland Research Foundation. He stated that affiliation with our Society was not desired at this time. It was decided the Grassland Area Committee of the Society will continue to work on other phases of its assignment.

It was decided to publish names of the new Society officers in the January issue of the Journal.

The Board approved use of Society letterheads for personal use at no cost to the Society.

A policy was adopted requiring that a "mother" section approve formation of a new Section within its territory before the Board takes action. It was voted to formally request approval by the Northern Great Plains Section before the Board approves formation of the South Dakota Section.

It was decided to informally ask the Wyoming Student Local to dissolve their section and form a Chapter after the new Society Bylaws are approved. A motion was passed to provide for dissolving a Section for cause in the revised Bylaws.

Application blanks and billings to be printed in 1951 will have a space for a member to indicate which Section he wishes to join.

A motion was passed to establish definite geographical boundaries of those Sections which do not state definite boundaries in their constitution, and adopt as a policy that new Sections must define their boundaries.

A. W. Sampson suggested in a letter that the Board consider publishing a glossary of "Range" terms. It was decided to refer the suggestion to a special committee.

A motion was passed to appoint a committee to see that range matters are adequately covered in the outline, and to work up specific subject matter for the "Handbook for Conservation Technicians."

Treasurer Hochmuth discussed several points: (1) storage of back issues of the Journal—approximately 200 copies of each number. (2) that the Society charge $6.00 per volume for all back volumes of the Journal or a proportionate amount for each issue. Approved. (3) Committees who have Society bills close their books by December 1.

Discussion ensued as to policy for publishing the Journal in 1951. On the basis of 2,500 copies, printing cost for six issues of 80 pages each would be about $5,700. The Treasurer reported $7,562.48

balance on hand as of July 1. Probable 1951 income is about $10,000. Probable Society expenses, exclusive of Journal printing, are $2,500. A motion was passed that in 1951, the Society publish 2,500 copies of the Journal in six issues of approximately 80 pages each.

It was decided to hold in abeyance any decision regarding increasing size of the Journal.

Secretary McIlvain suggested use of an underprint of a Charles M. Russell painting on the cover of the Journal. A motion was passed to accept F. G. Renner's offer of the Charles M. Russell plate for use as an underprint on the cover of the Journal; that the matter be taken up with Editor Campbell and, if deemed economically feasible, to start using the underprint on the January 1, 1951 Journal.

It was decided to order 50 additional copies of the October 1950 Journal for the exclusive use of the membership and finance committees; and that 50 copies of each issue be reserved for similar purposes in 1951.

It was decided that Editor Campbell should send mutilated and extra copies of the Journal to the Executive Secretary after his office is established in 1951.

Past and present Finance Committee activities were discussed and several suggestions were made. The Board is to compile a justification statement for funds to be solicited.

A motion was passed that the Society is not now in position to collect dues for Sections.

Nominees suggested by the nominating committee were approved for submission to the membership for final election. Biographical sketches will be included in the ballot sent out prior to October 1, as well as in the October Journal.

The Board approved a proposal for the Program Committee chairman to arrange to have the winning essay presented on the program of the 1951 meeting, by the author if he can be at the Billings Meeting.

M. W. Talbot discussed the tentative program for the 4th Annual Meeting of the Society at Billings, Montana, in January 1951.

A report was given on the work of the Range Investigation Techniques Committee.

The 1952 Annual Meeting Committee was authorized to investigate the two central cities, Denver, and Salt Lake City, as possibilities for the location of the 1952 annual meeting.

Possible candidates for a permanent Executive Secretary were discussed.

It was agreed that the Board of Directors would meet at 8:00 A.M. on January 22, 1951, at Billings, Montana.

It was suggested that Waverly Press be requested to make all possible effort to get the January 1951 issue of the Journal out on the scheduled date early in January.

The Board Meeting adjourned at 3:25 P.M.—*E. H. McIlvain*, Secretary.