In This Issue

AMERICAN SOCIETY OF RANGE MANAGEMENT

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

Persons shall be eligible for membership who are interested in or engaged in practicing range or pasture management or animal husbandry; administering grazing lands; or teaching, or conducting research, or engaged in extension activities in range or pasture management or related subjects.

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Letters to the Editor

This section is open to comments by any member of the Society. Opinions expressed do not necessarily represent those of the Journal and the Society.

Change in Burning Terminology

We, as members of the Society, wish to suggest a change in the terminology of burning, substituting the term "control-burn" for "controlled burn." We also wish to point out the need for more rational definitions and employment of terms describing the use of fire for land clearing.

The term "controlled burning" is offensive because of its lack of euphony and its inaccurate implication. Reading the clause "The area was controlled burned in 1954" is undeniably awkward, whereas "The area was control-burned" is the common usage in speaking, hence it could and should be carried over into writing.

Implication of the term "controlled burn" is that the fire was at all times under control. But this is not true, at least in California, as witnessed by the number of escapes that become wildfires each year in this State. We feel that the term "control-burn" would imply burning with effort to control, which is the true situation, but without the degree of control certainly implied by "controlled burn."

With respect to more careful use of terminology, we recognize several degrees of intensity within what might be called the spectrum of burns used in land management. They are not clearly distinguished, however, in the accepted glossaries. For instance, the Society of American Foresters' Glossary on Forest Terminology defines controlled burning as:

The deliberate use of fire on an area whereby burning is restricted to a predetermined area and intensity.

The Soil Conservation Society of America's *Soil and Water Conservation Glossary* defines controlled burning as:

"Any deliberate use of fire on land where the burning is restricted to a predetermined area and intensity. The intensity of fire is controlled by the time of year, the time of day, and the moisture content of vegetation in the area. Syn. *Prescribed Burning.*"

Writing in California Agriculture, 1951, on *"Use of Fire in Land Clearing"*, Arnold, Burcham, Fenner, and Grah defined controlled burning as . . . *"the planned application and confinement of fire to a preselected land area."* They also recognized the . . . *"convenience fire where the only elements planned are time and place of burn."*

The basic terminology of Arnold *et al.* was accepted by Sampson and Burcham in their California State Division of Forestry Bulletin, 1955, on *"Cost and Returns of Controlled Brush Burning for Range Improvement in Northern California"* in which the authors defined controlled burning as:

> The planned application and confinement of fire to a preselected land area; usually, these are wild lands. The actual burning may be done in many different ways: in some instances so-called "convenience fires" are set in which the only elements predetermined are time and place of burn.

All of these terms have merit, but the slight changes in them as used from year to year by different persons point clearly to a need for redefinition in terms that are subject to general agreement. We propose the following:

Management burning.—A general term covering the deliberate use of fire on land for the purpose of removing unwanted plant material. Management burning includes convenience burning, control-burning, and prescribed burning.

Convenience burning. — The simplest form of management burning, in which the only elements planned are time and place of firing.

Control-burning.—The application of fire to a preselected land area according to a definite plan, utilizing control forces adequate to confine the fire to the area selected.

Prescribed burning.—The ultimate in careful use of fire as a tool for land clearing, involving:

Use of fire as a silvicultural tool:
burning under rigid restrictions with respect to the humidity and temperature of air and fuel;
burning within rigidly specified ground limits;
burning with the fire under control at all times; and
not burning when weather or other conditions are unfavorable at the time planned for firing.

Inasmuch as these conditions are not met in the "controlled burns" commonly conducted in California, they cannot be called "prescribed burns". In this respect the glossary definition of the Society of American Foresters is inadequate, whereas that in the Glossary of Soil and Water Conservation is inaccurate.

Copies of this letter go to the Society of American Foresters, the Soil Conservation Society of America, and the American Society of Range Management because the terminology in question is used in the subject fields of all three groups. We shall appreciate its consideration by the appropriate persons in your group, and shall be glad to have our letter published if you feel it desirable to contact your membership in that way.—*A. W. Sampson,* Professor Emeritus, University of California; *Clark H. Gleason,* Forester, California Forest and Range Experiment Station. (*Received, Nov. 14, 1956*).

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Basic Subjects Must Be Taught

On April 30, 1955, I presented my Dillon paper to the Montana Conservation Council. In this paper, based on a large amount of historical research and substantiated by my own experiences, it was set forth that, if we are to progress in the science and art of range management, we must

teach ecology and range management and toss conservation out the window.

That I was not merely setting up a straw man to knock down, is indicated by Civil Service requirements 58B for Agricutural Research Scientists. This includes some twenty-three scientific fields, such as Agronomy, Animal Husbandry, Dairy Husbandry, Fishery Research Biology, Genetics, Research Forestry, and Soil Science. It also includes "Range Conservation."

As pointed out editorially in American Forests, November 1953, some individuals, unable to fulfill requirements of more rigid disciplines, became specialists in conservation.

Following this thought through, Civil Service requirements for a Research Scientist in "Range Conservation" can be met by 10 semester hours of Agronomy, or by 10 semester hours of Genetics, or by 10 semester hours of "Related Problems" (whatever that means).

To be an Animal Husbandman researcher, 15 semester hours of Animal or Poultry Husbandry are required. To be a Fiber Technologist researcher, 20 semester hours in Fiber Technology and closely related subjects are required, and so on. To be a Range Conservationist researcher, any botanist from Ohio or any Agronomist from Pennsylvania or any Plant Breeder from North Carolina fulfills all the requirements to solve all of our western range management problems.

It really looks as if, to make any progress in the science and art of range management, it is vitally necessary to not only throw the conservationists out the window but to put a bounty on them as well.—*Dan Fulton,* Fulton Ranch, Ismay, Montana. (*Received Oct. 11, 1956*).

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RANCHER OPINION NEEDED!

I have heard some rancher members of the ASRM express their reluctance to present ideas and relate their experiences either at meetings or in written articles for the Journal. This reluctance, in my opinion, often stems from an erroneous concept of professionalism. Many of these ranchmen have not been formally trained in range management, and because our programs and Journal articles are often predominantly technical, they apparently question their own professional status. Certainly they should not do so, since many of them have profound knowledge and many years of experience in both the science and art of range management. Range livestock operators are true professionals in every sense of the word. They are better able to foster the science and especially the art of range management by their "on the ground" practice and example, than the so-called technician.

It is true that most ranchers attend meetings and read the Journal, to better understand scientific range and pasture problems as presented by the technician. But the rancher has an obligation, too—that of helping the technician to better understand practical range problems and to *exchange* ideas and facts. The Ranchman's Issue (Nov. 1956) of the Journal certainly proved ranchmen can and are fulfilling that obligation.—*Clyde W. Doran,* U. S. Forest Service, Albuquerque, New Mexico. (*Received March 7, 1957*).

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"Water-Belly" (Urolithiasis) in Range Steers in Relation to Some Characteristics of Rangeland[1]

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Water-belly, urinary calculi or urolithiasis, has caused widespread losses among cattle. Cattlemen in the Great Plains of the United States ranked water-belly second in occurrence among all nutritionally sick cattle in 1954 (Ensminger, et al., 1955). In the western states, except the Great Plains, it ranked fifth, and in the southern states it ranked seventh.

Range operators think of water-belly as being strictly a range cattle problem. Livestock feedlot operators think of it as being strictly a feed-lot problem. Actually, it is common to both, but the majority of scientific investigations into the problem have been on feedlot cattle.

This study follows the "range approach" to the problem. It was undertaken to determine relationships of range vegetational types, range condition, range sites, the annual and seasonal incidence of the disease in cattle, and the mineral content of range forages in relation to the incidence of water-belly. It was limited primarily to cattle and the range upon which they grazed. Another purpose of the study was to find practical means by which ranchers might reduce the extensive losses due to water-belly in range cattle.

The study covered a period of two winters, the winter of 1954-55 and the winter of 1955-56.

Mathams and Sutherland (1951) observed that cows coming to an Australian abatoir from the Gympie-Eumundi district had considerable amounts of kidney stones. Analysis showed these stones to be composed almost entirely of silica. Such instances occurred rarely in cattle from other districts. These workers indicated that pastures in the Gympie-Eumundi district have a great deal of "blady grass", (*Imperata cylindrica major*) in the pastures in which the affected cattle grazed. Swingle (1953) analyzed stones from 63 steers. All contained a high percentage of silica.

Jones, Black, Ellis, and Keating (1949) of the Texas Agricultural Experiment Station recognized that urinary calculi condition of steers in feedlots was probably not due entirely to feedlot environment. Madsen (1954), found a high but variable content of silica in certain harvested range forages collected in New Mexico and Texas. These and other workers have speculated on the presence of a relationship between the high silica intake from forage and soil and the later incidence of water-belly in steers on fattening rations. Silica is one of the most abundant single minerals of the soil (Byers, et al., 1938).

Relationships of mineral composition of range plants to the sites in which they grow was suggested in a study by Gordon and Sampson (1939). In their study, it was noted that low soil phosphorus resulted in low phosphorus and high potassium content of plants.

The actual metabolic changes undergone by minerals absorbed from plants by range cattle is not well understood and little research has been done along this line. A mineral balance type of metabolism experiment was conducted in Ohio by Forbes and Beegle (1916). The retention of silicon from rations containing timothy hay and corn silage was surprisingly large.

The Study Area

This study was conducted primarily in the southeastern one-fourth of Montana. The ranches studied were located in Rosebud, Musselshell, Carter, Carbon, and Wheatland Counties. Information from other areas in Montana, Colorado, and Utah was also obtained.

The study area was well suited to investigation of this problem. Most of it is considered to be within the mixed prairie associa-

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1 *Contribution from Montana State College Agricultural Experiment Station, Paper No. 397, Journal Series. This paper is adapted from the author's Master of Science Thesis. The Thesis is available through interlibrary loan service from the Montana State College Library.*

Acknowledgement is made to Dr. G. F. Payne and Dr. F. A. Branson, Department of Animal Industry and Range Management, Montana State College, for assistance during the study and in preparation of the manuscript.

tion of the grassland formation. This association or type alternates with the desert shrub and salt desert shrub type. The latter type occupies a much smaller percentage of the study area than does the former.

Most of the study area is in the 10 to 14 inch rainfall belt. Southern Rosebud County is in the 15 to 19 inch rainfall belt. The precipitation in the study area ranged from 8.49 inches to 13.33 inches in 1954, but in 1955 the precipitation was higher, ranging from 10.01 to 17.51 inches. Precipitation was about three inches below normal the first year of the study and two inches above normal the second year.

The average annual temperatures ranged from 41.5 degrees to 46.8 degrees Fahrenheit.

FIGURE 1. Steers grazing on high benches selected threadleaf sedge during December, January, and February in the winter of 1954-55. Water-belly incidence was 28.6 percent in this herd.

Methods and Procedure

Ranch units were studied in pairs in order to permit clear expression of animal-soil-vegetation-water relationships. Two ranch units for a pair were selected for comparable size, kinds of cattle, climatic conditions, and management. At the same time, these units were selected to provide a degree of contrast in their experience with the incidence of water-belly.

Ranches were visited and data obtained on cattle management, range vegetational types, range sites, range condition, and the incidence of water-belly. Composite samples of range forage plants, supplemental forages, and water utilized by the cattle during the fall and winter months were collected. The estimated utilization of the important range species was recorded at the time of the ranch visits. Practice in estimation of utilization and range condition was gained in a preparatory program which made use of exclosures and clip quadrats.

Range condition and site relationships were determined on the basis of technician's guides to range condition classes, and recommended stocking rates, prepared by the Soil Conservation Service.

A corollary study to obtain information on the mineral composition of the important range species was conducted over a period of one year on a ranch near Ashland, Montana. Samples of the important species were taken at two-week intervals May 1954 through January 1955 and once a month during February, March and April, 1955. Species sampled included western wheatgrass (*Agropyron smithii*), bluebunch wheatgrass (*Agropyron spicatum*), blue grama (*Bouteloua gracilis*), Junegrass (*Koeleria cristata*), Sandberg bluegrass (*Poa secunda*), needle-and-thread (*Stipa comata*), green needlegrass (*Stipa viridula*) and threadleaf sedge (*Carex filifolia*).

Forage samples were analyzed by the Chemistry Department of the Montana Agricultural Experiment Station for moisture, protein, calcium, phosphorus, magnesium, silica, and for potassium on some samples. Water samples were analyzed for calcium, phosphorus and silica.

A mail survey of 24 ranches in the northern desert shrub-saltbush type of central Utah was conducted.

Results and Discussion

Vegetational Types and Incidence of Water-belly

Six vegetational types were encountered on rangelands in this phase of the study. They are listed in Table 1.

Only three of twenty-one ranch units had cattle grazing on a single vegetational type. Thus, it was necessary to base this study on the complexes and transitions of type, instead of pure vegetational types. There was a total of 3,451 cattle on these ranch units. The minimum number of cattle grazed on any one of the six vegetational types was 198; the maximum number on any one type was 987.

Cattle herds on vegetational types containing only grass and unpalatable shrubs had ten times as much water-belly as herds on types containing shrubs that were palatable.

Four additional ranch units wintered steers on cultivated crops including cultivated hays and aftermath of legumes, together with small grain stubble. There was no water-belly among these 541 steers.

Eight ranches in the northern desert shrub-saltbush range of

Table 1. Range vegetational types in relation to the incidence of water-belly on selected ranch units in southeastern Montana; winters of 1954-55 and 1955-56.

Vegetational Types	Number of Ranch Units In Which Type Occurred	Number of Water-belly Cases In Herds	Total Number of Cattle In Herds	Percent Water-belly Incidence
Mixed grass—savannah deciduous trees and shrubs	2	1	198	0.51
Desert shrub (silver sagebrush) mixed grass—saltbush complex	5	3	400	0.75
Desert shrub-mixed grass transition (few palatable shrubs)	2	15	367	4.09
Ponderosa pine savannah-mixed grass	6	49	880	5.57
Mixed grassland	3	58	987	5.88
Mixed grass (predominantly)—desert shrub (big sagebrush) complex	3	42	619	6.78
Total	21	168	3,451	

Utah, carrying 876 steers through the fall and winter months, reported no water-belly. Most of the ranchers in that vegetational type range stated that they "have never seen a case of water-belly in cattle."

Range Condition and Water-belly Incidence

Range condition on the units studied was predominantly good (50 to 75%) condition (Dyksterhuis, 1949). Sixteen units had range in the good condition class, nine units had range in the excellent condition class, and only two units had range in the fair condition class. One unit was found to be on the line between good and excellent range condition. No units could be found where steers were carried through the fall and winter months on range that was in poor condition. Table 2 shows data on range condition and the incidence of water-belly on the ranches studied.

The water-belly incidence was slightly lower among cattle wintering on good condition range than on excellent condition range. There were a total of 61 cases of water-belly, or 4.66 percent incidence among 1,310 steers grazing on good condition range, while on excellent condition range there were 55 cases, or 5.13 percent among 1,073 steers. One ranch in fair condition reported no water-belly cases in 28 steers during the two years of the study.

It was noted that where steer cattle were wintered on range and where factors of management and range condition were rather constant, there were wide variations in the percentage of incidence of water-belly on a given ranch unit from one year to the next. This suggests the influence of factors other than range condition.

Range Site and Water-belly Incidence

Generally, cattle on the respective ranches studied were found to be grazing over several different range sites. Therefore, it was a problem to identify the disease directly with certain sites. Site classes of the kind that appeared to be less conducive to water-belly were quite limited in size and number.

In a few instances where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was very little water-belly. On the other hand, where cattle grazed on clayey and savannah (pine) sites continuously in the fall and winter,

Table 2. Range condition in relation to water-belly on selected ranch units in southeastern Montana.

Unit	Winter of 1954-55 Number Cattle	Water-belly Cases	Water-belly %	Range Condition %	Winter of 1955-56 Number Cattle	Water-belly Cases	Water-belly %	Range Condition %
I	65	11	16.9	91	—	—	—	—
S	21	6	28.6	87	15	2	13.3	87
U	70	0	0	85	70	1	1.4	85
Q	60	6	10.0	84	60	0	0	84
M	500	9	1.8	83	—	—	—	—
C	212	20	9.4	81	—	—	—	—
O	106	9	8.5	75	106	3	2.8	75
E	175	22	12.6	73	—	—	—	—
K	—	—	—	—	55	14	25.5	66
A	70	8	11.4	60	90	2	2.2	60
P	75	1	1.3	60	75	0	0	60
N	104	0	0	59	—	—	—	—
L	—	—	—	—	60	0	0	57
G	30	7	23.0	55	30	3	10.0	55
H	16	0	0	53	—	—	—	—
F	150	0	0	53	150	1	0.7	53
B	40	0	0	52	100	2	2.0	52
D	90	1	1.1	51	—	—	—	—
V	48	0	0	28	48	0	0	28
Total	1,832*	100	4.37	—	859*	28	3.26	—

*A total of 2,691 steer calves were included in this phase of this study.

Table 3. Incidence of water-belly in the winters of 1954-55 and 1955-56 on selected southeastern Montana ranches by range sites.

Site and Site Complexes	No. Ranch Units On Which Site Occurs	Water-belly Number Cases	Number Cattle	Water-belly Percent Incidence
Overflow	1	0	98	0
Thin breaks, clayey and overflow	1	0	16	0
Saline upland and clayey	1	0	110	0
Clayey	11	126	3,469	3.34
Clayey and saline lowland	1	5	144	3.47
Savannah	3	16	398	4.07
Clayey (predominantly) and overflow	2	11	235	4.66
Clayey, savannah and overflow	1	24	345	6.96

water-belly was common. (See Table 3.)

Sites which supported a rather homogeneous cover mostly of grasses or grasses and trees, to the exclusion of palatable shrubs and forbs, showed a higher incidence of water-belly during the study period of two years.

Cropland sites were not surveyed in detail, but it was observed that the incidence of water-belly in cattle on diversified cropland was very low compared to cattle on savannah and clayey sites.

Yearly and Seasonal Incidence of Water-belly

During the two winters of this study, a record was kept of the chronological incidence of water-belly. The data obtained were graphed by semi-monthly periods —1st to 15th and 16th to the last day of month (Figure 2.).

There were 2,350 head of cattle included in this record during the winter of 1954-55 and 3,140 head of cattle during the winter of 1955-56. One hundred thirty-two cases, or a 5.62 percent incidence occurred in the 2,350 cattle, while only 44 cases, or 1.40 percent incidence occurred in the 3,140 cattle in the winter of 1954-55. This difference presents a remarkable contrast between the two years.

There is also a remarkable contrast in the time of occurrence and the seriousness of the water-belly problem during the two winters (Figure 2.). Weather appears to have been a definite influence.

It is well known to the residents, and particularly to stockmen in the study area, that the winter of 1955-56 was much more severe than the winter of 1954-55. United States Weather Bureau records (1956) bear this out. This suggests consideration of two outstanding factors (1) water, and (2) feed, as affected by snow cover.

Colder weather is known to cause reduced intake of water by cattle (Winchester and Morris, 1950). Reduced intake of water has been associated with increased incidence of water-belly by many ranchers. Data obtained through this project is definitely contradictory to such a theory. Less water-belly occurred during the colder of the two winters when cattle supposedly drank less water.

The snow cover had a marked effect on the kind of feed available to cattle during these two winters. During the period November to January of the winter of 1954-55, snowfall was light. Most cattle grazed out on range and even were able to graze "short grasses". There was wide-spread selective grazing on threadleaf sedge by cattle during this winter. Mild weather reduced the normal supplemental feed requirement for this period.

The feed situation was quite different during 1955-56. A general snow fell on the range in the study area during the early part of November. "Heavy feeding was necessary following the cold wave of the 11th (November 1955) and

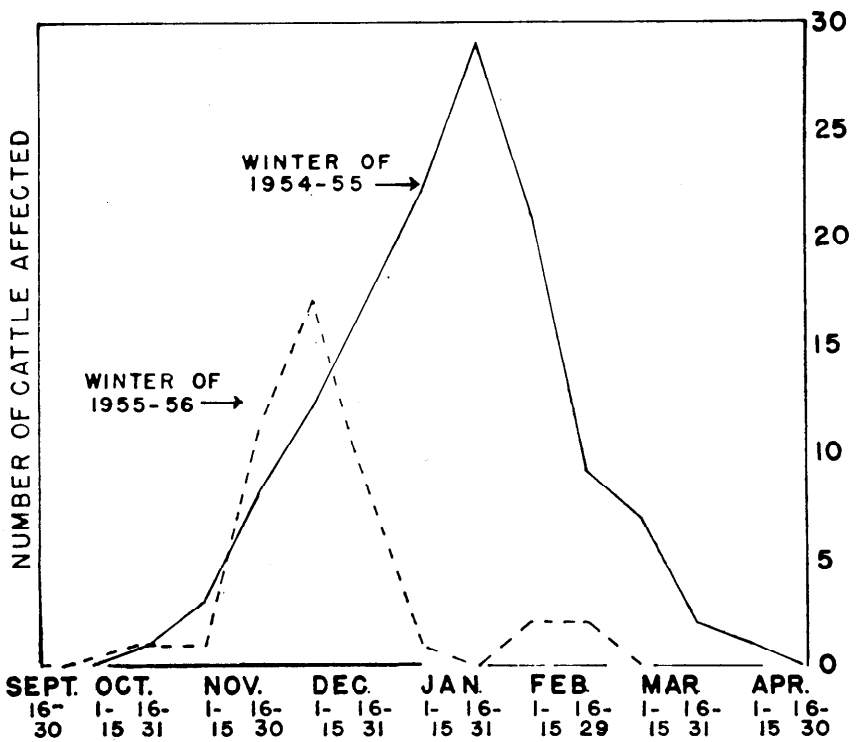

FIGURE 2. Yearly and seasonal incidence of water-belly in cattle on ranches studied in southeastern Montana during the winters of 1954-55 and 1955-56.

was continuous through the 30th". (U. S. Weather Bureau, 1956.) Many of the cattle were moved into ranch headquarters and given a maintenance feeding of supplemental forage. During the rest of this winter there was very little grazing on the shorter range species until about March 1, 1956. Most ranches had an abundant supply of supplemental forage, much of which was alfalfa or mixtures of alfalfa and grass hay, so there was more feeding than normal.

This fortunate combination of weather and resultant management practices furnishes evidence which strongly supports conclusions reached in other parts of this study—that grazing on mature, weathered grass is likely to cause water-belly in cattle. The "short grasses" appear to be more closely associated with the disease than the medium height species.

Water-belly in Relation to Minerals of Forage and Stock Water Samples

Chemical analysis of the samples of mixed range forage taken from the various ranches in this study were analyzed for phosphorus, calcium, magnesium, potassium, protein, and silica. These data are reported on a moisture-free basis.

There was a highly significant negative correlation between the amount of phosphorus, calcium, magnesium, and potassium in the forage and the incidence of water-belly. There was a highly significant positive correlation between the amount of silica in the samples and the incidence of water-belly in the steers. Table 4 shows the coefficients of correlation.

Water used by the cattle contained very little calcium, phosphorus, and silica. The contributions of these minerals to the grazing animals' diets from stock water was very small compared to that furnished by range and other forages. A steer would need to drink 1,000 gallons of water to acquire as much silica in its diet as it would get in one day from 30 pounds of range grass forage. The mineral content of water is not considered to be an important factor in the water-belly problem.

Table 4. The incidence of water-belly in relation to plant minerals: coeficients of correlation.[1]

	Incidence vs. Phosphorus	Incidence vs. Calcium	Incidence vs. Magnesium	Incidence vs. Potassium	Incidence vs. Silica
Linear	—.5546**	—.4899**	—.5657**	—.4769**	.5581**

**Significant at .01 level

[1] Statistical analysis was conducted by Montana State College Statistical Laboratory

The corollary study of mineral content of western wheatgrass, green needlegrass, bluebunch wheatgrass, needle-and-thread, Junegrass, Sandberg bluegrass, blue grama, and threadleaf sedge revealed some new and valuable information.

The trend in the mineral content of these species during the year varied seasonally and in a way which again suggests relationships to the water-belly problem. The silica content of all plants was high during the late fall and winter—the season of high water-belly incidence. The content of potassium, phosphorus, and magnesium particularly, was low during that same season. Calcium followed a somewhat modified path, but was high during the early part of the water-belly season.

The silica was by far the most abundant mineral found in the species sampled. Potassium ranked second to silica, followed by calcium, magnesium, and phosporus. These findings agree with those of Tobiska, *et al.*, (1937), except that in their study, phosphorus exceeded the magnesium. The trend in silica content by growth stages was similar to that found in annual plants in California ranges during the growing season, as reported by Gordon and Sampson (1939).

The November 13 samples were divided and half of each sample was washed to determine the amount of superficial (soil) silica burden. Washing reduced the silica in the samples about one-twentieth. The residue washed from the samples contained 48 percent silica.

Figure 3 shows the mineral content of the seven grasses and one sedge sampled by growth stages for one year.

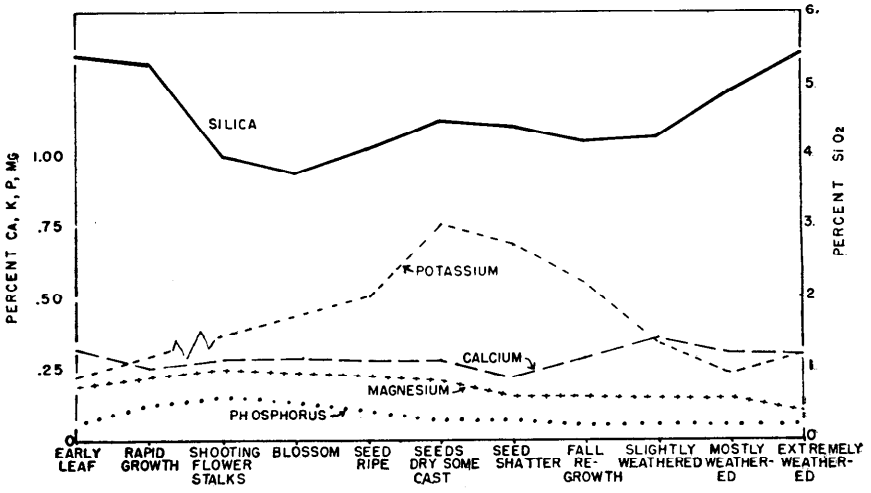

FIGURE 3. Minerals in seven grasses and one sedge, by growth stages for one year: western wheatgrass, bluebunch wheatgrass, blue grama, threadleaf sedge, Junegrass, Sandberg bluegrass, needle-and-thread, and green needlegrass. Samples collected near Ashland, Montana.

Figure 4 shows the mineral content of the two "short grasses", blue grama and threadleaf sedge, for one year (1954-55). The silica content of these two species was extremely high during the late fall and winter season, when there was a high incidence of water-belly in range cattle. The silica content of the important mid-grasses, western wheatgrass, needle-and-thread, and green needlegrass was lower and the content during the winter time was only 4.1 percent as compared to 7.6 percent for the so-called "short grasses."

More recent research work along this line by the Montana Agricultural Experiment Station indicates that range shrubs such as saltbush, winterfat, greasewood, silver sagebrush, and rabbitbrush have a very low content of silica at all times, usually less than one percent.

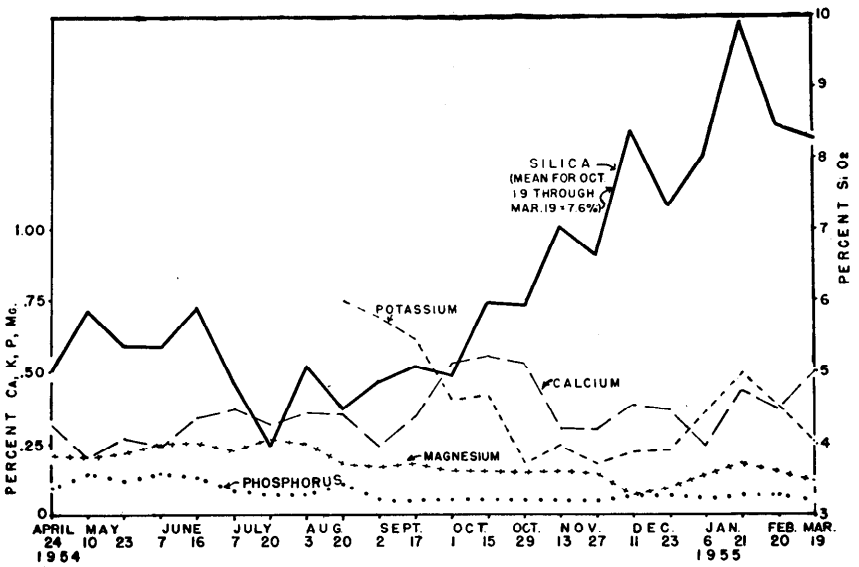

FIGURE 4. Minerals in two "short grasses"—blue grama and threadleaf sedge—for one year, 1954-55. Sampled near Ashland, Montana.

From these results, it appears that the practical cattlemen can avoid some of the losses due to water-belly by removing steers from native grass ranges as they dry up and moving the animals to range containing an abundance of palatable shrubs, legumes or green, immature grasses. Since many range areas, particularly in the Great Plains, have very little shrubby vegetation, planting fall pastures to grasses and legumes may offer some relief. Use of legumes and early cut grass hays to supplement range forage may also help reduce the incidence of this disease among steers on ranches where it is a problem.

Summary

Urolithiasis, or water-belly, is one of the greatest nutritional disease problems of the beef cattle industry.

This exploratory study was conducted for the purpose of developing a better understanding of the rangeland factors which affect water-belly, and to find a means of reducing losses due to water-belly of range steers. The relationships of range vegetational types, range condition and range sites, and the mineral content of range forages and stock water in relation to the seasonal incidence of water-belly were investigated.

Studies were made of twenty-five ranches in the southeastern one-fourth of Montana which lies in the 10 to 14 inch rainfall belt. Most of the area is considered to be within the mixed prairie association of the grassland formation. Comparable ranch units were studied in pairs.

There was less water-belly in steers on range containing palatable shrubs than on range containing only grasses, or grasses and unpalatable shrubs.

On ranches studied there were fewer cases per hundred steers of water-belly on good condition range than on excellent condition range.

Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was less water-belly.

The study of minerals in range forages and supplemental forages showed a strong positive correlation between silica content and water-belly incidence. The correlation was negative in the case of other minerals studied.

During the two years of this study, the seasonal incidence of water-belly in range cattle varied markedly. The difference in seasonal incidence in the two years and the difference in percentage incidence was attributed to a difference in availability of weathered range forage due to snow cover. It is believed that reduced intake of weathered range grasses, particularly blue grama and threadleaf sedge, because of heavy snow cover, and the consequent increase in the feeding of good quality hay, played a part in reducing the incidence of water-belly during the winter of 1955-56 compared to the previous winter.

In a one-year corollary study of range forage mineral content, seven important range species and one sedge were sampled on one ranch, at two-week intervals May through January and at monthly intervals February through April. All samples were analyzed for moisture protein, calcium, phosphorus, magnesium, potassium, and silica. A distinct annual trend in the amount of silica in these species was discovered. A high silica content of these plants in a weathered condition during the winter coincided with a high incidence of water-belly. Potassium, magnesium, and

phosphorus were higher in the summer and lower in the winter.

It is suggested that cattlemen can prevent some of the losses due to water-belly by making greater use of green fall pastures and legumes, by saving range with palatable shrubs for fall and winter pasture for steer calves, and by feeding legume and early cut hays to steers prior to and during the normal water-belly season.

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The Variable Plot Method for Estimating Shrub Density

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Reliable measurements of shrub density on range lands can be made without the use of time-consuming line transect or plot methods. A quick, one-man system of counting shrubs can be used to estimate the percentage of an area covered by woody plants. This procedure has been employed successfully to estimate densities of shrubs and half-shrubs ranging from 6 inches to 30 feet in crown diameter.

Usually called the variable-plot method, the system was developed in Austria. It was first proposed by Bitterlich (1948), who used it to make timber volume estimates without the necessity of establishing sample plot boundaries. Bitterlich's method was introduced to American foresters by Grosenbaugh (1952). A simple modification of the original technique permits it to be used to estimate shrub cover directly in percent.

The variable-plot method requires no actual measurements in the field. No plots or lines are laid out on the ground, and it is unnecessary to measure the dimensions of any plant. The usual measured plots or lines are replaced by a series of sampling points distributed at random throughout the area to be surveyed. At each sampling point, the observer views through the eyepiece of a hand-held angle gauge every shrub visible from that point. The angle gauge is illustrated in Figure 1. Those shrubs are counted whose horizontal crown spread appears larger than the crossarm of the angle gauge. Shrubs whose crown spread appears less than the length of the crossarm are ignored. Figure 2 is a schematic diagram showing a shrub that would be counted and one that would not. The distance at which a shrub is

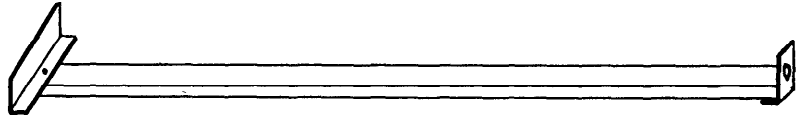

FIGURE 1. The angle gauge. Crossarm is at the left, eyepiece at the right.

[1] *At the time that this article was prepared the author was employed by the Arizona Watershed Program, Phoenix, Arizona.*

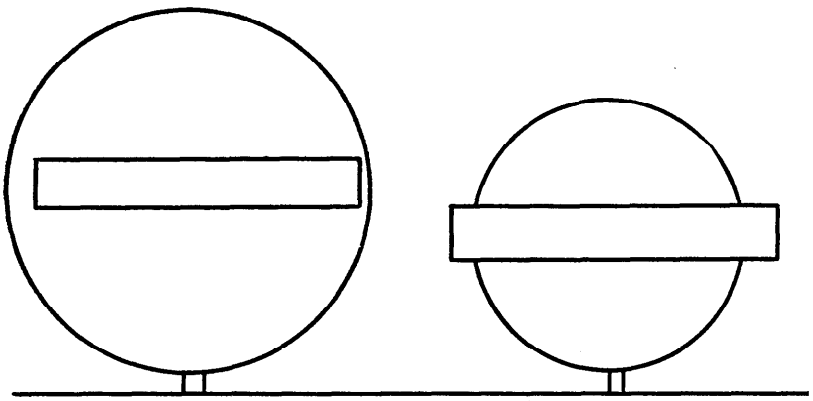

FIGURE 2. Schematic diagram of two shrubs viewed with the angle gauge. The shrub on the left would be counted; the one on the right would not.

counted depends upon its size. Large shrubs are counted at a greater distance from the observer than small ones.

To determine shrub crown density in percent, it is necessary only to divide the average shrub count for all the sampling points by a predetermined constant. This constant is determined by the dimensions of the angle gauge. The number of sampling points required on any area depends on the desired intensity of the survey.

Principle of the Method

The plots from which the method takes its name are entirely theoretical—they are not laid out on the ground. Each sampling point is the center of several theoretical circular plots of varying radii (Husch, 1956). At each sampling point, there are many overlapping plots with a common center, each plot corresponding to one of the shrubs counted with the angle gauge.

Let us assume that an angle gauge has an overall length of 30 inches, with a crossarm six inches long. When held to the eye, this gauge intercepts a horizontal angle of 9°25′. This angle just includes a circle at five times its diameter from the observer. A circle that intercepts a larger angle than 9°25′ will appear larger than the instrument crossarm, and is closer to the eye than five times its diameter. One which intercepts a smaller angle is farther away and will appear smaller than the cross arm. These relations follow from the fact that the overall length of the gauge is five times the length of its crossarm.

A small circle occupies one percent of the area of a large circle if the radius of the large circle is five times the diameter of the small one. For instance, a circle ten feet in diameter has an area of about 78.54 square feet. A large circle whose radius is five times the diameter of the small one, or fifty feet, has an area of 7,854 square feet. Thus, the small circle occupies one percent of the area of the large one.

Now let us consider a shrub stand as observed with the angle gauge from a single sampling point. Any shrub whose horizontal crown spread appears exactly equal to the length of the crossarm is five times its own diameter from the sampling point; if it appears to extend beyond the edges of the crossarm it is closer than this limit. These are the shrubs that are counted.

Each shrub counted with the angle gauge occupies one percent of the area of a hypothetical plot whose radius is five times the diameter of the shrub. When a shrub is observed with the angle gauge, a theoretical plot of this radius is automatically set up. The limits of this plot are established by the fact that if a shrub is outside the plot, it appears smaller than the instrument crossarm and is not counted. Each shrub counted therefore represents one percent shrub cover, and the total number counted is the percent of shrub cover at that sampling point.

A numerical example may help make this clear. A shrub, exactly ten feet in diameter, is located 25 feet from a sampling point. When this plant is observed through the angle gauge, a theoretical plot fifty feet in radius is automatically set up, and the shrub is observed to lie within this plot. Since the area of the shrub is 78.54 square feet, and that of the plot is 7,854 square feet, the shrub occupies one percent of the theoretical plot. At first glance, it might appear that since this shrub is less than fifty feet from the plot center, it represents more than one percent ground cover. A little thought will show that this is not so. The angle gauge sets up a maximum limit beyond which shrubs are not counted, and any shrub within this limit represents one percent of the area of the hypothetical plot.

A second shrub ten feet in diameter forty feet from the observer is still within the fifty foot limit, and it also occupies one percent of the area of the plot. If these two are the only shrubs which lie within five times their own diameter from the plot center, the shrub density at that sampling point is two percent, no matter how many plants there may be on the area that are more than five times their diameter away. If, however, a shrub twenty feet in diameter is sixty feet from the observer, it also is less than five times its diameter away. Its theoretical plot has a radius of 100 feet, and the shrub occupies one percent of the plot. These three plants taken together then indicate a three percent ground cover at that sampling point.

In other words, any shrub which is not more than five times its own diameter from the sampling point represents one percent of shrub cover at that point. The total number of shrubs that lie within

this limit represents the percent of ground cover at that point. Many other shrubs will be visible from each sampling point, but only those that lie within the specified limit contribute to the estimate of ground cover. The variable-plot method is nothing more than a means of counting all the shrubs that lie within this limit.

The instrument just described is unwieldy and hard to use in the field. Better results are obtained if the crossarm is made smaller, thus intercepting a smaller angle. A smaller crossarm means that shrubs will be counted at a greater distance from the eye, and that more than one shrub will be needed to equal one percent ground cover. Therefore, with a smaller crossarm the shrub count must be divided by a constant to determine the percent of shrub density.

To determine the relation between this constant and the dimensions of the instrument, it is necessary to consider the mathematics of the method. Percentage of ground cover may be written

$$P = \frac{n\ S^2}{(2R)^2} \times 100 \qquad (1)$$

where P is percentage, n is number of shrubs on the plot, S is shrub diameter in feet, and R is plot radius in feet. The angle gauge is so constructed that

$$\frac{W}{L} = \frac{S}{R} \qquad (2)$$

when W is the length of the crossarm and L is the overall length of the instrument (more precisely, the distance of the crossarm from the eye). Substituting in (1),

$$P = n \times \frac{W^2}{(2L)^2} \times 100 \qquad (3)$$

This can be expressed in the form

$$W = \frac{L}{5\sqrt{\frac{n}{P}}} \qquad (4)$$

If r is the constant by which the shrub count at any point must be divided to find the percentage of ground cover, then

$$P = \frac{n}{r} \text{ and } r = \frac{n}{P} \qquad (5)$$

Substituting (5) in equation (4), the final form becomes

$$W = \frac{L}{5\sqrt{r}} \qquad (6)$$

It should be pointed out that this formula is mathematically not strictly accurate. A correction should be made for the fact that the line of sight intercepts a chord closer to the observer than the true crown diameter. The error due to omission of this correction is so small as to be almost undetectable in variable-plot sampling.

From equation (6) it can be seen that if an instrument is 30 inches long and has a division constant of 2, its crossarm must be 4.24 inches long. The ratio of crossarm length to the distance of the crossarm from the eye is 1:7.07. Table 1 lists several other convenient division constants, with their accompanying ratios and crossarm lengths.

Table 1. Convenient division factors and crossarm lengths.

Division Factor	Ratio of crossarm length to distance of crossarm from the eye	Length of crossarm for instrument length of 30 inches	Width of calibration target at 100 feet from the eye.
		Inches	Feet
1	1:5	6.0	20.00
2	1:7.07	4 15/64	14.14
3	1:8.66	3 15/32	11.54
4	1:10	3.0	10.00
5	1:11.18	2 11/16	8.94
6	1:12.27	2 29/64	8.15

Construction and Use of the Instrument

The angle gauge can easily be made from a strip of hardwood and some scrap metal. Extruded aluminum angles of the "do-it-yourself" variety sold by hardware stores make excellent material for the eyepiece and crossarm. The angles should be about 1¼ inches on a side. The eyepiece should have a viewing hole about ⅜ inch in diameter. An instrument length of about 30 inches is convenient. If it is much shorter, difficulty will be experienced in keeping both the crossarm and the more distant shrubs in focus at the same time.

To illustrate the procedure followed in using the variable plot method, Table 2 lists the actual counts from a field trial made in an open stand of creosote bush (*Larrea tridentata*) and palo verde (*Cercidium microphyllum*). The angle gauge was calibrated to require a division constant of 2. Twelve sampling points were located at arbitrary intervals of four chains, on two lines through the area. From each sampling point, those shrubs were counted whose diameters appeared larger than the crossarm. The counts were totaled and divided by 12 to find the average. This average was then divided by 2, the division constant of the instrument, to estimate the percentage of the area covered by shrubs. In this case, the total

Table 2. Sample variable-plot tally in a creosote bush type.

Sampling Point	Shrubs Counted: Creosote Bush	Shrubs Counted: Palo Verde
1	22	4
2	21	9
3	27	11
4	49	8
5	27	7
6	23	10
7	29	7
8	40	7
9	38	14
10	29	16
11	40	9
12	29	2
Total	374	104
Average	31.17	8.67
Density	15.58%	4.33%

crown density of creosote bush was estimated at 15.6 percent; that of palo verde at 4.3 percent.

The principal difficulty in the use of the variable-plot method is that distant shrubs which should be counted tend to be obscured by those nearby. This difficulty is minimized by using a crossarm length which permits a division factor of 2. Shorter crossarms, with larger division constants, are occasionally useful in very sparse and open shrub stands. A longer crossarm, with a division constant of unity, becomes completely unmanageable, and introduces serious errors.

In dense shrub stands, many distant shrubs are obscured and accuracy falls off rapidly. The method is not very reliable where densities exceed about 35 percent. For this reason, it is best suited to sparse desert-shrub types, to areas of shrub invasion in grasslands, and to other open types. If the plants are small, it is necessary to crouch down in order to keep the line of sight nearly horizontal.

Steep slopes require a correction of shrub counts to increase accuracy. The count at any point is multiplied by the secant of the angle of slope perpendicular to the contour. An average slope correction can be used if shrub density does not change markedly with changes in slope.

Another possible source of trouble lies in the distance of the crossarm from the eye. It is this distance which determines the characteristics of the angle gauge, rather than the actual overall length of the instrument itself. It is best to use the following calibration procedure in adjusting the final position of the crossarm. Support the instrument firmly and measure a distance of 100 feet from the eyepiece. At this distance, lay out a target at right angles to the line of sight. If the angle has a division constant of 2, the target should be 14.14 feet across. Sizes of target for other constants are listed in Table 1. With the eyepiece held firmly against the bones surrounding the eye, move the crossarm backward and forward on the wooden base until the target is exactly covered. Fasten the crossarm securely at this point. A slotted bolthole on the crossarm facilitates calibration. If eyeglasses are worn, the instrument can be made shorter so that the eyepiece rests against the glasses.

The data obtained from variable-plot samples are subject to the usual statistical analyses. Commonly used formulas can be used to compute standard deviation, standard error of the mean, and other useful statistics. Furthermore, variable-plot data lend themselves readily to the calculation of an index of dispersion. This index is a measure of the spatial distribution of individual plants, indicating whether they are more or less uniformly distributed than would be expected as a result of pure chance. Rice and Penfound (1955) describe in detail the method of calculating this index, which is of value in many ecological studies.

Bitterlich's method was first used to measure basal area of tree stems in square feet per acre. For this purpose, a crossarm length to eye distance ratio of 1:33 has commonly been used, rather than the 1:7.07 recommended for shrubs. Estimates using this small crossarm have been found quite reliable in forest stands (Rice and Penfound, 1955; Shanks, 1954). Husch (1955) found that he obtained more accurate estimates of basal area by using a 1:16.5 ratio. All of these investigators found that the variable-plot method took much less time than the conventional methods with which it was compared.

Table 3. Results of tests of variable-plot method in various shrub types.

Species	Estimated percentage of shrub cover				
	Variable Plot		Line Transect		100% Tally
	Number of plots	Percent of cover	Number of lines	Percent of cover	Percent of cover
Creosote bush	12	15.58	10	15.25	
Palo verde	12	4.33	10	3.10	
Mesquite	15	12.07			12.64
Burroweed	36	10.43	24	9.78	

Comparisons with Other Sampling Methods

Several tests were made to compare the variable-plot procedure with standard estimating methods in diverse shrub types in southern Arizona. Results of these comparisons are summarized in Table 3.

Data were available on the percentage of crown cover in a 6-acre stand of mesquite (*Prosopsis juliflora*). The crown area of each tree had previously been measured, and the percent of ground cover determined. The complete tally showed a cover density of 12.64 percent, while the variable-plot samples estimated density to be 12.07 percent.

The variable-plot method was next compared with the line transect method (Canfield, 1941) in common use by range technicians. As the line transect method is generally considered to give fairly reliable estimates of plant density, a comparison of the two methods will presumably give an index to the accuracy of the variable-plot technique.

The 12 variable-plot samples in the creosote bush stand previously described were compared with ten 200-foot line transects run through the same area. The variable-plot samples gave a creosote bush density estimate of 15.58 percent, while the line transect estimate was 15.25 percent. There was a greater difference in the palo verde estimates, which were 4.3 percent and 3.1 percent, respectively. However, the palo verdes were so widely scattered that neither sample was adequate.

In order to test the effect of a smaller crossarm, a second set of

variable-plot samples was taken from the same sample points as in the first survey, using an instrument with a division constant of 4. Collection of the data for this second set of samples took longer than the first because of the greater number of shrubs that had to be counted, and to the greater effort required to avoid missing some. In spite of all precautions, a few were evidently missed, because the 4X angle gauge yielded a density estimate of only 14.3 percent for the creosote bush, compared with the previous estimate of 15.6 percent. The palo verde estimate was almost the same for the two instruments, because of the large size and small number of these trees, which were easily visible even at a distance.

A final comparison was made in a stand of burroweed (*Happlopappus tenuisectus*), a desert half-shrub averaging about one foot in diameter. Thirty-six variable-plot samples were compared with 24 line transects, each 100 feet long. The variable-plot density estimate was 10.43 percent, while that by line transects was 9.7 percent. The difference between these two results was less than the expected sampling error calculated for either method.

Since these tests compared one sampling method with another, it was not possible to calculate the statistical significance of the difference between them. However, it has generally been considered that any sampling method is satisfactory that yields an estimate within 10 percent of the true cover density. The agreement between the variable-plot estimates and those made by other methods strongly suggests that density estimates made by the variable-plot method will fall well within these limits.

The variable-plot technique is most applicable where nearly circular objects are sampled. If shrub crowns are extremely irregular, considerable bias will be introduced. For this reason, the method is most useful in reconnaisance and extensive surveys. In forestry work, the angle prism suggested by Bruce (1955) has been widely adopted instead of a stick. This idea could be tried for estimating shrub cover, but the angle prism appears to have fewer advantages in counting shrubs than it does in counting small tree trunks.

Summary

The variable-plot method can be used to estimate shrub density in percent without measurement of distance or area. This method is faster and easier to apply than any of the standard shrub-estimating procedures now in common use. In tests in three different vegetation types, it closely approximated the estimates obtained by other sampling methods. It is most reliable in open shrub stands with a density of less than 35 percent; beyond that point accuracy falls off rapidly. Variable-plot data are subject to statistical analysis, and are particularly useful in calculating an index of dispersion. The variable-plot method appears to be a practical means of reducing the labor required in collecting field data on shrub density.

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Report On Argentina

WALTER DUTTON, back from his F.A.O. range assignment in Argentina, is enthusiastic about the future possibilities for increased livestock production in that country. Breeding standards are high. A favorable climate over much of the area allows exceptionally long growing periods. Grazing capacities on both natural grasslands and artificial pastures are outstanding—in many places 2 to 5 acres per head per cow for one year. Currently, however, the outlook is not encouraging. General failure during the growing period to convert surplus forage to hay and silage for use in winter is the main stumbling block to increased production. All too common are low calving and lambing percentages, long periods for steers to reach maturity, and heavy incidence of foot-and-mouth disease, stemming directly from lack of adequate feed during critical periods. On the other hand, and indicative of what can be done, a few outfits are marketing 18 month old steers, weighing 1100 to 1200 pounds, from alfalfa-rye grass-bromegrass pastures without any supplemental feeding. In Patagonia, about 70 percent of the land is owned by the Federal Government but is entirely without any provision for management or protection such as that given Bureau of Land Management and National Forest lands in the States. Consequently, as a result of many years of abusive use, much of the land in this province is in a serious stage of depletion.

Differential Effect of Herbage Removal on Range Species

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An extensive survey of California livestock operations conducted over nearly a decade by Jones and Love (1945), revealed that the various ranges exemplified every degree of transition from better species toward poorer and *vice versa.*

In every case the trend upward or downward in grazing values was a direct result of practices applied. Where livestock were grazed on a given range only while the plants were green and growing, and were removed before soil moisture became inadequate for maturing the better annuals and perennials, the transition toward better feed proceeded rapidly, provided the livestock load was neither excessive nor too light. On the other hand, where livestock use was deferred until the more rapidly developing annuals had reached the flowering stage or later, the transition toward poorer quality feed was rapid. When a range was used on a year-long basis, the transition to poorer feed was somewhat slower, but range deterioration was in progress as evidenced by an increasing population of weedy plants. Even low rates of stocking did not answer this last problem, because this allowed more opportunity for selective grazing. Such was evidenced by the development of larger and larger colonies of undesirable species that early became unpalatable, *e.g.* red brome (*Bromus rubens*), annual fescues (*Festuca* spp.), annual foxtail barleys (*Hordeum* spp.), and ripgut (*Bromus rigidus*). This was accompanied by a decrease in the population of desirable annuals such as bur clover (*Medicago hispida*) and soft chess (*Bromus mollis*).

Grazing Treatment

These observations indicated strongly that range species react differentially to grazing treatment. Love (1944, 1952) reported the results of experiments showing highly significant response of perennial grasses to early and deferred grazing, especially with respect to stand establishment of the perennials. For instance, line transect counts of seeded *Stipa pulchra* showed 111 plants following early grazing, while only 23 plants were counted under deferred grazing. With *S. cernua* the plant counts following the two grazing treatments were 228 and 24, respectively. Depending on the grazing treatment, Love and Williams (1956) reported significant differences in bur production of *Medicago hispida.* Continuous grazing throughout the season was compared with a grazed-ungrazed-grazed treatment. The latter resulted in 2,264 pounds of burs per acre left on the ground at the end of the season compared with only 664 pounds in the continuously grazed field. These investigators suggested that alternating the two treatments annually would probably result in a high level of annual bur production as well as lamb gains.

Growth Characteristics

Manipulation of species on the range can be guided by critical study of the growth characteristics of the individual plants. Branson (1953) reported differences in growth habit in perennial grasses in regard to elevation of the growing points and the ratio of flower stalks to vegetative stems, and related these characteristics to the tendency of the grasses to decrease or increase under grazing.

Differential responses to herbage removal among species should be recognized so they may be utilized to advantage through proper grazing management. In annual grasses especially, the production of tillers, heads, and seed relate to persistence under grazing. The investigation of such features, particularly as affected by the timing of herbage removal, was the objective of the following studies.

November plantings of soft chess (*Bromus mollis*), foxtail fescue (*Festuca megalura*), slender wild oats (*Avena barbata*), and Mediterranean barley (*Hordeum hystrix*) were made in replicated 4-foot rows in the field at Davis for two years to compare the effect on growth termination of clipping the spring following planting. Clipping was at 3 to 4-inch height, commencing when the "early boot" stage was reached. Such clipping removed the immature inflorescence of the elongating culm, thereby stimulating the development of tillers. By repeating the clipping at approximately two-week intervals, the growing points of successive sets of tillers were removed, and vegetative growth through the production of new tillers was stimulated. The tillers became progressively shorter and fewer, however, as the season advanced.

A comparison of clipped and unclipped rows during the spring of 1954 revealed that green growth in the repeatedly-clipped rows was terminated about two weeks later than in the unclipped. This occurred regardless of the date of "maturity" of the species, which for unclipped plants in this instance was May 21, June 7, June 14, and July 6 for the foxtail fescue, mediterranean barley, soft chess, and wild oats, respectively.

It should be observed that these responses were obtained on deep and fertile soil, with reduced competition from other species, and in a season of favorable rainfall distribution through February, March, and April. The last effective rain fell April 27-28 and totaled 1.3 inches.

Greenhouse Study

To study individual plant behavior more thoroughly, greenhouse plantings of soft chess and of foxtail fescue were made periodically in 6-inch pots. Plants were thinned to three per pot, and 27 plants comprised a treatment. Growth conditions were maintained to permit development to maturity regardless of the date of planting, this being accomplished in winter by providing long photoperiods.

Clippings were made at 1½ inch height, when the first heads were emerged. Measurements included dry weights of clipped tissue, head height, and tillering behavior. Two clipping procedures were employed in each planting. One treatment was clipped twice, giving opportunity to compare the first regrowth with the original production. The other was clipped repeatedly as each successive rank of tillers headed, and indicated the potential growth duration.

Under the conditions of this experiment soft chess continued growth by repeated tillering and heading over a prolonged period. A mid-March planting was still tillering and heading in April of the following year. By then it had been clipped eight times, and two-thirds of the plants had died. However, there had been 83 percent survival through the fifth clipping.

Certain comparisons between the original growth and subsequent regrowth of soft chess were noted under these greenhouse conditions. The dry weight per plant of both the first and subsequent regrowth was approximately one-fifth that of the first production. The average head height of the first regrowth was 40 percent that of the original heads, and each successive rank of heads tended to be slightly shorter than the preceding ones.

Foxtail fescue differed from soft chess in that, following the second clipping, growth was reduced markedly and essentially was terminated after the third herbage removal. Such behavior agrees with the very early maturity exhibited by this species in the field.

Field Clipping

Unlike plants in the greenhouse, those in the field are subjected to variation in environment and respond with seasonal growth. Here the effects of herbage removal have importance in regard to the regulation of growth from the standpoint of grazing management.

Though it is well-known that the time of herbage removal has a pronounced effect on the behavior of a species, very little quantitative data are available on these responses. A field seeding was intensively studied to determine the effects of timing of herbage removal on regrowth and culm development, seed characteristics, and growth cessation in two species of annual grass; namely, soft chess and red brome.

The two species were seeded on November 19, 1954, at a depth of 1½ inches in 5-foot rows spaced 12 inches apart. Treatments were randomized with four replications. Eleven inches of rain fell between planting and May 8, this latter date marking the last effective rain of the season. With the exception of a dry March, the distribution pattern of the precipitation was relatively normal. Growing conditions were favorable, though cool-

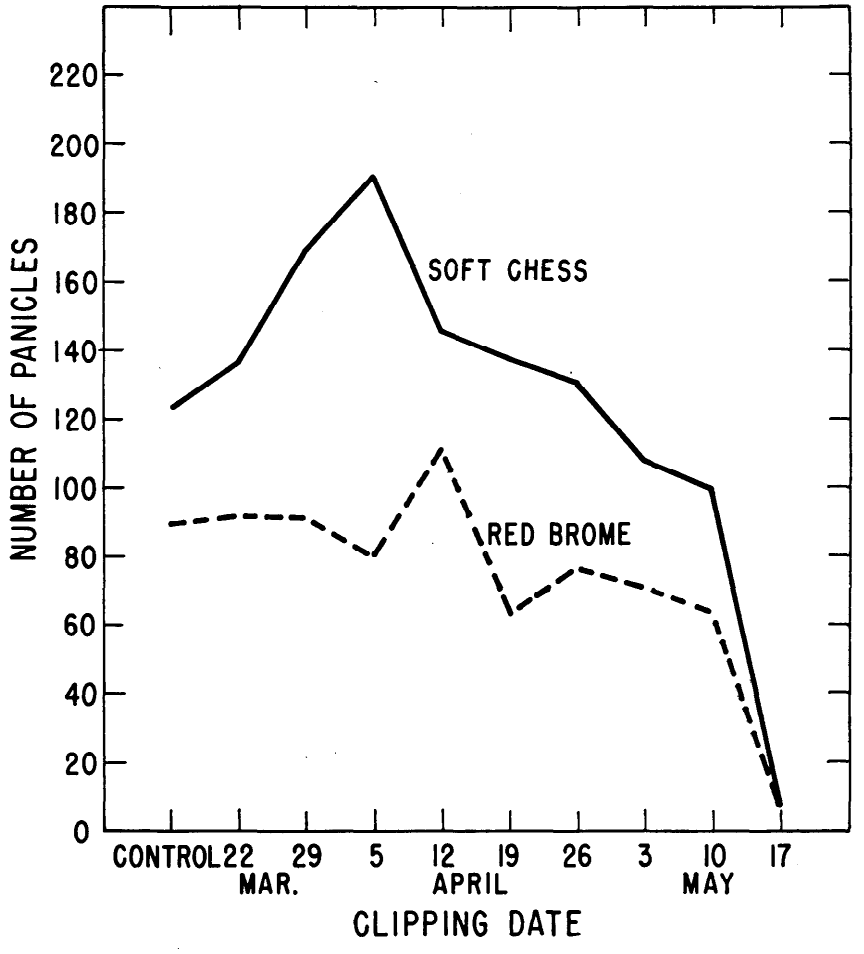

FIGURE 1. Average total number of panicles per foot of row.

ness delayed early growth. First heading was observed in controls of both species on April 4.

The ten treatments consisted of a control and nine treatments clipped once at 1½ inch height. Dates for clipping commenced March 22, by which time culm elongation had started, and continued at weekly intervals until May 17. This permitted a comparison of regrowth following herbage removal on successive dates with the production of unclipped plants.

The panicles were cut from one linear foot of row when mature but before shattering. In the case of the earlier clipping dates, the first inflorescences were followed by a second rank of shorter headed culms which matured later. Two dates of sampling were necessary to get the complete production of these plants. Results were obtained directly, or by computation from counts of culms, weights of spikelets, and determinations of the number of filled caryopses in a given weight of spikelets.

The average total number of panicles produced following the several dates of clipping is presented in Figure 1. Though both species were subjected to the same environment, the response was somewhat different. Soft chess responded to the clippings of March 22, 29, and April 5 with increased numbers of heads in the regrowth, while red brome exhibited relatively little change from the control during the same period. The greatest difference followed the April 5 clipping, when total inflorescence production of soft chess averaged 112 greater per foot of row than did that of the red brome. After mid-April there was a rapid reduction in panicle production in the regrowth of both species and this trend continued throughout the remainder of the growing season.

Change was visible in the size of inflorescences produced as the season advanced. In general, the weight of spikelets per panicle progressively decreased with later

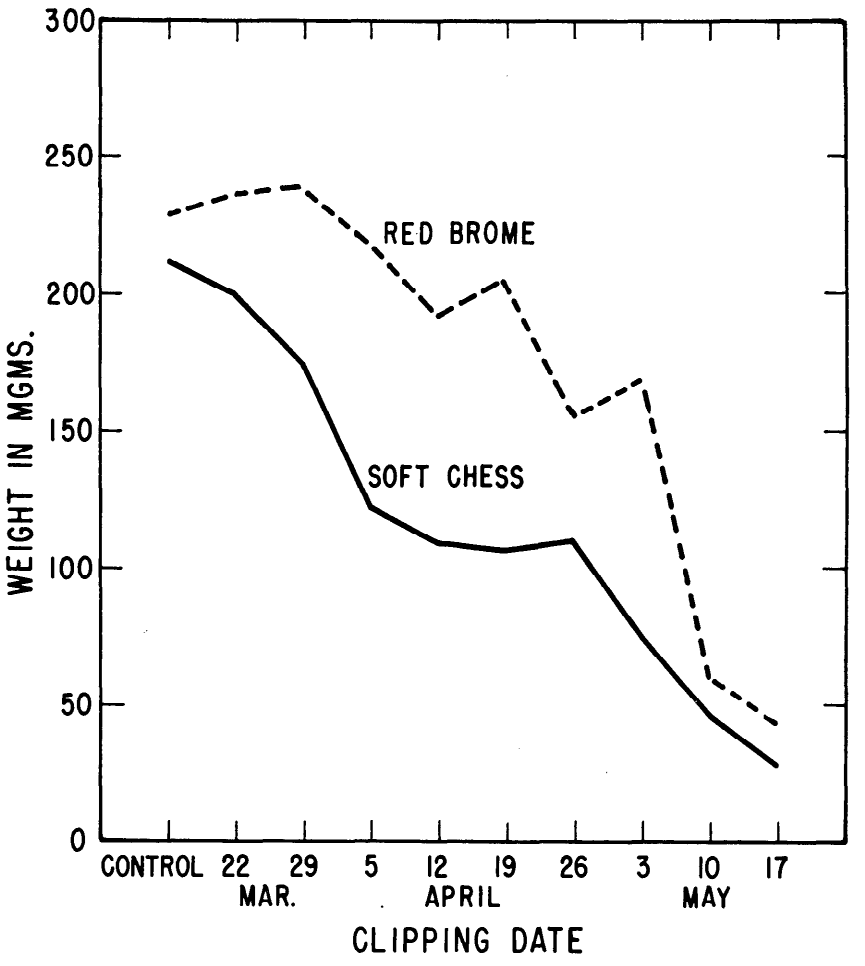

FIGURE 2. Average air-dry weight of spikelets per panicle.

dates of clipping. This is illustrated by the air-dry weight of the spikelets per panicle, determined after removal of the culm and rachis from the inflorescence. Figure 2 depicts this change, and, although the red brome tended to be heavier, both species followed the same pattern.

In the control of an annual species through management the reseeding potential is of primary importance. An evaluation of seed production was made by determining the actual number of filled florets in a given weight of spikelets and then computing the total number of seeds produced per foot of row. The "seed" in this determination included the caryopsis with attached lemma and palea. Empty florets were not included in the count. Increased accuracy was gained by counting three samples within each lot of spikelets. Figure 3 shows the trend in seed production. As might be expected, similarity exists between the number of panicles and the amount of seed produced.

The declining weight of the spikelets following the later clippings suggested lighter seed. Since it is recognized that a relationship may exist between seed size and seedling vigor (Kneebone and Cremer, 1955), this was checked. Plantings of both species were made in soil in the greenhouse using seed from the control and from the regrowth of the clipping treatments of March 29, April 26, and May 3, 10 and 17.

The relationship between seed weight, seedling emergence, and seedling vigor is presented in Figure 4. Seedling emergence 7 days after planting had reached 75 per-

cent or more in all cases, and with additional time the minimum emergence was 80 percent. The dry weight of top growth of 50-plant samples 35 days after planting reflects no reduction in vigor of seedlings from late maturing seed. Rather, increased vigor in soft chess is indicated from mid-season seed. The late matured seed, under the conditions of this experiment, is not associated with marked reduction in emergence or seedling vigor.

The clipping treatments provided opportunity in the spring of 1955 to study the effect of herbage removal on prolongation of green tissue production. The transition from completely green to mature and brown plants was arbitrarily divided into nine classes. On May 30, just before the controls were devoid of green tissue, and again on June 7 and June 14, the treatments were rated visually according to this scale. Both species behaved in like manner. On May 30, depending upon the date of clipping, the range from green to nearly brown was represented. By June 7 green tissue was apparent only in those treatments clipped after mid-April, while by June 14 all treatments except the last two were completely brown. Late developing tillers were the source of the green tissue after clipping at the 1½ inch height.

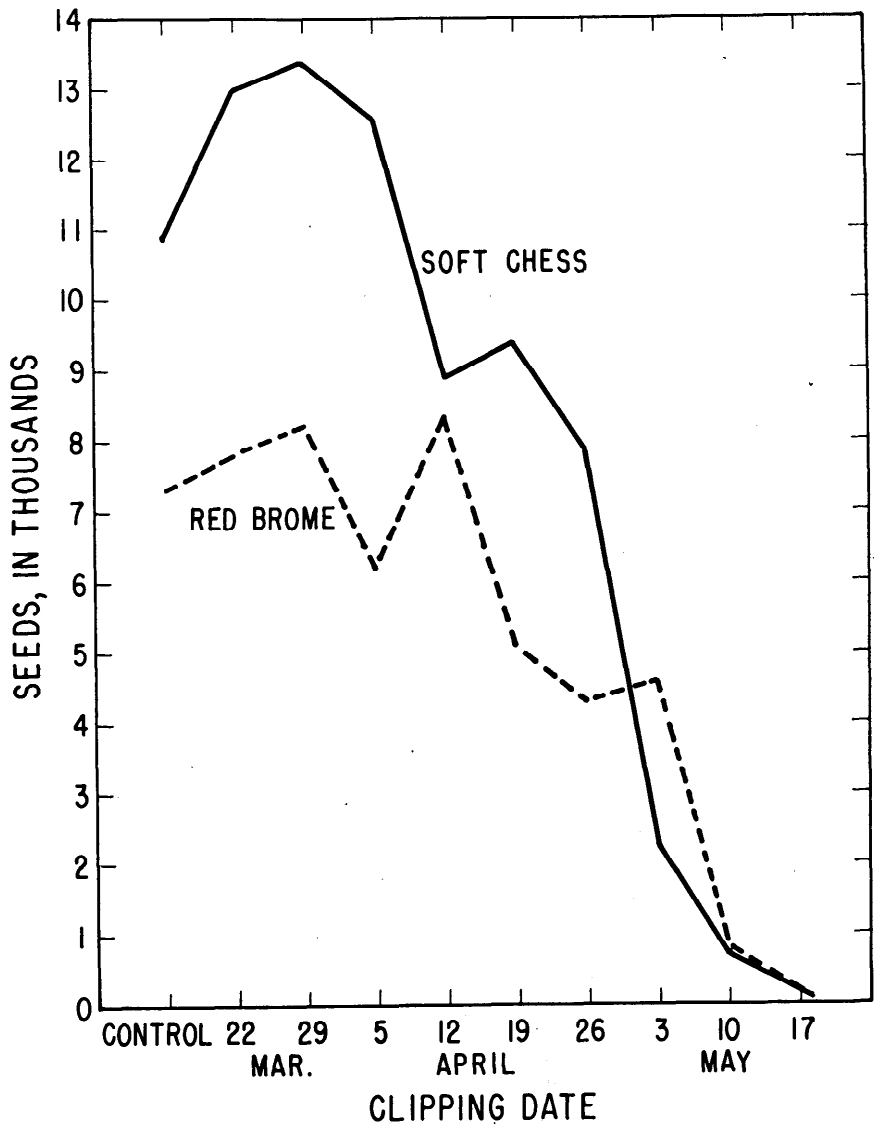

FIGURE 3. Average number of seeds produced per foot of row.

Summary and Conclusions

Herbage removal, timed with regard to the growth characteristics of individual species, offers a means which has not been adequately recognized, for manipulation of vegetation. Differences in behavior among the species of grass make this possible, and permit choice of management practices to encourage or discourage a given species or group of plants.

Range species react differently to grazing treatment. Grazing at such time as to reduce the seed production of one annual species more than another provides a way to limit the reseeding potential and, thus, the prevalence of the species in the vegetation. After herbage removal, soft chess was found to continue tillering and heading much longer than foxtail fescue. In such a comparison it would appear that early grazing could be continued to the growth termination stage of the fescue, thus depressing this species, yet this being early enough to permit later tillering and abundant heading in soft chess.

Under the same environment soft chess and red brome responded differently to the early clippings. Increased heading in the regrowth of soft chess relative to red brome persisted to mid-April, after which heading in both decreased as the season progressed. To markedly affect seed production, grazing would be necessary until the late-season decline in heading was well advanced. At this time not only are fewer heads produced, but the inflorescences are smaller, and mature less seed. The seed produced, however, may retain high germinability and the potential for good seedling vigor.

Animal preferences must be considered in determining the results of vegetation manipulation through herbage removal once these plants have headed out. For example, livestock do not graze the headed

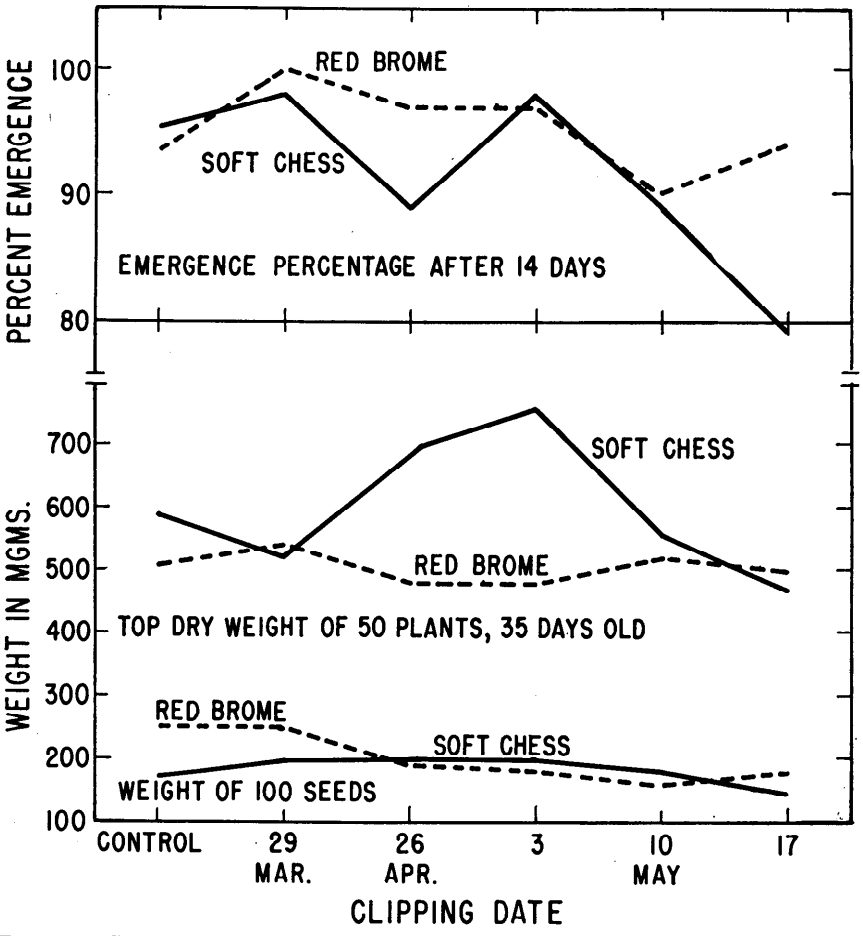

FIGURE 4. Comparison of seedling emergence, seedling vigor, and seed weight in soft chess and red brome.

red brome as they do soft chess because of the obnoxious awns of the former. In effect, this would increase the seed of red brome relative to that of soft chess.

Among the variables which influence the success of herbage removal as a tool in range management are the inherent growth characteristics of the species, plant competition, selective grazing, and weather. Though the degree of control a rancher has over these variables is more or less limited, timed herbage removal, taking into account the growth characteristics of the species and the palatability preference of the grazing animal, can be advantageously employed.

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In Memoriam

HUGH M. BRYAN (1890-1956), range and forestry staff officer of Area 2, Bureau of Land Management, Salt Lake City, died at Rochester, Minnesota, on October 31, 1956, following an operation. This closed a professional career spanning more than 40 years, in which he was one of the pioneers in the development of scientific principles for the conservative management of range lands in Western United States.

A native of Albuquerque, New Mexico, he was educated at the universities of New Mexico, Princeton, and Oxford in England, where he was a Rhodes scholar.

He was employed 5 years (1913-1918) by the U. S. Forest Service.

During World War I he served in the U. S. Army. For 16 years (1919-1935) he was engaged in range livestock operations in New Mexico as employee, owner, or corporate manager of range sheep and cattle outfits which used both private and public ranges.

From 1935-1956 he was employed by the Grazing Service and BLM where he served in various regional and national professional staff assignments related to developmental exploration, administration, and management of public ranges in 10 Western States.

He was a charter member of the American Society of Range Management and has served efficiently on many national and sectional committees.

MR. BRYAN leaves as a monument many notable professional contributions to the advancement of scientific range management. Few men had a more comprehensive understanding of the western range livestock industry and the complex inter-dependent relationships of public and private ranges in Western United States. Few men could as ably expound these subjects to a younger generation or an audience of graziers or laymen. *Milo H. Deming.*

Range Management Education
V. College Training for Range Management Students: An Employer's View

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The education and training needs for a career in range management are both general and specific. In prescribing professional training for range technicians and range managers we need to recognize at least the following overall principles: (1) range management is no longer a mere trade, but a profession; (2) success in any profession dealing with natural resources depends on a thorough understanding of basic laws pertinent to biological systems; and (3) greater emphasis is now needed on science, less on the trade school approach; more on why and how things happen, less on what happens.

Attributes of the Man

In selecting men for range management positions, I find myself looking for other attributes, in addition to the important ones of knowledge and training. While the routine questions about education, experience, marital status, military career, etc. are being asked, I find myself wondering, "Is this a man with whom I would like to work? Does he have a well-rounded personality that will enable him to deal with others? Is he aware of the world around him, and beyond his specialty of range management? What is his speaking and writing ability? His judgment, initiative, orginality? His ability to grow and adapt himself to new situations?" In asking these questions in my own mind, I am well aware that a man seldom ends in the exact field of work of his choice. But if he can grasp opportunity when it comes, and adapt to new situations, he will get along.

This article was originally presented as part of a panel discussion on range management education at the Ninth Annual Meeting of the Society at Denver, Colorado, in January, 1956. Articles I, II, III, and IV appeared in previous issues of the Journal. Other papers in the series will be published in subsequent issues.

Extent of Specialization

With respect to formal training for range management, it is possible to combine effectively the fundamental sciences and professional disciplines of more than one field of work, but one must always be subordinate to the other. For example, we can develop specialists in either the field of range management or the field of animal husbandry. These specialists can have a general working knowledge of each other's fields. But we cannot make a useful half-and-half hybrid by crossing or combining equal amounts of knowledge from both fields. Somewhere in his career, the student must choose his major profession. If he is well trained, however, he will acquire sufficient grasp of numerous broad fields to know which specialists to call on when integration of different sciences is needed.

In considering the training needs of range-management students, a distinction between true specialization and broad education is useful. Sherlock Holmes may have been a "screwball," but he was a true specialist. You will remember how Watson listed his capacities. Sherlock's knowledge of literature, philosophy, and astronomy was nil. His knowledge of politics, botany, and soils was feeble, variable, or practical, depending on the use he planned to make of these fields. He became one of the world's greatest consulting detectives because his knowledge of chemistry and criminal literature, for example, was profound. He knew what he wanted and he specialized for it.

We do not expect the college graduate to be a specialist when he comes to us. If he ultimately becomes a specialist, it will be because of what he has within himself. What we hope for in the new employee is a reasonably broad perspective that will ultimately enable him to cope with any professional situation. His college preparation for this should include orientation and a general view of both his own and of related fields. At graduation time, the student is not expected to be familiar with all the professional and technical situations he will encounter in life. But he should know a great deal about the mechanics of how to find out what he needs to know.

If a college student believes that he wants to major in range management, he should start with the basic sciences and liberal arts in his first and second years. This is equivalent to the type of training received in most premedical, prelaw, prejournalism, or predentistry courses. The beginning of his specific training can start in the third and fourth years of college. In these last two years, he can begin to acquire training in the profession of his choice. He can also gain knowledge of the coordination that exists between major fields such as range management, animal husbandry, game management, and forestry. Any one of these may become his final specialization, if he decides to specialize.

Every young graduate should

understand that he is likely to be a victim of circumstances, or a beneficiary of opportunity, in whatever field he works. He should realize that specialization does not come with the bachelor's degree. It increases as work is done for the master's and doctorate degrees. But even these are not absolutely necessary. Breadth and depth comes with the man himself. And true specialization does not appear until the scientist becomes an "authority" in one or more phases of his chosen field through long continued investigation and accumulation of information and experience.

Possibly the best we can do with 4-year college graduates, in addition to giving them a broad orientation and a general understanding of their chosen subject and its related fields, is to help them attain knowledge that will aid them in sympathetic cooperation in joint studies or participation with workers in other fields, intelligent participation in planning courses of action, and a knowledge of the boundaries of their field of work which will enable them to recognize when they are getting out of bounds, or when others are encroaching on their field.

Scope of Range Management

If we keep in mind the scope of range management, we have a better basis for deciding what should be the nature of training given to range students in college. Workers in range science administer, supervise, or perform professional or scientific work in the utilization, protection, development, and management of rangelands for the continuous production of livestock or big-game animals or both. Included in range management are such phases as range inventories, range-grazing-capacity determination, range ecology, range reseeding, big-game range habitat improvement, and range economics. Thus range management essentially is a vegetation management, attained through handling of animals and mechanical devices. Certainly, range management does not require a profound knowledge of such fields as dairy husbandry, bacteriology, anatomy, and animal diseases.

Curriculum Changes Desirable

In the training of range experts, it would appear, therefore, that certain changes in the average college curriculum would be desirable. The following should receive greater emphasis, or be added to the curriculum: English and journalism; more ecology; more study of experimental methods and forms of evidence; plant physiology; and more systematic botany and agrostology.

The following subjects could receive decreased emphasis, or even be omitted from the curriculum: economics (one course instead of two or three); chemistry (omit quantitative analysis and physiological chemistry); microbiology; bacteriology; and horticulture.

The content of some courses could profitably be changed. In English, for example, more emphasis is needed on letter writing, report writing, radio talks, television, forms of scientific exposition, and writing the popular article. Actual materials should be used in courses of instruction, and less emphasis should be placed on textbook examples. In mathematics, if the students were taught to do simple arithmetic, it would be useful in their life's work. They seldom need the furbelows that go with mathematics courses.

Finally, some college curricula are notably lacking in broad coverage of conservation and resource management. Students in range management could profit by taking survey courses which give the essentials of animal husbandry; animal husbandry students could profit from courses that survey the field of range management. *All students could profit from courses in how to think.* Too few of us understand the scientific method and the principles of reasoning based on constructive and destructive argument.

The only hope for modern resource managers to cope with the wide problems of today is to base their actions on fundamentals that include a proper balance of basic sciences, humanities, and the techniques of their professions. The college can do much to achieve this balance in the men they train.

We look for these qualities in the men we employ.

CALL FOR PAPERS FOR THE 1958 ANNUAL MEETING

Members who wish to present papers at the next annual meeting of the Society in Phoenix, Arizona, January 29-31, 1958, are invited to offer titles now.

Approximately 200-word abstracts should reach the Program Chairman as soon as possible, but not later than July 15, 1957, for consideration by the Program Committee. Papers on plant control, range reseeding, management, and technical problems of range management are especially desired. Send your titles and abstracts to: HUDSON G. REYNOLDS, Rocky Mountain Forest and Range Experiment Station, 107 Agriculture Building, Arizona State College, Tempe, Arizona.

Viability of Medusa-Head *(Elymus caput-medusae L.)* Seed Collected in Idaho

LEE A. SHARP, M. HIRONAKA, AND E. W. TISDALE

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Medusa-head (*Elymus caput-medusae*), an annual grass with undesirable forage qualities, is presently estimated to occur on approximately 190,000 acres of rangeland in Idaho. This plant is a serious problem in Gem, Payette, and Washington Counties in southwestern Idaho, where it occurs in extensive stands and grows almost to the total exclusion of other species. Spot infestations have been reported in five other counties in this part of the state and in two counties in north-central Idaho.

The long-awned seed is easily carried for great distances by man, machinery, and animals. Seed can be transported in the coat or fleece of animals and also in the digestive tract. Lehrer and Tisdale (1956) report that germinable seeds of medusa-head were recovered in fecal material for a period of four and nine days after ingestion by rabbits and sheep, respectively. The ease with which the seed can be transported poses a threat to many additional thousands of acres of annual type rangelands now free of medusa-head.

Preliminary studies on the phenology and competitive ability of the plant were reported in an earlier paper by Sharp and Tisdale (1952). Since the publication of that paper, germination tests of medusa-head collected from a number of locations and under a variety of conditions have been conducted. It is the purpose of this paper to report the results of these tests as a basis for further studies of the plant and for the formulation of a control program.

Description

In Idaho medusa-head is normally a fall germinating annual. Germination occurs in October or November as moisture becomes available from fall rains. Leaf development of several inches may be produced before cold weather stops the growth process. In the spring growth is resumed, but the plant matures two or three weeks later (late June or early July) than cheatgrass (*Bromus tectorum*). Flowering occurs in early June, and by July the seed has matured. Unlike cheatgrass, medusa-head seed persists in the head until fall.

The area of main infestation in southwestern Idaho lies in a pre-

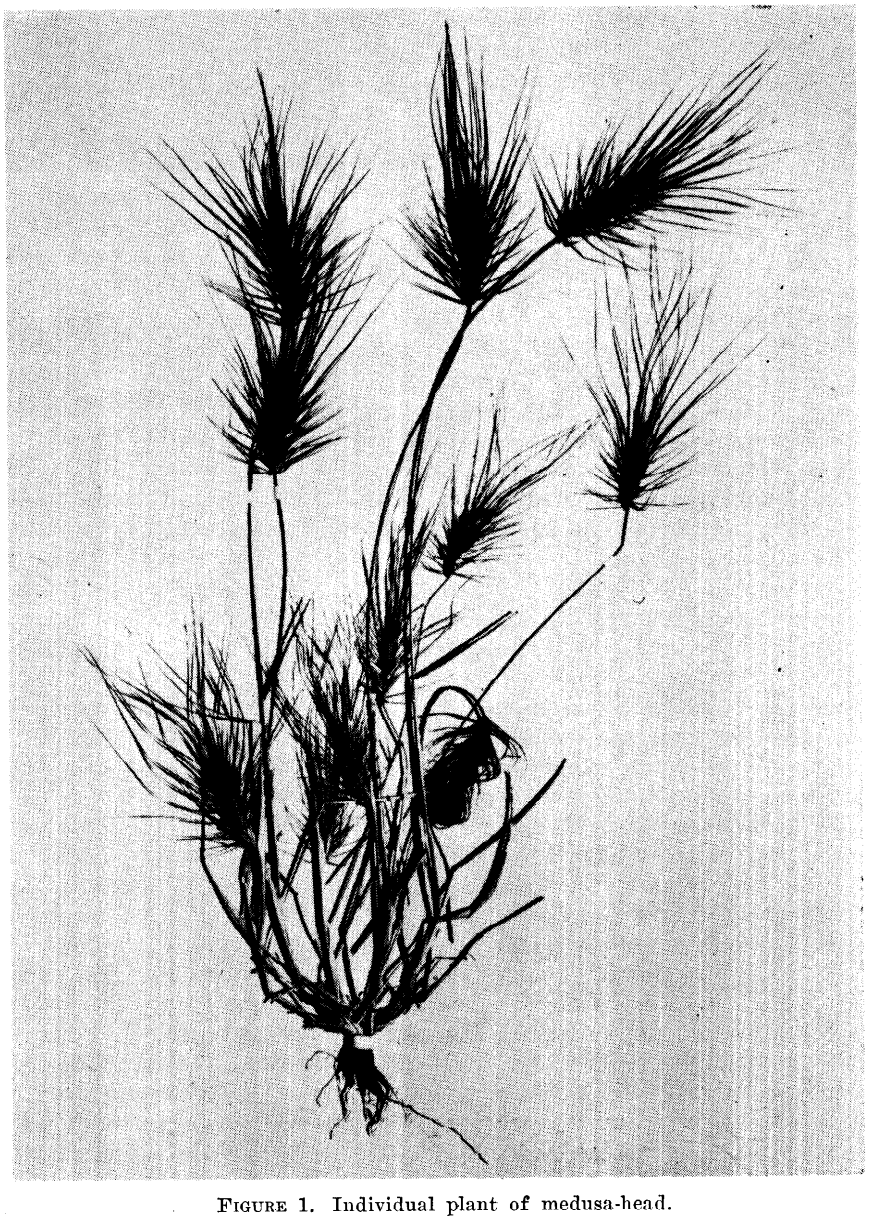

FIGURE 1. Individual plant of medusa-head.

cipitation zone ranging from 10 to 20 inches annually. Examination of relatively undisturbed stands of vegetation in this foothill region indicates that the climax vegetation consisted, in the main, of a sagebrush-grass cover with a good complement of perennial grasses and forbs. Prior to invasion by medusa-head, however, the cover had deteriorated to an annual type of vegetation with a predominance of cheatgrass. Medusa-head occupies a variety of soil types in southwestern Idaho. It is found growing on heavy clays, on well developed loam soils, and on scablands. The plant appears to be associated with a stage of deterioration in plant cover, rather than with any particular soil type.

The plant is a strong competitor with other annuals. Furbush (1953) states that as early as the 1930's this species was taking over extensive areas in northern California and crowding out more desirable annual species. The species replaced by medusa-head in California were mainly annual grasses and legumes. In Idaho, medusa-head is replacing cheatgrass primarily. Observations indicate that perennial grasses are effective barriers to the spread of this noxious annual.

Sharp and Tisdale (1952) found that within three year's time medusa-head became the dominant plant on an area formerly dominated by cheatgrass and other annuals. The aggressive nature of medusa-head is indicated by the number of plants able to grow in a limited area. Counts made in 1950 gave results of 1,500 to 2,000 plants per square foot on a valley bottom soil of moderate depth, and 500 plants per square foot on scabland soil. The average number of seeds per head was 8.7 and 5.6, respectively. In dense stands the plants usually produce one seed head per plant. Where the stand has been thinned and competition among plants is not too great, the number of culms commonly increases to three to five per plant.

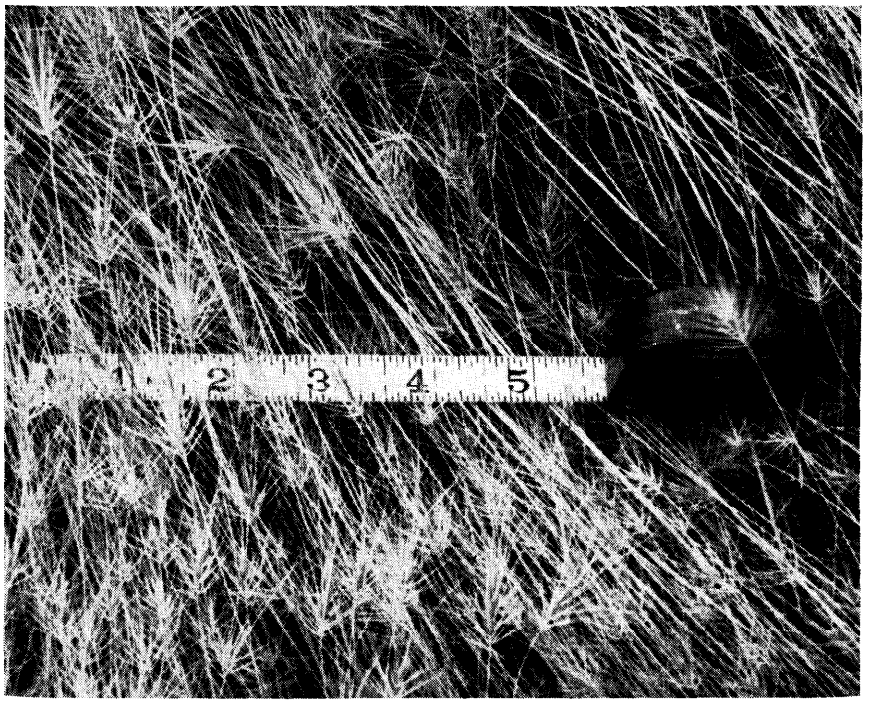

FIGURE 2. The dense growth of medusa-head results in the almost complete exclusion of other species from the extensive stands of this noxious annual grass.

In one rare instance a plant produced 133 seed heads.

Germination Studies

Period of Viable Seed Production

During the 1952 and 1953 growing seasons, seed of medusa-head was collected from three areas at periodic intervals to determine at what time in the post-flowering stage of the plant the seed becomes viable. Collections were made at approximately weekly intervals in the two years at a location on the north side of the Clearwater River valley in north-central Idaho. The collection area is located in Nez Perce County and is on a southeast slope at approximately 2,400 feet elevation. The site is in the *Agropyron-Poa* zone (Daubenmire, 1942). The native bunchgrasses of the area (principally bluebunch wheatgrass, *Agropyron spicatum*) have been replaced by annual brome grasses (*Bromus* spp.), foxtail fescue (*Festuca megalura*), medusa-head, and goatweed (*Hypericum perforatum*), a noxious perennial forb.

Weekly collections were made north of Emmett in Gem County in southwestern Idaho during June of 1952. The collection area is located on gently rolling terrain at an elevation of approximately 2,600 feet. The present vegetation is primarily medusa-head with some cheatgrass, common sunflower (*Helianthus annus*), and tall willow herb (*Epilobium paniculatum*).

Infrequent collections were also made during 1952 in the Crane Creek area of Washington County. This site has somewhat more favorable growing conditions than the site in Gem County. It is situated at approximately 3,500 feet elevation. The vegetation is primarily medusa-head with some perennial grasses (*Sitanion hystrix* and *Poa secunda*), annual bromes, and annual forbs. The climax vegetation consisted of sagebrush-grass with a predominance of bluebunch wheatgrass.

Four replications of 100 seeds each from samples collected on various dates at each site were germinated in the laboratory at room temperatures ranging from 70° to

Table 1. Germination percentages of medusa-head seed collected at various dates on Coyote Grade, Nez Perce County, Idaho. Period of germination trial was 28 days in 1952 and 21 days in 1953.

Stage of Plant Development	1952 Collection Date	1952 Collection % Germ.	1953 Collection Date	1953 Collection % Germ.
Pre-anthesis. Plant green except for lower leaves and stem, head partially in sheath.	*	*	5/31	0.0
Milk stage. Plant similar to above except head is completely clear of sheath.	*	*	6/6	0.25
Milk to early dough. Stem dry about ½ its length, remainder of plant green.	*	*	6/23	8.0
Early dough. Similar to above.	*	*	6/27	12.0
Mid-dough. Stems nearly dry to head, awns and glumes green, lemmas with slight reddish to brownish tinge.	6/7	74.0	7/5	78.0
Late dough. Stem dry to head, awns and glumes greenish and fading to brownish color, lemmas brown.	6/16 6/22	92.0 95.0	7/11 *	97.0 *
Seed ripe. Stems pale straw color, awns and glumes brownish to straw color, lemmas brown.	7/6	93.0	7/27	94.0
Seed ripe. Similar to above but awns and glumes continuing to fade to straw color.	7/14–8/21	90–96	*	*
Seed ripe. Whole plant straw colored in appearance.	9/6 –9/17	89–94	9/1	98.0

*Collections not made.

90° F. Each replication of seed was placed between 3- by 10-inch strips of blotter and kept moist during the period of trial. Germination tests were conducted six to eight months after collecting dates, during which times the seed had been stored at room temperature under dry conditions.

A summary of the results obtained for the site located in Nez Perce County is presented in Table 1. Comparable germination results were obtained with samples collected three to four weeks later in 1953 than in 1952. The spring months in 1953 were cooler and delayed plant maturity. Temperature records at the Lewiston airport, which is a few miles from the site, show that it was three to four degrees cooler during the months of April, May, and June in 1953 than in 1952.

Fairly high germination percentages (74 to 78 percent) were obtained from seed samples collected while there was still a greenish appearance to the heads. The seed at this time was in the mid-dough stage of maturity, and with the exception of the heads, the entire plant appeared completely cured. Approximately one week later, seed development had advanced to the late-dough stage and the heads had lost their greenish color. Germination percentages at this time increased to more than 90 percent. The germination percentages of seed collected after the late-dough stage remained high, with no significant downward trends through the period of collection.

Germination results obtained from samples collected in southwestern Idaho are presented in Table 2. Medusa-head development in this part of the state is from one to three weeks later than in north-central Idaho. In all cases high germination percentages were obtained from samples collected after the late-dough stage of seed development was attained.

Seed Burial Study

During the fall of 1954 two replications of 100 seeds each were placed in small baskets made of plastic hardware cloth and buried in the ground at depths of ½ inch, 2 inches and 4 inches, in Washington County. The seeds were recovered in December of 1955 for germination trials. Average germination percentages of 10, 9.5, and 11.5 were obtained for the ½-, 2-, and 4-inch depths, respectively. Because of the large amount of medusa-head produced annually, even the relatively small germination percentage obtained is significant for it indicates that a fair amount of seed is able to remain viable in the soil for at least one year, if buried by cultural practices or other means.

Soil and Litter Germination Trials

Several collections of surface litter and soil to a depth of 1 to 2 inches were made at various locations in 1953 and 1954. Most of the collections were obtained prior to the production of seed by medusa-head for that year. Where collections were made after seed heads had been produced, the heads were removed from the surface before taking the sample. In no case had seed shattered from the heads of the plants at the time of collection.

The numbers of seedlings of medusa-head and other annuals

Table 2. Germination percentages of medusa-head seed collected in Gem and Washington Counties in southwestern Idaho in 1952 and 1953. Period of trial was 28 days in 1952 and 21 days in 1953.

	Gem County				Washington County			
	1952		1953		1952		1953	
State of seed development	Date Coll.	% Germ.	Date Coll.	% Germ.	Date Coll	% Germ.	Date Coll.	% Germ.
Early dough	6/ 7	38.0	*	*	*	*	*	*
Mid-dough	6/13	79.2	*	*	*	*	*	*
Late dough	6/21	90.7	7/9	80.0	7/7	91.0	7/9	91.5
Ripe seed	6/28	93.5	9/21	81.5	7/21	87.0	*	*

*Collections not made

Table 3. Emergence of medusa-head and other annuals from surface material (6″ by 6″) collected from various locations in 1953 and 1954.

Location	Date of Collection	Number of Plants Emerging	
		Medusa-head	Other Annuals
Gem County, S-1	5/6/53	17	41
Gem County, S-2	5/7/53	38	12
Washington County	5/7/53	161	9
Nez Perce County	5/31/53	7	22
Nex Perce County	6/2/54	32	5
Gem County	6/24/54	120	5
Washington County	6/24/54	113	0

that emerged during the period of trial are given in Table 3. These results indicate that large numbers of viable seeds are carried over for at least one year in the litter and topsoil. The other annuals consisted primarily of cheatgrass and foxtail fescue. It was not determined what percentage of these plants were from current year's seed. Caryover, however, of viable cheatgrass seed has been reported as uncommon in northern Idaho and southeastern Washington (Hulbert, 1955).

It was noted that the amount of viable seed of medusa-head carried over was related directly to the amount of medusa-head litter. The converse of this appeared to be true for other annuals. Accumulation of 3 to 5 inches of medusa-head litter is not uncommon in southwestern Idaho.

Burned Seed Trials

Burning of medusa-head stands as a means of control has been tried with some success in California. Furbush (1953) cites the case of one burn in June of 1948 in which medusa-head was almost completely eliminated in 1949. The area was still relatively free of the plant in 1951. However, burning has not been widely adopted as a method for medusa-head control in California.

Medusa-head seed from both scorched and unburned heads was collected from an area that was burned in June of 1950. Tests in the laboratory resulted in 0 percent and 87 percent germination, respectively. Four replications of 100 seeds each for the two treatments were used. The fire had consumed the awns and charred the tips of the lemmas of seeds from the scorched heads. The unburned seeds showed no sign of damage, although the culms were burned nearly to the heads by the fire.

Surface samples, 12 inches by 6 inches by 1 inch, were obtained from three plots that were experimentally burned in Gem County on July 6, August 6, and September 11 of 1953. Germination of these samples produced 2, 2, and 8 plants, respectively. Samples of burned seed from these plots did not germinate. Because the samples from the plots were not replicated the values presented do not necessarily indicate the true emergence of germinable seeds for the three burning dates. The important thing is that all of the viable seeds were not destroyed by fire, and sufficient seed remained to reinfest a burn area.

Discussion

The large areal extent and the type of terrain infested with medusa-head in Idaho make formulation of control methods difficult. Control is further complicated by the persistent nature of the species. Its large annual production of viable seed, the ability of seed to maintain viability in the litter and soil for one year at least, and its superior competitive ability over most annual species, make replacement of medusa-head with desirable species extremely difficult. Although burning destroys many viable seeds, sufficient numbers remain uninjured and the reduction in density is only temporary. The area is soon reoccupied by medusa-head with a density as great as before burning. Burning may also destroy seed of desirable species and weaken perennial species that are present. It appears that burning alone will not be an effective method of control but may be important, if supplemented by other means.

Summary

This paper reports the results of seed viability and germination tests of medusa-head, an undesirable winter annual grass now infesting approximately 190,000 acres of rangeland in Idaho. At present this species is largely confined to ranges formerly occupied by native perennials, and more recently by annuals, especially cheatgrass.

Medusa-head produces a large amount of seed annually, and fairly high viability is attained even when seed is collected while the heads still retain a greenish color. Carryover of viable seed in both litter and soil is shown to occur for one year at least. Fire-damaged seed from burned areas did not germinate in the laboratory, but substantial numbers of undamaged seeds from the burned areas germinated readily.

Acknowledgment

The authors are grateful to John E. Rinard of the Soil Conservation Service for his cooperation and assistance in gathering information for this paper.

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Some Variations in Morphological Characteristics and Palatability Among Geographic Strains of Indian Ricegrass[1]

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Indian ricegrass (*Oryzopsis hymenoides*) is a drought-resistant, cool-season bunchgrass common throughout the western United States, western Canada, and northern Mexico. It is particularly well adapted to sandy soils and is somewhat tolerant to alkali. In common with other native species which have occupied a wide area during a long period of time, natural selection has developed geographic strains or "ecotypes" showing wide variation in growth habit, size and shape of leaf, forage production, size and shape of seed, and other characters.

Variations in the palatibility of Indian ricegrass have been noted in different areas of Wyoming, and it was thought that these variations in palatability might be associated with geographic strains. Consequently, a study was undertaken with the following three principal objectives in mind: (1) to study the morphological variation in strains of Indian ricegrass from widely separated geographic locations, (2) to determine possible differences in palatability between these geographic strains and whether such differences are constant when the strains are grown on two different soil types, and, (3) to test the relationship between the chromogen content of plant material and its palatability to animals.

Previous Studies

Because of its wide range of adaptability to dry habitats having low soil fertility, Indian ricegrass is an important species for revegetating depleted land in the semiarid West. However, Stoddart and Wilkinson (1938) state that it is essential to treat the seed chemically or mechanically before it can be used in a reseeding program because of its low germination.

Johnson (1945) conducted cytotaxonomic studies of Indian ricegrass and considered that the genera *Stipa* and *Oryzopsis* have arisen from a common basic stock. Stebbins and Love (1941) and Nielsen and Rogler (1952) state that many plants which appeared to be intermediate between various species of *Stipa* and Indian ricegrass have been found in nature. One of these has been increased and is known as Mandan ricegrass (*Stiporyzopsis*).

The literature reveals great diversity of opinion regarding the meaning of the term "palatability" as well as the causes of the variation in preference exhibited by grazing animals. Rogler (1944) lists the following factors which may affect palatability: (1) maturity of the forage, (2) intensity of grazing, (3) rate of recovery after grazing, (4) amount in mixture with associated species, (5) drought resistance, (6) previous feed or grazing activities, (7) individual differences in animals, (8) fertilizers, (9) kind of livestock, and (10) local conditions.

Archibald, *et al.* (1943) found a close relationship between vitamin A (carotene) and palatability. Ritchey (1936) using tame rabbits in a palatability and toxicity test found an apparent relationship between the palatability of nine species of rattlepod (*Crotalaria*) when tested with rabbits and when tested with cattle at the Florida Agricultural Experiment Station. Arnold (1942) conducted a palatability study on a wide variety of grass, weed, and browse species in Arizona. He used two species of wild rabbits in an attempt to determine their preferences in relation to those of cattle and found that they compared favorably on the more "highly preferred" grass species, but there was no close relationship between palatability to rabbits and cattle in the weeds and browse.

Research workers have devised several indirect methods for measuring the digestibility and consumption of forages by animals. No literature concerning indirect methods for determining palatability has been noted.

Reid, *et al.* (1950) reported a new indicator method for determining digestibility and consumption of forages by ruminants, involving the use of natural plant pigments or "chromogens" as reference substances. Smart, *et al.* (1953) have reported that these "chromogens" are composed of at least seven pigments: chlorophyll a, chlorophyll b, pheophytin a, pheophytin b, luteol, violaxanthol, and carotene.

Reid, *et al.* (1950) also stated that "In a few cases where animals refused a small quantity of the forage offered, the chromogen content of the orts was much less than that of the forage offered." From this statement, it was inferred that chromogen and palatability are closely related. It was thought to be conceivable that the chromogen technique could also be used as a simple laboratory method for determining the palatability of various forage plants by their chromogen content.

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1 *Published with the approval of the Director, Wyoming Agricultural Experiment Station, as Journal Paper No. 81. Portions of the material in this paper were used by the senior author in partial fulfillment of the requirements for the Master of Science degree.*

Methods and Materials

Seed Sources

From 1953 to 1955, collections of Indian ricegrass seed were obtained from sources in most of the western states, and the present collection contains seed from 106 locations in 14 western states, Minnesota, and Canada.

Establishment and Locations of Strain Nurseries

Seeds of 50 geographic strains of Indian ricegrass were planted in vermiculite and the seedlings individually transplanted into three-inch pots of soil. In the spring of 1954, plants of 24 of the strains were large enough to be transplanted to the field. Ten plants of each strain were transplanted at the Nebraska Agricultural Experiment Station and at the University of Wyoming Agronomy Farm. Those which winterkilled were replaced in the spring of 1955.

Of the strains established at both Lincoln, Nebraska, and Laramie, Wyoming, eleven fully established strains of Indian ricegrass and the hybrid Mandan ricegrass were selected for study. These strains showed wide differences in growth habit, leaf size and type, and seed size and shape.

Palatability Studies

Two tame rabbits were used in the feeding trials. They were fed alfalfa hay and pellets for several days so that they would become accustomed to their surroundings before the feeding trials started. Forage from the 12 selected strains of Indian ricegrass grown at Lincoln, Nebraska, were fed in an air-dried condition while that from the same 12 strains grown at Laramie, Wyoming, was fed green. Alfalfa hay and pellets as well as water were available to the animals at all times, so as to be sure that the forage of the strains under test was consumed by choice rather than because of extreme hunger.

A portion of each of four strains was weighed and placed in separate pans located at intervals inside the cage. Each pan of material was weighed in grams at the time it was placed in the cage in the evening and removed and weighed again in the morning to determine the amount of forage eaten. When all 12 of the strains had been offered to the experimental animals, each strain of Indian ricegrass was again placed before them in different combinations of four until all 12 strains had been available to the experimental animals three successive times. The palatability ratings for each strain grown at both locations were then calculated on the basis of the percentage of the weight of each strain offered which was eaten.

Chromogen Tests

The procedure used for determining chromogen content of the Indian ricegrass strains studied was that developed by Reid, *et al.* (1950). Chromogen determinations were made in duplicate from the 12 Indian ricegrass strains grown at the Lincoln, Nebraska, nursery.

Results and Discussion

Morphological Variations Among Geographic Strains of Indian Ricegrass

Many morphological variations were observed among the entire collection of geographic strains of Indian ricegrass. However, actual measurements and detailed notes were collected only for the 12 strains with which this study is principally concerned.

In comparing the seeds of the entire collection, it was noted that most of the geographic strains could be classified into two categories on a basis of either elon-

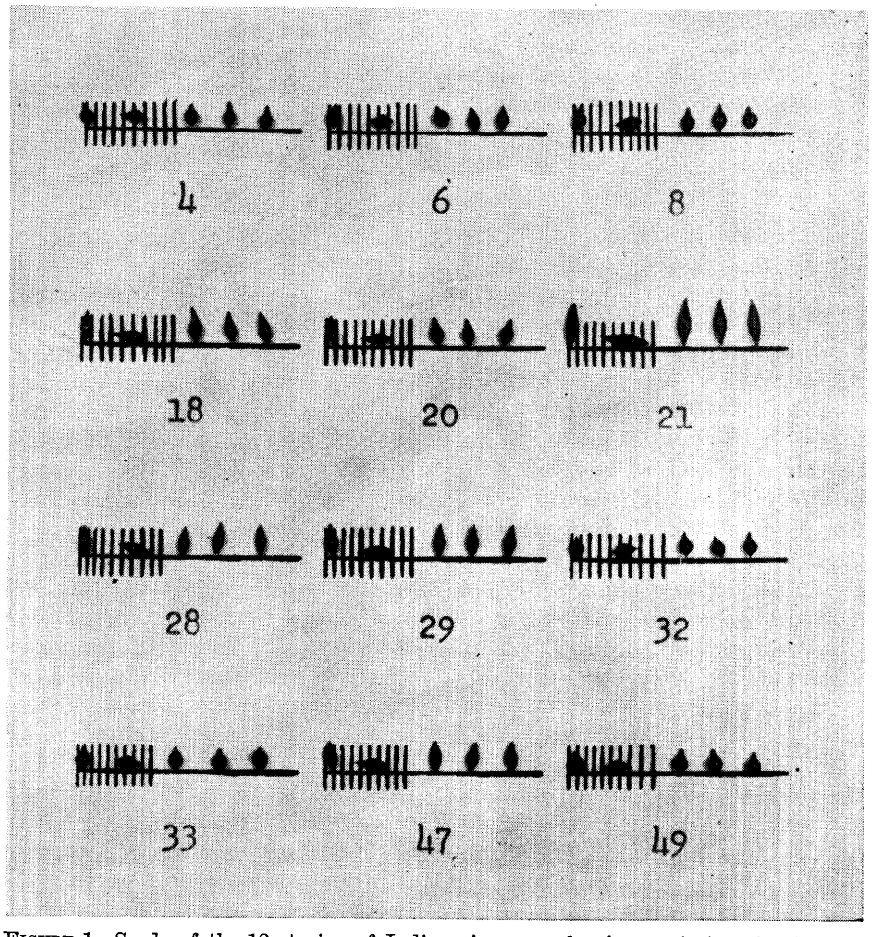

FIGURE 1. Seeds of the 12 strains of Indian ricegrass showing variations in size and shape. The pubescence has been removed from these seeds by mechanical means. Numbers refer to strains listed in Table 1. Scale at left of each line is in millimeters.

Table 1. Some morphological variations among 12 geographic strains of Indian ricegrass.

Identification No.	Strain Origin	Growth habit	Height of mature plant	Leaf type	Width of widest leaf	Average length of seed	Average width of seed at widest point
			Inches		mm.	mm.	mm.
33	Lethbridge, Alberta, Canada	Prostrate	15	Involute	1.5	3.0	1.8
8	Scottsbluff, Nebraska	Semi-erect	18	Semi-involute	2.5	3.0	1.8
32	Medicine Hat, Alberta, Canada	Erect	24	Semi-involute	3.0	3.0	1.8
47	Aberdeen, Idaho	Semi-erect	24	Involute	3.5	3.8	1.3
29	Antelope Valley, California	Semi-erect	16	Semi-involute	3.0	4.0	1.5
6	Cheyenne, Wyoming	Prostrate	12	Semi-involute	3.0	3.0	1.8
4	Hell's Half Acre, Wyoming	Erect	17	Involute	3.5	2.9	1.7
49	Swift Current, Saskatchewan, Canada	Erect	17	Involute	2.0	3.0	1.8
21	Mandan, North Dakota	Erect	37	Flat	6.0	5.2	1.5
20	Arizona	Erect	20	Involute	4.0	3.6	1.4
28	Whitebird, Idaho	Erect	30	Flat	4.5	3.6	1.1
18	Pullman, Washington	Semi-erect	34	Involute	3.0	3.8	1.3

gated or globose shape. A few of the collection numbers were intermediate between these two categories. Seed from most of the strains were similar in size within either the elongated or globose category, but some notable size variations were observed. For example, the seed collected from near Melba, Idaho, was very small, whereas seed from a Pullman, Washington, strain was comparatively large in size. When planted in a common nursery, these strains reproduced seed of approximately the same size as the original, which would indicate that at least in these instances the size characteristic noted was inherent within the strain rather than environmentally induced.

Of the 12 strains studied most intensively, six were of the globose seed shape, five elongated, and one was intermediate between these two categories. Some differences in seed size were also noted. Table 1 shows that in a random sample of the seed of each of these strains, the average length varied from 2.9 to 5.2 millimeters, and the width at the widest point varied from 1.1 to 1.8 millimeters. These differences in seed size and shape are illustrated in Figure 1.

Considerable variation in the size and type of leaf was noted among the strains established in the nursery. Among the 12 strains studied, only two had flat leaves; the remaining eight were either of involute or semi-involute type. Table 1 shows differences in leaf width and plant height found among the 12 strains selected for study. Using growth habit and leaf width as criteria, the 12 strains of Indian ricegrass could be divided into three groups. Four strains were low-growing and narrow-leaved, four were intermediate in height and leaf width, and four were tall, erect, coarse-leaved plants.

From their widespread distribution it appears that there was little or no correlation between

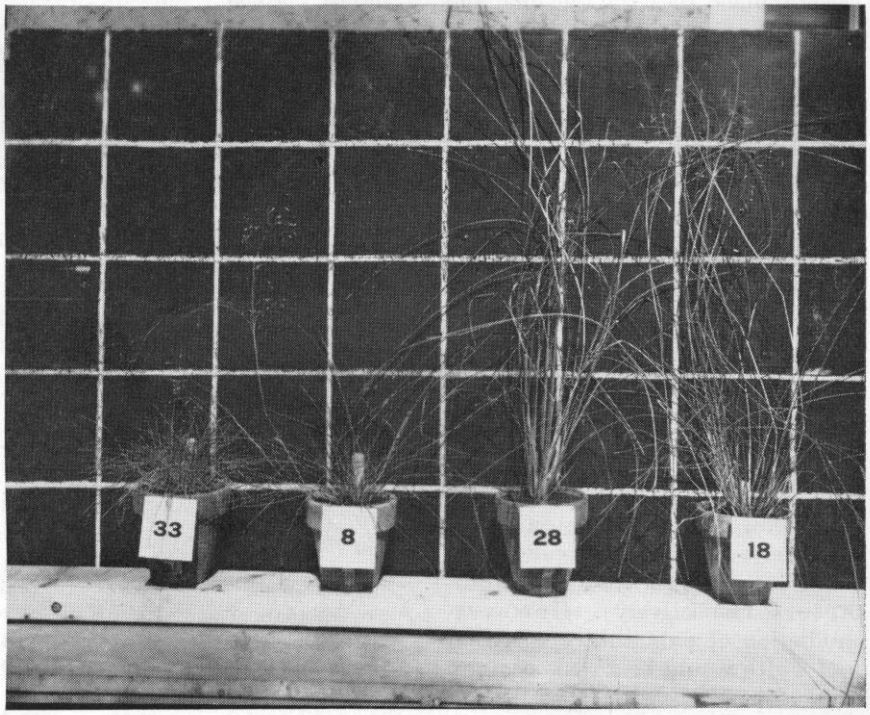

FIGURE 2. Individual plants of the two most palatable (*left*) and the two least palatable strains (*right*) among the 12 strains of Indian ricegrass. Scale unit = 6 inches.

growth habit and geographic location for any of the groups.

Palatability Differences Among Geographic Strains of Indian Ricegrass

Separate palatability trials were conducted using the dry forage from the selected strains grown at Lincoln, Nebraska, and the green forage from the same strains grown at Laramie, Wyoming. The trials were carried out consecutively with two tame rabbits used as experimental animals, and the resulting palatability ratings were based on the percentage of the weight of the material offered which was consumed by the experimental animals during an approximately 15-hour period of time.

Strain No. 33, from Lethbridge, Canada, was the most highly preferred strain in both the dry and green forage palatability tests. It averaged 91.67 percent palatability in four tests using dry forage and 93.83 percent palatability in four tests using the green forage. This strain has a low and prostrate growth habit and narrow, involute leaves. Strain No. 8 from near Scottsbluff, Nebraska, ranked in second place in both the dry and green forage tests.

The least palatable strain, No. 18, collected near Pullman, Washington, averaged 56.89 percent palatability in the dry-forage trials and 75.43 percent palatability in the green-forage trials. This strain, one of the tallest of those tested, was semi-erect and its widest leaf measured three millimeters. Strain No. 28, from Whitebird, Idaho, ranked in eleventh place in average palatability but differed only slightly from No. 18.

As noted in Tables 1 and 2, the two most highly palatable strains had narrow leaves (1.5 and 2.5 millimeters, respectively) and the two least palatable species had wide leaves (3.0 and 4.5 millimeters, respectively). However, prediction of palatability based on leaf width would be a rash assumption, for even with the limited number of strains tested in this study, several exceptions were found. Figure 2 shows the general growth habit of the two most highly palatable and the two least palatable strains tested.

The experimental animals consumed a greater percentage of the fresh green forage offered than they did of the dry forage. Regardless of this difference in preference, it should be noted that the rank in palatability for the three most highly palatable and the three least palatable strains was identical based on both dry and green forage tests.

These results are based on preference exhibited by experimental rabbits and do not necessarily apply directly to domestic livestock. The differences in palatability among strains of Indian ricegrass shown for rabbits are apparently inherent among the geographic strains of this species.

Relationship Between Chromogen and Palatability

The results of chromogen determinations made from a sample of the forage of each of the 12 geographic strains of Indian ricegrass grown at the Lincoln, Nebraska, nursery are presented in Table 2. Strain No. 8 from Scottsbluff, Nebraska, had 19 chromogen units per gram of dry matter, the lowest value found among the 12 strains tested. The highest chromogen reading, 38.5 units per gram of dry matter, was observed in Strain No. 21 from Mandan, North Dakota, and Strain No. 29 from Antelope Valley, California.

Chromogen content shows an inverse relationship to palatability in a comparison of the three most palatable and three least palatable strains. The top three strains in palatability rating had an average of 21.1 chromogen units, whereas the lowest three had an average of 27.0 units of chromogen. However, a linear correlation analysis of all strains gave a coefficient of correlation of —.32, indicating only a

Table 2. Palatability percentage and rank and units of chromogen for the 12 strains of Indian ricegrass grown at Lincoln, Nebraska, and Laramie, Wyoming.

Identification No.	Strain Origin	Grown at Lincoln, Nebraska			Grown at Laramie, Wyoming		
		Units of chromogen per gram of dry matter	Percentage of dry forage which was eaten	Rank in dry forage tests	Percentage of green forage which was eaten	Rank in green forage tests	Rank in both tests (av.)
33	Lethbridge, Alberta, Canada	24.0	91.7	1	93.8	1	1
8	Scottsbluff, Nebraska	19.0	87.6	2	93.8	2	2
32	Medicine Hat, Alberta, Canada	20.5	86.5	3	87.8	3	3
47	Aberdeen, Idaho	33.5	82.3	4	82.8	7	4
29	Antelope Valley, California	38.5	79.7	5	80.0	9	7
6	Cheyenne, Wyoming	20.5	76.7	6	84.2	6	5
4	Hell's Half Acre, Wyoming	26.5	75.3	7	84.9	4	6
49	Swift Current, Saskatchewan, Canada	23.5	74.6	8	84.5	5	8
21	Mandan, North Dakota	38.5	68.4	9	82.5	8	9
20	Arizona	25.5	65.0	10	77.0	10	10
28	Whitebird, Idaho	29.0	57.8	11	76.8	11	11
18	Pullman, Washington	29.0	56.9	12	75.4	12	12

weak relationship between these two factors.

From this study it would appear that units of chromogen in plant material would not be a reliable method of predicting the probable palatability. However, the number of strains tested was small and a larger number of strains might conceivably show a closer correlation than found here. Further refinement of the chromogen testing method might lead to a quick test of palatability.

Summary and Conclusions

A study of variations in morphological characteristics and palatability of 12 geographic strains of Indian ricegrass was made.

The principal objectives were: (1) to determine morphological differences exhibited by geographic strains of Indian ricegrass; (2) to determine possible differences in palatability between the geographic strains and the constancy of such differences in strains grown on two soil types; and (3) to test the relationship between the chromogen content of plant material and palatability as a possible laboratory method for determining animal preference.

Indian ricegrass was found to have wide variation in growth habit, leaf type, and size and shape of seed. These differences are probably due to natural selection, and when the geographic strains were grown in a common nursery, the differences noted appeared to be inherent within the geographic strain.

In general, the seed of strains could be classified into two categories on the basis of shape: elongated and globose. A few of the collections showed intermediate characters.

Palatability ratings for the 12 strains of Indian ricegrass studied were determined by the percentages of forage of the different strains consumed by rabbits.

Strains from near Lethbridge, Alberta, Canada; Scottsbluff, Nebraska; and Medicine Hat, Alberta, Canada, were the most preferred strains of those tested. Strains from near Pullman, Washington, Whitebird, Idaho, and Arizona, were the least preferred.

There appeared to be little correlation between palatability and the amount of chromogen in each strain. Linear correlation analysis gave a coefficient of correlation of —.32, indicating only weak relationship between palatability and the amount of chromogen present in the plant material.

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Seeding Crested Wheatgrass on Drought Depleted Range[1]

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The effects of severe drought in reducing production, carrying capacity, and in changing the composition of native range vegetation are widely known. Likewise the problems inherent in post-drought restocking of drought depleted range have been recognized. Native range recovers slowly from drought, and little is known of methods of accelerating this rate of recovery, or the rate of increase in forage production which could be obtained by reseeding adapted grasses immediately after drought.

Between 1931 and 1937 eastern Montana suffered from the effects of severe drought. Droughts in 1931, 1934, and 1936 were the most severe during the 62 years of record, and precipitation of 1933 and 1935 was also below normal. As a result of this extended dry period, the native ranges were reduced to less than 20 percent, and in some cases to less than 10 percent, of their pre-drought density.

Beginning in the late spring of 1937, moisture conditions became more favorable, and recovery of the range began. Sandberg bluegrass (*Poa secunda*), needle-and-thread (*Stipa comata*), and buffalo

[1] *Study conducted by the former Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Montana.*

grass (*Buchloe dactyloides*) increased most rapidly. Western wheatgrass (*Agropyron smithii*) and blue grama (*Bouteloua gracilis*) recovered more slowly.

In 1938 a study was undertaken on the U. S. Range Livestock Experiment Station near Miles City, Montana, to determine whether crested wheatgrass could be seeded successfully directly into drought-depleted native range, thereby hastening recovery of the range.

During the past thirty-years considerable work has been done in the Northern Great Plains region with Standard crested wheatgrass (*A. desertorum*). Investigations have been made on methods of establishment, nutritive qualities, and the general forage value and adaptability of this species as compared to others for reseeding (Westover *et al.*, 1932; Reitz *et al.*, 1936; Whitman *et al.*, 1941; Williams and Post, 1941; Williams *et al.*, 1942; McCall *et al.*, 1943; Williams and Post, 1945; Woolfolk, 1951; Short and Woolfolk, 1952; and others). It is now recognized that crested wheatgrass is well adapted to the region, and that it compares favorably with native range species in many respects.

Crested wheatgrass is normally used as early spring forage. It is usually grazed at a heavy rate during this time to obtain maximum use while the plant is still green and succulent, as it tends to become coarse and unpalatable at maturity (Williams, 1941; Short and Woolfolk, 1952). Occasionally a significant amount of fall regrowth may be obtained (Woolfolk, 1951).

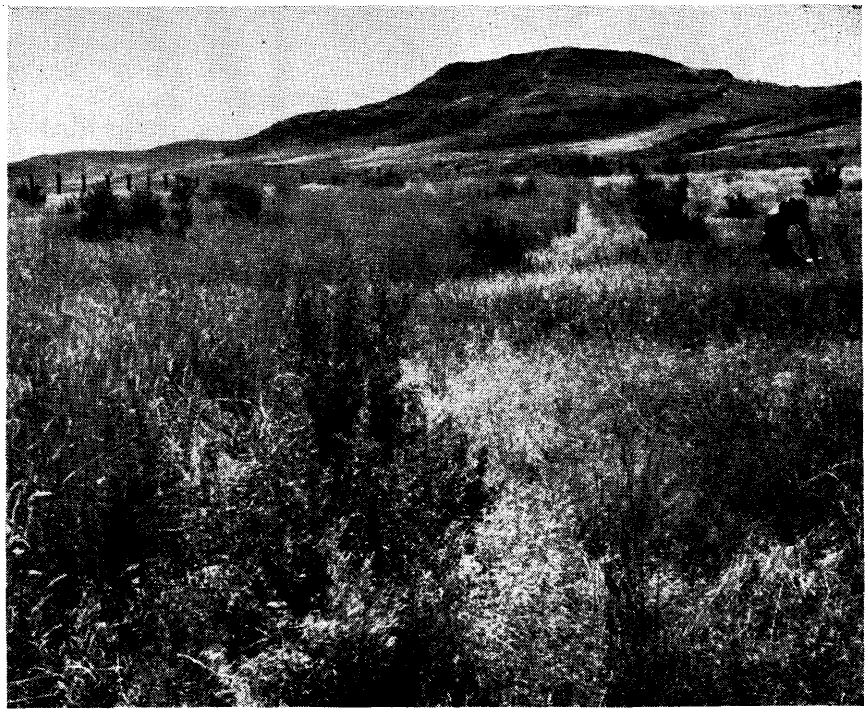

FIGURE 1. Camelback study area, U. S. Range Livestock Experiment Station, near Miles City, Montana, in 1950, showing strip seeded to crested wheatgrass in fall of 1938 (*left*) and part of control strip (*right*). The annual grasses still comprise a considerable portion of the vegetation on the control strip after 12 years of protection from grazing. Photo U. S. Forest Service.

Experimental Procedure

The site selected for the study was located near the east boundary of the station in an area that had been severely abused for many years by transient and market herds of livestock. This period of over-use began before World War I and ended in 1932, when the area was fenced and the transient herds excluded.

The study was set up in a split plot design with four blocks or replicates on a gently sloping, blue grama subtype on Havre very fine sandy loam soil. In each block were two main plots, each 40 x 217.8 feet, or 0.2 acre. Each main plot was divided longitudinally down the center into sub-plots. One of the sub-plots in each of the main plots was left in untreated native range to serve as a control. The two remaining sub-plots (one in each main plot) were seeded to crested wheatgrass, one in the spring and the other in the fall. Main plots were randomized within blocks as were sub-plots within main plots.

Crested wheatgrass was drilled into the native sod without seedbed preparation at the rate of 4 pounds per acre. Spring plantings were made on April 23, 1938, and fall seedings on October 25, 1938. The spring planted sub-plots were seeded again on April 18, 1939, because of almost complete failure of the 1938 spring plantings. At the time, this failure was attributed in large measure to competition from the dense growth of annual grasses and forbs.

A one-meter square chart quadrat was laid out in each sub-plot in 1938, prior to seeding, to study changes in plant density and composition as measured by basal area. The quadrats were carefully matched between the two sub-plots in each plot as to species composition and vegetation density. A series of eight 0.1 mil-acre clipping areas for yield determinations were also laid out in each sub-plot, spaced mechanically on two lines running parallel to the long axis of the sub-plots.

The study area was fenced in 1938 and protected from grazing throughout the course of the study.

Weather

Weather during the period of study was generally favorable, following the succession of dry years during the mid-thirties. Both annual and growing season precipitation (April 1-September 30) were 10-15 percent below the long time

average of 13.00 and 9.29 inches, respectively, in 1938 and 1939. In 1940 these totals were above average. During the years 1941 through 1948, they averaged slightly above normal. In 1949 the growing season precipitation dropped to about 40 percent of average (about the same level as during the drought years of 1931, 1934 and 1936), while total annual precipitation was about 60 percent of normal. During 1950 both growing season and annual precipitation totals were approximately normal.

Experimental Results

Examination of plots in midsummer of 1939 disclosed that all spring seedings of crested wheatgrass were barely successful, averaging 0.34 plants per square foot. The fall seeding was rated as highly successful with an average of 1.03 plants per square foot. A highly successful stand of crested wheatgrass was considered to be 0.7 or more plants per square foot; a succesful stand, 0.4 to 0.6; and a barely successful stand, 0.1 to 0.3 plants per square foot.

By 1940 the number of plants had declined markedly on all plots. At that time the fall seeding of crested wheatgrass was rated as barely successful—0.13 plants per square foot—and the spring seedings as complete failures with no plants present. It was concluded at the time that competition from native vegetation was primarily responsible for the poor success of the crested wheatgrass plantings.

Vegetation Density

A statistical analysis of the initial total density and blue grama density, as determined from the chart quadrats, disclosed no significant differences between the controls and seeding treatments or between seeding treatments at the beginning of the study.

When inspection of the reseeded plots in 1940 indicated that the reseeding was a failure on some of the plots and barely successful on others, it was decided to chart some of the quadrats to ascertain changes that had occurred in density of the native vegetation between 1938 and 1940. For this purpose, charting was limited to the quadrats in the four control sub-plots of the fall seeding. These were charted in October, 1940.

Average density of the perennial grasses and prickly-pear *(Opuntia polycantha)* increased from 401 (.04 percent) to 1,901 (.19 percent) square centimeters per quadrat or 373 percent in the two-year period (Table 1). Most of this increase was due to blue grama which increased 847 percent. Sandberg bluegrass increased 11 percent.

This increase in native vegetation took place while the number of plants of crested wheatgrass was declining rapidly. It may be inferred that the competition afforded by the native vegetation was a primary cause of this decline.

Vegetation Production

The eight 0.1 mil-acre sample clipping plots in each sub-plot were first laid out and the native species clipped in late June of 1938 to determine the amount of forage produced at the beginning of the study. No significant differences in total production, perennial grass, or annual grass and forb production were found at the outset of the study between treatments or between treatments and controls.

Since a successful stand of crested wheatgrass was established only on the fall seeded plots, yield samples were taken of this treatment in 1940 to determine the increase in native forage and also the increase due to reseeding. As the stand of crested wheatgrass did not appear to be sufficiently dense to noticeably affect forage production by native species, the control sub-plots of this treatment were not sampled. These same fall-seeded crested wheatgrass sub-plots and the corresponding control sub-plots were sampled in 1950.

Average forage production in pounds per acre on fall-seeded crested wheatgrass sub-plots in 1938, 1940 and 1950, and control sub-plots in 1938 and 1950, is summarized in Table 2. The most notable changes between 1938 and 1940 on the fall seeded plots were

Table 1. Average density of perennial vegetation on native range as determined on chart quadrats (one-meter square) in 1938 and 1940.

	Density per Quadrat in Square Centimeters	
Species	1938	1940
Western wheatgrass	0	T
Needleleaf sedge (*Carex eleocharis*)	0	T
Blue grama	173	1641
Sandberg bluegrass	228	254
Sand dropseed (*Sporobolus cryptandrus*)	0	6
Prickly pear	0	T
Needle-and-thread	T	0
Total	401	1901

Table 2. Average forage production in pounds per acre, air-dry, on two treatments, in 1938, 1940 and 1950.

	Pounds Per Acre				
	Fall seeded plots			Control	
Species	1938	1940	1950	1938	1950
Crested wheatgrass	0	28	1393	—	—
Blue grama	12	257	—	7	—
Other perennial grasses	73	60	132*	117	—
All perennial grasses	85	345	1525	124	187
Annual grasses	630	165	—	593	—
Forbs	112	290	—	125	—
Annual grasses and forbs	742	455	50	718	398
Total	827	800	1575	842	585

*Includes blue grama.

the four-fold increase in perennial grass production, and the 39 percent decrease in production of annual grasses and forbs. The perennial grass increase was due mostly to the 20-fold increase in blue grama, which comprised 17 percent of perennial grass production in 1938 and 74 percent in 1940, but also partly to the presence of crested wheatgrass which was seeded after the 1938 sampling. This increase was partially offset by the decrease in production of other perennial grasses.

The decrease of slightly over one-third in total production of annual grasses and forbs was due, no doubt, to increased competition from the perennial grasses. Within this group the annual grasses declined 75 percent over the two-year period, while the forbs increased 150 percent.

The net result over the two-year period was a non-significant 3 percent decline in total forage production.

Between 1940 and 1950 the changes in production by plant groups on the fall seeded plots were considerable. Crested wheatgrass increased 50-fold during the period, while blue grama and other perennial grasses together decreased 60 percent. The total change for all perennial grasses was a 340 percent increase. During this period production of annual grasses and forbs decreased 89 percent.

These changes resulted in doubling of total forage production over the 10-year period, due primarily to the enormous increase in crested wheatgrass.

On the crested wheatgrass plots, over the entire 12-year period, production of perennial grasses increased 18-fold, annual grass and forb production declined 94 percent, and total forage production almost doubled. During this period, on the native range, perennial grass production increased 50 percent, annual grasses and forbs declined 40 percent, and total production declined about 30 percent.

It is evident that the fall seeding of crested wheatgrass, which was rated as successful in 1939, but only barely successful in 1940, was a complete success by 1950, ten years later (see Figure 1).

Summary

It has been commonly observed that native range in the Northern Great Plains region recovers slowly from the effects of extreme drought. In 1938 a study was initiated at the U. S. Range Livestock Experiment Station near Miles City, Montana, to follow the course of recovery in native range, and to determine if recovery could be speeded up by seeding crested wheatgrass.

Crested wheatgrass was seeded on native range in a replicated, split plot design in 1938 and 1939. Spring and fall seedings were compared with each other and with non-seeded native range. Changes in vegetation density and production were followed from 1938 to 1950, a period of recovery from the drought of the 1930's.

From this study the following conclusions were drawn:

1. Fall seeding of crested wheatgrass was superior to spring seeding in obtaining successful stands, where competing vegetation was not removed.
2. Crested wheatgrass in the first few years after seeding was hindered by competition from native range vegetation with a basal area density of 4 per cent or more.
3. Native perennial grass species, particularly blue grama, tended to increase in density and production more rapidly at the end of a drought period than did crested wheatgrass planted at the end of a drought.
4. The observed increase in crested wheatgrass and perennial grass production was at the expense of annual grasses.
5. After twelve years of recovery from drought under protection from grazing, range, which had been seeded to crested wheatgrass at the end of the drought, produced 700 per cent more perennial grass forage and two to two and one-half times as much total production as did native range under the same conditions.

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The Effects of Plant Competition on the Growth and Survival of Bitterbrush Seedlings[1]

RICHARD L. HUBBARD

Range Conservationist, California Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Berkeley, California[2].

Many winter deer ranges throughout the West have been steadily deteriorating as a result of overgrazing, fire, and insect depredations. Lack of winter forage has caused heavy mortality of deer. The problem has become so acute that some of the western states have started research to determine what can be done to rehabilitate these ranges, if and when the causes of deterioration can be controlled.

The California program was started in the deer winter range area east of the Sierra Nevada mountains. This area extends from Oregon to the Owens Valley in Inyo County. Special attention has been given to studies of bitterbrush (*Purshia tridentata*), the most important winter deer browse species in the eastside region.

This paper reports on a study of the effects of plant competition on bitterbrush seedlings. The work was done in Modoc County on the winter range of the California-Oregon Interstate deer herd. Here, the predominant vegetation is a transition type between ponderosa pine and the sagebrush-juniper complex. Big sagebrush (*Artemisia tridentata*), juniper (*Juniperus occidentalis*), rabbitbrush (*Chrysothamnus spp.*), and bitterbrush make up the bulk of the brush cover. The understory is composed of perennial grasses and annual and perennial forbs. A few scattered ponderosa pine (*Pinus ponderosa*) are also present. The annual precipitation averages between 12 and 14 inches, much of it falling as snow.

Methods

In areas of relatively low precipitation, such as the Modoc County study area, the most important, if not the limiting factor, in seedling establishment is soil moisture. It may be impractical in a range seeding program to improve soil moisture conditions by irrigation, but it is feasible to prepare seedbeds and control the vegetation that competes with seeded species for available soil moisture.

For this study of the effects of competition, three areas were selected inside a deer-livestock exclosure. One area was drilled with bitterbrush seed without soil preparation or removal of the stand of native plants. The other two were plowed, harrowed, and dragged with a rail. One of these was drilled with bitterbrush seed alone and the other with a mixture of bitterbrush and crested wheatgrass seed. Plots on the area prepared and drilled with bitterbrush alone were segregated for three different treatments. Some were kept weeded during three growing seasons, others were weeded only during the first growing season, and some were not weeded at all. The weeded plots represented negligible competition and those weeded only the first year were considered to represent light competition. The native and crested wheatgrass areas offered heavy competition. The crested wheatgrass probably did not use as much soil moisture as the established native vegetation during the first growing season. During the second and third season, however, the crested wheat-

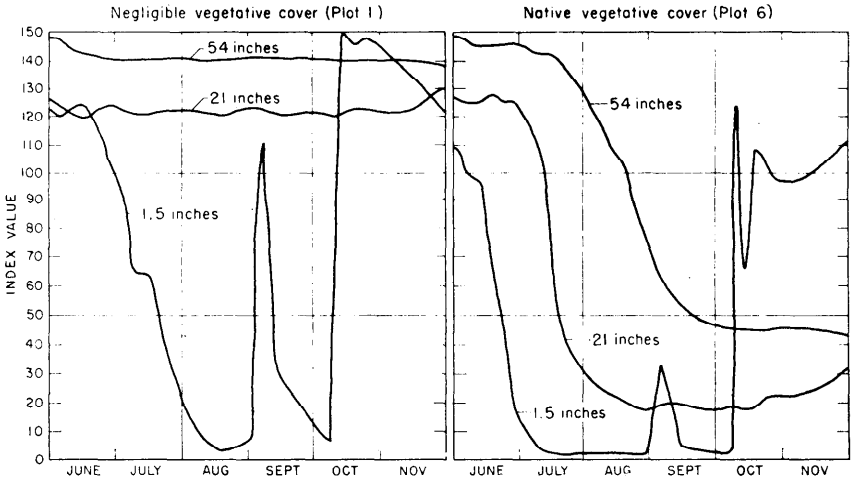

FIGURE 1. Trends of soil moisture indices at three soil depths— 1.5, 21, and 54 inches—under negligible and native vegetative cover during the first growing season (1953). Indices of 120 to 150 are in the range of high soil moisture; 0 to 30, in the range of low soil moisture.

1 *Contribution from cooperative investigations between the California Forest and Range Experiment Station and the California Department of Fish and Game. Work was done under Federal Aid in Wildlife Restoration Act, Pittman-Robertson Research Project W51R, entitled "Game Range Restoration."*

2 *The Experiment Station is maintained at Berkeley in cooperation with the University of California.*

grass competed at least as heavily as native plants for available soil moisture.

To obtain indices of stored soil moisture, fiberglas soil-moisture units (Colman, 1947) were installed at 1.5, 21, and 54 inches below the surface in both the plowed and weeded and the undisturbed areas. These units measure soil moisture in terms of electrical resistance. It is possible to calibrate the resistance readings with actual soil moisture percent. However, this was not done in this study. Instead, indices derived directly from weekly resistance readings were plotted to show soil moisture depletion.

Results

During the first growing season, soil moisture on the undisturbed, native area was depleted rather rapidly (Fig. 1). Moisture to a depth of 1.5 inches was largely used during June, and by late July most of it was taken to a soil depth of 21 inches. Even at the 54-inch depth soil moisture was heavily drained during August and September. Where plant competition was negligible, soil moisture was reasonably stable at 21 and 54 inches throughout the growing season. Even at the 1.5 inch depth, soil moisture was not depleted until mid-August, a full month later than on the undisturbed area.

The earlier and more complete depletion of soil moisture under heavy competition was reflected in bitterbrush seedling mortality and growth. Seedling mortality under heavy competition was between 57 and 60 percent during three growing seasons (Table 1). Under light competition, mortality was only 21 percent. Mortality under negligible competition was essentially the same as under light competition; apparently the invading annual weeds used relatively little of the stored soil moisture.

Table 1. Mortality through three growing seasons of bitterbrush seedlings emerging in the spring of 1953 under different levels of competition.

Level of competition	July 13 1953	At end of first growing season	At end of second growing season	At end of third growing season
		Percent		
Negligible	17.1	21.0	22.4	22.4
Light:				
Weeded during first growing season	17.1	21.0	21.0	21.0
No weeding	17.1	20.5	20.8	20.8
Heavy:				
Crested wheatgrass	20.5	31.2	46.5	60.0
Native vegetation	17.8	45.0	55.0	56.6

From the time of bitterbrush seedling emergence until July 13 of the first growing season (Table 1), seedling mortality was essentially equal at all competition levels. Soil moisture below 1.5 inches held up well until about this date under both clear-cultivated and undisturbed conditions. Mortality before July 13 can probably be attributed, at least in part, to cutworms and other insects. After that date, the bulk of the die-off was probably due to the lack of soil moisture. It was during the latter period that the big differences in mortality began to show up between the plots with negligible and heavy competition. Considerable mortality occurred during the second year in the undisturbed and crested wheatgrass areas, and the third year in the crested wheatgrass area. Under negligible and light competition few seedlings died in the second year and none in the third.

The most striking contrast, however, was in the size of bitterbrush seedlings under the different levels of competition (Table 2, Fig. 2). Bitterbrush seedlings under heavy competition grew only during a relatively short time in the spring.

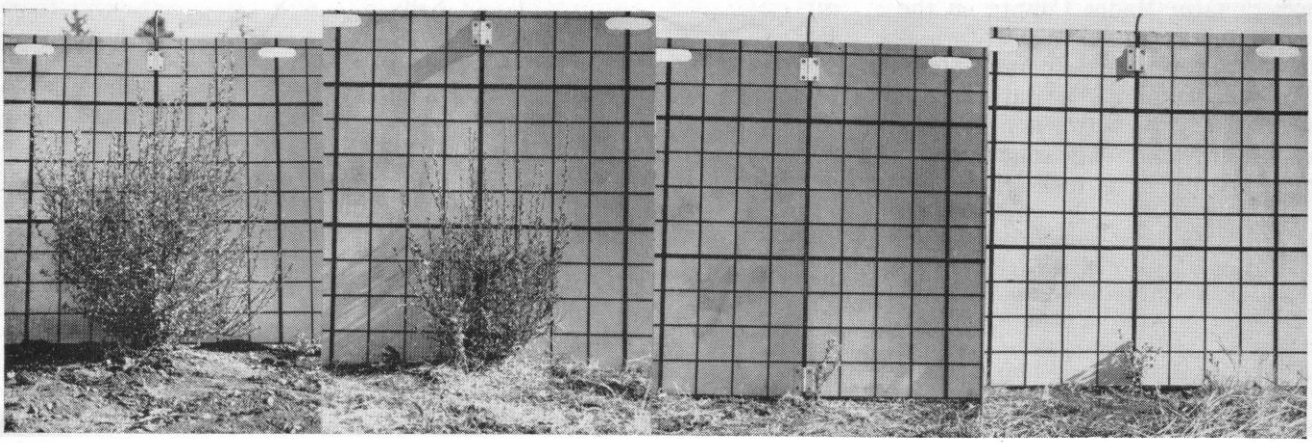

FIGURE 2. Three-year-old bitterbrush seedlings under four levels of plant competition at the Flukey Spring experiment area. *Left*: Negligible competition. *Next*: Light competition. *Third*: Heavy competition, crested wheatgrass. *Fourth*: Heavy competition, native vegetation. (Small squares on the backboard are 3 inches across.)

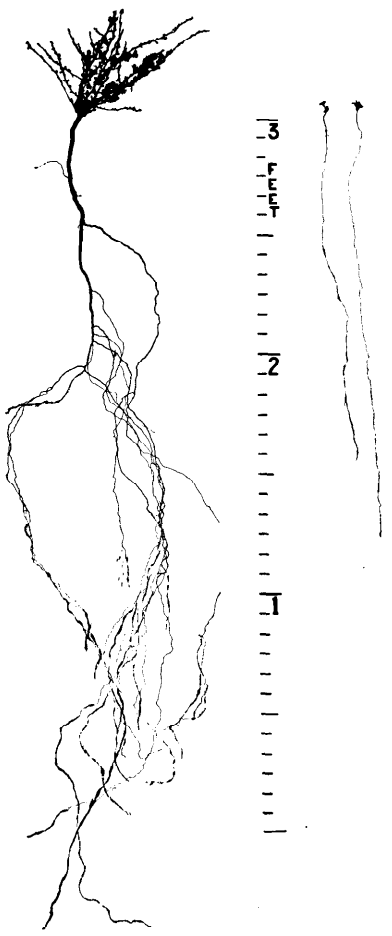

FIGURE 3. Root development of bitterbrush seedlings grown under two degrees of plant competition. *Left*: Negligible competition. *Right*: Heavy competition.

Those on the plowed area continued to grow throughout the summer. After three growing seasons seedling heights varied from 4.5 inches on the undisturbed native area, and 5.5 inches on the crested wheatgrass area, to 26 inches on the plowed and weeded plots.

The difference in the vigor of the plants was also reflected in development of their root systems. Under light and negligible competition the roots penetrated to 42 inches during the first growing season and were extensively branched. Under heavy competition they penetrated only 20 to 30 inches and generally were unbranched, thin taproots (Fig. 3).

Table 2. Average height through three growing seasons of bitterbrush seedlings emerging in the spring of 1953 under different levels of competition.

Level of competition	End of first growing season	End of second growing season	End of third growing season
	Inches	Inches	Inches
Negligible	6.0	13.8	26.0
Light:			
Weeded during first growing season	6.0	12.8	21.4
No weeding	4.7	9.5	18.0
Heavy:			
Crested wheatgrass	1.9	2.8	5.5
Native vegetation	1.3	2.6	4.5

Conclusion and Summary

Seedbed preparation, alone and with subsequent weeding, permitted greatly increased seedling growth of bitterbrush and reduced seedling mortality. Even though some of the seedlings growing under heavy competition from native plants may survive many years, there is little chance that they will break free of the competition and become dominant plants. This study was conducted under favorable site and precipitation conditions. Preliminary results from another study indicate that complete mortality of emerged bitterbrush seedlings may occur under less favorable conditions on native, untreated areas.

Weeding after seedbed preparation increased the growth rate of bitterbrush seedlings over soil preparation without follow-up weeding, but the increase was not enough to warrant the extra expense. Weeding could not be justified in an extensive range seeding program.

Planted crested wheatgrass provided about the same level of competition as native vegetation, judging from growth performance of bitterbrush seedlings. It may sometimes be desirable to seed both bitterbrush and crested wheatgrass to provide additional forage, reduce livestock use of bitterbrush, or aid fire protection. Seeding of this type was done (U. S. Forest Service, 1950) in Oregon with the two species sown in alternate drill rows. Seeding alternating drill widths might be another feasible method. Mixing the two species, as in the present study, seems unlikely to give satisfactory results.

Many areas suitable for bitterbrush reseeding would be expensive to cultivate; some would be impossible, but other methods of removing competing vegetation, such as burning and chemical spraying, can sometimes be used. It would be advisable to study other sites and other levels of competition to determine the maximum level of competition by sites under which satisfactory establishment and growth of bitterbrush seedlings can be obtained. Economical methods of reducing existing vegetation must then be developed.

Acknowledgement

The author acknowledges that this study was planned and designed by A. L. Hormay, Range Conservationist, California Forest and Range Experiment Station.

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The Future of the Range Livestock Industry[1]

DON C. COLLINS

President, American National Cattlemen's Association, Denver, Colorado.

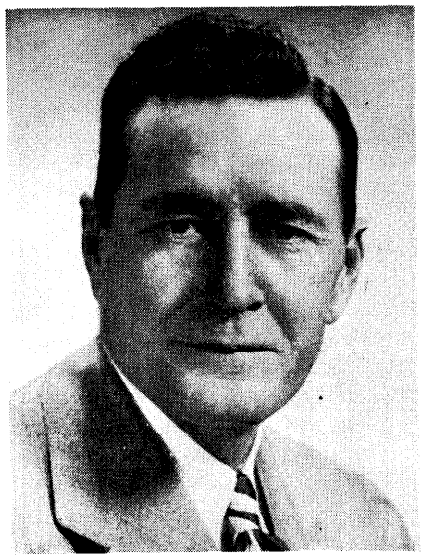
A couple of weeks ago in Phoenix, more than 2,000 stockmen had a chance to learn a great deal more about the American Society of Range Management from your able President, Danny Freeman. Danny was one of the featured speakers on the 60th Anniversary convention of the American National Cattlemen's Association. And I can tell you all most sincerely that Danny made a great many new friends for himself and for the Society.

So today, I do not feel among strangers at all. In fact, I recognize many ranchers and soil technicians I've known for years. And in that fact alone, I believe, lies the greatest strength of the range management society—this close and sincere cooperation between practical and theoretical approaches to our common problems.

There is, and can be, no difference in the objectives of range scientists and of ranchers for better forage for their cattle. The only difference might be in the application of research results or in the search for practical versus theoretical answers.

First, let us establish that few, if any, of us here can do anything about the biggest problems that face the cattle and beef industry. Such things as drought, the philosophy of supports and controls, and the very nature of an industry which has millions of producing units—all run by men who make their own decisions.

Actually, if we could solve the problems of rainfall, we might not have to worry so much about everything else!



DON C. COLLINS

But the rainmakers—those of witchcraft or of silver iodide—haven't been able to do too much good, so we'll just have to work harder to make range management, cattle production, feeding and marketing more efficient all along the line.

Revolution or Evolution

There has been a lot of talk about various types of grasses, feed rations, or bulls which will "revolutionize" the production of beef. Now, gentlemen, let's quit talking *REVOLUTION* and talk about *PRACTICAL EVOLUTION*. You and I know that much of the resistance of which ranchers are accused is caused because so many scientists or promoters have talked "revolution". But the revolution usually doesn't show up. You can holler "wolf" just so long. . . .

So let's be logical in our approach to the overall problem, and let's be cautious that our enthusiasm doesn't carry us into a blind alley.

I don't believe that any rancher can sit down and quickly list all of the things that need to be done to give us better range production or to develop better management practices. I think the very fact that so many suggestions are available, or so many new ones pop up, demonstrates that a common meeting like this can stimulate much constructive thought and work.

Drought has certainly focused most of our attention on water—or lack of it. What more can we do to develop more water resources or to conserve what we have so that drought won't bother us so much? Perhaps it isn't in our field to look so far into the future, but what can we do in the areas of atomic or solar power for pumping, purifying or transporting water to where it is needed.

Have we done all the research on reseeding, have we hit upon the best answer for brush clearance or burning, and have we found any good ways to make some feeds palatable when they are "out-of-season"?

What do we know about the cow's innards—even though they're building windows so we can see inside? Is there any way we can lessen the bloat danger so that we can take more advantage of all kinds of grass mixes? And how about poisonous weeds?

Much of the research I have been talking about is certainly in the field of the practical, as well as in the realm of the theoretical. Cattlemen might be considered inconsistent in insisting on practical study while still urging theoretical study.

This is not conflicting, actually, because we have to keep an eye on the future while solving some of the ways we can meet present hard times and stay ahead of competition. I'll admit that this is a comparatively recent realization on the part of the cattle industry.

[1] *Paper presented at the Tenth Annual meeting of the American Society of Range Management, Great Falls, Montana, January 30, 1957.*

Poor Research Salesmen

The excuses that there is not enough research are usually laid to lack of funds and lack of encouragement and interest from industry. A lot of this is the fault of the industry indeed. But I doubt if any one in research or the Halls of Congress, for that matter, has failed to observe the increased attention which the cattle and beef industry is paying to research. I am confident that this interest is sincere and sustaining.

But I would like to make a point of one thing: a lot of the fault behind the lack of earlier interest from industry must be laid at the feet of scientists and administrators of research units themselves.

I think they have been poor salesmen. I believe that they have forgotten, or never understood, that "evolution" is understandable and acceptable to a stockman, where "revolution" is not. The cowman has seen the seasons come and go, he knows much of birth and death, and he has seen little "revolution" in the ageless grandeur of his environment.

I believe that science has badly neglected its development of "public relations" in gaining the support of stockmen for projects, facilities and general activities.

On the one hand, research findings are carefully "sat on" until duplicating study is made. On the other, wild cries of "revolution" accompany publication of research results. It is hard for the stockman to know whether he is supporting "duplication", "revolution", or some worthwhile activity.

It used to be considered excellent if research findings were generally applied within 20 years. Recent events have proven that stockmen are closing up that time lag—not overnight, but gradually. And more and more stockmen are advancing ahead of the scientists in research ranch and feedlot laboratories.

All over the nation, stockmen are demonstrating that they are willing to work for new research grants, to give wholehearted support to projects of *understandable* benefit, and to undertake on their own and through their associations many activities which will help scientists do a better job. The findings of the American National Cattlemen's Association's research committee are important. The support of state and national organizations for increased legislative appropriations can be cited as further examples. Each one of you know incidents where the "stockman's plug" has helped you—and if you do not know of such incidents, I would wager that something is haywire with your public relations.

The challenge is equal to both stockman and scientist. The responsibility must be shared. But I believe that an unusual challenge is presented directly to the scientists. They must develop better salesmanship. And they must remember that many of their salaries are paid by many "bosses"—and you can't get a raise anywhere without first convincing the boss that you merit his loyalty and support.

Future Is Bright

The cattleman is willing and able to get behind any worthwhile activity—and he is ready to be convinced that "science needs a raise!"

I know my title was "The Future of the Range Livestock Industry", and I know that I have deviated from that somewhat. But I think there is little question that the "future" for range livestock production is limited only by the boundaries of man's enthusiasm and imagination.

There is nothing ahead, barring serious continuation of the drouth and a major economic depression, which should limit the cattleman. Our cattle numbers, I am confident, will show little change from last year when the estimates are released next month. In fact, the heavy slaughter of she-stuff during the year and particularly in the latter months of 1956 may well leave us with fewer producing units. Certainly our numbers will be comparatively high for such a precarious season as we face this spring and summer, unless the rains come. But we have halted the wild annual increases, we have begun to balance supply with demand and we have begun to make real progress in achieving efficiency at all levels of the industry.

I speak with optimism for the future with only two or three major qualifications. The drought and depression danger I've already mentioned. Another factor is that everyone in the cattle and beef industry must work at utmost efficiency and economy so that some of the inequities or flaws in our system of production, finishing, marketing, processing and retailing will be worked out.

But a major factor in our future is in how well the stockman can withstand the "get-rich-quick" seduction of those who would solve every problem by legislation. If we accept price supports and controls, for instance, we would be in great danger of forfeiting the promise of the future—and still have to pay the bill for this kind of help for generations to come.

Many problems will face us in each year of the future, some to be solved easily with the passage of time or conditions, and some to be the same as those our forefathers faced, as we face them today.

But it is through the cooperative spirit developed through meetings such as this, and through others to be held in the future, which will provide us with the practical answers for making our range lands flourish and provide abundantly through all the years—drought or no drought.

BOOK REVIEWS

Edited by Donald W. Hedrick, Dept. of Animal Husbandry, Oregon State College, Corvallis, Oregon

The Range and Pasture Book. By Roy L. Donahue, Everett F. Evans, and L. I. Jones. *Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 406 pages. 1956. $5.60.*

"The Range and Pasture Book" represents a new approach to the study of grassland management. It is written for the layman in nontechnical language, yet it is based on sound, factual information. The writers have made free use of recent experimental results without the book becoming laborious to read.

Subject matter in "The Range and Pasture Book" is presented under 13 chapter headings: Grasslands and Their Use, Grasslands Pay, The Important Grasses, Legumes in Grassland Agriculture, Pastures, Range Management, Hay and Silage, Grasses for Soil and Water Conservation, Grassland Watersheds, Grasslands and Wildlife, Principles of Grassland Agriculture, The Grassland Program, and Three Blades of Grass.

The chapters on grassland watersheds and grasslands and wildlife are appropriately included to relate grassland management more specifically to other land uses. Most books on pastures and forages have overlooked these other land uses which are important, and are becoming more so, even on intensively used areas. Although Chapter 11 is entitled "Principles of Grassland Agriculture", only three pages are devoted to general discussion of principles. The remainder of this chapter is concerned with a discussion of grassland problems on a regional basis. Actually, it also contains a fair sketch of the native vegetation in the range area west of the Mississippi.

Grazing calendars which show seasonal use of species included in the chapter on pastures are effective summaries for presenting ways of balancing the total feed supply. It is unfortunate that grazing calendars are not available from other areas in order to make this portion of equal value to all readers.

This book, as the writers point out, will be of maximum value to producers and other nontechnical workers interested in grassland management. Also, it should give the less well-informed readers a better perspective of grassland management than was formerly available. Many will ask why the title was headed by range instead of pasture, since only one short chapter deals specifically with range management. However, the writers have included about one-half of their examples of important grasses from among the native species.

In the reviewer's opinion, the authors are to be commended for incorporating such a wealth of information on grasslands into an attractive package. Well-chosen and clear illustrations enhance the effectiveness of the subject matter. This book should be of interest to all grassland workers.—*Donald W. Hedrick,* Oregon State College, Corvallis, Oregon.

Theory and Dynamics of Grassland Agriculture. By Jack R. Harlan. *D. Van Nostrand Co., Inc., Princeton, N. J. 281 pages. 1956. $6.75.*

Dr. Harlan, agronomist, geneticist, and professor, with broad experience on grasslands here and abroad, has succeeded in organizing a host of currently pertinent basic scientific truths into a very scholarly book.

You have only to read page one to learn that this is not one of the many quickly read and easily digested books on grassland agriculture. Yet any one grasslander will find great sections of digestible concentrates that he will relish. It is a book to be kept; with the hope that some portions not understood at the first reading may later, with additional study and experience, become understandable. It is, as the author states, ". . . basic theory and dynamics from which practical application may be derived." Few will dispute that "Theory, if sound, should apply as well in Alaska as in tropical Africa"; or that "Practice must be taught and learned at the most local level" and perhaps ". . . can only be learned by experience."

The first two chapters are on vegetation as they might be dealt with by a climatologist and an ecologist. The third provides an interesting and enlightening summary of the world's grasslands, their cultures and historic roles. These are followed by a chapter on evolution in the grasses and a chapter on the legumes, both of which are enriched by the author's extensive knowledge of genetics and plant breeding.

Chapters six, seven, and eight deal with plant physiology, soils, and animal nutrition, respectively. They reflect a praiseworthy effort to distill modern knowledge in these fields to the most fundamental facts of chemistry and physics. The potency of the end product is so great that dilution with supplementary reading or classroom instruction may be necessary.

Any one rangeman, I believe, will find at least one of these chapters in which he will feel utterly beyond his depth. This is a challenge rather than a criticism. Your reviewer found such sections in more than one chapter among the three and was caused to wonder whether great portions of graduate courses entailing biochemistry of 15 short years ago had already been forgotten, or whether science had mean-

while compounded its complexities. Nonetheless, there also are in these chapters portions that will be understood and are of immediate value to any rangeman. For the student with thorough and recent advanced courses in these subjects, the three chapters should provide an excellent resume of the pertinent biochemic phenomena in grassland agriculture.

The ninth chapter discusses application of fundamentals. It is a philosophical chapter, loaded with statements worthy of the most careful consideration and repetition in high places. There is a discussion of limiting factors leading to the inescapable conclusion that ". . . maximum production is, for practical purposes, impossible to achieve." Irrigation of dryland is fittingly portrayed as analogous to a Pandora's box. A practice such as deferred grazing is exposed as a "shotgun" treatment. Its ramifications are lucidly summarized and followed by the conclusion that no management practice is simple. These are but glimpses of the contents.

The last three chapters deal with mensuration of forages, theory of range management, and theory of pasture management, respectively. They are intended as a review and synthesis based on the underlying reasons given in the preceding chapters. Each of the three is a useful resume. In the description of a system of range classification, on page 195, the climax should be understood as the 100 percent from which condition *classes* are determined rather than as the most desirable condition. The chapter on range management should bring many fresh viewpoints to rangemen. The chapter on theory of management of tame pastures, the final chapter, should prove to be an authoritative and meaty review of current knowledge in a field so closely related to range management that it cannot be ignored.

The statement on page 240 that "The chief difference between good range management and good pasture management is simply one of degree," and a similar viewpoint expressed on page 37, might better have stated that range management and pasture management have much in common. It is true that the fundamentals of pedology apply in both instances. Moreover, the basic physiology and genetics of plants and animals apply equally in either case. But theoretical knowledge in other sciences useful in management of grazing must be varied in more than degree when applied to ranges or natural pastures as contrasted with tame pastures. Secondary succession restores ranges but destroys tame pastures. The natural grasslands of North America show the scars of management theories learned on pastures and modified only in degree for application on ranges. The discussions of effects of density of stand and of shade (p. 35), of control of annuals by preventing production of seed (p. 223), of plowing down deteriorated range and seeding to higher producing exotic species (p. 229), are instances where differences between tame pastures and natural pastures might have been emphasized. Particularly, the usual differences in their climates and the difference between an increase in forage production and an increase in net profit. On ranges, renovation, including seeding to exotics, and hence conversion to tame pasture, commonly produces hundredfold increases in forage production, but after a decade or two the result commonly is less *net* profit and less topsoil than where only inexpensive management of grazing was applied. The latter is usually an appropriate alternative for restoration of a depleted range but is seldom a possibility for restoring a depleted tame pasture. Indeed, Dr. Harlan has treated theory of range management and of pasture management in separate chapters.

A miscellany of items appear worthy of note. The 17-page index worked wonderfully well on several tests. Typographical and spelling errors are exceedingly rare. The sentence (p. 38), "We have seen that vegetation is organic," probably resulted from someone other than the author making this a sentence and thought separated from the sentence that follows. Citation is unorthodox for reasons given in the preface. The first eight chapters are followed by brief lists indicating principal sources of information, largely books, which also are suggested for further reading. Both the Latinized and common names of plants are given. The latter, commendably, are standardized common names with but rare exceptions.

The book was needed. It will advance our science, add stature to the profession, and advance the practice of range management. It required specialization and keeping abreast in not one but many fields of pure science. Basic subject matter of this nature is supremely difficult to sort, condense, and to present along a new central axis. Dr. Harlan projected and completed this task, which few others could and would undertake. We shall long be indebted for his labors.—*E. J. Dyksterhuis*, U. S. Soil Conservation Service, Lincoln, Nebraska.

CURRENT LITERATURE

Edited by G. W. Tomanek, Fort Hays Kansas State College, Hays, Kansas,
and
John Launchbaugh, Fort Hays Branch Experiment Station, Hays, Kansas

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SOCIETY BUSINESS

TENTH ANNUAL MEETING

Great Falls, Montana
January 29-February 1, 1957

The Tenth Annual meeting of the American Society of Range Management was held at Great Falls, Montana, January 29-February 1, 1957. Headquarters for the meeting were at the Rainbow Hotel. Total registration for the meeting was 474.

Business meetings of the Board of Directors were held on January 29 and on February 1. Highlights of the Directors meetings are presented later in this report.

The Section Chairmens' meeting was held on Tuesday, January 29, under the chairmanship of ROBERT L. "BOB" ROSS, Chairman of the Pacific Northwest Section. The chairmen and their representatives gave special attention to problems of membership, increased publicity—especially through the newspapers, financing the sections, advertising for the Journal, and the stimulation of interest in the Society through displays, contests, and other local activities. The group favored the adoption of a pin or button with the "Trail Boss" emblem, as the official insignia of the Society.

At the general business meeting of the Society on the evening of the 29th the "Trail Boss" was adopted as the official emblem of the Society, and action was initiated on the matter of getting a pin, button, or other device bearing this emblem for the members to wear.

The possibilities of summer meetings were discussed and the invitation of the Wyoming Section to meet at Jackson Hole in 1957 considered briefly. A committee was appointed to prepare a resolution to be sent to the Civil Service Committees in both Houses and to the Civil Service Commission, directing attention to the fact that the entrance salary for Range Conservationists is lower than that of foresters and engineers and requesting immediate remedial action. The resolution was passed unanimously.

Regular sessions of the main meeting started on Wednesday morning with a six paper session on "Ranching in the Northern Great Plains." The "Tenth Anniversary Session" was held in the afternoon. A split session was held on Thursday morning featuring "Wildlife on the Range" in one room and "Range Improvement Highlights" in another room across the hall. Other sessions included "Management as a Method of Range Improvement", "General Session", and a "Technical Session." A field trip to the Sun River Winter Game Range had to be cancelled because of heavy snow, but a short trip to the Black Eagle Smelter of Anaconda Company was held Saturday morning.

During the period of the meeting numerous informal inspection trips to the Charles Russell Museum were made, and a ladies tour to the museum under the guidance of FRED RENNER was part of the scheduled program.

A. L. HAFENRICHTER showed slides of the grasslands of New Zealand at an informal session on the evening of January 28. Excellent colored movies were shown on the evening of January 30 by BURTON BREWSTER of the X Diamond Bar, JOHN J. BAUCUS of the Sieben Ranch Co., and by A. L. HAFENRICHTER.

The program for the entire meeting was arranged by MELVIN S. MORRIS and his Program Committee. ED STEIN served as chairman of the Local Arrangements Committee, BOB ROSS was a particularly effective expediter, and M. D. BURDICK was chairman of the Displays and Contests Committee.

EDWARD WOOZLEY presided as toastmaster at the annual banquet. A Certificate of Merit was awarded to DR. A. W. SAMPSON, the certificate being accepted by DON CORNELIUS in the absence of DR. SAMPSON. LEON NADEAU presented an award to the National Capital Section for the greatest percentage increase in membership in 1956. GEORGE BRADLEY received the award on behalf of the chairman of the Section's Membership Committee. FRED RENNER spoke briefly on the work and times of CHARLIE RUSSELL.

The Plant Identification Contest was won for the second consecutive time by the team from Texas A. and M. College, with second place won by the team from Utah State, and third by Colorado A. and M. High individual scorer was RICHARD PAGE, Utah State, with 199½ out of a possible 200. FRITZ LUNDERS and DEAN BIBLES of Texas A. and M. tied as second high scorers with 196 points.

Grand Champion winner in the photographic contest was HURLON RAY. First place winners in the black and white divisions were VERNON YOUNG, R. L. KENT, CLYDE DORAN, and BOB GARTNER. Winners in the colored slides division were IRV HACKETT, HURLON RAY and MIKE STEED.

REPORT OF THE EDITOR

The 1956 volume of the Journal (Vol. 9) contained 74 articles and technical notes with a total of 302 pages. Paid advertising occupied about nine pages in the volume.

Three special issues were released during the year: The January Convention Issue containing the program and the details of the annual meeting; the September Student Issue featuring student articles and news about range management students; and the November Ranchers Issue containing 16 articles by ranchers from all sections of the range country.

Appreciation is expressed to PROFESSOR KENNETH A. VALENTINE of the Department of Animal Husbandry, New Mexico State College, for his help and leadership in assembling the material for the September Student Issue. Ten student articles and editorials, four contributed papers, and reports of student activities in the Range Student Roundup were included in the issue.

The Rancher Issue, produced by EDITOR ROBERT DARROW, proved to be the outstanding issue of the year. There was a very favorable reaction to the issue from Society members, several of the articles were reprinted by other publications, and more reprints were ordered from this issue than from any other single issue.

Recognition is given to JOHN T. CASSADY, Marianna, Florida for his assistance and counsel as a member of the Editorial Board, 1954-56. New members of the Board chosen by the Directors for 1957-59 are FRANK

GYBERG, Cornville, Arizona, and E. J. WOOLFORK, Berkeley, California.

Special recognition is given to ROBERT A. DARROW for his outstanding performance as Editor of the Journal for the period 1954-56.

HIGHLIGHTS OF THE DIRECTOR'S MEETINGS

President JOHN D. FREEMAN presided at the Director's meeting held at the Rainbow Hotel, Great Falls, Montana, on January 29. Incoming President E. W. TISDALE presided at the meeting of the Directors at the Hotel on February 1. Officers and Directors were present except for GEORGE E. WEAVER, who was represented by KENNETH CONRAD. Major items of business and highlights of the committee reports are as follows.

Program of the Future: HAROLD COOPER, Chairman, made a number of suggestions regarding the Journal, especially that the Society should move toward monthly publication of the Journal as quickly as possible. He suggested that consideration be given to a permanent headquarters for the Society.

1958 Convention City Preliminary Arrangements Committee: President FREEMAN read a report from FRANK ARMER, Chairman, on the situation at the Westward Ho Hotel, Phoenix, Arizona, site of the 1958 meeting. The convention program will be inserted in the December issue of "Arizona Highways".

1959 Convention City Committee: CLARENCE KINGERY reported for the committee. Omaha, Kansas City, Wichita, Topeka, Oklahoma City, and Tulsa were considered by the committee. The Directors selected Tulsa as the 1959 convention city.

Committee on Cooperation With Youth: KARL PARKER, Chairman, reported that a range management manual for youth of the 6th-7th grade level should be in essentially final form by mid-summer. An item of $200 for pre-publication costs of this manual was put in the 1957 budget.

Committee on Range Management Handbook: HAROLD F. HEADY, Chairman, reported by mail that the committee felt that no action should be taken on the publicaton of the Handbook at this time. The Directors voted to adopt this recommendation.

Committee on Range Research Methods: Chairman C. WAYNE COOK reported by mail that the book prepared by the committee, "Range Research Methods", should be completed by April 1, 1957.

Committee for National Inventory of Range Management Research: E. W. TISDALE, Chairman, recommended that the committee be continued and enlarged, and that special efforts be made to secure a grant for financing the inventory. These recommendations were accepted by the Directors.

Committee on Career in Range Management Brochure: R. R. HUMPHREY, Chairman, reported that the committee was attempting to secure the services of a cartoonist to illustrate the brochure. The brochure will cover the following seven points: Industry and Business, Ranching, Public Agencies, Range Research, Teaching, Range Economics, and Journalism.

Summer Meeting: HAROLD JOSENDAL, Chairman, said that July 25 and 26 had been tentatively set as the dates of the summer meeting of the Wyoming Section at Jackson. The Directors approved meeting at Jackson on July 25, with the remainder of the meeting to be held jointly with the Wyoming Section. Members of the Society will be invited to meet with the Wyoming Section at this time for a Summer Meeting.

Budget: The budget for 1957 was approved as follows:

Estimated Receipts	$21,175.00
Estimated Expenditures	
Office of the President.	200.00
Office of the Editor....	600.00
Executive Secretary...	9,881.00
Journal publication....	10,200.00
Total	$20,881.00

Trail Boss Emblem: President TISDALE appointed two members of the Board and the Executive Secretary to investigate the possibilities of developing a pin, tie-clasp, and tie bearing the official emblem of the society.

Editorial Board: The Directors appointed FRANK GYBERG of Cornville, Arizona, and E. J. WOOLFOLK of Berekley, California to the Editorial Board of the Journal for the period 1957-59.

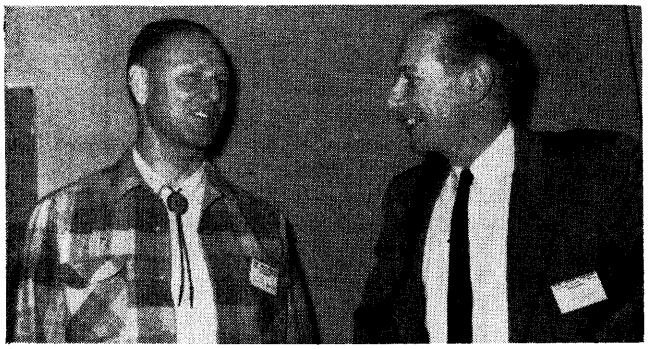
Letter of Commendation: The directors moved that ROBERT A. DARROW be presented with a letter of commendation for his outstanding work as Editor of the Journal of Range Management during the period 1954-56.

Checking program arrangements: R. S. "BOB" CAMPBELL, Society vice president; JOHN G. CLOUSTON, executive secretary; JOHN D. "DANNY" FREEMAN, 1956 president; and KENNETH CONRAD, director.

GEORGE E. BRADLEY, Agricultural Conservation Program Service, Washington, D. C., chairman of the session on "Management as a Method of Range Improvement", confers with MELVIN T. MORRIS, University of Montana, general Program Chairman.

MR. AND MRS. WILLIAM K. ARMITAGE, Armitage Ranch, Cameron, Montana.

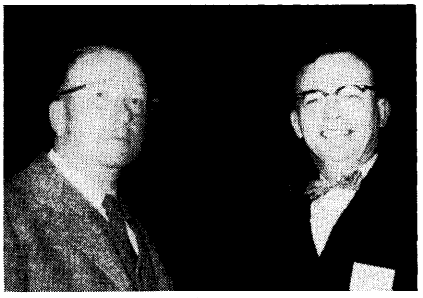
MR. AND MRS. J. A. "SCOTTY" CAMPBELL, Department of Lands and Forests, Edmonton, Alberta.



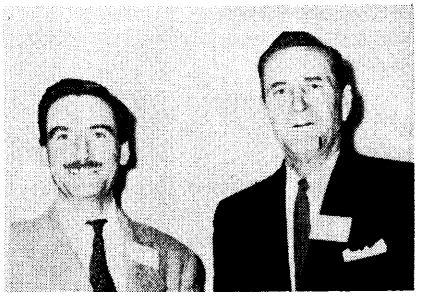
LES ALBEE, Society director, Soil Conservation Service, Rapid City, South Dakota, and GRANT HARRIS, Washington State College, Pullman, Washington.

DAN FULTON, Ismay, Montana, and MR. AND MRS. LEWIS ARCHAMBEAULT, Wolf Point, Montana.

EDWARD WOOZLEY, Director, Bureau of Land Management, Washington, D. C. and HAROLD JOSENDAL, Society director, Casper, Wyoming.



S. V. CIRIACY-WANTRUP, University of California, Berkeley, California, and CARL KRAENZEL, Montana State College, Bozeman, Montana.



JOHN M. CROSS, A-7 Ranch, Nanton, Alberta, Society director, and DON C. COLLINS, president, American National Cattlemen's Association, Kit Carson, Colorado.

PROGRAM FOR SUMMER MEETING WITH WYOMING SECTION

The tentative program for the summer field meeting of the Wyoming Section in Jackson Hole, July 25-27, to which all Society members and other interested persons are invited, calls for a technical panel discussion on livestock-game relations on the evening of July 25. Panel members will include ROBERT L. CASEBEER of Idaho, ODELL JULANDER of Utah, WALTER KITTAMS of the National Park Service, and MARGARET ALTMAN of the New York Zoological Society. Activities for the 26th and 27th include field trips through the National Elk Refuge, Gros Ventre Mountains, and Hoback Canyon.

Headquarters for the meeting will be the WORT HOTEL in Jackson, Wyoming. Requests for hotel or motel reservations should be mailed to that address. Campgrounds are available for those who prefer to camp out during their visit to Jackson Hole.

WITH THE SECTIONS

ARIZONA

Officers of the Arizona Section for 1957 are:

Chairman: JIM FINLEY, P. O. Box 136, Gilbert.

Vice Chairman: DAVID G. WILSON, U. of Arizona, Tucson.

Secretary-Treasurer: CHARLES C. MICHAELS, P. O. Box 659, Holbrook.

Councilmen: WILLIAM L. SCHROEDER, Valentine; EARL E. HORRELL, Globe; D. K. WINGFIELD, Rimrock; WAYNE KESSLER, Phoenix; GEORGE GLENDENING (Honorary), Tucson.

Nine committees have been appointed to carry on the program of the Section for the year. The Membership Committee, under the chairmanship of DANNY FREEMAN, has begun action on the 1957 membership drive. On March 1 the Section total was 275 members—the highest thus far attained. Prospects for reaching the 300 mark before the end of the year look good.

The summer meeting of the Section will be at Showlow, July 30-31. The program will center around the theme "Range Management". Reservations should be made early because of the limited facilities at Showlow.—*Wayne Kessler.*

COLORADO

The first 1957 meeting of the Colorado Section was integrated with the traditional Foresters' Days at Colorado A and M College, February 22-23. The program Friday afternoon was a symposium: "Nutritional problems on Colorado ranges", presided over by Director RAYMOND PRICE of the Rocky Mountain Forest and Range Experiment Station. Papers were given by DR. L. E. WASHBURN, FORD DAUGHERTY, and BOB ESTOUP of the Animal Husbandry Department; G. E. KLIPPLE, Agr. Res. Service; W. M. JOHNSON, Rocky Mountain Forest and Range Experiment Station; and by ranchmen MARVIN KNIESE of Wray, and GEORGE SALISBURY, JR. of Slater.

Student members of the Section, led by CLARENCE RICE were active in planning the program and were excellent hosts.

After an early, but well attended business meeting Saturday morning, members enjoyed a full day's program, including a joint meeting of professional societies that featured a panel discussion on "Multiple use in wildland management". An outstanding conservation talk by JOE PENFOLD, contests in log bucking, rolling and chopping by students in the Forestry Club, an Alumni luncheon, and a Foresters' Day tea, banquet, and ball, made a memorable experience for all attending.—*Clyde W. Doran.*

NEBRASKA

The Executive Council of the Nebraska Section met January 31 to make tentative plans for the 1957 Section program. Present at the meeting were DON SYLVESTER, *Vice chairman* "PELTY" HOWARTH, *Secretary-Treasurer* EUGENE NEWTON, and *Directors* RALPH BAKER and ROBERT KOCH.

LORENZ BREDEMIER was appointed chairman of the Membership Committee. As of January 16, there were 101 members in the Nebraska Section.

GEORGE WISEMAN was appointed chairman of the Nebraska Range Judging Contest Committee. A number of associations and agencies will be requested to participate actively in promoting range judging activity. Organizations expected to participate include the Nebraska Stockgrowers, Sandhills Cattle Association, Extension Service, Soil Conservation Districts Association, Soil Conservation Service, Vocational Agriculture and 4-H, and many others.

The Council proposed to actively promote the Range Management Curriculum now offered at the University of Nebraska. It is anticipated that considerable interest in the cause may be created by the range judging days. High school students present at the judgings will be informed of the opportunities in the field of range management.—*George Wiseman.*

WYOMING

Plans for the summer meeting of the Wyoming Section at Jackson Hole on July 25, 26 and 27 are progressing. The National Officers and the Board of Directors of the Society will meet at Jackson at the same time, and Society members and other interested persons are invited to attend. A three day program of panel discussions and field trips is being planned. Headquarters for the meeting will be in the Wort Hotel, Jackson, Wyoming.

The Wyoming Range Management Scholarship sponsored by the Wyoming Section will be awarded this year to ROBERT ADAMS, candidate for the M.S. degree. This is the second time that this scholarship has been awarded since it was established in 1953. The first recipient was MORTON MAY, 1953-1954. —*Alan A. Beetle.*

NEWS AND NOTES

Grass Breeders Conference

The 11th annual Western Grass Breeders Work Planning Conference will be held July 8, 9 and 10 at Montana State College, Bozeman, Montana. Workers from federal and state experiment stations in the western United States and Canada will participate in the conference.

Included in the meeting will be a session on the use of animals to evaluate forage species and varieties, and another session devoted to a discussion of the problems of grass breeding in the far western and mountain states. A discussion, similar to the latter, but concerned with grass breeding problems in the plains areas was held at the 1956 conference in Brookings, South Dakota.

Olsen, Intermountain Regional Forester, Retires

CHESTER J. OLSEN

CHESTER J. OLSEN, Regional Forester, Intermountain Region of the Forest Service, is retiring on April 1 after 37 years with the Forest Service. MR. OLSON has served every step on the career ladder from forest ranger to regional forester. His leadership brought about many outstanding accomplishments in resource management in the Intermountain Region, particularly in watershed management, restoration of ranges, construction of timber access roads and forest insect and disease control. For his outstanding contribution to rural life and the conservation of natural resources MR. OLSEN in 1955 received the Department's Superior Service Award.

22nd North American Wildlife Conference

The 22nd North American Wildlife Conference was held at the Statler Hotel in Washington, D. C., on March 4, 5 and 6. The theme of the 1957 Conference Program was "Conservation Is Everyone's Business." Members of the National Capital Section who participated in the program were: C. R. GUTERMUTH, vice-chairman of the Wildlife Management Institute, who was chairman of the program committee; EDWARD H. GRAHAM, who was on the program committee; and RICHARD E. GRIFFITH, who presented a paper entitled "Waterfowl Habitat Management on National Refuges." Many of the papers which were presenteed will be of interest to members of the Range Society. All papers and discussions from the floor will be printed in Conference Transactions which will be published by the Wildlife Management Institute, Wire Building, Washington 5, D. C.

BLM National Advisory Board Meets in Washington

The annual meeting of the Bureau of Land Management National Advisory Board Council was held February 26, 27 and 28 at the Department of the Interior in Washington, D. C. The National Council is composed of one cattleman representative and one sheepman representative from each of the ten Western States, plus a representative of wildlife interests from each of the three Areas of the Bureau.

Among the problems of general interest discussed by the Council members were effects of the drouth on the range and livestock industry, improved methods of tresspass control, wildlife management of the range, the range improvement and weed control programs, and recommended amendments to Federal regulations governing the administration and management of the Federal range.

Widened Research on Feeds and Forages

The U. S. Department of Agriculture's Feed and Forage Research and Marketing Advisory Committee has given high priority recommendations for increased research on a number of important projects.

An expanded research program has been requested on insect physiology and toxicology, including work on the nature and action of insecticides, repellents, and attractants, and studies on why some insects develop resistance to insecticides. Increased research on range practices, including grazing and soil water management, was requested. It was recommended that basic investigations on ruminant bloat be expanded, with emphasis on the study of animals bloating under natural or field conditions for correlation with studies in the laboratory.

The Advisory Committee is composed of persons outside USDA who have been selected to review the Department's research program on feeds and forage and to advise the Secretary of Agriculture on research needs in the field.

IN THE FIELD

FLOYD IVERSON, assistant regional forester of the Intermountain Region of the Forest Service at Ogden, Utah, since 1955, has been named regional forester there. He succeeds CHESTER J. OLSEN, who is retiring April 1.

In his new job IVERSON will be responsible for the overall administration of 19 national forests in Utah, Nevada, western Wyoming, and southern Idaho, and for the related cooperative programs with the States and other public agencies in the area.

WILLIAM D. HURST, Assistant Chief of the Division of Range Management, Forest Service, Washington, D. C., is being transferred to the Intermountain Region of the Forest Service to head the Division of Range and Wildlife Management in that area. He fills the vacancy created by the elevation of FLOYD IVERSON to Regional Forester.

EVERETT R. DOMAN, assistant chief of the Division of Wildlife Management, U. S. Forest Service, is transferring to Alamogordo, New Mexico, where he will be supervisor of the Lincoln National Forest. DAVID M. (MIKE) GAUFIN, assistant supervisor of the Teton National Forest, at Jackson, Wyoming, has been promoted to fill the Washington office position vacated by DOMAN.

WALTER L. GRAVES, forest supervisor of the Carson National Forest in New Mexico, has been promoted and assigned to the Washington office of the Forest Service as assistant chief of the division of operation. GRAVES will head up the organizational work of the division.

LOWELL G. WOODS, assistant regional forester at Ogden, Utah, was promoted

January 1 to assistant to EDWARD P. CLIFF, assistant chief of the Forest Service in charge of National Forest resource management, including range and game habitat. MR. WOODS will headquarter at Washington, D. C.

RANGE MEN ABROAD

DR. OSVALDO BOELCKE of the Argentina Department of Agriculture arrived in the United States in February for a 6-month tour and study of range management practices and research, principally in California. In Argentina, DR. BOELCKE has worked closely with MR. ROALD A. PETERSON of the Interamerican Institute of Agricultural Sciences, Southern Zone, of the Organization of American States. The Institute conducts an annual program of training for range and pasture technicians and assists the member countries in their grassland research. Both MR. PETERSON and DR. BOELCKE are members of the Society, and also were instrumental in the organization of a South American range society known as Sociedad Sudamericana de Pasturas. Currently, BOELCKE and PETERSON have under way some of the first range seeding studies attempted in Patagonia, the southernmost province of Argentina. DR. BOELCKE will return to Washington, D. C. in August for a several weeks' visit before leaving for home.

C. KENNETH PEARSE, formerly of the Southwestern Station, and for the past 3 years in charge of range and forage development on Egypt's desert range lands under ICA, has been assigned to the U. S. Operations Missions to Guatemala as forage specialist. There he will assist the Government of Guatemala in improving and making better use of forage and fodder resources and increasing livestock production. Rainfall in Guatemala is ample for production of good forage growth, but is so lacking during part of each year to result in serious seasonal forage deficiencies.

PEARSE'S principal accomplishment in Egypt was the establishment and operation, with Government of Egypt technicians, of a 25,000 acre experimental and demonstration range area on Egypt's Western Desert. Methods of range management, reseeding, water conservation and livestock handling and improvement were demonstrated.

R. W. "BOB" LODGE, Dominion Experiment Station, Swift Current, Saskatchewan, has been at University College of North Wales, Bangor, North Wales, since last fall, working on his doctorate. Within a few miles of Bangor nearly every vegetation type in Great Britain can be found. Grazing lands in the area vary from highly productive cocksfoot and clover fattening pastures, through rough grazings, to sour upland heaths. Rough grazings and mountain ranges are mainly given over to sheep production. Much of the grazing land in the region could be improved by cultivation, liming, manuring, drainage, and reseeding.

AMERICAN SOCIETY OF RANGE MANAGEMENT

National Committees for 1957

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M. L. Upchurch

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Fort Collins, Colorado
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D. L. Goodwin
D. L. Huss
L. A. Sharp
Ned A. Smith

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Department of Range Management
Utah State Agricultural College
Logan, Utah

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Wesley Keller
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Dwight R. Cable
D. A. Dobkins
Volney M. Douglas
Harry B. Embach
Fred O. Leftwich
Theodore L. Moeller

Elections

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State Office, Bureau of Land Management
P. O. Box 2237
Boise, Idaho
R. L. Casebeer
Justin G. Smith

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Agronomy Department
Utah State Agricultural College
Logan, Utah
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J. A. Campbell
David F. Costello
W. W. Dresskell
E. J. Dyksterhuis
George E. Weaver
Douglas E. Henriques
Paul B. Mast

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Henry H. Stidham

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Jackson Hole!

Rangelands in the Jackson Hole country are of great scenic beauty. Sheepmen and cattlemen use this area for summer range. It is the winter range for a large herd of elk, as well as deer, moose, and mountain sheep. Excellent opportunities exist for the study of livestock-game relationships.

You are invited to our

SUMMER MEETING AT JACKSON, WYOMING

July 25, 26, 27, 1957

WYOMING SECTION

AMERICAN SOCIETY OF RANGE MANAGEMENT

Address inquiries to:
Secretary-Treasurer,
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Room 216
Agricultural Building
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Laramie, Wyoming