In This Issue

Report of the President, 1957 .... *E. W. Tisdale* 57

A Message from the New President .... *Robert S. Campbell* 60

Effects on Associated Species of Burning, Rotobeating, Spraying, and Railing Sagebrush
Walter F. Mueggler and James P. Blaisdell 61

Quantitative Effects of Twenty-three Years of Controlled Use on Mountain Range
F. A. Branson and Thomas Lommasson 67

Testing New Range Forage Plants .... *John L. Schwendiman* 71

Economics of Ranch Appraisal .... *Arden B. Gundersen* 77

Profitable Use of Fertilizer on Native Meadows
Michael Nelson and Emery N. Castle 80

Blue Grama Types from West Texas and Eastern New Mexico .... *Jack R. Harlan* 84

Some Slope-Plant Relationships in the Grasslands of the Little Missouri Badlands of North Dakota .... *Ralph L.Dix* 88

Technical Notes

Bunchgrass Form Classes for Trend Studies
Glen F. Cole and Bruce T. Wilkins 92

A Loop Method for Measuring Ground-Cover Characteristics on Permanent Plots .... *Richard S. Driscoll* 94

Modifications of the Point Frame
Harold F. Heady and Lynn Rader 95

Book Reviews: The Underground Organs of Herbage Grasses *(Troughton)*; **America's Natural Resources** *(Callison)*; **Grassland Seeds** *(Wheeler and Hill)*; **Meditations of a Forester** *(Shaw)* 97

Current Literature .... *G. W. Tomanek and John Launchbaugh* 100

Society Business: Range Women; The Depository—Library 103

With the Sections 104

News and Notes 106

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.

The **JOURNAL OF RANGE MANAGEMENT,** published bi-monthly, is the official organ of the American Society of Range Management. The Society, however, assumes no responsibility for the statements and opinions expressed by authors and contributors.

Office, Executive Secretary. Address all inquiries and correspondence including memberships, renewals, replacements of JOURNALS, etc., to Executive Secretary, American Society of Range Management, P.O. Box 5041, Portland 13, Oregon.

Change of Address. Notices of change of address should be received by the Executive Secretary one month before the date of issue on which the change is to take effect. Both the new and old addresses should be sent to the Executive Secretary.

Dues. Membership dues should be sent to the Executive Secretary. The dues are $6.00 per year of which $4.00 is a subscription to the JOURNAL OF RANGE MANAGEMENT. Dues for student members are $4.00 per year, including the JOURNAL. All subscriptions mailed outside the North American continent and insular possessions of the U. S. are $7.00 per year. Subscriptions must be paid in advance. Remit by draft or check on U. S. banks in U. S. funds.

Reprinting. The reprinting of articles or parts of articles published in the JOURNAL OF RANGE MANAGEMENT is authorized on the express condition that full credit be given the JOURNAL and the author. The date of original publication must be shown with the credit line.

Post Office Entry. Entered as second class mail at the post office, Portland, Oregon, under the Act of March 3, 1879, as amended June 11, 1934. Additional entry made at Lincoln, Nebraska.

Printers. The Nebraska Farmer Company, 1420 P Street, Lincoln, Nebraska.

Journal of
RANGE MANAGEMENT
Volume 11, Number 2
March, 1958

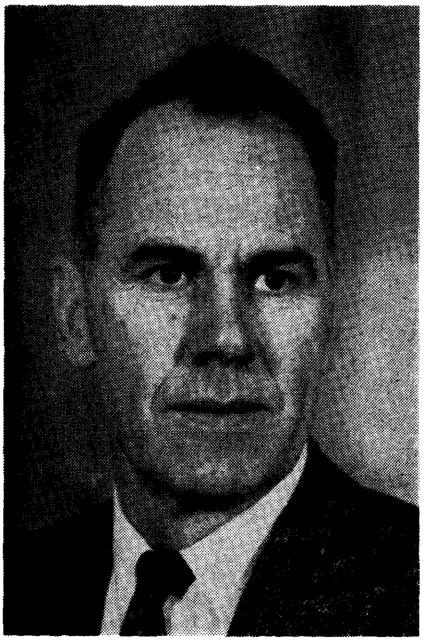
Report of the President, 1957

Presidential Address—Eleventh Annual Meeting, American Society of Range Management, Phoenix, Arizona, January 27-February 2, 1958

E. W. TISDALE
University of Idaho, Moscow, Idaho

Here in this wonderful setting for our 11th annual meeting, it is hard to realize that it is a full year since your present officers assumed positions of responsibility in the Society. Now it is our obligation to give an accounting of what we have accomplished during this time. I say "we" advisedly, for although this presentation is called "the President's report," it obviously represents the work and accomplishments of many persons. The Executive Secretary, the Vice President and Directors, the National Committees, the Editor and Editorial Board, the Section officers and many others have all contributed. To all who have helped so well during the past year I give thanks. It has been an honor and a pleasure to work with such a fine group of people and to be your presiding officer for the year.

The year just ended has seen the start of our second decade as a Society. The first youthful stage of initial establishment and rapid development is being succeeded by one of greater maturity and increasing responsibilities. We have become, rather rapidly, a recognized Society, taking our place along with many older and larger groups. We are now an acknowledged spokesman for the range resources and their management. Our publications, our meetings and other activities are now a part of the accustomed scene in the range areas of this continent. To our 18 sections has just been added a new member, the first section from our good neighbor to the south, the great country of Mexico. I am sure that I speak for all in extending a hearty welcome to Martin Gonzales and all of the group from Mexico whose efforts during the past year have built up membership and made this new Section a reality.



E. W. TISDALE

This latest addition gives us 2 Sections which are located entirely in other countries than the United States, and 3 others which have a substantial part of their membership in another country—Canada. This international flavor is something to be valued, and presents a great opportunity to help with the development of range resources in many parts of the world. As one contribution in this direction, we have recently entered into an agreement with the International Cooperation Administration whereby membership in our Society is provided at nominal cost for a 3-year period to persons from other countries who have trained here under the I.C.A. Technical Assistance Program.

New Responsibilities

Growth and recognition bring responsibilities, and with increasing frequency the Society is being called upon to measure up to its position. One aspect of this position involves cooperation with other organizations concerned with grazing and forage problems. Last fall, in connection with the American Institute of Biological Sciences meetings at Stanford, the Joint Committee on Grassland Farming participated in the program. This Joint Committee (recently renamed the American Grassland Council) is a coordinating group composed of about twenty societies interested in grasslands. As a member of the Joint Committee, our Society took part in the program at Stanford, and a committee headed by Dr. Harold Heady brought range into the picture along with cultivated pastures and forage crops.

More recently we have been invited to take part in a symposium on methods of forage evaluation to be held in connection with the next annual meeting of the American Society of Agronomy. Other groups involved in this symposium include the American Society of Animal Production and the American Dairy Association. In the near future, probably at the Tulsa meeting, our Society plans to act as host for some or all of these groups in a joint session with the American Grassland Council. Additional projects, planned or already initiated, involve working cooperatively with other national organizations.

I am certain that you are all well aware of the tremendous part played by the Sections in Society affairs. They constitute the real mainspring of the organization, and are the means by which most of our members, along with many other persons, are reached. As our Sections continue to grow in the strength and variety of their programs, so will the Society grow. It has been a pleasure over the past two years to read the Section newsletters and realize the fine programs of meetings, field tours, youth programs and other activities which have been developed. These Section activities are conducted on a scale and in a manner that is building recognition and prestige for our organization.

Committee Work

There is another important phase of the Society's activities which may not be so fully appreciated, namely the work of the National Committees. There are 17 of them at present, covering a wide range of activities. These committees are set up to handle specific items of Society business and considerable effort is given to making them broadly representative both area and occupation-wise. The largest group consists of committees essential for the normal functioning of our Society. These include the Program, Local Arrangements, Displays and Contests, Nominations, Membership and many others without which we could not operate. The fine program we are enjoying here, and the excellent arrangements are good examples of the work done by these committees, and of the many hours of work contributed by their members.

Another type of committee deals with special problems. We have 4 of these at present, working on range research methods, a national inventory of range research, cooperation with youth organizations and a brochure on careers in range management. Each of these committees has been working for more than this past year, but because of the importance of their jobs I would like to report briefly on their overall progress to date.

A comprehensive publication on range methods is being prepared by the Committee on Range Research Methods, under the chairmanship of Dr. Wayne Cook. This relatively small committee is being helped by many other persons, with the various chapters assigned to different authorities. Publication in book form will be financed by the National Research Council. Good progress is being made, but this is a tremendous job, and not something to be tossed off in a hurry. When complete, this work will mark a major step in reviewing and presenting in one volume the many methods now being used in various phases of range research.

The work on a national inventory of range research is still in the preliminary stages. The idea is to conduct a nation-wide survey of range research now in progress and of additional research needs. Many partial surveys have been made, but nothing really comprehensive. The ground work is now being laid for a full-scale survey similar to that conducted 3 years ago by the Society of American Foresters. Like the Foresters, we hope to enlist the support of one of the Foundations to finance this project on the scale required for a satisfactory job. The present committee, headed by Royale Pierson, includes representatives of the major research and land management agencies and of the universities.

Another project of major importance is that of the Committee on Cooperation with Youth Organizations, headed by Karl Parker, and composed mainly of men in the range extension field. The principal task of this committee is the preparation of teaching materials on range management suitable for the use of high school and other youth groups. There has been a dearth of material which is at once factual and attractive. Already this committee has a manual prepared in draft form which, when adapted for each major range region, should go far toward supplying the present needs. There is probably no phase of land management with which the general public is less acquainted than that of range. The opportunity for disseminating such knowledge is particularly good among young people, provided that we have the right sort of materials as a base. This we can expect to have in the near future, and the project is one which our Society is proud to support.

Another problem which is being attacked is that of recruiting young men for college training in range management. At present, and for some years past, there has been a shortage of college graduates majoring in range, although there are adequate training facilities in many parts of the country. A committee with Dr. Bob Humphrey as chairman is now working on a brochure on careers in range management, which will tell boys entering college something of the opportunities available in the field of range management. Many other professions have such publications, and it is time we did likewise. It is hoped that this first brochure will be published this summer, in time to be effective with students starting college or electing their major field this fall.

Apart from the "project" committees, there are a couple of others which have a continuing and important function. One of these is the Committee on the Program of the Future, whose job it is to look ahead and suggest ways in which our Society can grow stronger and keep in tune with changing conditions. Already Harold Cooper and his committee have come up with a number of instructive ideas, and this study is continuing.

Salaries and Standards

A group which has an important task on its hand just now is the Civil Service Committee, under chairman Joe Wagner. It is the responsibility of this committee to keep us informed as to the employment and salary policies of the public agencies who hire professional range management people. There are many problems in this area. At this time last year we were concerned over the discrepancy in entrance salaries at the GS-5 and GS-7 grades for range graduates as compared to foresters. A resolution protesting this situation, was sent to the Federal Civil Service Commission and the principal employing agencies. This situation has now been rectified for the Range Conservationist and Range Manager positions.

A current problem in this field is that of entrance standards for professional jobs in range management. For several years there has been a shortage of well-qualified graduates, which has made it difficult for the employing agencies to fill available positions. As a result, pressures have developed which could lead to a permanent lowering of standards. Protests have already been made by your Executive, and continued vigorous action is needed to guard against any downgrading of educational requirements.

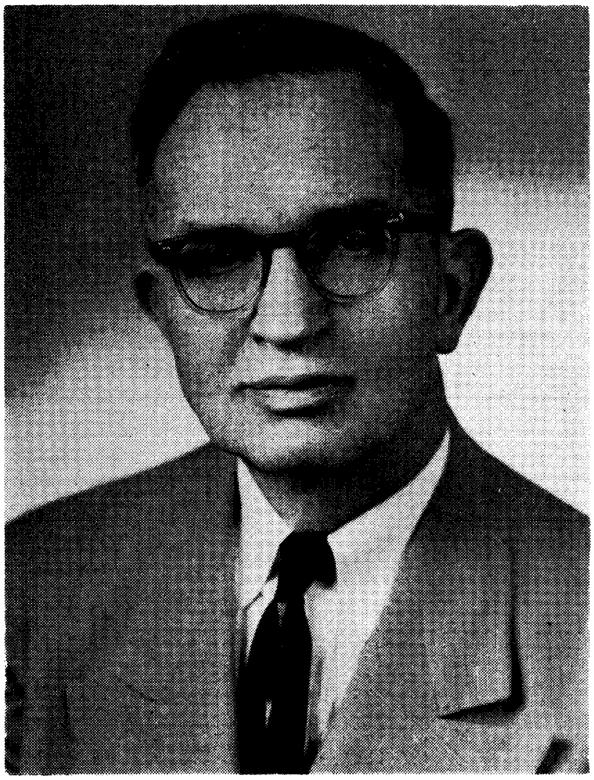
Your Society has not endorsed the idea of accredited curricula in range management. It has, however, expressed its opinion definitely as to the minimum training which can qualify a person for entering this field of work. Details of the recommended curriculum was published in the September, 1952, issue of the Journal of Range Management, and have formed the basis for the GS-5 Range Conservationist rating which has been used for the past few years. To depart basically from the desirable standards set in this Range Conservationist rating for any technical position in the field of range management would be a step backward in a profession which still needs further strengthening. There are now some 16 or 17 schools equipped to offer full-fledged training in range management. If these range departments receive the full support of employment agencies, they should be able to supply all the personnel needed, with no need for recourse to students with little or no training in range, or those without college training.

New Developments

Following discussion at Great Falls last year, the idea of a summer meeting of the Society was tried out for the first time. For a beginning, it was decided to combine a regular Section meeting with the summer meeting of the Board of Directors, and to invite all Society members to attend. The place chosen was Jackson, where the Wyoming Section played host in fine style. While the attendance did not approach that of our winter meetings, the program did attract members from many parts of the country. There are some real advantages to a summer meeting, even though many members are unable to attend at this season. Perhaps the greatest advantage is the opportunity to see the range resources and problems of the host area in a much more satisfactory manner than is possible in most areas in the winter time. This summer meeting idea is one that deserves full support, and could develop into a regular feature of great interest and value.

There are many other matters which could be reported here, but most of them are already familiar to you. Our financial situation presents some problems, as has been indicated in a special report by our Executive Secretary in the November issue of the Journal, and at the general business session. It does not appear to be a problem that need slow down any of our activities. In these days of rising prices, our annual dues are remarkably low for the services rendered. They will have to be increased soon to put us on a sound business basis, and I see no reason to anticipate any appreciable loss of members through such action. In finances, as in membership and related problems, our past record gives us no reason to fear for the future. As long as our Society is growing in its activities and influence, so will its membership and financial support.

In conclusion, let us never forget the basic nature of the resource upon which our organization is founded. "All flesh is grass" now as in the pre-Sputnik era, and food remains a fundamental need of mankind. The process by which green plants manufacture food by means of the sun's energy still remains the basic force which dominates the affairs of men and his animal kin. As self-professed students and custodians of grass we need not feel outmoded by the noise of rockets and the flight of artificial satellites. We are still dealing with the very basis of life, and in this field the challenges and opportunities were never greater.



Robert S. Campbell

1958 President, American Society of Range Management

Chief, Division of Range and Watershed Management Research, Southern Forest Experiment Station, New Orleans, La. Reared on farms in west and central Texas. Obtained B.S. degree University of Chicago, 1925; M.S., 1929; Ph.D., 1932. Engaged in range research, U. S. Forest Service Jornada Experimental Range, New Mexico, 1925-1932. Assistant Chief, Division of Range Research, U. S. Forest Service, Washington, D. C., 1933-1943; in charge western range utilization standards study, 1936-1937. In charge, forest grazing studies, Southern Forest Experiment Station, 1943-1955. Appointed to present position in 1955.

Author of numerous articles and bulletins on range management, range ecology, and range livestock management. Charter member of the American Society of Range Management. Member Board of Directors, 1949; Editor, Journal of Range Management, 1950-1952. Chairman, Southern Section, 1954. Vice President of the Society, 1957.

A Message from the New President:

Greetings to grassland managers everywhere!

Our Annual Meeting at Phoenix, Arizona provided a great stimulus for the work ahead. And there is work a plenty for all of us, both as individuals and as a Society. It is through the Society that each of us can make his greatest contribution to grassland conservation and management.

Innumerable details require attention to keep the Society running smoothly and efficiently. We plan to cooperate with other societies in discussions of grazing problems and research techniques. We must maintain the outstanding quality of our Journal, by giving it increased financial support to meet higher printing costs. We must find ways to lighten the contributed time load of the Editor. We must find means to finance other Society publications which are nearing completion. Inevitably these activities necessitate higher dues to keep up with increasing costs.

The Society, through active committees and Sections, must continue to strive for more interchange of ideas between ranchers and range workers in the public agencies. We must help maintain high standards in the education, employment, and advancement of technical range men.

We are looking forward to the Annual Meeting at Tulsa next January. Start making your plans now to attend. But even more important than the Society Annual Meeting is active participation by each member in his Section activities. It is through our Sections that we reach the greatest number of range men, increase our membership, and enlarge our usefulness as a Society.

Beyond our responsibility to the American Society of Range Management is our duty to all human society. There is urgent need for each of us to think and work for better human understanding, tolerance, and ultimate World peace. Such peace will be brought about by men who work with plants, with animals, and with the soil. A dedicated mental attitude is necessary to make the right decisions and do the right things in each crowded day. As Isaac Watts has said: "Though reading and conversation may furnish us with many ideas of men and things, yet it is our meditation must form our judgement."

I sincerely appreciate the opportunity to serve as President of the Society in 1958. I am grateful for the fine work done by President Tisdale, Executive-Secretary John Clouston, and other officers and members last year. With your help, I am confident this will be another good year.

Robert S. Campbell
President

Effects on Associated Species of Burning, Rotobeating, Spraying, and Railing Sagebrush

WALTER F. MUEGGLER AND JAMES P. BLAISDELL

Range Conservationists, Intermountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Ogden, Utah.

Control of big sagebrush (*Artemisia tridentata*) on heavily infested areas has long been recognized as an effective range improvement practice. By killing this one undesirable species the grazing capacity of rangelands can often be increased manyfold.

During the past 20 years several methods have been developed to reduce sagebrush numbers and bring about such range improvement (Pechanec *et al.*, 1954). Generally these methods can be divided into two main categories: those that destroy all existing vegetation, and selective methods that destroy sagebrush without complete destruction of the herbaceous understory. When there are few plants of desirable species, consideration in the selection of a control method generally need be given only to effectiveness of sagebrush removal, relative cost, and development of a satisfactory seedbed. Establishment of forage species will be dependent upon artificial seeding. On the other hand, if a good stand of desirable species is present, it is upon these that increased production should depend; selection of the eradication method should not only consider degree of sagebrush kill and cost but also the effect of treatment upon these associated plants. It is with this question of the effect of treatment on associated forage species that this paper is concerned.

Considerable information has already been obtained on the effect of various selective methods of sagebrush control. Blaisdell (1953) reported in detail the effect of sagebrush burning on residual vegetation on the Upper Snake River Plains of Idaho. Bohmont (1954), Hyder and Sneva (1956), and Blaisdell and Mueggler (1956) are among those who have studied the effect of the sagebrush-killing 2,4-D sprays on associated vegetation. Burning, spraying, rotobeating, and railing as well as other methods were described by Pechanec *et al.* (1954), but only general information was presented on the relative effects of these methods on associated vegetation. Evidently little information is available on direct comparisions of various methods of sagebrush removal under carefully controlled conditions.

A comparison of four methods of sagebrush control that maintained the native herbaceous understory—burning, rotobeating, railing, and spraying with 2, 4-D—was started in 1952 on the Upper Snake River Plains in southeastern Idaho. The study area is in a fairly homogeneous, dense stand of big sagebrush between 2 and 3 feet in height, on the spring-fall range of the U. S. Sheep Experiment Station near Dubois, Idaho. The topography has only slight relief with little surface drainage; the sandy-loam soil is underlain by basaltic lava. Precipiation averages about 13 inches annually.

A good understory of native perennial species was present throughout. This herbaceous understory consisted predominantly of bluebunch wheatgrass (*Agropyron spicatum*), thickspike wheatgrass (*A. dasystachyum*), Idaho fescue (*Festuca idahoensis*), plains reedgrass (*Calamagrostis montanensis*), subalpine needlegrass (*Stipa columbiana*), blue grasses (*Poa* spp.), threadleaf sedge (*Carex filifolia*), fleabane (*Erigeron corymbosus*), lupines (*Lupinus* spp.), and minor amounts of other grasses and forbs. Besides the dominant big sagebrush, the shrubby vegetation included spineless gray horsebrush (*Tetradymia canescens*), downy rabbitbrush (*Chrysothamnus puberulus*), and antelope bitterbrush (*Purshia tridentata*). A more detailed listing of species and relative amounts can be found in Table 2.

Methods

A 54-acre area was divided roughly into quarters, and a different treatment was imposed upon each. An untreated check was reserved adjacent to the treated areas. Field-scale treatments were used and cost data were kept.

One-quarter was sprayed in early June 1952 using a ground spray unit with a 16-foot boom mounted on a truck. The 2,4-D ethyl ester (Weedone 48) was applied in a water carrier at the rate of 2 pounds of acid and approximately 20 gallons of water per acre. Unfortunately it was necessary to spray the area when winds were fairly high. Spray drift, combined with unexpected rockiness of the area, resulted in poor spray coverage with the ground vehicle. For this reason the sagebrush kill on the experimental area was much lower than would ordinarily be expected. Similar treatments on nearby areas have caused almost complete eradication of big sagebrush.

One of the areas was rotobeaten in early August 1952. A standard Case rotobeater with chain flails was run over the area only once to shred the brush. The machine was adjusted so that the flails just cleared the ground surface. Ample power was supplied by a wheeled tractor.

Railing was also done in early August. The rail used was constructed of three 11-foot sections of heavy railroad rail loosely bolted together at the ends to make a semiflexible 33-foot length of rail. The center section was of double weight. Drags were attached to the rear to keep the rails upright. A deisel motor patrol pulled this rail over the area twice, once each way.

The fourth area was burned in late August. Prior to burning, a standard fire line was constructed, consisting of a double grader line and a 100-foot backfired strip on the leeward sides and a single grader line on the windward. The fire was set simultaneously along both windward edges and a hot, clean burn was obtained.

The entire study area was deferred from grazing the year of treatment and the year following. Moderate grazing by sheep was permitted thereafter.

Each area, including the untreated check, was sampled by 20 permanent, 48-square-foot circular plots spaced in a regular pattern. The weight estimate method (Pechanec and Pickford, 1937) was used to obtain herbage production by species prior to treatment (1952), 1 year after treatment (1953), and 3 years after treatment (1955). Estimates were also made of the percentage of herbage available to sheep, that is, the percentage that was not obstructed by brush.

In order to obtain pretreatment data, the 1952 inventory was of necessity made prior to the early June spraying and consequently before plant maturity. At this time it was difficult to segregate individual grass species rapidly; therefore all grasses were handled as one unit in the 1952 inventory. The 1953 and 1955 inventories were made later in the growing season, and grasses were segregated by individual species with the exception of two pairs, *Agropyron dasystachyum-Calamagrostis montanensis* and *Carex filifolia - Festuca idahoensis*. Because of similarity of vegetative appearances, grouping in these two pairs was necessary for rapid field identification.

Results And Discussion

Effects of Treatments

All four treatments caused sizable reductions in sagebrush and increases in herbaceous species (Fig. 1). Burning and roto-

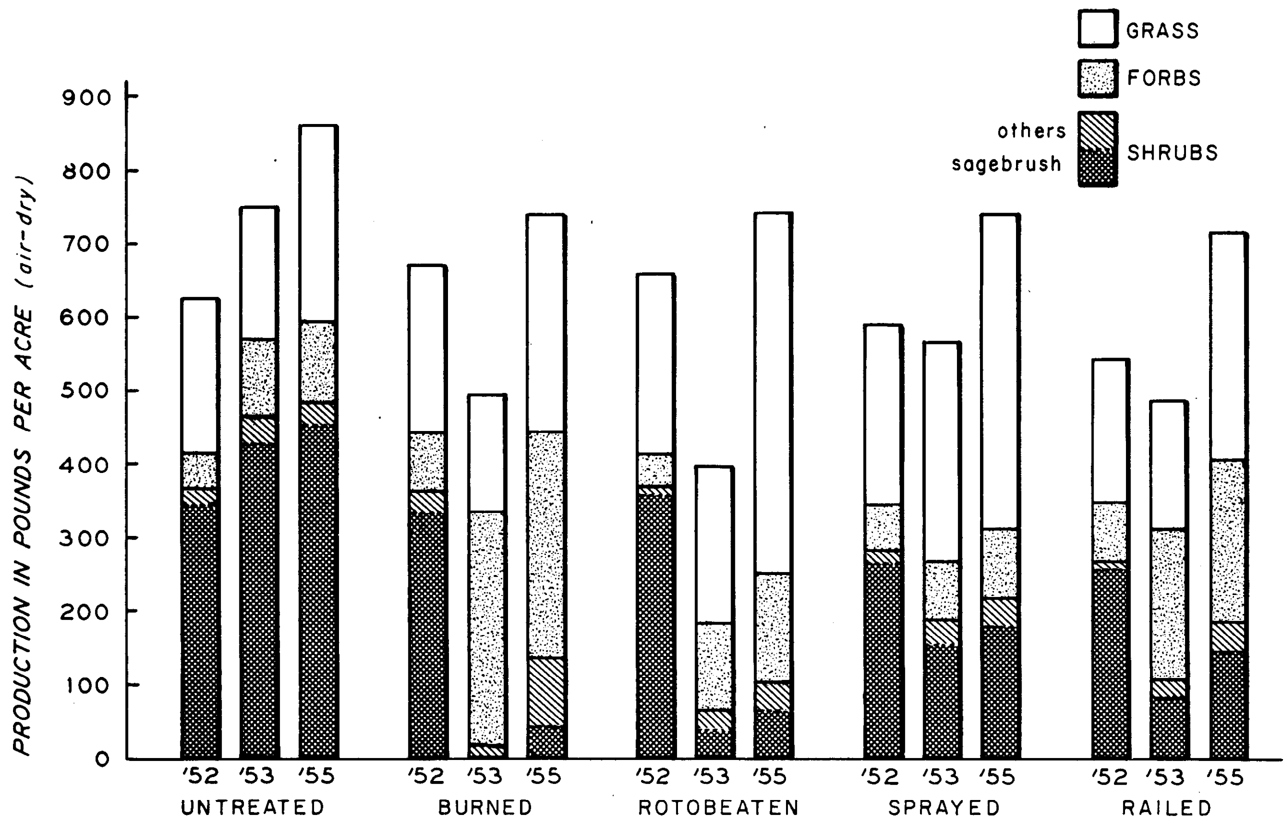


FIGURE 1. Grass, forb, and shrub herbage production prior to treatment (1952), and 1 year (1953) and 3 years afterward (1955), as compared to production on untreated range.

beating reduced sagebrush considerably more than spraying and railing. Burning brought about a much greater increase in forbs than any of the other treatments, and rotobeating and spraying a greater increase in grasses. Railing caused intermediate increases in both grasses and forbs. Despite general increases in grasses, forbs, and shrubs other than sagebrush on all treated areas, total vegetal production 3 years after treatment was still considerably less than on the untreated area. The inability of a predominantly herbaceous cover to produce as much foliage dry matter as a shrub-herb complex has been previously observed by Blaisdell (1953).

It should be noted that there were differences in herbage production on the various areas prior to treatment as well as natural year-to-year fluctuations on the untreated area (Fig. 1). Therefore, to determine accurately the effect of treatment upon vegetation it is necessary to compare relative rather than absolute vegetal changes over the 3-year period.

As compared with production on the untreated area, grasses decreased slightly on the burn the first year, remained about the same on the rotobeaten and railed areas, and increased markedly on the sprayed area. Three years after treatment the deleterious effect of burning on total grass production had been overcome, but there still had been no increase attributable to burning. Blaisdell (1953) found similar injury to grasses the first year after burning, but reported that rhizomatous species generally recover fully within 3 years after burning, and that losses incurred by most other grasses are recovered in 12 to 15 years. Rotobeating resulted in a 50-percent gain in grass production over what it would have been by the end of the third year had there been no treatment, spraying caused better than a one-third increase, and railing resulted in approximately a one-fifth increase of grass. Apparently burning was the only treatment that actually injured the grasses.

Although other treatments caused no injury, only on the sprayed area were grasses able to take immediate advantage of the release from sagebrush competition. During the first growing season after treatment grasses were noticeably more vigorous on the sprayed range than on adjacent areas, and herbage production was greatly increased. Substantial gains in grass production the first year after spraying with 2,4-D is apparently the rule (Bohmont, 1954; Hurd, 1955; Hyder and Sneva, 1956). However, the reason for such increase on the sprayed area and not on the rotobeaten or railed area is not clear. This may have resulted from reduced evaporation and a greater accumulation of snow among sagebrush skeletons. A comparison of March 1 snow accumulation showed 0.9 inch more moisture in the form of snow on the sprayed than on the rotobeaten area, about 7 percent of the average annual precipitation. It is also possible that the vigorous grass production may have resulted from an actual stimulus by the 2,4-D.

Production of forbs increased on the burned, rotobeaten, and railed areas during the first season, but decreased on the sprayed area in relation to the untreated area. By the third year relative forb production on all treated areas was slightly less than the first year after treatment. However, burning was still considered responsible for a 61-percent increase in total forb production, rotobeating a 50-percent increase, and railing a 20-percent increase, and railing it would have been with no treatment. During this same period spraying had caused a 39-percent loss in forbs. Such forb damage from 2,4-D is common (Bohmont, 1954; Hurd, 1955; Blaisdell and Mueggler, 1956).

Very pronounced reductions of shrubs occurred with all treatments. This reduction reflects the effect of treatment upon sagebrush which composed almost 95 percent of before-treatment shrub production. Greatest reductions in sagebrush were apparent the first year after treatment; thereafter production increased slightly. After 3 years sagebrush production on the burned area was still only 11 percent and on the rotobeaten area only 14 percent of what it would have been with no treatment; production on the sprayed and railed areas was 50 and 43 percent, respectively. Production of the shrub group excluding sagebrush was increased by all treatments with the exception of an initial reduction on the burn. By the third year production of associated shrubs, as a group, had doubled and tripled on treated areas. Such increases are attributed to the sprouting habit of most of these species.

Additional information on effectiveness of the various treatments for sagebrush control is supplied by plant counts (Table 1). Before treatment the number of sagebrush plants per 48-square-foot plot ranged from 9.8 on the area to be burned to 11.6 on the untreated area, or an average of approximately 11 plants per plot. The greatest reduction in numbers was obtained by burning, which killed all the old plants. The first year after treatment the burned area had only 1.5 plants per plot (all seedlings) and by the third year after treatment only 2.8 plants per plot, or an over-all reduction in numbers of 72 percent. Railing was the least effective method for reducing sagebrush numbers, as there were 3.8 plants per plot the first year after treatment and 6.2 by the third year, or a reduction of only 42 percent. Despite the rather

Table 1. Average numbers of sagebrush plants per 48-square-foot sample plot on five different areas before, 1 year after, and 3 years after using different methods to kill sagebrush.

	1952 prior to treatment	1953 First year after treatment	1955 Third year after treatment
Untreated	11.6	10.4	11.9
Burned	9.8	1.5*	2.8
Rotobeaten	10.7	2.0	3.6
Sprayed	11.1	3.5	4.3
Railed	10.7	3.8	6.2

*Seedlings

low kills of sagebrush from the 2,4-D treatment in this test, it should be recognized that spraying is an effective method for sagebrush eradication; kills of more than 90 percent are not uncommon (Blaisdell and Mueggler, 1956).

Species Herbage Yields

Herbage yields of individual species prior to treatment and 3 years afterward are shown in Table 2. The data are grouped into arbitrary desirability classes for sheep in order to obtain a better understanding of changes in amount and type of forage. The classification is based upon sheep preferences in this particular spring-fall range area; the same species may of course be rated differently elsewhere. Although pretreatment estimates were not made for individual grasses, the effect of each treatment is indicated by comparison of subsequent yields with those on the other areas. Caution must be exercised in deducing treatment effects by direct comparison with the untreated area. This is especially true in the case of the grasses where no before-treatment figures are available for individual species. An attempt has been made to avoid erroneous interpretations by utilizing supplementary information to indicate inequalities in original production.

Of all the treatments, burning caused some of the most pronounced changes in individual species. Species other than sagebrush that were harmed by burning were *Agropyron spicatum, Antennaria microphylla, Penstemon radicosus*, and especially *Carex-Festuca* and *Purshia*. Although *Stipa comata* may have suffered a loss, it was probably not as severe as the figures indicate; frequency data suggest that there was less of this species on the burned area originally than on the untreated. Burning appeared to benefit most *Agropyron-Calamogrostis, Stipa columbiana, Astragalus convallarius, Lupinus, Erigeron, Chrysothamnus*, and *Tetradymia*. These observations agree essentially with long-term observations by Blaisdell (1953), who found, however, that initial decreases in many of these species, with the exception of *Festuca* and *Purshia*, were only temporary and that they eventually regained or exceeded their original production.

None of the species on the rotobeaten area, other than sagebrush, was seriously injured by this treatment; all appear to have responded favorably. The apparent decrease in *Agropyron spicatum* is deceptive, for frequency data indicate a markedly greater occurrence of this species in 1953 on the untreated area than on any of the treated plots, suggesting an inequality of original production. What seems a slight decrease on the rotobeaten area, and on the sprayed and railed areas as well, may actually be a slight increase. As pointed out previously, there was a lag in response of grasses to release by rotobeating the first year as compared to the forbs. This is illustrated by relative production figures between the two groups over the entire period (Fig. 1). Before treatment production of grasses was almost six times that of the forbs; 1 year after it was less than twice as great; and in 3 years, by which time grasses had taken advantage of reduced brush competition, it was over three times as great as the forbs.

The most pronounced effects of spraying were reductions in *Lupinus* and *Erigeron*, besides sagebrush, and increases in most grasses, especially *Stipa columbiana*. The indicated increase of *Stipa comata* is of doubtful validity because of the erratic occurrence of this species on the sample plots. Both *Purshia* and *Tetradymia* benefited by spraying. Production of other species was not appreciably changed.

With greater sagebrush kill from spraying, which might ordinarily be expected, grasses that increased under this limited reduction in competition would probably show greater gains, and forbs would probably be damaged more severely. Blaisdell and Mueggler (1956) found that such species as *Penstemon, Arnica fulgens, Comandra umbellata, Eriogonum heracleoides*, and *Chrysothamnus*, not obviously affected in this study, were lightly damaged by spraying with 2,4-D.

Changes induced by railing were not as pronounced as with other treatments; no species were greatly favored and none aside from sagebrush was noticeably damaged. The effects of railing were similar to those of rotobeating, but to a lesser degree because of lower sagebrush kill. Species that appear to have benefited most are *Carex-Festuca, Poa, Lupinus, Chrysothamnus*, and *Tetradymia*. The

Table 2. Herbage production before treatment (1952) and 3 years after (1955) on comparable areas subjected to different methods of sagebrush removal.

	Untreated		Burned		Rotobeaten		Sprayed		Railed	
	1952	1955	1952	1955	1952	1955	1952	1955	1952	1955
	(Air-dry pounds per acre)									
Total Grass	207	268	229	295	250	490	245	430	200	310
Total Forbs	49	114	82	307	43	150	65	92	80	223
Total Shrubs	367	481	361	137	368	102	281	219	267	184
Desirable Species										
Agropyron spicatum		41		18		33		29		30
Agropyron dasystachyum-Calamagrostis montanensis		31		68		68		46		30
Carex filifolia-Festuca idahoensis	*	106	*	36	*	204	*	146	*	143
Koeleria cristata		3		8		7		5		9
Poa spp.		18		35		66		25		34
Stipa comata		13		4		20		40		1
Stipa columbiana		51		123		91		138		63
Astragalus miser	1	7	—	3	1	8	Trace	4	1	6
Astragalus convallarius	—	1	—	10	—	5	—	2	—	4
Lupinus spp.	—	1	41	148	3	26	15	4	6	51
Penstemon radicosus	3	6	5	3	2	4	5	7	5	9
Purshia tridentata	8	8	14	Trace	—	—	5	13	—	—
Others	1	8	6	26	—	Trace	2	2	5	8
Total Desirable	220	294	295	482	256	532	272	461	217	388
Moderately Desirable										
Achillea lanulosa	1	2	3	9	1	1	—	Trace	—	1
Antennaria microphylla	4	18	4	4	1	17	5	18	7	39
Arnica fulgens	8	9	1	2	4	7	5	6	23	20
Comandra umbellata	Trace	1	3	2	1	3	5	3	1	1
Erigeron corymbosus	26	40	9	38	21	49	14	13	21	44
Eriogonum heracleoides	3	7	8	13	4	14	8	17	2	10
Chrysothamnus puberulus	4	11	5	68	4	16	3	12	3	20
Others	6	3	2	3	4	4	4	3	5	4
Total Mod. Desirable	52	91	35	139	40	111	44	72	62	139
Undesirable Species										
Artemisia tridentata	346	452	337	47	360	67	269	178	257	144
Tetradymia canescens	5	8	5	21	4	20	4	17	6	20
Others	Trace	18	—	50	1	12	2	13	5	26
Total Undesirable	351	478	342	118	365	99	275	208	268	190
Total Production	623	863	672	739	661	742	591	741	547	717

*1952 production for total grasses given above.

remaining species showed little change that can be directly attributed to railing. The apparent reduction in *Stipa comata* is probably not real, since frequency data suggest very erratic distribution of this species.

Changes in amount and type of forage are indicated by class totals of desirable and moderately desirable species in Table 2. Three years after treatment total air-dry production of desirable and moderately desirable species was 621, 643, 533, and 527 pounds per acre on burned, rotobeaten, sprayed, and railed areas, respectively, as compared to 385 pounds per acre on the untreated range. Production of the desirable class alone was 482, 532, 461, and 388 pounds per acre for the respective treatments, while that for the untreated range was only 294 pounds. Such changes were not immediate but occurred gradually over the 3-year period. The rotobeaten area especially was slow to respond with an increase in forage production.

Only 75 percent of the herbage on the untreated range was considered available to livestock, whereas 98, 98, 88, and 90 percent was available on the burned, rotobeaten, sprayed, and railed areas, respectively. It is apparent, then, that all treatments produced sizable increases in available forage and that increases were greatest on burned and rotobeaten range. It can be expected that availability of forage on the sprayed area will increase as the sagebrush skeletons decay.

Eradication Methods

Cost of the various eradication methods may vary considerably, depending upon size of area to be treated, equipment used, etc. The following figures may be considered indicative of comparative costs. The cost of burning, which includes construction of adequate fire lines, actual burning, and the loss of grazing because of 1-year mandatory deferment, is about $0.70 per acre. Rotobeating costs vary from $3.00 to $6.00, spraying with 2 pounds acid equivalent 2,4-D, $2.50 to $3.00, and railing twice over, $2.00 to $2.50 per acre. It is readily apparent that despite the 1-year grazing deferment, burning is by far the least expensive method of sagebrush eradication. More specific information on burning procedure and costs is given by Pechanec, *et al.* (1954a).

When selecting a method best suited for a particular area, it is necessary to consider not only effect upon existing vegetation and cost but also adaptability of the method to the site and effect upon erosion hazard. Rotobeating and railing leave a good litter cover and do not increase the erosion hazard, but both methods are restricted to fairly rock-free areas. Rotobeating should not be attempted where rocks protrude more than 3 inches above the soil surface or excessive equipment breakage may result. Spraying does not increase the erosion hazard appreciably and is suitable for any terrain where airplanes can be used, but may be highly undesirable on sheep ranges which have a high percentage of susceptible forbs. Burning is suited to any terrain where the fire can be kept under control; however this method should not be used on readily erodible soils or on slopes steeper than about 30 percent, for burning destroys all litter and exposes the soil to erosion.

Summary

Four different methods of selective sagebrush control were studied on sagebrush-bunchgrass range at the U. S. Sheep Experiment Station near Dubois, Idaho. Burning, rotobeating, spraying with 2,4-D, and railing were compared on adjacent areas to obtain a better understanding of relative effects upon associated native species and forage production.

Burning was the only treatment that injured any grasses. The *Carex filifolia-Festuca idahoensis* group was most severely reduced by burning. Other grasses, though set back temporarily, soon recovered. Grasses as a group were greatly favored by the other treatments. There was a lag in increased grass production the first year after rotobeating and railing, but grass production increased immediately with spraying.

Although burning brought about the greatest increase in total forbs, *Antennaria microphylla* and *Penstemon radicosus* were injured; *Astragalus convallarius, Erigeron corymbosus,* and *Lupinus* spp. were most benefited. Rotobeating and railing tended to favor all forbs, perhaps *Lupinus* spp. more than the others. Spraying caused a pronounced reduction in forbs, with *Lupinus* spp. and *Erigeron corymbosus* being most severely affected.

Sagebrush was greatly reduced by all treatments. By the third year after treatment sagebrush production on the burned area was only 11 percent of what it would have been with no treatment, 14 percent on the rotobeaten area, 50 percent on the sprayed area, and 43 percent on the railed area. Sagebrush plants were reduced to 28, 33, 39, and 58 percent of their former numbers under the respective treatments. *Purshia tridentata* was severely injured by burning; it was favored by spraying. *Chrysothamnus puberulus* and *Tetradymnia canescens,* which sprout readily, increased under all treatments.

All treatments produced sizable increases in available forage. Three years after treatment total production of desirable and moderately desirable species was approximately two-thirds greater on the burned and rotobeaten areas, and better than one-third greater on the sprayed and railed areas, than on the untreated range. Only 75 percent of the grass and forbs was available to livestock on the untreated range, but 98, 98, 88, and 90 percent was available on the burned, rotobeaten, sprayed, and railed areas, respectively.

LITERATURE CITED

BLAISDELL, JAMES P. 1953. Ecological effects of planned burning of sagebrush-grass range on the Upper Snake River Plains. U. S. Dept. Agr. Tech. Bull. 1075, 39 pp.

———— AND W. F. MUEGGLER. 1956. Effect of 2,4-D on forbs and shrubs associated with big sagebrush. Jour. Range Mangt. 9: 38-40.

BOHMONT, DALE W. 1954. Chemical sagebrush control—good and bad. Wyoming Agr. Exp. Sta. Cir. 54, 7 pp.

HURD, RICHARD M. 1955. Effect of 2,4-D on some herbaceous range plants. Jour. Range Mangt. 8: 126-128.

HYDER, D. N. AND F. A. SNEVA. 1956. Herbage response to sagebrush spraying. Jour. Range Mangt. 9: 34-38.

PECHANEC, J. F. AND G. D. PICKFORD. 1937. A weight estimate method for the determination of range or pasture production. Jour. Amer. Soc. Agron. 29: 894-904.

————, *et al.* 1954. Controlling sagebrush on range lands. U. S. Dept. Agr. Farmers' Bull. 2072, 36 pp.

————, *et al.* 1954a. Sagebrush burning — good and bad. U. S. Dept. Agr. Farmers' Bull. 1948, 34 pp.

Quantitative Effects of Twenty-three Years of Controlled Use on Mountain Range

F. A. BRANSON[1] AND THOMAS LOMMASSON

Plant Ecologist, U. S. Geological Survey, Denver, Colorado, Senior Range Examiner (Retired), Forest Service, U. S. Department of Agriculture, Missoula, Montana

In 1926 a forest allotment which had been heavily used was made available to the Montana Agricultural Experiment Station. At that time—"vegetation on many of the steep, non-timbered slopes had largely disappeared as a result of overuse. Accelerated erosion had developed on these slopes and in the drainage channels extending from them. Bed grounds were barren except for a scattered cover of mustard, knotweed, niggerhead, and other weeds of low value. The vegetation surrounding the bed grounds was greatly reduced as a result of grazing and trampling by the band as it left and returned on successive days." (Heady *et al.*, 1947).

In 1929 the following management practices were put into effect on the allotment:

1. Grazing was delayed until July 1 each year to permit the forage plants to reach a stage that would minimize damage from grazing.
2. The range was divided into camp units that permitted efficient use of the available forage and regulation of time of grazing with plant development at different elevations.
3. Once-over and twice-over grazing systems were tried and the twice-over system abandoned in 1936.
4. Open herding was used at all times.
5. The one-night bed-ground system of grazing with sheep was used.

The following is a report on some of the effects of these management practices on vegetation.

Description of Area

The area, known as the "College Allotment", consists of 3,788 acres of which about 2,900 are usable for grazing. The allotment is on the east slope of the Bridger Mountains about 15 miles northeast of Bozeman, Montana. The range is rolling to steep with an elevation of about 6,000 feet at the eastern edge to about 8,500 feet at the western edge. The range is characterized by alternating grassland parks and timber. Timber, mostly lodgepole pine and douglas fir, is most abundant on north-facing slopes, with the area dominated by timber being far greater than that occupied by herbaceous vegetation (Fig. 1).

Climatic data from a station a few miles from the allotment (elevation 5,980 feet, with four years of complete records) show an average annual precipitation of 30.7 inches. There was an average of 63 days with temperatures above freezing during the year and an average annual temperature of 39 degrees Fahrenheit. Extremes of temperature were 39 degrees below zero to 90 degrees above zero.

Unfortunately, climatic data were not recorded at the weather station near the College Allotment during the years previous to or immediately following 1932 when the study was initiated. In an attempt to estimate the precipitation pattern immediately preceding 1932 (Table 1), data for the five years at the weather station near the College Allotment were compared with several stations in southwestern Montana. The precipitation data of Loweth, Montana, were most nearly correlated with the station near the College Allotment.

By graphing the data for the two stations for the years 1951 through 1955 it was possible to estimate precipitation on the College Allotment for earlier years from the available Loweth record. The graph was used to estimate the precipitation for the five years (1928 through 1932) preceeding the initiation of the study. June, the month of greatest precipitation and probably the segment of the annual pre-

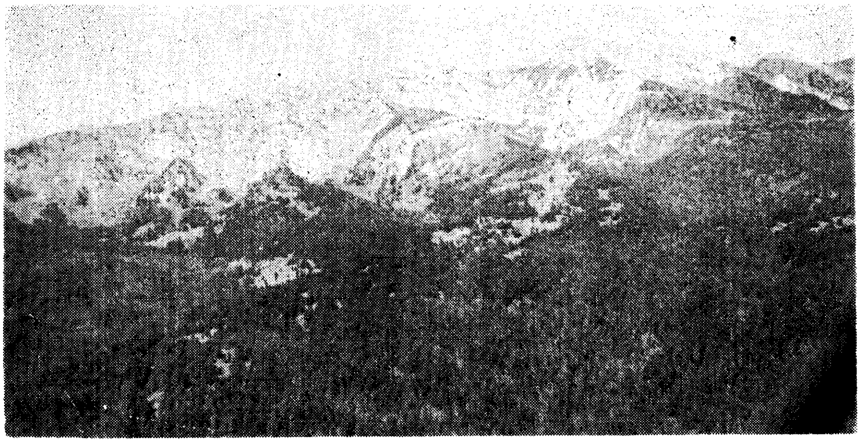


FIGURE 1. An aerial photo of the College Allotment showing the predominant timber cover and interspersed grassland. Sacajawea Peak is in the background.

[1] *Formerly Assistant Professor of Range Management, Montana State College, Bozeman, Montana.*

Table 1. Precipitation for the month of June at the weather station near the study area and at Loweth, Montana.

Year	College Allotment*	Loweth	Year	Loweth	Estimated College Allotment
1951	3.13	1.10	1928	3.21	6.7
1952	3.97**	1.97	1929	2.40	5.3
1953	6.49	3.10	1930	0.40	1.6
1954	7.78	3.46	1931	1.54	3.6
1955	6.29	3.02	1932	1.94	4.4
Total	27.66	12.65		9.49	21.6
Average	5.53	2.53		1.90	4.3

* Data from weather station 12 miles northeast of Bozeman or about 3 miles from the College Allotment.

** Estimated value entered in U. S. Weather Bureau records.

cipitation having the most effect on yearly plant production on the study area, was selected for the analysis. The estimated precipitation for the College Allotment for the years preceding the 1932 sampling was somewhat lower than that which occurred previous to the 1955 vegetational sampling.

Methods

In 1932 four study plots were established on the College Allotment. One of these was established at the lower edge of the allotment at about 6,100 feet, one at the upper edge at 7,500 feet, and two at intermediate elevations on the allotment (at 6,500 and 7,000 feet). All four areas were in grassland or in grass-forb types. At each location two 1/640 acre plots were clipped, dried, and the amounts of each species present determined by weight. In 1955 the same procedure was followed except that 10 plots, each containing 9.6 square feet, were clipped and species bagged separately at each location.

Exclosures made with poles and woven wire were constructed in 1932. These deteriorated over the years. To avoid effect of protection and of the scattered poles and fence, the temporary exclosures in 1955 were placed outside the old exclosures. Snow fences were used to exclude sheep from plots sampled in 1955. Samples in 1932 and 1955 were collected during the month of August. Samples were air-dried in 1932 and oven-dried in 1955. The 1955 yields were increased by 5 percent to give data more comparable with the 1932 air-dry weights.

Results and Discussion

Total yields on the three plots at lower elevations increased greatly during the 23 years but yields decreased slightly on the plot at 7,500 feet (Table 2). The plot at 7,500 feet was on relatively unstable soil, and near a spring used by the herder when the sheep were on that camp unit. Yields of the plots at 6,100 and 6,500 feet were more than twice as great in 1955 as in 1932. Total yields on the plots at 7,000 feet in 1955 were about 182 percent of the 1932 yield. A part of this increase in yield should be attributed to the more favorable moisture conditions during and preceding 1955 (Table 1). Undoubtedly much of the increase in plant production was due to the improved range management practices used during the 23 years.

Grasses increased greatly on the three plots at lower elevations during the 23 years. On the highest plot, grasses and forbs contributed about the same percentages to the total yield in both 1932 and 1955 (Fig. 2). These results indicate that vegetation at the higher elevations was a forb-grass type while that at lower elevations undoubtedly was originally grassland.

The only grass that occurred on all plots in substantial amounts was slender wheatgrass. Yields of slender wheatgrass decreased on all plots except the one at 6,500 feet elevation. Mountain brome increased on all plots except the one at 6,100 feet. On the lowest plot (6,100 feet) Kentucky bluegrass showed a marked increase over the 23 years. Idaho fescue was abundant on all plots except the plot at 7,500 feet elevation. Idaho

FIGURE 2. The forb-grass type at 7,500 feet, near the upper edge of the College Allotment.

Table 2. Yields in pounds per acre and botanical composition in percent based on average weights of species found on each plot.

	Plot Numbers and Elevation of Plots							
	No. 1 (6100 ft.)		No. 2 (6500 ft.)		No. 3 (7000 ft.)		No. 4 (7500 ft.)	
Grasses	1932	1955	1932	1955	1932	1955	1932	1955
	%	%	%	%	%	%	%	%
Bearded wheatgrass *(Agropyron subsecundum)*	—	T	—	1.7	—	—	—	.2
Slender wheatgrass *(Agropron trachycaulum)*	1.7	2.4	11.5	2.9	1.3	1.2	6.6	.4
Mountain brome *(Bromus marginatus)*	12.2	12.5	—	15.1	—	3.3	3.2	6.1
Sedge *(Carex* sp.)	—	.2	2.1	.4	2.6	2.4	—	—
Timber danthonia *(Danthonia intermedia)*	—	.8	—	4.3	—	—	—	—
Onespike danthonia *(Danthonia unispicata)*	—	—	—	—	11.6	—	—	—
Idaho fescue *(Festuca idahoensis)*	2.2	1.7	34.4	14.0	20.6	.6	—	—
Prairie junegrass *(Koeleria cristata)*	.3	.4	—	.3	—	—	—	—
Showy oniongrass *(Melica spectabilis)*	—	—	—	—	—	.7	3.4	6.3
Timothy *(Phleum pratense)*	—	.1	—	22.4	—	11.7	—	.2
Nevada bluegrass *(Poa nevadensis)*	—	1.3	—	—	—	—	—	—
Fowl bluegrass *(Poa palustris)*	—	—	—	.2	1.7	—	—	—
Kentucky bluegrass *(Poa pratensis)*	10.1	45.1	—	9.3	—	17.5	—	—
Subalpine needlegrass *(Stipa columbiana)*	.3	2.2	—	.8	—	.2	—	—
Others*	.6	.2	—	.3	—	—	—	—
Total grasses %	27.3	66.9	48.0	71.6	37.8	37.6	13.2	13.2
Average yields lbs./A.	244.0	438.0	460.0	1646.9	440.0	793.9	290.0	267.3
Forbs								
Western yarrow *(Achillea lanulosa)*	10.1	11.1	14.6	8.9	10.6	15.9	1.6	—
Pale agroseris *(Agroseris glauca)*	—	—	—	.2	—	1.0	—	—
Common pearleverlasting *(Anaphalis margaritacea)*	—	—	—	T	—	1.3	—	—
Lyall angelica *(Angelica lyallii)*	—	—	—	—	—	—	2.7	—
Sandwort *(Arenaria* sp.)	—	—	5.2	—	.2	—	—	—
Aster *(Aster* sp.)	1.7	2.0	—	—	.9	—	11.3	2.4
Bluebells *(Campanula rotundifolia)*	—	.2	1.0	T	—	.1	—	—
Starry cerastium *(Cerastium arvense)*	20.2	.1	4.2	—	8.6	.2	—	—
Canada thistle *(Cirsium arvense)*	—	—	—	—	—	—	—	11.1
Glia *(Collomia linearis)*	13.5	3.7	—	.2	—	1.3	—	—
Duncecap larkspur *(Delphinium occidentale)*	2.2	—	—	—	3.4	5.5	—	3.5
Northern bedstraw *(Galium boreale)*	.3	2.2	6.2	2.1	—	1.8	—	—
Richardson geranium *(Geranium richardsonii)*	—	—	—	—	—	—	—	4.6
Sticky geranium *(Geranium viscosissimum)*	9.3	3.7	9.4	7.6	20.6	14.0	5.4	1.6
Hackelia *(Hackelia cineria)*	—	—	—	—	—	—	—	4.7
Oneflower helianthella *(Helianthella uniflora)*	—	—	—	—	—	—	5.9	1.7
Rocky Mountain iris *(Iris missouriensis)*	—	—	—	—	—	1.3	—	—
Flax *(Linum* sp.)	—	1.5	—	—	—	.4	—	—
Lupine *(Lupinus* sp.)	—	—	6.8	1.9	2.6	—	—	—
Mountain bluebells *(Mertensia ciliata)*	—	—	—	—	—	2.2	9.1	7.6
Mintleaf beebalm *(Monarda menthaefolia)*	—	—	—	—	2.2	3.7	—	—
Sweetanise sweetroot *(Osmorrhiza occidentale)*	—	—	—	—	—	—	26.8	22.4
Cinquefoil *(Potentilla gracilis)*	6.7	1.1	2.1	.6	10.3	4.2	.9	.2
Douglas knotweed *(Polygonum douglasii)*	4.5	T	—	—	—	2.6	.4	.3
Niggerhead *(Rudbeckia occidentalis)*	—	—	—	—	—	3.9	18.1	19.9
Arrowleaf groundsel *(Senecio triangularis)*	—	—	—	—	—	—	1.4	3.7
Prairiesmoke sieversia *(Sieversia ciliata)*	1.1	T	—	—	1.7	T	—	—
Common dandelion *(Taraxicum officinale)*	2.6	2.5	2.1	4.9	—	T	3.2	1.1
Others*	—	1.3	.4	1.9	1.1	3.0	—	2.3
Total forbs %	72.8	29.2	52.1	28.4	62.0	62.6	86.8	86.8
Average yield lbs./A.	642.5	629.2	500.0	654.1	722.5	1321.7	1915.0	1759.6
Shrubs								
Big sagebrush *(Artemsia tridentata)*	.6	3.8	—	—	—	—	—	—
Total shrubs %	.6	3.8	—	—	—	—	—	—
Average yields lbs./A.	5.0	82.2	—	—	—	—	—	—
Average total yields lbs./plot/acre	891.5	2149.7	960.0	2301.0	1162.5	2115.6	2205.0	2026.9

* Includes species contributing less than 1 percent to any plot average: *Bromus ciliata, Danthonia californica, Phleum alpinum, Poa ampla.*

** Includes species contributing less than 1 percent to any plot average: *Arabis drummondii, Arnica sororia, Astragalus* sp., *Brodiaea grandiflora, Capsella bursa pastoris, Carum gardneri, Castelleja cervina, Epilobium angustifolium, Equisetum* sp., *Frageria virginiana, Frasera speciosa, Gaillardia aristata, Hieracleum lanatum, Hiracium gracile, Myosotis alpestris, Orthocarpus luteus, Pediluclaris* sp., *Polygonum bistortoides, Pulsatilla hirsutissima, Dodecatheon* sp., *Tragopogon pratense, Zygadenus* sp., and three unidentified forbs.

fescue was the most prominent species on the plot at 6,500 feet in 1932 but produced less of the total yield in 1955 than timothy. Prairie Junegrass was found only on the two lower plots, while showy oniongrass occurred only on the two plots at higher elevations.

The increase in timothy over the 23 years was most striking. This introduced grass was not found on the plots in 1932, but occurred on all plots in 1955. Timothy was most abundant on the plot at 6,500 feet elevation. Kentucky bluegrass, another introduced grass, occurred only on the plot at 6,100 feet in 1932, but was also present in considerable quantities on the plots at 6,500 and 7,000 feet in 1955. On the lowest plot (6,100 feet) Kentucky bluegrass showed a marked increase over the 23 years.

The total yield of forbs did not change greatly during the 23 years. There was a slight decrease on the lowest and highest plots; a slight increase on the plot at 6,500 feet, and a marked increase on the plot at 7,000 feet.

Western yarrow was abundant on all plots except the one at 7,500 feet. There was no apparent trend in the abundance of this species due to management practices. Starry cerastium, a plant listed as poor forage by the U. S. Forest Service (Heady *et al.*, 1947), decreased considerably during the 23 years of controlled management. However, Canada thistle, an introduced weed was present in appreciable quantities in 1955 on the plot at 7,500 feet, where it had not occurred in 1932. Gilia, a plant of little forage value, showed a marked decrease on the plot at 6,100 feet but increased slightly on the two plots at intermediate elevations. Tall larkspur, a plant poisonous to cattle but seldom affecting sheep, decreased at lower elevations but increased on the higher plots. Sticky geranium, a plant frequently grazed by sheep, decreased on all plots. Lupine decreased on the two plots at 6,500 feet and 7,000 feet and did not occur on the lowest and highest plots. A study by Teigen (1949) indicated that sheep show a high degree of preference for lupines of this area. Mountain bluebells, choice feed for sheep, increased slightly on the plot at 7,000 feet but decreased slightly on the plot at 7,500 feet. Cinquefoil occurred on all plots and decreased on all plots. Sheep preferentially graze cinquefoil (Teigen, 1949). Arrowleaf groundsel occurred only on the highest plot. It is considered choice sheep feed but showed a slight increase over the 23-year period. Common dandelion occurred on all plots but trends in abundance of this plant apparently were not related to grazing management or elevation.

The only shrub of importance found on the plots was big sagebrush. Its occurrence was limited to the plot at 6,100 feet. Its average yield increased from 5 pounds per acre in 1932 to 78 pounds per acre in 1955. This plot was located near the northeast corner of the College Allotment where it is grazed by sheep and by cattle from the adjacent cattle range.

Summary

Yields of species (determined by clipping and weighing separately for each plot) were determined on a mountain range near Bozeman, Montana in 1932 and in 1955. Previous to 1926 this range had been heavily grazed by sheep and cattle. In 1928 controlled use including proper stocking, open herding, one-night bed grounds, and uniform distribution of grazing, was started on the forest allotment and continued through 1955.

Yields increased greatly on the lowest plot and the two at intermediate elevations but decreased slightly on the highest of the study area. These higher areas where slopes are steep and soils are relatively unstable need careful management to bring about desired improvement in production. The data clearly show that over most of the area, forage production had increased. High precipitation in the years previous to 1955 and low precipitation in years previous to 1932 partially explain this marked increase in total yields, but some of the increase must be attributed to better management practices.

Species that increased, decreased, or invaded the range during the 23-year period are discussed.

LITERATURE CITED

HEADY, H. F., R. T. CLARK, AND THOMAS LOMMASSON. 1947. Range management and sheep production in the Bridger Mountains, Montana. Mont. Agr. Exp. Sta. Bull. 444. 30 pp.

TEIGEN, M. L. 1949. Forage Preferences of range sheep. Montana State College, unpublshed M. S. thesis.

Special to the Editor:

The Secretary's office recently received 15 new student memberships and two regular memberships in one day from DR. R. MERTON LOVE of the University of California, Davis. This is one of the largest group memberships ever received at one time. Plans are underway to form a student chapter of the California Section.—*John G. Clouston, Executive Secretary*

Testing New Range Forage Plants[1]

JOHN L. SCHWENDIMAN

Plant Materials Specialist, Soil Conservation Service, U. S. Department of Agriculture, Pullman, Washington [2]

America's wide open spaces, the range lands of the West, are beginning to receive some long deserved attention. Large areas of this country's original range lands have been diverted to uses other than grazing. They were first used by native game and native Americans, then crossed by explorers, missionaries, and livestock growers. Finally permanent settlers came to plow up and dry farm or irrigate large tracts of range land. Although some plowed areas have been abandoned, range lands are still decreasing in acreage because of new reclamation projects and the expansion of highways, cities and industrial sites.

The remaining range lands, heavily used for more than a hundred years, are still important to the economy of the West, first because of the tremendous acreage involved; second because the roughages produced on these wild lands can be profitably used by livestock; third because the range lands are adjacent to ranches producing livestock in small irrigated valleys where hay for winter feeding can be produced; and fourth range lands are often watersheds for irrigation projects and are also used for recreation and by big game animals.

Many attempts to domesticate range plants have failed, largely because the methods used were too direct. They were based on collections of seed where abundant, and direct seeding of such seeds into range areas without intermediate testing. Under the rigorous and droughty climatic conditions the seed produced on native stands and vigor of seedlings from native seed were seldom good. Cultural practices were not known. The wide variation among ecotypes of many species made improbable the selection of the right strain for optimum establishment. After heavy use almost to the extinction of some species, native grasses have finally caught the attention of plant collectors, plant breeders, conservationists and eventual users. Native American range grasses are now being developed and tested for use in reseeding depleted ranges and marginal farm lands. Figure 1 shows the physical plant and main development area of a Plant Materials Center.

Work on range reseeding has been slow in developing because of the high cost of reseeding in relation to the value of the land involved. Range reseeding has also been retarded by the lack of adapted varieties, the lack of successful cultural methods, and the general thought that forage production could be increased by range protection and a reduction in livestock numbers. Proper management and integration of domestic livestock and wild game use are still the most important hope for improvement of non-plowable acres. On many other range acres where important productive native plants are scarce, large tracts are now invaded by sagebrush, rabbitbrush and other weeds. Here manage-

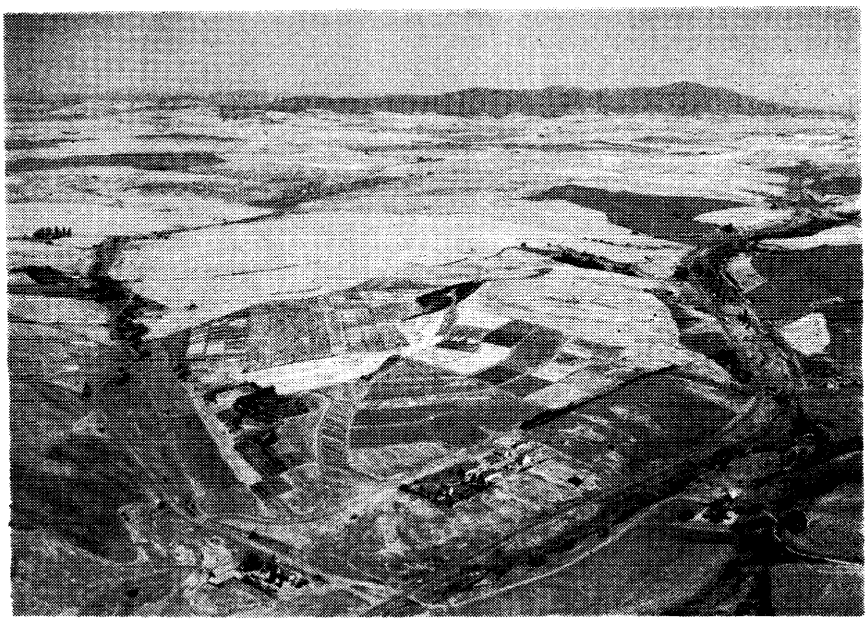


FIGURE 1. Aerial view of the U.S.D.A. Soil Conservation Service Plant Materials Center at Pullman, Washington, adjacent to and cooperating with the Washington Agricultural Experiment Station. This center is important in the introduction, domestication, testing, and increase of plant materials for use in the conservation program of the northwest. Near the left center cattle are on grazing trials, and in the lower right some foundation seed fields can be seen. The observational test areas in the center are separated by terraces and roadways.

[1] *Paper presented at the 1956 A.A.A.S. meetings and included in their forthcoming symposium volume on "Grasslands."*

[2] *All work at the Pullman Plant Material Center is in cooperation with the Agricultural Research Service and the Washington, Idaho, and Oregon Agricultural Experiment Stations.*

ment is a slow, if not impractical, method of increasing production.

When in the early 1930's this country became erosion conscious and attempts were made to reseed worn out and eroded lands to commercially available grasses and legumes, conservationists became aware of the lack of adequate plant materials for use on depleted range sites.

Assembling Plant Material

Beginning with the extensive foreign plant explorations made in 1930-34, forage plants from northern Asia began to arrive in the United States. These introductions were supplemented by collections from the native vegetation of the western United States, by strains from plant breeders and commercial seeds used as checks. Material was assembled with the thought that somewhere on the western ranges from the various site, soil and climatic conditions there could be found plants of superior performance and adaptation — plants equal to those from European countries from which some introductions have been under cultivation in this country for more than 200 years. In order to be useful any new plant would also have to be as good or better, at least in some characteristics, than presently available material. The most widely used introduced range grass was crested wheatgrass, therefore, any new dryland range forage plant had to be as good or better than crested wheat.

Testing Procedure

The large number of plants assembled, required thorough, rapid and economical methods of testing. The testing procedure used at the U.S.D.A. Plant Material Centers begins with an observational rod row of each accession established in the field, or if seed is scarce, in the greenhouse and transplanted to the field. Figure 2 shows a group of native wheatgrasses. Within each particular "use group" a standard commercial check plant is included at regular intervals so that direct visual comparisons can be made. This observational testing is based not so much on the botanical differences in the plants as upon their eventual use.

FIGURE 2. Initial observational testing of strains of beardless wheatgrass *(Agropyron inerme)* and bluebunch wheatgrass *(A. spicatum)*. These Pacific Northwest collections show a wide variation in growth habit and productivity.

In all testing procedures, grasses were compared within "use groups." A "use group" may be defined as a group of grasses having similar growth requirement, adapted to similar sites and to a large degree interchangeable with respect to conservation use. For example, two important range grass use groups are: (1) Drought tolerant, long lived bunchgrasses. Included here are crested wheatgrass, Fairway crested wheatgrass, Siberian wheatgrass, Whitmar beardless wheatgrass, bluebunch wheatgrass and Russian wildrye. (2) Vernal dominant dryland grasses, which includes Sherman big bluegrass, Nevada bluegrass, Sandberg bluegrass, prairie Junegrass (*Koeleria cristata*) and bulbous bluegrass. The "use group" concept of testing plants in groups based on their similarities in growth characteristics and possible conservation use has saved many man years of technical help by speeding up the testing procedure. Many species of only botanical interest rapidly fell by the wayside.

Individual plant performance records for each accession include such data as source, date of planting, emergence, seedling vigor, growth stages on various dates, dates of bloom, maturity, disease-resistance, cold tolerance, drought-resistance, forage characteristics, aggressiveness, production, and conservation use.

Notes taken over a period of five years resulted in a thorough acquaintance of the technician with each accession. Many plants were eliminated by rigors of the climate or simple non-performance. In 20 years of testing some 14,000 accessions were subjected to this observational procedure. About five percent have been selected for secondary testing.

Even within "use groups" great differences within species occurred, which resulted in selection of prominent ecotypes of each important range grass to represent that species in secondary tests, called field evaluation studies. Range plants were promptly put into field evaluation studies along with appropriate checks at six outlying sites, mainly on State Agricultural Experiment Station Branch locations. At these stations the rainfall varied from approximately 9 inches to 18 inches per year, the elevation from 1,600 to 3,500 feet, the growing season from 150 to 200 days, the seasonal temperatures from -22°F. to 100°F. and the soil types from very light, deep silt loam to a medium heavy, shallow soil over basalt.

While these adaptation tests were being run at locations, studies on germination and seedling vigor, seed habits and seed production, cultural trials, mixture studies, and others were being made at the plant material centers. In this secondary testing stage experiment stations and federal research agencies assisted in randomized replicated trials involving all phases of testing. Assistance of other groups was also obtained to get the widest possible information on adaptation and performance. From limited seed stocks seed was made available to cooperating experiment stations for independent tests.

New promising species were included in standard seed packets supplied to Smith-Hughes Agricultural Instructors, 4-H clubs, and County Agents. Packets were made up on the basis of adaptation areas. For example, in Washington these areas are semi-humid, dryland, irrigated and West Coast. These nurseries served to acquaint the general public with new grasses and legumes. Some nurseries have developed into seed production studies under irrigation, others into range reseeding trials or mixture studies. At one time over 300 such small nurseries were being observed in the state of Oregon, many of them on range sites far removed from any other test locations.

The Forest Service Research Centers have provided many tests on lands and conditions not accessible to private owners. These have been effective in checking adaptation and the performance of grasses and legumes, particularly on high elevation mountain meadows and timbered sites. The Bureau of Land Management, Bureau of Reclamation and other agencies have also cooperated in testing new dryland grasses under actual use conditions.

On the basis of field evaluations plus other studies, small seed increase plantings of a limited number of range grasses are made at the plant material centers. This provides sufficient seed for field planting trials which are essentially an extension of nursery plot seedings to farms in soil conservation districts. Such field plantings are made in comparison with standard practices and species which the rancher would normally use. Figure 3 shows a good field planting. New dryland grasses have been tested alone and in mixture by grazing animals on a typical site in the semi-humid area. Field size plantings of improved range grasses are now being made on range sites where comparative grazing data can be obtained.

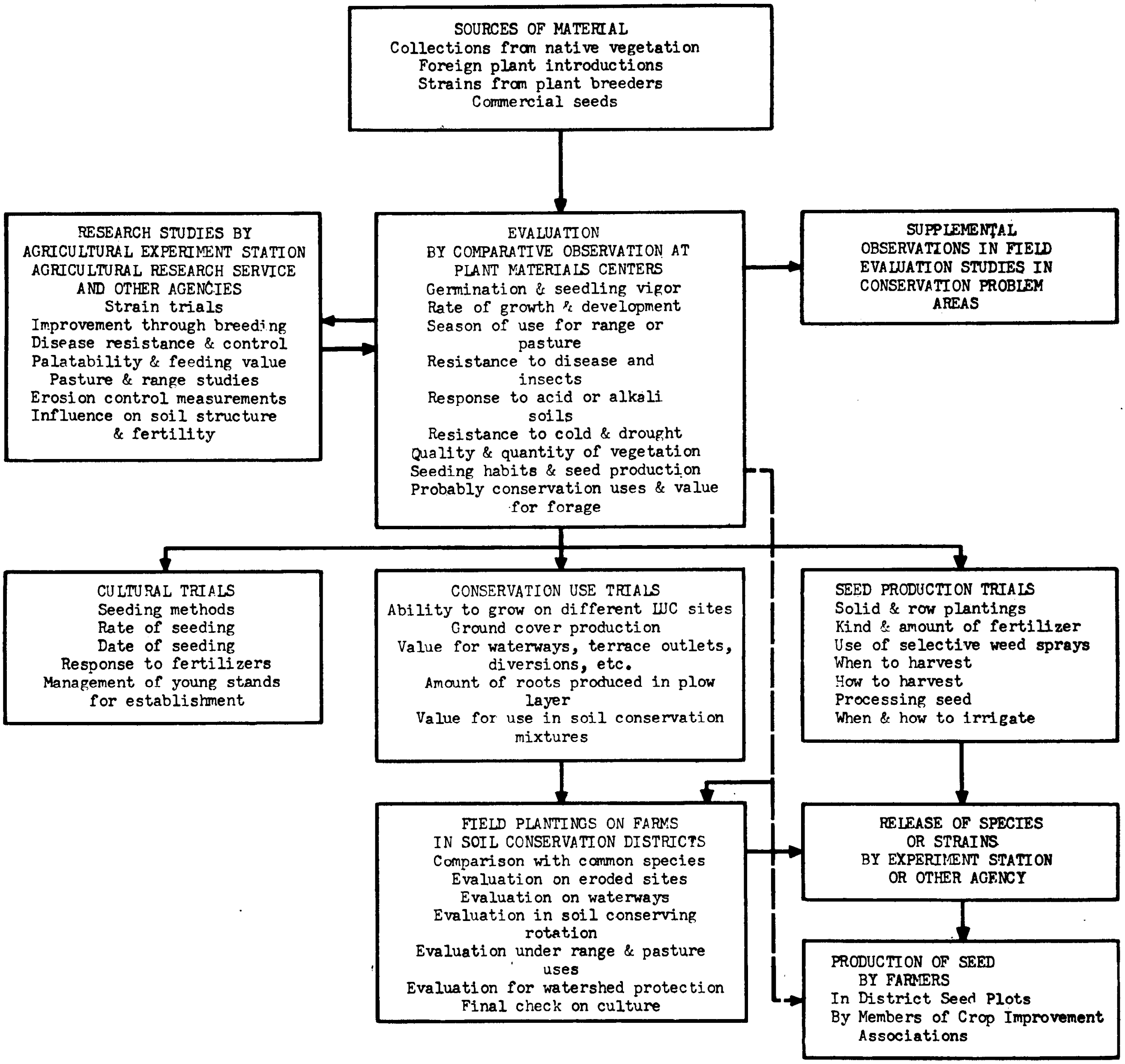
The participation of district supervisors in selecting cooperators and in choosing sites from variable land conditions has helped in making these trials effective. Grasses, legumes, trees, shrubs, and other materials have been widely used in these trials in comparison with common materials or practices. To date there have been 856 grass or legume trials and 280 woody plant trials in the Pullman Plant Materials Center zone. About one-third of these are still active. These trials allow new things to speak for themselves. Results are used in modifying and keeping technical standards for use of plant materials up to date.

When results from the field scale trials and the various cooperative research studies are summarized, an excellent cross section of the performance under various testing conditions is available. This summary provides data for decisions on the possible release of new varieties.

Release of New Varieties

New varieties are released through state experiment stations after the performance data have been presented and an agreement has been reached both on the value of the variety and on a designated name. Upon release the plant material centers make foundation seed available to state experiment stations and crop improvement associations as well as to soil conservation district seed producers. The seed bears an official foundation seed tag and is for the purpose of registered and certified seed production. This is the way improved varieties get into commercial production. Thereafter the plant materials center is responsible for the continued maintenance of foundation seed. Limited seed production is also maintained with which to continue the field

FIGURE 3. A good field planting of Whitmar beardless wheatgrass on the Mont Johnson farm in the Wood River Soil Conservation District of Southern Idaho. Ranchers are intensely interested in this two year old range seeding.



Procedure for evaluating and domesticating grasses for conservation uses at the U.S.D.A.-S.C.S. plant material centers

planting trial program until the areas of adaptation, and the culture and management of the variety are well known. The effectiveness of this combination testing procedure developed by the plant material centers is attested by the relatively abundant seed supply of improved range grasses in the Pacific Northwest.

The procedure for evaluating grasses, leading to the release of new varieties, is summarized and the relationship of the various steps is shown in the chart.

Whitmar Beardless Wheatgrass —a Case History

During the years of 1934-38 more than 1,000 field collections of beardless wheatgrass and related bluebunch wheatgrasses were made in the Pacific Northwest states. These were planted in observational rod rows. Seed in quantity was collected from a native bluebunch wheatgrass field near Shaniko, Oregon, and beardless wheatgrass from Fort George Wright Military Reservation near Spokane, Washington. These two strains were used as checks in all observational plantings.

In the Spokane area 1,000 to 5,000 pounds of native wheat-

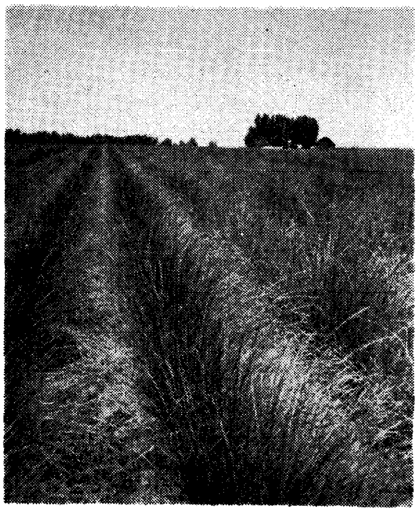


FIGURE 4. A registered Whitmar beardless wheatgrass seed field on the Ernest Egan farm in the North Side Soil Conservation District, Kimberly, Idaho. Good seed of an adapted strain is essential to successful range seedings. Foundation seed came from a Plant Materials Center.

grass seed were collected each year during 1937-40. Seed varied by seasons in germinative capacity, abundance and quality. Results from field plantings in which this seed was used were only fair. It was found that the strains occurring in greatest abundance and available for large scale seed collection were not the most desirable or productive strains. This accelerated the work of testing to find a superior strain.

The various ecotypes of beardless wheatgrass were studied in the field and in observational plantings. Representative strains of each major ecotype were selected for secondary testing and included in plantings at outlying stations. The sites which most nearly provided dryland range testing conditions were at Moro, Pendleton, and Condon, Oregon, and at Lind and Goldendale, Washington.

Results of tests showed that strains most productive at Pullman were also the most productive at the outlying dryland test sites.

Bluebunch wheatgrass was found generally more robust and vigorous than beardless wheatgrass, but it had the disadvantage of awned seeds. A method of de-awning was developed as a stop-gap measure, while further testing for a suitable awnless strain continued.

The most vigorous disease resistant productive strain of beardless wheatgrass was one found in a strip of the native Palouse prairie at Colton, Whitman County, Washington. On the basis of its performance in field evaluation studies a small seed field was established in 1938 to obtain seed for plot trials, additional plantings, and exchange purposes.

A 1941 summary of data showed this strain was more productive, by 130 to 1000 pounds of dry matter per acre, than crested wheatgrass at all six dryland test locations. In 1942 an eight acre seed field was established. Resulting seed was used for field planting trials on range and abandoned farm lands in soil conservation districts.

In 1947 accumulated data were reviewed and the name "Whitmar" was recommended and accepted by cooperating experiment stations. Foundation seed was released to district seed producers and through crop improvement associations for registered and certified seed production. The new improved range grass was on its way to commercial production. Figure 4 shows a seed production field of Registered Whitmar.

The Plant Materials Center continues to produce a small foundation seed field from which authentic seed stocks are obtained. Some seed is also produced for use in field planting trials in new areas and for management studies. This will continue until adequate commercial seed is available, and Whitmar has been either accepted or rejected as a standard grass for range seeding in areas of its adaptation using good cultural techniques and under good management practices. Present commercial production is about 20,000 pounds annually. The demand for seed is greater than the supply. Whitmar does not replace crested wheatgrass in range seedings. It supplements crested. Results from large range seedings indicate that Whitmar has a great future on western range lands that need reseeding.

Range Grasses Cooperatively Developed

Some of the range grasses developed in the West that have been through this testing procedure now available commercially for use in range reseeding are:

Native Grasses

Whitmar beardless wheatgrass *(Agropyron inerme)* selected from the native vegetation of the Palouse climax prairie is a vigorous, productive, leafy, highly awnless type. Figure 5 is a portrait of Whitmar. It is a perennial bunchgrass with good seed production. It matures uniformly but shatters readily. It is adapted to use on class IV and VI lands in the Pacific North-

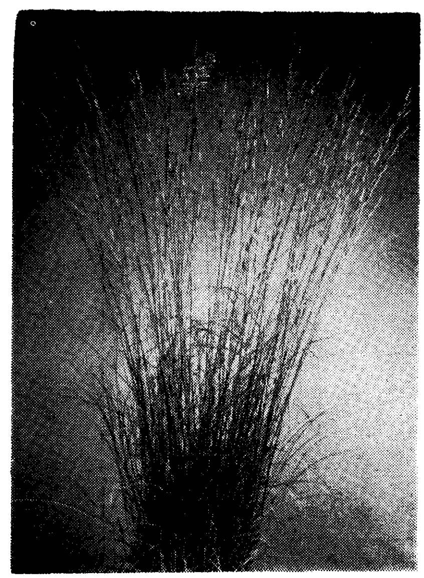


FIGURE 5. Portrait of Whitmar beardless wheatgrass, one of the important improved named varieties resulting from extensive testing and intensive work with the native range grasses of the West. Certified Whitmar seed is grown in Washington, Oregon, and Idaho.

west dryland areas of 8-15 inches average annual precipitation. When properly managed, it exceeds crested wheatgrass in forage and root production. It has a later season of use and is slower in becoming established.

Sodar streambank wheatgrass *(Agropyron riparium)* is drought-resistant, alkali-tolerant, low-growing and produces a good ground cover. "Sodar" refers to its rapid sod-forming ability. It is easy to establish, aggresive, spreads rapidly, suppresses weeds and forms a smooth, long-lived protective sod. In range seedings Sodar serves as an understory cover when used with large wheatgrasses. When mixtures are grazed, the percentage of Sodar may increase, since it is relatively low in palatability.

Sherman big bluegrass *(Poa ampla)* is a selection from a collection made near Moro, Sherman County, Oregon. It is early in spring growth, early maturing, drought escaping, tall, erect-growing, fine stemmed. It has blue, moderately abundant leaves and a large compact purplish seedhead. It is a long-lived productive perennial bunchgrass adapted to range use in semi-humid and dryland areas of the Northwest. It is superior to crested wheatgrass in earliness and amount of spring growth. In low rainfall areas of light soil it should always be fall seeded. It must be well established before grazing, otherwise it is easily uprooted, especially on sandy soils.

Introduced Grasses

Greenar intermediate wheatgrass *(Agropyron intermedium)* is a vigorous growing, mild-sod-forming, late-maturing, leafy, dark green, high producing variety. Plants are variable. It grows best on well drained soils in the rainfall areas of 15 to 30 inches at elevations of 1,000 to 3,500 feet. It produces well in the Northwest, wherever dryland alfalfa is adapted.

FIGURE 6. Topar pubescent wheatgrass is a representative improved named grass variety resulting from selection and testing among the many foreign plant introductions of recent years.

Topar pubescent wheatgrass *(Agropyron trichophorum)* is a drought-resistant, sod-forming, late-maturing wheatgrass. Figure 6 is a portrait of Topar. It resembles intermediate wheatgrass but has pubescence on the leaves, stems and seed. It spreads more rapidly by rhizomes. It is better adapted than intermediate wheat to rainfall areas of 10 to 15 inches and low fertility, to eroded and alkaline soils, and to high elevations.

Siberian wheatgrass *(Agropyron sibiricum)* is essentially an awnless form of crested wheatgrass. It has narrow leaves, narrow heads and blunt glumes. It is a little lower in seedling vigor, but on dry sites and light soils or in dry years it is better adapted and more productive than crested wheatgrass.

Hard fescue *(Festuca ovina* var. *duriuscula)* is similar to Idaho fescue in growth and adaptation but is much higher in seed production and easier to establish. It is a bunch-type, fine-leaved fescue with long, narrow, rolled, lax leaves. It is being used in rainfall areas of 12 to 30 inches annually pending the development of a superior Idaho fescue. It is a very abundant root producer.

All of the above grasses are in commercial production. Their total annual production is nearing 1,000,000 pounds of clean seed. Foundation seed is available for certified seed production.

Other promising range grasses in various stages of development and testing include sheep fescue (*Festuca ovina*), a dwarf, more densely tufted, drought-resistant grass than hard fescue; a superior strain of bulbous bluegrass *(Poa bulbosa)*, which is more productive and stays green longer than commercial types; Canby bluegrass *(Poa canbyi)* for use in understory seedings, and several hybrid bluegrasses resulting from cooperative work of the Carnegie Institution of Washington.

The system of finding superior range grasses used at the Soil Conservation Service Plant Materials Center at Pullman, Washington, has been effective in getting them into seed production and into use on range lands.

Economics of Ranch Appraisal[1]

ARDEN B. GUNDERSEN

Ranch Appraiser, The Equitable Life Assurance Society of the United States, Gering, Nebraska

Let me point out that *efficiency* is the *key* to *a sound* ranching venture. The past is a poor pattern to follow and has little relationship to conditions of the present time.

The methods and techniques employed a few generations ago when a large outfit ran 75,000 head of cattle in unfenced territory from the Yellowstone River in Montana to the North Platte River in Wyoming have changed considerably. The old methods are steadily disappearing as our agricultural technology has progressed. We have a tremendous back-log of technical know-how that is yet to be applied. The great progress that has been achieved to date is only a token compared with that which is still to come.

In about 1900 the big outfits, with millions of acres of free land, began to disappear as the homesteaders came in. Then began the change to a more complex form of ranching. The change was very slow at first but is now taking place at a highly accelerated rate.

We must be very careful now, and appraise every angle of our ranching operations with nonsentimental, cold facts. We can no longer afford to keep 50 ponies just for the sentimental value attached. Competitive conditions in ranching today are separating the men from the boys. In the early 1950's when good cows were selling for $250 to $300 a head and still going higher, every drug store cowboy who could afford 25 head went into the cattle business, hoping to get rich in a few seasons. Cattle was King and the ranchman rode an unprecedented crest of popularity.

By the fall of 1953, some were requesting Government aid. The "High Stakes", suddenly topped with the $250 cow at that time, which is now (Jan. 1957) selling for $110 to $125, and costs of production have risen sharply.

Carrying Capacity

Since the bubble has burst and things have settled down these questions arise: How much can I pay for a home for a cow? What is an economic unit to operate? What percent of the total investment is most favorable for Land? For livestock? For equipment and buildings?

In actual ranch appraisal, the most important item is to determine the average year long carrying capacity.

Unless this information is determined accurately, the operator is inviting disaster and is beaten before he starts. The true carrying capacity must be known, or it is impossible to know how much is being invested per animal unit, which is the basis of his investment. Knowing the cost per animal unit for production, is just as important in ranching as it is in the manufacture of tractors, hay balers, or shoes.

It is very important that the operator does not stock up to the last stem of hay or the last blade of grass, but be prepared for a hard winter followed by a dry spring. But on the other hand, being understocked can also cause unsuccessful operation. This is why practical experience and the factual appraisal of the situation is invaluable.

There are several agencies that assist ranchers in determining the proper stocking rate, if they need the help, and wish to take advantage of this service. We cannot ignore the large number of actual, and practical tests showing that conservation and proper range management pay many dollars to them that practice it. Now, even fertilizing pastures and the better range lands in certain areas, in addition to conservation practice, has paid off handsomely.

It is not difficult to determine generally, the carrying capacity.

If you will visit several of the successful neighboring ranches and ascertain how many cattle they have run over a period of years, and determine the average number; then compare their ranges with the optimum you desire, and, considering long time conservation and good range management practice, you can obtain a good index of the proper carrying capacity for your ranch, or on any ranch you desire to purchase in any locality.

Factors in Ranch Prices

The cost of a ranch varies a great deal according to: (1) The locality; (2) the livestock market at the time; (3) its desirability as a ranch unit, which involves many factors such as dependability of year around feed production, availability of assured leased lands; whether the unit is well blocked, adequacy and distribution of stock water, buildings, corrals, fences and natural shelter; and (4) the salability—will the ranch sell in times of stress for a reasonable figure? The better ranches do not change hands frequently.

When cattle bring just an average price, the speculators and business men are not inclined to get the fever to be ranchers and run the price up. If a purchaser

---

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

has the cash to buy, and outside income to enable him to operate *without a net profit,* thereby benefiting on his income taxes, it is not such a serious matter what is paid for a home for a cow. But, if ranching is his only income, and if borrowed capital is required — then, whether the price is right, is just a matter of success or failure in the ranching business.

When individuals pay high cash prices for ranches to operate at a loss, a false sense of value is given to some of the boys who expect to make a profit. They will later realize that most of their profit came from just the pleasure of being a rancher. This false sense of value also causes some purchasers to think they are getting a bargain, but bargains in ranches these days are rare.

As a rule, when the price of livestock has been down for a few years, ranches can be purchased at a reasonable figure, based on what they produce. At such times business men are rarely interested, ranchers are not financially able to buy, and many lending agencies fear the risk. Foreclosure records in every County Court House in the West will prove that the greatest interest is shown in buying and lending to ranch enthusiasts when the cost of a home for a cow approaches the summit of a boom.

We have just gone thru one. It is temporarily rough for some ranchers; there have been and will continue to be a lot of heartaches and tough adjustments. The efficient ranchers are going to prosper and grow, and the inefficient ones are going to have to sell out.

Several persons polled, including ranchers and finance lenders, were of the opinion that outfits with 250 animal units or more, with expert management, could go on indefinitely as an economic unit on the present basis facing the "cost-price" squeeze. However, the optimum family sized ranch should carry about 300 to 400 animal units. But of course, we all know that in individual cases some families have made a living on less than 250 units.

Twenty-five years ago an operator could survive under severe adversity for 9 years before his total investment was wiped out; now this can happen in just 2½ years.

We must consider, especially when borrowed capital is used, that the ranch must first earn a living for the family; second— pay all taxes, and third — have sufficient funds remaining to retire the mortgage under normal price conditions and not only at boom-time prices.

In a study of 45 ranches in 1950, scattered throughout Wyoming and averaging 390 animal units each, there was a total average investment of $427 per animal unit; that is — there was $166,530 invested in land, livestock, buildings and equipment. (An animal unit is considered to be a mature cow; a yearling is 85 percent of an animal unit; a weaned calf is 65 percent of an animal unit).

Cattle and Feed Investments

Of the 45 Wyoming ranches those having the largest rate of return on the investment had the largest percentage in cattle and feed, and less invested in improvements, machinery and equipment. The average was 42 percent in cattle; 38 percent in land; 10 percent in buildings, 5 percent in machinery and equipment, and 5 percent in feed. *The highest net income* producing ranches had 50 percent in cattle; 33 percent in land; 7 percent in improvements; 4½ percent in machinery and equipment and 5½ percent in feed.

In the Nebraska Sandhills in 1955 $400 per animal unit was about the selling price for ranches carrying 500 or more units. Some smaller outfits sold for as high as $425 per animal unit. These figures seem a little high per animal unit, considering the present price of livestock.

Let us consider the costs from a few scattered sections and see just how much capital it takes to keep one animal unit in operation. The figures obtained for ranches in northern Nebraska and southern South Dakota on today's costs per animal unit for the 300- to 400-unit class show expense items in production to be $44.50 per unit.

A study in Western Colorado in 1954 with an average of 376 animal units per ranch showed operating expense per head for all cattle to be $47.17, not including the operator's labor or interest on his investment in land, livestock and equipment. On the 45 Wyoming ranches studied the total average expense per animal unit was $47.74.

Actual income per animal unit on today's (Jan. 1957) market may vary from $55 to $70. This is a small margin between cost of production and selling price, and every effort must be made to keep costs down, if the operator is going to show a profit.

Value of Buildings

The value of buildings to a ranch is often confusing. Unless one understands the theory back of the appraisal process, the appraiser's decision sometimes does not make sense. To illustrate this, let me recount an experience of a couple of appraisers who also had with them an elderly uncle of one of the men. The men were traveling through western South Dakota. One deal they looked at was a small upland ranch with a rather elaborate set of buildings. An appraisal for a loan had already been made on this place. The men agreed with the rather conservative appearing valuation of the ranch and the loan recommendation. "Well," the uncle exclaimed, "you couldn't even put the buildings on it for that. You fellows must be crazy."

They began an explanation of

has the cash to buy, and outside income to enable him to operate *without a net profit,* thereby benefiting on his income taxes, it is not such a serious matter what is paid for a home for a cow. But, if ranching is his only income, and if borrowed capital is required — then, whether the price is right, is just a matter of success or failure in the ranching business.

When individuals pay high cash prices for ranches to operate at a loss, a false sense of value is given to some of the boys who expect to make a profit. They will later realize that most of their profit came from just the pleasure of being a rancher. This false sense of value also causes some purchasers to think they are getting a bargain, but bargains in ranches these days are rare.

As a rule, when the price of livestock has been down for a few years, ranches can be purchased at a reasonable figure, based on what they produce. At such times business men are rarely interested, ranchers are not financially able to buy, and many lending agencies fear the risk. Foreclosure records in every County Court House in the West will prove that the greatest interest is shown in buying and lending to ranch enthusiasts when the cost of a home for a cow approaches the summit of a boom.

We have just gone thru one. It is temporarily rough for some ranchers; there have been and will continue to be a lot of heartaches and tough adjustments. The efficient ranchers are going to prosper and grow, and the inefficient ones are going to have to sell out.

Several persons polled, including ranchers and finance lenders, were of the opinion that outfits with 250 animal units or more, with expert management, could go on indefinitely as an economic unit on the present basis facing the "cost-price" squeeze. However, the optimum family sized ranch should carry about 300 to 400 animal units. But of course, we all know that in individual cases some families have made a living on less than 250 units.

Twenty-five years ago an operator could survive under severe adversity for 9 years before his total investment was wiped out; now this can happen in just 2½ years.

We must consider, especially when borrowed capital is used, that the ranch must first earn a living for the family; second— pay all taxes, and third — have sufficient funds remaining to retire the mortgage under normal price conditions and not only at boom-time prices.

In a study of 45 ranches in 1950, scattered throughout Wyoming and averaging 390 animal units each, there was a total average investment of $427 per animal unit; that is — there was $166,530 invested in land, livestock, buildings and equipment. (An animal unit is considered to be a mature cow; a yearling is 85 percent of an animal unit; a weaned calf is 65 percent of an animal unit).

Cattle and Feed Investments

Of the 45 Wyoming ranches those having the largest rate of return on the investment had the largest percentage in cattle and feed, and less invested in improvements, machinery and equipment. The average was 42 percent in cattle; 38 percent in land; 10 percent in buildings, 5 percent in machinery and equipment, and 5 percent in feed. *The highest net income* producing ranches had 50 percent in cattle; 33 percent in land; 7 percent in improvements; 4½ percent in machinery and equipment and 5½ percent in feed.

In the Nebraska Sandhills in 1955 $400 per animal unit was about the selling price for ranches carrying 500 or more units. Some smaller outfits sold for as high as $425 per animal unit. These figures seem a little high per animal unit, considering the present price of livestock.

Let us consider the costs from a few scattered sections and see just how much capital it takes to keep one animal unit in operation. The figures obtained for ranches in northern Nebraska and southern South Dakota on today's costs per animal unit for the 300- to 400-unit class show expense items in production to be $44.50 per unit.

A study in Western Colorado in 1954 with an average of 376 animal units per ranch showed operating expense per head for all cattle to be $47.17, not including the operator's labor or interest on his investment in land, livestock and equipment. On the 45 Wyoming ranches studied the total average expense per animal unit was $47.74.

Actual income per animal unit on today's (Jan. 1957) market may vary from $55 to $70. This is a small margin between cost of production and selling price, and every effort must be made to keep costs down, if the operator is going to show a profit.

Value of Buildings

The value of buildings to a ranch is often confusing. Unless one understands the theory back of the appraisal process, the appraiser's decision sometimes does not make sense. To illustrate this, let me recount an experience of a couple of appraisers who also had with them an elderly uncle of one of the men. The men were traveling through western South Dakota. One deal they looked at was a small upland ranch with a rather elaborate set of buildings. An appraisal for a loan had already been made on this place. The men agreed with the rather conservative appearing valuation of the ranch and the loan recommendation. "Well," the uncle exclaimed, "you couldn't even put the buildings on it for that. You fellows must be crazy."

They began an explanation of

our method by asking him how much he would pay for the place.

Without thinking of the effect on his argument he said, "I wouldn't have it — too many buildings."

"Well," they continued, "somebody would pay something for it. How much could you sell it for?"

Then he got down to thinking like an appraiser does by saying, "The grazing land is good, but there isn't enough of it. It would be all right to add it to this good place down the creek. It will summer a hundred and fifty head or maybe two hundred head of cattle. But a man would starve to death trying to make it on this place—it's too small. He'd never pay out with all these buildings."

"That's probably right," they said, "but if we acquired this place, we would have it to sell. What would it bring?"

What will something sell for? That presumably is its value. It makes little difference what you have paid for it. To find out what it's really worth try to sell it.

The uncle finally concluded that the best prospective buyer was the adjoining owner, but the buildings still bothered him. He knew that the man down the creek would not want them and would not pay much for them. The alternative, he reasoned, would be to sell it to someone who would occupy the buildings. Such a man, if he could be found would probably pay more than the fellow who only wanted the land. But, he would not pay too much more unless he could find more land to add to the unit. And such land was not available.

Basing their judgement on other sales in the area, they finally arrived at an amount for which they thought the land *alone* could be sold, probably to enlarge the next ranch. Then in a similar manner they determined what the place as a unit would sell for. It was apparent that the owner could not expect to recover his investment in buildings because *they were not in keeping with the land resource*, nor were they in keeping with the accepted community standards.

While a building is still unexpended labor and quantities of lumber, cement, and steel, it has a value equal to the cost of construction because the market place has fixed a price on the component parts. Once the building is affixed to a piece of land it becomes real estate, and its value is not the summation of the component parts, but instead it is the amount which it adds to the value of the land.

If we accept the fact that ranch buildings are a part of the ranch unit, then it follows that appraisals on ranch buildings are actually appraisals on ranches and consequently, must meet the tests that fall in line with ranch appraisals generally.

The appraisal of ranches is not an exact science; it cannot be done by formula. It is an expression of judgement based on the market and the skill of interpretation of the data.

The Rancher's Problem

The limiting factor on ranch value, to an owner, when borrowed capital is used, is not the market value but rather the net income available for debt service, if he expects to retain the property. This important factor is often misunderstood and may lead the unwary into financial distress. How much can we expand our holdings for increased profit? This question is asked many times. Some risk all their holdings, which may not be warranted, in order to expand, on the theory that land is limited, and when it's for sale they must have it at any cost. This outlook also tends to keep the price of land high.

I heard a story setting forth "The Rancher's Problem." It went something like this: "Livestock are animals that are bred and raised in the Western States to keep the producer broke and the buyer crazy. Livestock are born in the spring, mortgaged in the summer, pastured in the fall and given away in the winter. They vary in size, color and weight. The man who can guess nearest the weight is called a livestock buyer by the public, a robber by the rancher, and a poor business man by his banker.

"The price of livestock is determined by consumers and goes up after you have sold and down after you have bought. A buyer for a Nebraska packer was sent to Omaha to watch the Livestock Market. After a few days' deliberation he wired to this effect: Some say the market will go up —some say it will go down — I say the same. Whatever you do will be wrong. Act at once.

"When you have light cattle the buyer wants heavy ones; and when you feed heifers they want steers, and vice versa. When they're thin they should be fat; and when your steers are fat the buyer tells you the market on tallow is all shot to hell, and you've got 'em too doggone fat. Yes sir! Some days you just can't make a nickel."

Let's watch these nickels, let's watch the balance between feed production and grazing land. The Wyoming ranches mentioned showed that the greatest profits came from those having the greatest investment in livestock and feed. This is important to have a balanced ranch unit where winter feed will be sufficient for the summer grazing capacity. Do not inadvertently become a high cost operation ranch with long feeding seasons and poor layouts. Keep your operational balance in line by constantly keeping good records and adjusting to better practices. A high percentage of calf crop is another prominent factor in profit making.

Don't forget what research can do for you in increasing production; explore newly developed methods and apply them to your operation. The National Planning Association, a non-profit organization, says that even if the amount of cultivated lands and numbers of livestock remain unchanged, increased yields alone can be expected to raise production 21.3 percent by 1965. The Colorado State University has announced feed lot gains of better than 4 pounds per head per day on steers. These fabulous results came from hormone injections—probably not practical for general use yet, but in the offing. Be sure to change and adjust to the new proven methods of ranching, including feed production.

Finally, for a sound investment in ranching, you must base the price you can pay on what the ranch will produce. Remember that efficiency in labor and management is the key to a sound investment.

Know the facts, don't guess; plug the leaks, manage the resource well, and make your enterprise pay by realistic analysis.

Acknowledgement

Some of the information used in the preparation of this paper has been taken from a 1953 University of Wyoming thesis by Guy Brook, Jr. "Some important management factors affecting profits on Wyoming cattle ranches." Other excerpts have been taken from an article by R. T. Burdick in Western Farm Life, *July 1, 1953, and from a report by Eli Ferguson of the Equitable Life Assurance Society of the United States.*

Profitable Use of Fertilizer on Native Meadows[1]

MICHAEL NELSON AND EMERY N. CASTLE

Department of Agricultural Economics, Oregon State College, Corvallis, Oregon

In an earlier article in this journal (8:20-22. 1955) C. S. Cooper and W. A. Sawyer of the Squaw Butte-Harney Range and Livestock Experiment Station, Burns, Oregon, presented results of experiments carried out in 1951 and 1952 on fertilization of mountain meadows in the Harney basin, Oregon. The subject of this paper is an economic interpretation of their most recent experiments with nitrogen, carried out in the same area in 1954 and 1955.

Three separate trials were conducted, all showing essentially the same degree of yield response to nitrogen. The pooled results of these trials are given in Table 1.

If the price of nitrogen is assumed to vary from 10 cents to 15 cents per pound, then the cost of additional hay in terms of the fertilizer requirement may be calculated from Table 1 (see Table 2).

Ranchers must figure that this additional hay is still in the field and to these figures one must add cost of harvesting and stacking. The additional hay has value, however, only if it can be used in the production of beef. The extent to which the hay can be utilized depends upon the amount of rangeland available and meadow acreage. The main purpose of the study is to investigate some aspects of the range-hay-livestock balance. The problem can be broken down into the following questions:

(1) What is the most profitable rate of fertilizer application as determined by its contribution in the production of beef?
(2) How is this rate affected by different ranch situations?
(3) How is the rate affected by changes in the price of beef and nitrogen fertilizer?
(4) What are the range policy implications of increased forage production from meadow land?

Study Procedure

Before it was possible to make an economic analysis of the experiments, it was necessary to consider the factors that influence a rancher's decision on whether or not to use fertilizer. This information was obtained from a survey of ranchers and from statements of federal and

Table 1. Pooled results of fertilizer-hay response data from three trials.

Rate of Nitrogen Application (pounds per acre)	Hay Yield per Acre		Pounds of Hay per Pound of N
	Pounds	Tons	
0	3664	1.83	—
50	5243	2.62	31.6
100	6102	3.05	24.4
150	6681	3.34	20.0
200	7316	3.66	18.3

[1] *Technical Paper No. 1045, Oregon Agricultural Experiment Station. This article is a portion of the senior author's Ph. D. thesis submitted to Oregon State College. W. G. Brown of that institution provided assistance in planning and carrying out the research.*

state agencies operating in the area. There are approximately 60 ranches in the Harney Basin, Silver Creek, and Diamond areas of Eastern Oregon. Because of the nature of the study it was decided that a selected sample of 20 ranchers would be sufficient to provide information on the various conditions and problems found in the area.

From the survey of ranchers the factors involved in a decision to use fertilizer were determined. These factors were as follows: The resource situation in terms of land, labor, and capital; the price of nitrogen and beef; the cost and requirements of stacked hay, bunched hay, and pasture.

The next step was the economic interpretation of the fertilizer experiments. To do this it was necessary to estimate hay yields for any given level of nitrogen (not just at the five levels of nitrogen used in the trials). This is obtained by formulating an estimating equation from the experimental data.

An exponential equation seemed to best fit actual yield conditions. The curves in Figure 1 were determined from this equation. The total product function is the total hay yield that can be expected with different applications of fertilizer. The average product curve represents the average yield per pound of nitrogen. The marginal product curve gives the additional hay yield associated with each additional or marginal pound of nitrogen.

Table 2. Cost of additional hay at various rates of nitrogen application.

Rate of Nitrogen Application (pounds per acre)	Cost per Ton of Additional Hay	
	Price of N 10 cents/pound	Price of N 15 cents/pound
0	——	——
50	6.32	9.49
100	8.19	12.29
150	9.92	14.90
200	10.92	16.39

Profitable Fertilizer Rate

Characteristics of ranching in the native meadow area make the determination of the most profitable rate of fertilizer application difficult. A ready market does not exist for wild hay. Therefore, it must be valued in terms of its use in producing beef. Some method was needed that would provide an analysis of the entire ranch business. There are a number of techniques available by which such an analysis could be made, notably budgeting, regression techniques, and linear programming.

Linear programming is a mathematical procedure that allows a system of equations, subject to certain limiting factors, to be solved in such a way that returns to the limiting factors are maximized. Applying this technique to ranch management, the limiting factors become the land, labor, and capital that the rancher has available for production. The technique was used in this study because it permits the simultaneous selection of the level of beef production; areas of meadow to be fertilized for stacked hay, bunched hay and pasture; and the rate at which these should be fertilized in order to maximize profit. Such a simultaneous selection is not possible with budgeting, and experience has shown that regression analysis is often unsuitable for problems of this type.

The data used in the programming was obtained from the ranch survey, experiment station results, U. S. Department of Agriculture reports, and 1955 Ontario, Oregon, market reports.

In the use of programming it is necessary to establish a ranching situation. When this hypothetical ranch set-up has been established, it is possible to determine the economic use of fertilizer.

The first ranch organization studied was a two-man unit producing 167,900 pounds of beef and running 300 cows, with six limitational resources. The range permit was 3,025 A.U.M.'s, the base property was 750 acres of flood meadow, of which 260 acres (Meadow II) gave unsatisfactory response to fertilizer because of deep swales or excess alkalinity of the soil. This area gave a yield of one ton of wild hay per acre. For the purposes of the analysis this 260 acres is assumed to be unfertilized, with 66 percent cut for stacked hay and 34 percent for bunched hay, yielding one ton per acre. The remaining 490 acres (Meadow I) gave a yield of 1.2 tons of hay per acre without fertilizer. It was assumed that the meadow would only be fertilized to produce stacked hay,

Table 3. Fertilization rates, land use and beef production with limited and unlimited range

	Solution I*	Solution II**
Stacked hay	282 acres at 50 lbs. N.	313 acres at 100 lbs. N.
Bunched hay	118 acres at 40 lbs. N.	177 acres at 90 lbs. N.
Meadow pasture	90 acres at 50 lbs. N.	—
Increase in beef production due to fertilization	26%	66%
Increase in net return	$2058	(See 1 below)

* Range limited to 3025 A.U.M.'s.
** Range unlimited.
1 Although net income was determined for this situation, it is not presented since it has little economic meaning.

bunched hay and pasture. It was further assumed that all additional capital necessary for the operation of the ranch using nitrogen fertilizer and running additional cattle, would be available at 7 percent interest. As pointed out earlier, 1955 prices were used.

The solution shows that the optimum nitrogen application was 50 pounds per acre on 282 acres for stacked hay, 40 pounds on 118 acres for bunched hay and 50 pounds on 90 acres for pasture (Table 3). The 260 acres of meadow which do not respond to nitrogen were assumed to produce 170 tons of stacked hay and 90 tons of bunched. The level of beef production which this forage output would support is 212,000 pounds from a herd of 360 cows, selling yearlings. This operating system would involve pasturing 110 yearling steers on the meadow through the summer. The increase in beef production due to fertilization is 26 percent, and the additional operating expenses amount to $4900 with a net increase in return to fixed factors, land, labor, and management, of $2058.

A second ranch organization was set up to take account of any possible expansion in range grazing through development or purchase. In this case there were four limitational resources, Meadows I and II, stacked hay and bunched hay, and four levels of nitrogen on each of the two forage production methods. The results of this analysis showed that the optimum production level would be 280,000 pounds of beef given by an operation running 500 cows and selling yearlings. The range requirement for this system is 5053 A.U.M.'s, or 67 percent more than the requirement without fertilization of meadow. This points up the need for additional range production if additional hay production is to be utilized. The nitrogen application required to support this level of production would be 100 pounds on 313 acres for stacked hay and 90 pounds on 177 acres for bunched (Table 3). Production from Meadow II would be as it was in the first situation. If range rental is charged at current federal rates, the capital requirement of this system is $9900 more than an operation using no fertilizer.

Table 4 shows the manner in which the optimum rate of fertilization is related to changes in the price of beef and nitrogen. This table was developed by using the hay-nitrogen relationship shown in Figure 1, and is based on the assumption that the value of stacked hay is directly related to the price of beef. This may not be a realistic assumption for heavy rates of nitrogen, say above 50 pounds. It would be realistic for lower rates of application. It is doubtful, however, if an operator should put on less than 30 pounds of N since too little is known about hay response for small application.

From Table 3 it can be seen that under the currently feasible

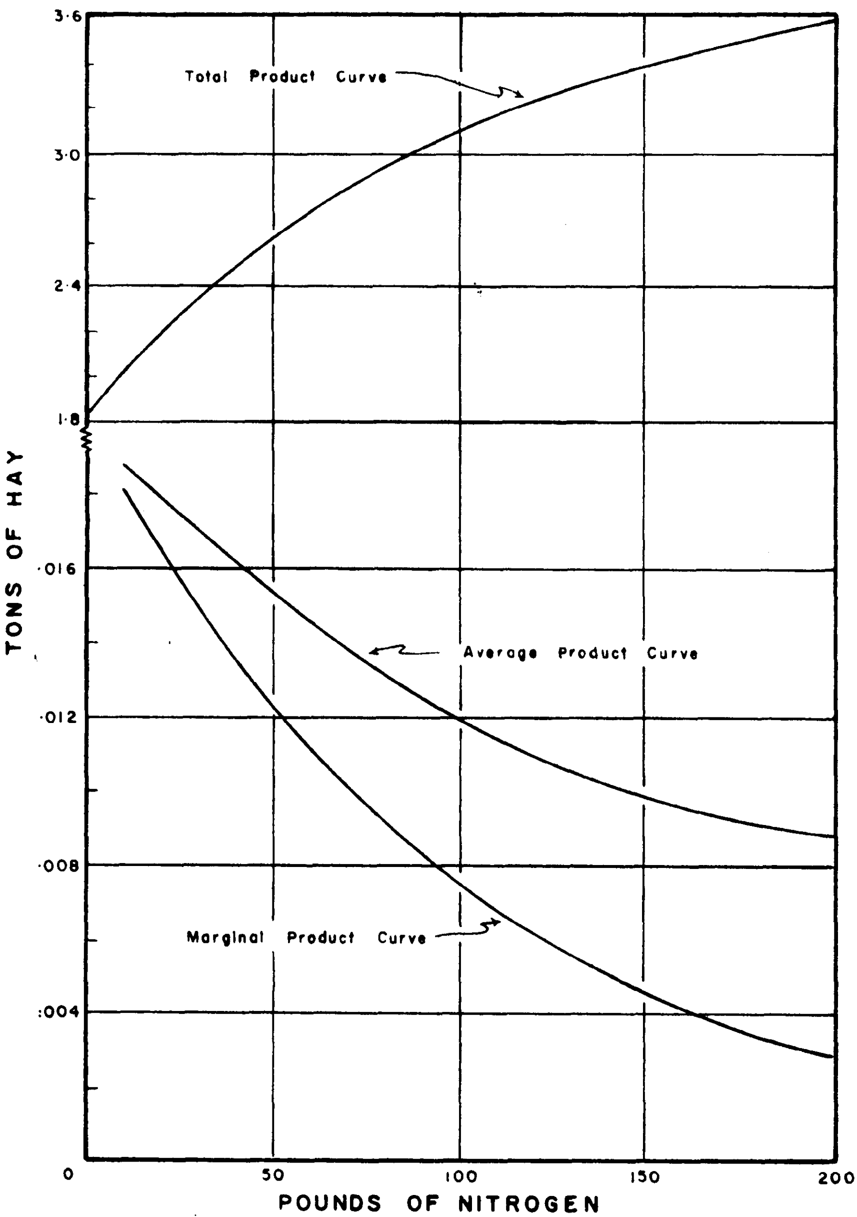


FIGURE 1. Total, average, and marginal hay yield response to nitrogen calculated from the results of experimental trials on mountain meadows in eastern Oregon.

Table 4. Relationship between price changes in beef and nitrogen and the optimum rate of fertilization.

	Price of Nitrogen—Cents per Pound										
Price of Beef	13.5	14	14.5	15	15.5	16	16.5	17	17.5	18	18.5
$ per cwt.	Pounds of Nitrogen Applied per Acre										
$10	30	30	30	20	20	20	10	10	10	10	0
11	40	40	40	30	30	30	20	20	20	20	10
12	50	50	50	40	40	40	30	30	30	20	20
13	60	60	50	50	50	40	40	40	30	30	30
14	70	60	60	60	50	50	50	50	40	40	40
15	80	70	70	60	60	60	50	50	50	50	40
16	80	80	70	70	70	60	60	60	60	50	50
17	90	80	80	80	70	70	70	60	60	60	60
18	90	90	90	80	80	80	70	70	70	60	60
19	100	100	90	90	90	80	80	80	70	70	70
20	100	100	100	90	90	90	80	80	80	80	70
30	150	140	140	130	130	130	120	120	120	120	110

price range for beef, up to $20 per 100 pounds, the highest optimum rate of fertilization is 100 pounds per acre at the lowest nitrogen price. At the nitrogen prices above 16 cents per pound, beef must be worth $9 or more per 100 pounds before any fertilization is profitable.

Conclusions

It is apparent from this study that any likely increase in range capacity can readily and profitably be matched by meadow output under a system of fertilization. However, Solution I indicates that without some development of range, the expansion through fertilization of meadow alone is limited to around 25 percent.

The prices of beef and nitrogen also affect the profitable limit of expansion with fertilizer. For instance, if the price of beef increases, relative to other prices paid by ranchers, then expansion of 30-35 percent may be profitable, using heavier applications of nitrogen (see Table 4).

The policy implications of meadow improvement are only indirectly related to fertilizer, but are nevertheless of importance. Fertilizer provides a relatively flexible method of increasing hay production and reserves. In this way it acts as a form of insurance and reduces the uncertainty in the operation. Where this is true the rancher can increase production, but summer range is still the most limiting factor. The administrators of public lands are therefore faced with the problem of obtaining the best utilization of range, and at the same time allowing the best use to be made of the meadows. There are two courses of action available to them. One is to develop rangeland, either themselves, or by financial assistance to ranchers; the second is to change the management of rangeland in light of meadow potential. In some cases it is impossible for the rancher to hold cattle on meadows in April and May due to pasture damage or because the meadows are covered by water. However, he may well be able to pasture them from July onwards or to bring them in from rangeland earlier in the fall. Other ranchers may be able to hold some cattle on pasture throughout the spring and summer. It is not the purpose of this article to go into range administration. The important point is that there exists a relationship between meadow improvement and range management.

Acknowledgement

The authors wish to acknowledge the assistance given by the staff of the Squaw Butte-Harney Experiment Station, particularly by Mr. C. S. Cooper and Mr. W. A. Sawyer whose field experiments formed the basis of this study.

Special recognition is also due to all ranchers, visited in the survey, for their splendid cooperation.

CALL FOR PAPERS FOR THE 1959 ANNUAL MEETING

Members who wish to present papers at the next annual meeting of the Society, to be held in Tulsa, Oklahoma, in January 1959, are requested to sumbit titles and short abstracts to the Program Committee. Final date for titles to reach the Committee is July 15, 1958.—E. H. McIlvain, Chairman Program Committee, U. S. Southern Great Plains Field Station, Woodward, Oklahoma.

Blue Grama Types from West Texas and Eastern New Mexico[1]

JACK R. HARLAN

Geneticist, Crops Research Division, A.R.S., U. S. Department of Agriculture, and Professor of Agronomy, Oklahoma State University, Stillwater, Oklahoma.

From the eastern edge of the Rolling Red Plains of Oklahoma and Texas westward across the High Plains, the Llano Estacado, the upper Pecos valley and lapping high up into the mountains of New Mexico is a broad expanse of natural grassland dominated to a large extent by blue grama. Southward from the New Mexico line into Texas, blue grama is found in islands at the upper elevations of the hills and mountains but seldom on the valley floors. Scattered throughout the area are several million acres of marginal and submarginal land that had been plowed up at one time and then abandoned. Attempts are being made to return this land to native grassland vegetation. Blue grama is the basic bread-and-butter grass for reseedings of this type.

Blue grama seed has always come from wild harvests, none of it being produced under cultivation. Sources of seed vary from year to year, depending entirely on the rainfall patterns of an erratic climate. It is important, therefore, to characterize the natural stands of blue grama in the region and obtain some idea of the relative agronomic value of the various sources.

Materials and Methods

The year 1946 proved to be an unusual year for blue grama development and collections were made by the author at 189 locations distributed fairly evenly over the region.

These collections were established in the breeding nurseries at the U. S. Southern Great Plains Field Station, Woodward, Oklahoma and maintained under observation until 1955 when the collection was plowed up. In 1950, a cytological survey of 108 of the collections was made by L. A. Snyder and reported elsewhere (Snyder and Harlan, 1953). The geographic pattern of chromosome numbers determined in this survey is reproduced in Figure 1 *(left)*.

Agronomic notes on flowering habits were taken on the full collection and reported here. Observations on growth and relative productivity of the 189 accessions led to the selection of nine source populations which were put into replicated yield tests (Kneebone and Heller, 1956). In addition, selected plants from the most promising sources with $2n = 20$ chromosomes were transplanted to an irrigated block at the Livestock Research Station, El Reno, for evaluation for seed production. A similar population of plants with $2n = 40$ chromosomes was established in the same way, as well as a block of collection no. 174 from the Capitan mountains of New Mexico.

In the fall of 1949 the Soil Conservation Service made a wild harvest on the site from which collection no. 34 was taken, a few miles north of Marfa, Texas. Since this material had given a good performance in spaced nurseries, sufficient seed was obtained to establish one 50 acre pasture on the Experimental Range Unit near Ft. Supply and a 2 acre block on the main station which has been used for a study of seed production practices. The results of these studies are largely available elsewhere (Kneebone, 1957; McIvain *et al.*, 1955) and will be summarized only briefly here together with some general observations on the collection as a whole.

Maturity and Flowering Habits

During the course of the collection in 1946 notes were taken on the maturity of the stand at each collection site. The maturity pattern is shown for the 189 collections in Figure 1 *(Right)*. It will be noted that on the whole, the ripest material was in northeast New Mexico and the higher elevations of the mountains of that state. The latest to mature was in the Davis mountains of Texas.

It was thought at the time that this was probably the result of rainfall patterns rather than due to inherent genetic factors. Notes taken on the same material in the breeding nurseries at Woodward in 1950 and 1951 showed clearly that this maturity pattern was inherent. As in many grasses, blue grama has an ill-defined blooming period. It was not possible to select a single date for blooming, but the flowering behavior of each accession was followed by taking notes on three separate dates as to the relative condition of the population on each of the three dates. The data for May 18, 1950, June 1, 1950, and June 12, 1950 were taken from 176 collections in the nursery at Woodward and then plotted on the maps shown in Figures 2 and 3. The flowering behavior of the accessions grown side by side at Woodward was very similar to the maturity pattern as noted in the field in 1946. Notes taken in 1951 were nearly identical to those of 1950.

Winter Hardiness at Woodward

Some plants in the collections from Sierra Blanca, Van Horn,

[1] *Contribution of Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.*

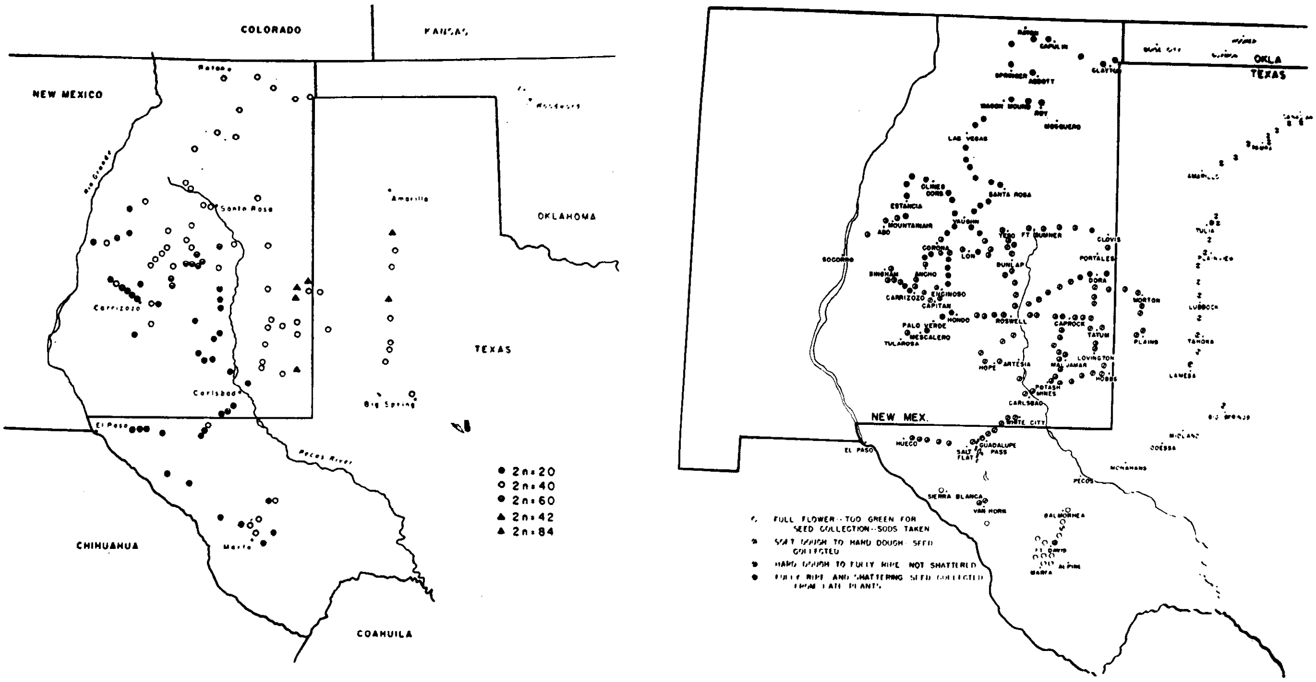


FIGURE 1. *Left:* Map of the area showing 108 localities from which cytological data were taken. *Right:* Maturity of the collections at the time of collection in October, 1946.

and near Marfa, Texas, showed considerable winter injury during the severe winter of 1950-51 and moderate injury in other years. Other accessions suffered no evident winter damage. Apparently there are many hardy plants in the Marfa population, since bulk seedings both at Ft. Supply and on the main station have survived well. No doubt the badly injured plants are replaced by fully hardy ones out of the same population where thick stands are obtained. Injury to these southernmost accessions, however, suggests that collections still further south should be used with caution, and that material from Van Horn, the Davis Mountain, etc. should not be used farther north than Oklahoma.

Distribution of Types

Because of space limitations, only 35 plants of each collection were established in the nursery. This sample was large enough, however, to show that very few of the collections were actual duplicates. Each population was in some way slightly different from every other population, yet certain broad agronomic types could be distinguished. Collections east and north of the Pecos River were rather similar for the most part and represented a broad, contiguous high plains type, highly variable, yet rather similar in growth habit and general aspect. The one exception to this generalization was collection 201 west of Roy, a site located deep in the Canadian River Canyon, and not truly of high plains origin.

Transpecos materials, by contrast, were remarkably diverse in appearance and performance. They included diploids ($2n = 20$), tetraploids ($2n = 40$), and hexaploids ($2n = 60$), Figure 1. Many were very tall, (36-40 inches in the nursery), leafy, robust, and apparently productive. Others appeared to be much less desirable. One (No. 174) had very long, weeping leaves, and was strikingly different from all other materials in the collection.

This last accession, under trial under the name of Capitan, came from a small meadow north of the town of Capitan, New Mexico. Since it appeared to be an agronomically desirable type, the site was revisited in 1949 and collections made at several points in the same meadow and at 0.5 mile intervals in all directions in order to determine its geographic range. When these collections were grown, it was found that none of them corresponded to the original collection except those taken within 100 yards of the original collection site. This strikingly different variety is apparently confined in its natural habitat to a meadow less than 20 acres in size.

Several of the other collections appeared to represent types with a distribution perhaps as limited. On the other hand, most of the material from the Davis Mountains appeared to be of a type, although diploids and tetraploids were represented and both contained considerable variability. Material from the hills between Hueco and Salt Flat was also distinctive and of the same general type; collections from the Guadalupe Mountains resembled each other more than they resembled other sources. Thus, the

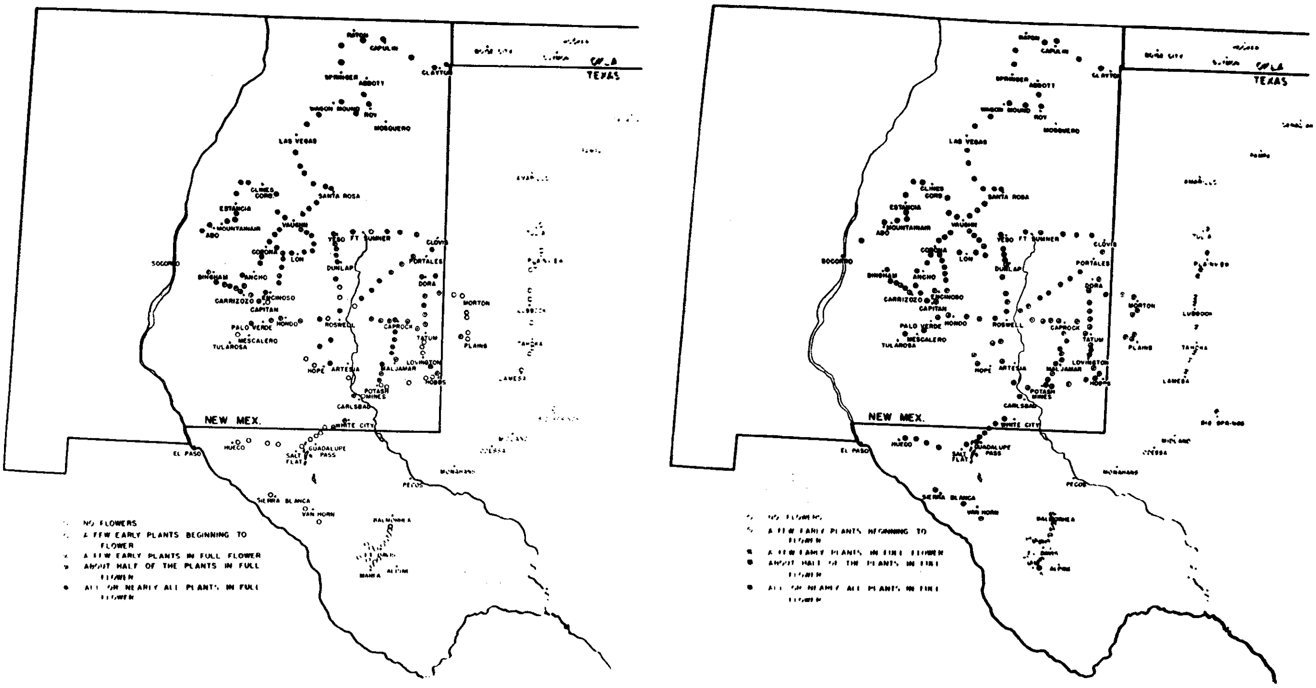


FIGURE 2. *Left:* Flowering notes taken in the nursery at Woodward on May 18, 1950, and plotted according to origin of each accession. *Right:* Flowering notes taken on June 1, 1950, plotted in the same manner.

transpecos material is rather finely divided into types and subtypes according to the physiographic features of the region, as well as into minute, distinctive colonies, as in the case of Capitan.

Forage Yield

Data from replicated clipping trials, Table 1, indicate a substantial difference in performance between the several sources tested (Kneebone and Heller, 1956). Some of the types like Van Horn, Capitan, and Ruidoso that stood out in the spaced nursery as strikingly vigorous and productive vegetative types made a relatively poor showing in replicated plots. Those that gave the best performance, Hueco, Pecos, Caprock, Dunlap, were relatively undistinguished in the spaced nursery, exhibiting more vigor and production than the average, but appearing in no way outstanding. The first two of the last group named are diploid, the other two tetraploid.

On the whole, the most southern sources were not the best adapted at Woodward, although perhaps all of the accessions might be considered satisfactory and generally superior to commercial sources from eastern Colorado and western Kansas. The best sources based upon performance at Woodward were those from intermediate latitudes and intermediate elevations of the general area sampled.

While W_3 was of Oklahoma origin, it could hardly serve as

Table 1. Yield in pounds air dry forage per acre in plots; average of three replications for a total of six clippings during the years 1951, 1952, and 1953.

Variety and Source	Yield lbs./acre	Av. protein— percent	Total protein yield lbs./acre
Hueco: Between Hueco and Salt Flat, Tex.	2654	8.36	222
W_3: Woodward and Noble Counties, Okla.	2290	7.93	182
Pecos: 3 locations 25-35 mi. N. Carlsbad, N. Mex.	2284	8.48	194
Caprock: Near Caprock, N. Mex.	2119	8.03	170
Dunlap: Near Dunlap, N. Mex.	2080	8.50	177
W_2: Selected late plants from collection	2066	7.78	161
W_1: Selected early plants from collection	2035	7.90	161
Roy: Canadian River Canyon West of Roy, N. Mex.	1990	8.21	163
Marfa-Davis: Selected plants Davis Mts., Tex.	1961	8.14	160
W_4: F_4 from Western N. Mex. x Okla. selections	1843	7.71	142
Van Horn: Near Van Horn, Texas	1817	8.13	148
Capitan: Near Capitan, N. Mex.	1719	7.67	132
Ruidoso: 3 locations Hondo-Ruidoso, N. Mex.	1666	7.99	133
L.S.D. .05	157	0.46	......

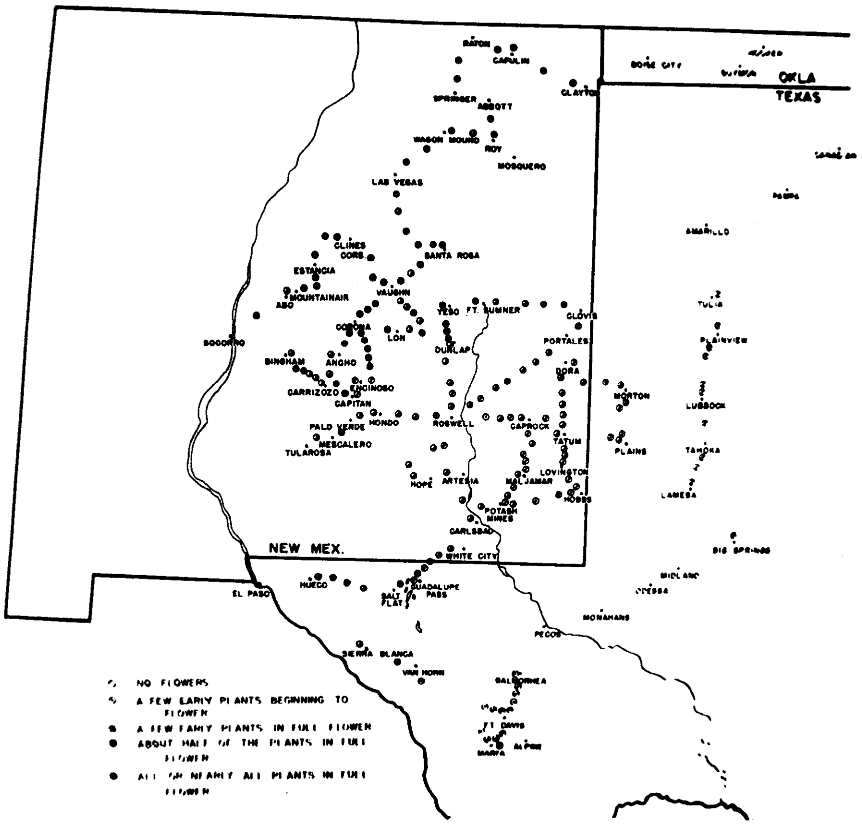


FIGURE 3. Flowering notes taken in the nursery at Woodward on June 12, 1950, and plotted according to origin of each accession. Compare with Figure 2.

an example of local commercial material, since it had been developed by selection and restricted breeding for several generations. A comparison with local check materials would be somewhat academic in any case, since blue grama seed is only rarely harvested in Oklahoma in commercial quantities. We may conclude from the limited plot studies that while almost any source of blue grama from the area sampled would be acceptable for northwest Oklahoma some sources are decidedly better than others. The best material for western Oklahoma would probably be from the hills east of Hueco and the mid-Pecos valley from Ft. Sumner southward to the Texas line.

The grazing trial at Ft. Supply comparing Marfa material with Texas panhandle material is inconclusive at the present time. A rather wide initial difference in stand was obtained which appears to confound the results of the first two or three years of the study (McIlvain, E. H., *et al.*, 1955).

Seed Production

A comprehensive study on seed production using the Marfa source was conducted by W. R. Kneebone and reported elsewhere (Kneebone, 1957; Harlan, Ahring, and Kneebone, 1956). A similar study has been started at El Reno using the Capitan variety. Results of these studies need not be repeated here, but it seems apparent that with suitable management and with irrigation water available, 300-450 lbs. of high quality seed can be produced per acre. Each variety and source appears to have its own specific requirements and it is difficult to generalize on specific recommendations. The Capitan variety, for instance, produces two seed crops at El Reno while Marfa produces only one at Woodward. The selected $2n = 20$ population has made a consistently better seed set at El Reno than the selected $2n = 40$ population, and the Capitan ($2n = 20$) has consistently performed better than either of them in both seed and forage production under irrigation.

Despite these variations in performance, we now probably have enough information on blue grama seed production under irrigation to produce seed of selected sources in artificial stands. It is hoped that the culture of selected types for seed production will eventually replace the present erratic wild harvests and provide the region with a steady, dependable supply of the blue grama of known and proven genetic origin.

LITERATURE CITED

SNYDER, L. A. AND J. R. HARLAN. 1953. A cytological study of *Bouteloua gracilis* from western Texas and eastern New Mexico. Amer. Jour. Bot. 40: 702-707.

KNEEBONE, WILLIAM R. AND V. G. HELLER. 1956. Leaf and crude protein percentages among strains of some forage grasses. Okla. Agr. Exp. Sta. Bull. T65. 23 pp.

———. 1957. Blue grama seed production studies. Jour. Range Mangt. 10: 17-21.

MCILVAIN, E. H., *et al.* 1955. Nineteen-year summary of range improvement studies at the U. S. Southern Great Plains Field Station, Woodward, Oklahoma. Prog. Rept. 5506. Mimeo. 41 pp.

HARLAN, JACK R., ROBERT M. AHRING AND WILLIAM R. KNEEBONE. 1956. Grass seed production under irrigation in Oklahoma. Okla. Agr. Exp. Sta. Bull. B-481. 15 pp.

Some Slope-Plant Relationships in the Grasslands of the Little Missouri Badlands of North Dakota[1]

RALPH L. DIX

Biology Department, Marquette University, Milwaukee, Wisconsin

The importance of slope in the determination of the kinds and numbers of plants which occupy a site has long been recognized. It is not possible, however, to isolate the influence of slope alone from the multitude of other environmental and biotic factors which are inevitably and inseparably linked to it. The degree of slope will strongly influence such factors as soil stability and erosion, runoff, received insolation, accessibility to grazing animals and ultimately the vegetal cover supported by a site. Since the kinds and numbers of plants occupying a site are a reliable index to its past and present environment, the investigation of correlations between slope and species composition would appear a promising approach to the study of slope-plant relationships. The aim of this paper is to describe the vegetational characteristics of four grassland stands differing in slope and exposure in the Badlands of the Little Missouri River, and to interpret their similarities and differences in terms of underlying causes.

Study Area

The location of the study area is SE¼ sec. 11, T. 40 N. R. 102 W. This area is approximately one mile south of the Peaceful Valley Ranch, Theodore Roosevelt National Memorial Park, Billings County, North Dakota.

Physiographically, the general area is on the unglaciated portion of the gently sloping Missouri Plateau and is part of the Tongue River formation of the Fort Union group (Paleocene) (Leonard, 1930). This formation is composed of stratified beds of sands, clays and silts together with interspersed beds of lignite. Since the formation of the Missouri Plateau, severe dissection by the Little Missouri River and its tributaries has carved the deep gorge-like valleys characteristic of "badlands." This rapid dissection has largely been due to the shift in the outlet of the Little Missouri River in Pleistocene times from the Yellowstone River to the Missouri River, thus lowering its mouth by some 250 feet. Other contributing factors were the soft unconsolidated clays and silts of the substrata, burning lignite seams, and the semiarid climate.

The soils of the stands concerned in the present investigation have been classified by Edwards and Ableiter (1944) as the hilly phase of the Bainville clay loam series. These soils are usually less than five inches deep, quite friable, and with carbonates sufficient to cause effervescence within a few inches of the surface. They occur on slopes and are excessively drained except where scattered blocks of scoria or sandstone concretions may hold sufficient moisture to permit more favorable growth conditions.

The climate is of the semiarid, continental type with long cold winters and short warm summers. The mean annual precipitation is approximately 16 inches with about one-half of this occurring during May, June and July. Precipitation varies considerably from year to year and severe droughts are not uncommon. The frost-free season averages about 111 days.

The native vegetation of the area consists principally of grassland. The well drained loam and clay soils with moderate slopes support mainly blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), thread-leaf sedge, (*Carex filifolia*), and needle-and-thread (*Stipa comata*). On steeper slopes little bluestem (*Andropogon scoparius*), plains muhly (*Muhlenbergia cuspidata*), side-oats grama (*Bouteloua curtipendula*), and little club-moss (*Selaginella densa*) are usually the dominant species. Sandy soils are usually dominated by prairie sandgrass (*Calamovilfa longifolia*).

Since the study area is located well within the borders of a national park, grazing by livestock over a period of about twenty years has been limited to a few stray trespassing cattle. There was no evidence that livestock had been on the study area in recent years.

Methods

All stands were located along the sides of a broad ravine and within a distance of 500 yards. Of the four stands selected, two had eastern and two western exposures; north and south facing slopes were deliberately avoided to minimize the influence of these more contrasting exposures. Stands 101 and 103 were directly below stands 102 and 104, respectively.

The vegetation was sampled by use of forty ¼-M.^{2} quadrats per stand. The presence of each species in each quadrat was recorded and the frequency index for each species in each stand calculated. This quadrat size was selected after preliminary field trials indicated that with

[1] *This investigation was supported in part by funds made available by the Committee on Research, Marquette University.*

Table 1. Indices of stand similarity. Numbers are in percent.

Slope: exposure, degrees	E8°	W3°	W11°	E16°
Stand Numbers	103	101	102	104
103	—	70.3	37.3	26.8
101	—	—	42.8	30.0
102	—	—	—	62.6
104	—	—	—	—

this quadrat size the most common species in each stand would have a frequency index approximating 86 percent (Curtis and McIntosh, 1950). The quadrats were placed at 20 pace intervals along four parallel lines (10 quadrats per line) which ran at right angles to the slope. The slope was measured (in degrees) with an Abney level and the exposure determined with a hand compass.

The data for each stand were tested for adequacy of sample. It was found that all species with frequencies greater than 50 percent when forty quadrats were used showed change of less than five percent when only thirty quadrats were used.

The field work for this study was done between July 5th and 20th, 1956. The taxonomic nomenclature is according to Stevens (1950).

Results

The similarities in species composition in each pair of the four stands were objectively determined by employing Sorenson's Index of similarity (Sorenson, 1948):

$$K = \frac{2c}{a + b} \times 100$$

In this formula K is the coefficient of similarity between two stands (A and B), a is the sum of frequencies for all species in stand A, b represents the sum of frequencies of all species in stand B, and c is the sum of frequencies shares by those species occurring in both stands. For example, the similarity coefficient (K) between stands 103 and 101 (Table 2) was determined by summing all frequencies in stand 103 ($a = 285$), summing all frequencies in stand 101 ($b = 349$), and summing the frequencies shared by these two stands ($c = 223$). This latter figure was obtained by adding 62 for blue grama, 75 for western wheatgrass, 15 for red mallow *(Sphaeralcea coccinea)*, etc. According to this formula, when the two stands are identical, $K = 100$ (i.e., the stands are 100% alike), while, when they have no species in common, $K = 0$.

Similarity coefficients for the four stands are presented in Table 1. The positions of the stands in this table were arrived at by placing those stand pairs with the highest similarity coefficients closest together and those with the lowest similarity coefficients farthest apart. Thus, stands 103 and 101 are most alike (70.3 percent), while stands 103 and 104 are least alike (26.8 percent).

The frequency index values for the leading species of the study are given in Table 2. In this table the stands are arranged according to their similarity coefficients, while the vertical positions of the species were determined by an inspection process which attempted to place those species with the highest frequency index values in stands 103 and 104 at the top and bottom of the species column, respectively. The total number of species which occurred in the quadrats of each stand are given at the bottom of Table 2. The sum of frequencies for each species in the four stands is given in the right hand column, while the slope, expressed in degrees, and the direction of exposure are presented at the top of each stand column.

The behavior of six leading dominants along the gradient of similarity coefficients, as estab-

Table 2. Frequency index values for the leading species of the study. Only those species with frequency index values of at least 15 percent in at least one stand are given.

Slope: exposure, degrees	E8°	W3°	W11°	E16°	Sums of Species Frequencies
Stand Numbers	103	101	102	104	
Bouteloua gracilis	92	62	52	25	231
Agropyron smithii	75	92	27	30	224
Sphaeralcea coccinea	15	32	5	5	57
Stipa viridula	15	20	20	7	62
Artemisia frigida	25	55	42	22	144
Selaginella densa	15	—	12	35	62
Comandra pallida	—	—	30	12	42
Carex filifolia	7	20	62	50	139
Stipa comata	5	10	17	2	34
Calamagrostis montanensis	5	—	15	7	27
Gutierrezia sarothrae	—	—	22	15	37
Eurotia lanata	2	5	20	17	44
Solidago missouriensis	—	—	17	20	37
Brauneria angustifolia	2	2	17	25	46
Eriogonum multiceps	2	—	10	20	32
Andropogon scoparius	—	—	37	60	97
Muhlenbergia cuspidata	2	5	40	70	117
Bouteloua curtipendula	2	2	7	72	83
Helianthus rigidus	—	—	2	50	52
Liatris punctata	—	—	—	17	17
Total Number of Species	19	22	43	47	
Sums of Stand Frequencies	285	349	589	714	

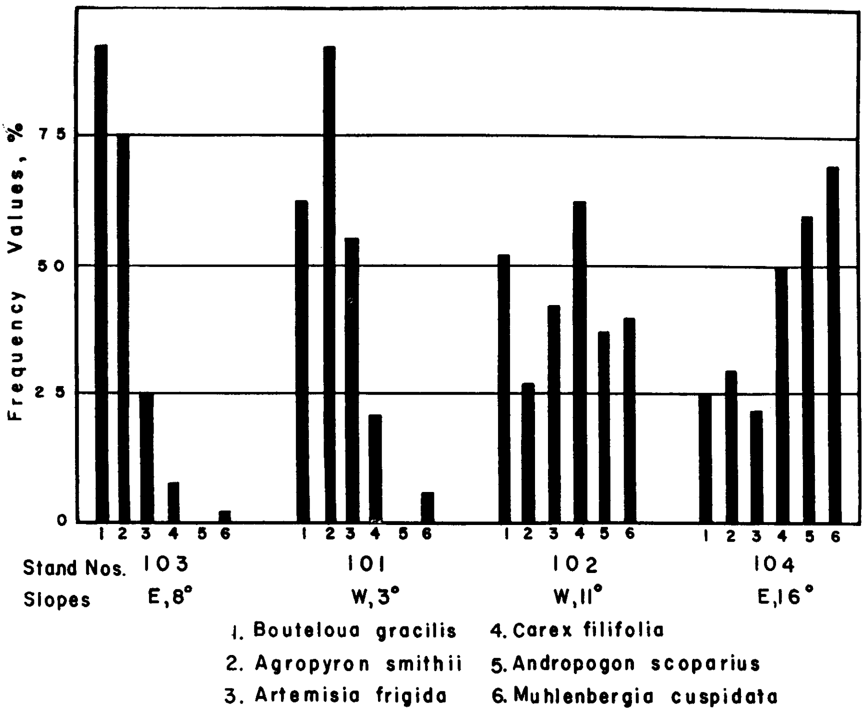


FIGURE 1. Frequency index values for six leading dominants. Stands are arranged according to similarity coefficients.

lished by the Sorenson Index, is illustrated in Figure 1. An examination of these bar diagrams reveals that each species demonstrates some sort of behavior pattern with regard to this order of stands. It may be observed, for example, that blue grama and western wheatgrass decrease while little bluestem and plains muhly increase from left to right. These bar diagrams further illustrate the relatively lower frequencies of the dominant species and the larger number of species with intermediate frequencies in stands with steeper slopes.

Raunkiaer's five frequency classes were employed to determine the distribution of frequencies in each of the four stands (Table 3). The interpretation placed upon this table is that it indicates the distribution of the number of species within particular mean area groups; *i.e.*, it shows the number of species with mean areas equal to, larger than, and smaller than the quadrat area. When randomly distributed, a species having a frequency of 60 per cent will have a mean area of approximately one quadrat area. Similarly, species with frequencies lower than 60 percent will have mean areas greater than one quadrat area, while species with frequencies greater than 60 percent will have mean areas less than one quadrat area (Curtis and McIntosh, 1950). It is not supposed that these frequency distributions are in any way a measure of stand homogeneity.

Discussion

The ordering of stands by use of similarity coefficients is a mathematical method of demonstrating the similarities in species composition between a group of stands and does not, of itself, imply or suggest the underlying nature of the obtained order. When environmental characteristics of the included stands are compared to this order, however, correlations between the ordination and environment may suggest fundamental causes.

An inspection of Table 1 clearly shows that the stands fall into two pairs—stands 103-101 (70.3) and stands 102-104 (62.6). Conversely, the highest similarity coefficient between the two pairs is 42.8 between stands 101 and 102.

Stands 102 and 104 occurred on rather steep slopes (11° and 16°) and soil erosion was strongly evident in both. These slopes are capped with sandstone concretions, and horizontal beds of this material outcrop throughout the stands. These beds, since they are impervious to water, create situations suggestive of small perched water tables. During wet periods water percolates through the soil and, meeting these impervious layers, is held briefly before gradually seeping to the surface to become available for plant growth over an extended period of time. These stands, therefore, receive water in excess of precipitation. From the exposure of these stands it would be expected that, due to protection from the hot and dry southwesterly winds of June and July (Sampson and Weyl, 1918, and Renner, 1936), the east facing stand 104 would be more mesic, or at least less xeric, than the west facing stand 102.

Stands 103 and 101 occurred on more gentle slopes (8° and 3°) and are, paradoxically, areas of both deposition and erosion.

Table 3. Number of species in Raunkiaer's five frequency classes.

Stand Numbers	0-20 %	21-40 %	41-60 %	61-80 %	81-100 %
103	16	1	—	1	1
101	18	1	1	1	1
102	35	5	3	—	—
104	37	5	3	2	—

That is, eroded soils from above are transported across these stands or temporally deposited there to be eroded away by the water from some future rainstorm. Over the years, the deposition process has stayed well ahead of erosion and has resulted in the formation of the broad terraces on which these stands are located. The horizontal beds of standstone are far beneath the surface and additional moisture due to seepage is lacking in these stands. Stand 103 has a slope of 8° and receives directly the runoff from stand 104 (16°). This runoff water enters stand 103 at a relatively high velocity and, though slowed by a decrease in slope, moves across the stand at a rate too rapid to permit its efficient infiltration into the soil. Stand 101 is on a slope of only 3° and receives runoff from stand 102 (11°). This runoff water enters stand 101 at a somewhat lower velocity than the water entering stand 103 and, being further slowed by the slight slope of this stand, moves across it at a sufficiently slow rate to permit good penetration. Although stand 103 is located on an east facing slope, its comparative steepness with regard to stand 101 renders it more xeric than that stand.

From the above it appears that the ordination of the stands determined by the Sorenson Index is based upon a moisture gradient. This suggestion is strengthened by considerations of the vegetation. Stands 103 and 101 are dominated by blue grama and western wheatgrass, species with ranges centered in and mostly confined to the semiarid Great Plains (Weaver and Albertson, 1956 and Hitchcock and Chase, 1950) while, conversely, the dominants of stand 104, little bluestem and side-oats grama, are important species of the more humid midwestern prairies (Weaver and Fitzpatrick, 1934, and Curtis, 1955). Increases along the ordination (from left to right) in the total number of species which occurred in the quadrats and in the sums of their frequencies are also indicative of a moisture gradient since more favorable moisture conditions tend to favor a greater variety of dominants and an increase in total density.

The successional relationships between these stands, if they occur at all, are not clear. All of the stands, due to the extreme erodability of the fine clay soils, undergo frequent disturbances by either erosion, deposition or both, and little opportunity is afforded for vegetal stabilization. The species composition of these stands is primarily controlled by soil moisture and exposure, and these factors are, in turn, determined by the physiography and not by previous vegetation. It seems doubtful, therefore, that, successional relationships exist between these stands. Rather, physiographic situations present environmental conditions which fall, to a greater or lesser degree, within the ecological amplitude of certain species of the flora. These species are then sorted out by physiographic situations and the stands are related to each other only in so far as their physical environments fall within the ecological amplitudes of the same species. Successional relationships in the Little Missouri Badlands have been treated by Hanson and Whitman (1938), Judd (1939) and Whitman and Hanson (1939).

The results of this study indicate that the most important single factor in determining the kinds and numbers of plants which occupy those sites is soil moisture; other variables, such as exposure, slope and topography, are correlated with soil moisture and are apparently important only in so far as they influence it. This does not imply, however, that soil moisture alone determines the species composition of these sites, since such factors as past history, available soil nutrients, and excessive salts also play significant roles (Hanson and Whitman, 1938).

It seems apparent from this study that interpretations of future research on the phytosociological characteristics of the grasslands of the Little Missouri Badlands would be significantly aided by detailed considerations of the physical environment—especially of physiographic and edaphic factors.

Summary

The roles of slope and exposure in determining the species composition of some grassland types in the Badlands of the Little Missouri River of North Dakota were investigated. Four stands, differing in slope and exposure, were selected as study areas; the stands had slopes and exposures of: 16° E., 8° E., 3° W., and 11° W.

The stands were sampled by the frequency method employing 40 ¼-M.^{2} quadrats per stand. Slopes and exposures were also measured. Similarity co-efficients between the stands were calculated and an ordination of stands established.

The behavior of the dominant species along this ordination indicated that it was based upon a moisture gradient. Blue grama and western wheatgrass, species of the more xeric Great Plains, were found to be more important at one end of the gradient, while little bluestem, side-oats grama, and plains muhly, species of the more mesic Midwestern prairies, were more important at the opposite end of the ordination. This ordination also correlated with apparent soil moisture, total number of species which occurred in the quadrats and in the total frequency per stand.

The relationships between the stands appeared not to be successional, since the species composition of the stands was based principally upon physiographic and edaphic factors.

Acknowledgment

Deep appreciation is expressed to Messrs. John W. Jay, Jr., and Ches-

ter L. Brooks, Superintendent and Historian, respectively, Theodore Roosevelt National Memorial Park, for many courtesies extended to the author during the course of this study.

LITERATURE CITED

CURTIS, J. T. 1955. A prairie continuum in Wisconsin. Ecology 36: 558-566.

——— AND R. P. MCINTOSH. 1950. The interrelations of certain analytic and synthetic phytosociological characters. Ecology 31: 434-455.

EDWARDS, M. J. AND J. K. ALBEITER. 1944. Soil survey of Billings County, North Dakota. U. S. Dept. Agr. Bur. Plant Indus. Ser. 1934 No. 25, 111 pp.

HANSON, H. C. AND W. WHITMAN. 1938. Characteristics of major grassland types in western North Dakota. Ecol. Monog. 8: 57-114.

HITCHCOCK, A. S. AND A. CHASE. 1950. Manual of the grasses of the United States. U. S. Dept. Agr. Misc. Pub. No. 200. 1051 pp.

JUDD, B. I. 1939. Plant succession on scoria buttes of western North Dakota. Ecology 20: 335-336.

LEONARD, A. G. 1930. The geology of North Dakota. N. Dakota Univ. Bull. 11.

RENNER, F. G. 1936. Conditions influencing erosion on the Boise River watershed. U. S. Dept. Agr. Tech. Bull. 528: 1-32.

SAMPSON, A. W. AND L. H. WEYL. 1918. Range preservation and its relation to erosion control on Western grazing lands. U. S. Dept. Agr. Bull. 675: 1-35.

SORENSEN, T. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. Konge. Dan. Vidensk. Selsk. J5: 4: 1-34.

STEVENS, O. A. 1950. Handbook of North Dakota plants. North Dakota Institute for Regional Studies, Fargo, N. D. 324 pp.

WEAVER, J. E. AND F. W. ALBERTSON. 1956. Grasslands of the Great Plains. Johnsen Publishing Co., Lincoln, Nebraska. 395 pp.

——— AND T. J. FITZPATRICK. 1934. The prairie. Ecol. Monog. 4: 109-295

WHITMAN, W. AND H. C. HANSON. 1939. Vegetation of scoria and clay buttes in western North Dakota. Ecology 20: 455-457.

BUNCHGRASS FORM CLASSES FOR TREND STUDIES[1]

GLEN F. COLE AND
BRUCE T. WILKINS

Senior Range Biologist and Project Biologist, Montana Department of Fish and Game, Helena, Montana

Idaho fescue (*Festuca idahoensis*) is a key forage grass on certain Montana elk ranges. While measuring basal areas and maximum leaf heights, differences were noted in growth forms of mature Idaho fescue plants. These forms were separated into Normal, Hollow Center and Clump Edge classes (Figure 1). The Normal class was assigned to plants if all portions of the bunchgrass clump produced leaves; the Hollow Center class, if a "ring" of leaves encircled a dead center by more than one-half the clump circumference; the Clump Edge class, if one or more segments of leaves grew on the edge of the clump and the largest segment did not encircle more than one-half the clump circumference. Segments of leaves were considered separate if they were apart from other segments by more than 0.3 inch.

Additional differences were noted on the surface of the dead portions of Hollow Center or Clump Edge plants. If old leaf structure was evident, an R (denoting *recent*) was assigned. If the surface was structureless, a D (denoting *decomposed*) was assigned.

Evanco and Peterson (1955) found that basal area measurements reflected differences in grazing intensities on Idaho fescue. Various workers have used maximum leaf heights as an indication of grass vigor. As reported here, the basal area of a Normal or Hollow Center plant was the product of two opposed diameter measurements through the clump base; of a Clump Edge plant, the product of two opposed measurements through the base of one segment. Maximum leaf heights were measured by placing a rule vertically within a clump or segment. All measurements were to 0.1 inch.

Results from measurements and form class assignments on two adjacent ranges are shown in Table 1. A seedling category is included to isolate plants which were considered to be too small (basal area .06 inches or less) to reflect the Hollow Center or Clump Edge classes. Both ranges receive heavy winter and early spring elk use. In addition, Range B receives light to moderate late spring or early summer

---

[1] *A contribution from Federal Aid in Wildlife Restoration, Montana Project W-37-R.*

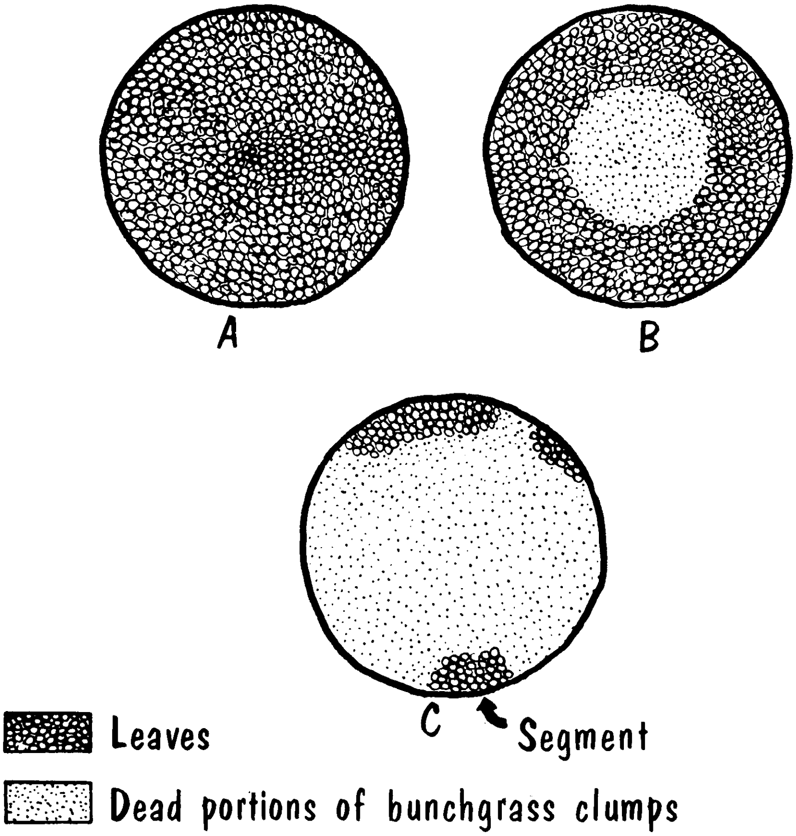


FIGURE 1. Bunchgrass form classes; A. Normal, B. Hollow Center, C. Clump Edge.

cattle use. Data from the two ranges were compared. A "Student's" t-test was employed to test hypotheses of equal leaf height and basal area means for the two ranges. A chi-square test was employed to check a hypothesis of equal form class percentages. The hypothesis of equal basal area means could not be rejected. Hypotheses of equal leaf height means and form class percentages were rejected at the 1 and 5 per cent significance levels, respectively.

If leaf height is considered an indication of grass vigor and the Hollow Center and Clump Edge classes represent stages of deterioration from the Normal class, it must be concluded that Idaho fescue plants on Range B are in a less vigorous and more deteriorated condition than those on Range A. In addition, the relatively high percentage of Hollow Center and Clump Edge classes in the R category suggests that recent use is largely responsible for the condition of plants on Range B.

Apparently the deterioration of Idaho fescue plants on Range B has not progressed to the stage where it will be reflected by the basal area measurements. It is expected that subsequent measurements and form class assignments will more clearly show the trends in Idaho fescue condition on the two ranges. At present, neither of the two ranges are grossly different. On other ranges, obviously in poorer condition, Hollow Center and Clump Edge classes have represented 71 out of 100 plants. This suggests that the use of form classes may permit an expression of condition trends over a scale of 100 percentage points.

Observations on various ranges suggested that a "Dead" class should also be used. Plants in this class would not have current leaf growth. Observations also indicated that the form class assignments could be applied to bunchgrasses other than Idaho fescue. Two important grasses, observed to reflect the described form classes, were bluebunch wheatgrass (*Agropyron spicatum*) and rough fescue (*Festuca scabrella*).

Observations of bluebunch wheatgrass within an exclosure provided evidence that ungrazed bunchgrasses will reflect the Hollow Center and Clump Edge from classes prior to dying from old age. Therefore, the use of the various form classes for trend studies must be based on the premise that overgrazing will cause mature bunchgrass plants to reflect the Hollow Center, Clump Edge and Dead classes at an accelerated rate.

LITERATURE CITED

EVANCO, ANTHONY B. AND ROALD A. PETERSON. 1955. Comparisons of protected and grazed mountain rangelands in southwestern Montana. Ecol. 36: 71-82.

Table 1. Basal area and leaf height means (inches) and form class percentages from 300 Idaho fescue plants on each of two adjacent ranges.

		Means and Standard Errors		Form Class Percentages*					
					Hollow Center		Clump Edge		
Range	Use	Basal Area	Max. Leaf Ht.	Normal	R	D	R	D	Seedling
A	Elk	0.85 ± .06	2.9 ± .05	73	2	7	3	4	11
B	Elk-Cattle	0.80 ± .05	2.2 ±.04	57	8	9	11	8	7

* Form class percentages are from 200 plants only on Range A.

A LOOP METHOD FOR MEASURING GROUND-COVER CHARACTERISTICS ON PERMANENT PLOTS

RICHARD S. DRISCOLL

Range Conservationist, Pacific Northwest Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Portland, Oregon

A method for making loop measurements on sample plots of various sizes and shapes has been developed at the Starkey Experimental Forest and Range in northeastern Oregon. This adaptation of the loop transect measures respective percentages of area covered by rock, litter, bare soil, and live plants and supplements vegetation data obtained by other sampling methods. Loop measurements on sample plots can be compared with loop records made on the conventional 100-foot line transect. Tests indicate that the method offers possibilities as a research tool and is a practical device for use in extensive inventories.

Equipment and Procedure

The method originally was designed for use on small circular plots on the Starkey. Equipment includes a hardwood board 2 inches wide by ⅜ inch thick and 3 to 4 inches longer than the diameter of the plot, a metal loop ¾ inch in diameter attached to a heavy gauge wire shank, and two chaining pins. The ends of the hardwood board are tapered to fit the loop in the chaining pins. Notches are cut at equal intervals along one edge of the board to fit the wire shank of the loop. The number of observations needed per plot determines the number of notches in the board.

In use, the board is oriented over the plot center and parallel with the ground. It is supported at each end by chaining pins (Fig. 1). Data on the various ground-cover characteristics are obtained by directing the loop to the ground at each notch and recording what it encloses (Fig. 2). The loop is placed perpendicular to the ground surface.

FIGURE 1. Orientation of the board over the plot prior to making observations.

FIGURE 2. The loop in position for observing and recording ground-cover characteristics.

Half or more of the loop occupied by rock, litter, or bare ground denotes a hit on that particular characteristic. A hit of live perennial vegetation is recorded if a perennial plant is rooted in the loop. Only one recording is made for each loop observation. The number of hits for each characteristic is expressed as a percentage of the total number of observations made. A small area around the perimeter of the plot and the plot center stake should be excluded from observation to reduce the effects of trampling and the plot center stake. Average time for 2 men to set up the equipment and observe and record information from 4 sets of observations along the board was found to be 20 minutes.

This quantitative method was initially designed to measure changes in various ground-cover characteristics on permanent plots over a period of years. It provides an index upon which to base changes in general ground-cover characteristics mentioned. Subsequent measurements of the same points on the same plots are possible if trends in range condition are to be evaluated.

MODIFICATIONS OF THE POINT FRAME

Harold F. Heady and Lynn Rader

Associate Professor, and Graduate Student, School of Forestry, University of California, Berkeley, California

Since Levy (1933) gave his complete description of the point method of sampling herbaceous vegetation, there have been many studies on the method and comparisons of the results obtained with those from other methods. This paper is concerned with the design of the apparatus rather than the appropriateness of the method for a particular objective or the analysis of point data. If the reader is interested in those phases, he is referred to recent papers by Goodall (1952), Whitman and Siggeirsson (1954), Kemp and Kemp (1956), and Heady (1957).

The point frame shown in Figures 1 and 2 evolved through several modifications after many hours of sampling over a period of five years. The frame is made from one piece of channel iron ¾ inch by ⅜ inch by ⅛ inch and 14 feet long and weighs approximately 8¾ pounds. Aluminum channel will reduce the weight. The two "A" frames which form the legs are made separately to facilitate storage and transportation and are fastened to the uprights with bolts and wing-nuts. A second set of longer legs is useful for sampling tall vegetation.

The uprights and pins are shown in a vertical position in Figure 1; however, they may be used at any angle to the soil surface by removing the lower bolt. Holes in the legs allow two positions on a permanent basis or tension with the upper wing-nuts and lock washers will hold the uprights at other desired angles. All joints in the frame are brazed except those shown with the four bolts. Iron frames should be painted to prevent rusting and aluminum to prevent sun glare and rubbing-off of the metal during handling.

The pins are made from stock of carbon-tested drill rod which is available in 36-inch lengths. We use pins of 3/32-inch diameter that have been sharpened to a needle point with a bevel that is at least ½ inch long. Otherwise, the shank of the pin will touch and move a nearly vertical plant part before the point will make contact. The ring at the top of the pin is simply a handle. The pins are easily bent so considerable care is required with them. However, we prefer this size to larger diameter pins because the larger the diameter the more difficult to obtain hits by the pin point before the pin disturbs the plants. A map tube makes a convenient carrying case for the pins.

The brake assembly around the pin at the lower crossbar holds the pin in any desired position. The metal holder is cut from a number 10 can and is 1¼ by 3½ inches. The edges are folded around small oak blocks. The brake shoes are soft leather which are fastened to the wooden blocks with waterproof glue. A rubber band around the entire brake provides the necessary tension on the pin. A thin coat of oil on the pins about twice daily maintains a smooth brake action and at the same time prevents rust.

The brake has many advantages. It holds the pin from falling out of the frame when the apparatus is moved between plots or from falling through the frame and damaging the sharp points. The pins are not removed between plot locations. If a hit is questionable or if the species needs close scrutiny for identification, the pin will remain in

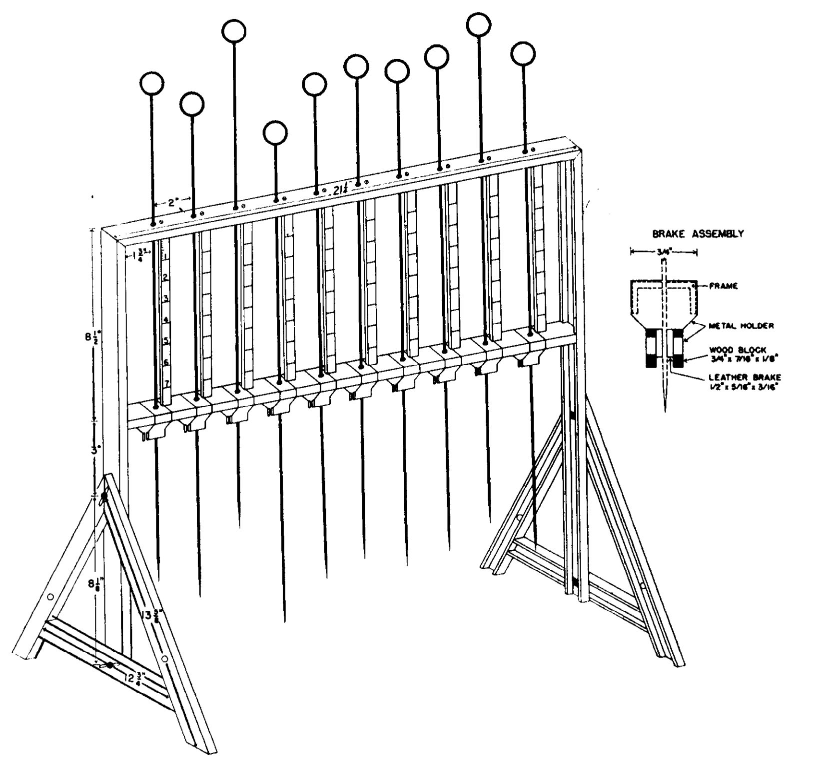


FIGURE 1. Diagram of the point-frame with details of the brake assembly. The brake holds the pin at any height and yet allows smooth action when the pin is lowered through the vegetation.

place while the investigator takes a close look. The brake lends considerable support to the pin, thus reducing side movements as the point is pushed through the vegetation. In summary the brakes greatly facilitate the mechanics of sampling and thereby improve the yield of accurate data.

A ruler is located along-side each pin and between the horizontal members of the frame. We have used two types. One is made of oak with pieces of a discarded 100 foot tape fastened to the wood with screws. The wooden pieces are held in place with small screws through the frame. The other type is made from ⅜ inch x ⅛ inch aluminum on which the length scale is hand made. The ends of the aluminum bars are bent to a right angle which allows the pieces to be fastened to the frame with 1/16 inch by ½ inch bolts. The aluminum pieces are the most satisfactory because they are more solidly fastened than the wood and do not have the sharp edges of a steel tape. The scale shown in Figure 1 is in inches and tenths while that shown in Figure 2 is tenths and hundredths of a foot. The usual inch scale may be used but either of the

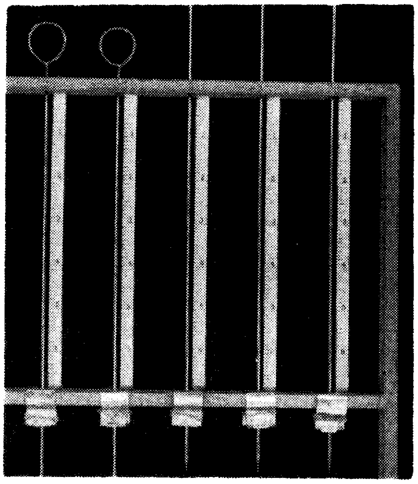


FIGURE 2. Photograph of the point-frame showing the rulers and the tapering, needle-pointed pins. The rulers permit measurement of height of the hits. Both the rulers and the brakes lend stability to the pin movement by reducing side action.

tenth scales is more manageable for recording in the field and for calculations.

The rulers serve two purposes. One is to measure the height of the hit above the soil surface. A discussion of this concept of height together with some representative data from the California annual type were presented earlier (Heady, 1957). The second advantage of the rulers is that they guide the fingers as the pins are pushed into the vegetation. Thereby, horizontal movement of the point is held to a minimum.

Every investigator in vegetational sampling has problems with equipment. These modifications of the point frame have made possible rapid and easy sampling of foliage cover, ground cover, and height of plant materials in the short, thick, cover of the California annual type. Others may find the modifications useful wherever the point system of sampling is employed.

LITERATURE CITED

GOODALL, D. W. 1952. Some considerations in the use of point quadrats for the analysis of vegetation. Aust. Jour. Sci., Res. Bull. 5. 41 pp.

HEADY, H. F. 1957. The measurement and value of plant height in the study of herbaceous vegetation. Ecology 38: 313-320.

KEMP, C. D. AND A. W. KEMP. 1956. The analysis of point quadrat data. Aust. Jour. Bot. 4: 168-174.

LEVY, E. B. 1933. Technique employed in grassland research in New Zealand. Imp. Bur. Plant Genet. Herb. Plants Bull. 11: 6-16.

WHITMAN, W. C. AND E. I. SIGGEIRSSON. 1954. Comparison of line interception and point contact methods in the analysis of mixed grass range vegetation. Ecology 35: 431-436.

Summer Meeting Scheduled!

The Pacific Northwest Section has invited the American Society of Range Management to its Summer Field Meeting at Kamloops, British, Columbia, July 11-12, 1958. Society members and friends should make their plans now to attend this meeting. The summer meeting of the Board of Directors of the Society will be held at Kamloops on July 10.

BOOK REVIEWS

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

The Underground Organs of Herbage Grasses. By Arthur Troughton. *Commonwealth Bureau of Pastures and Field Crops, Hurley, Berkshire, England. 163 pages. 1957. $3.50.*

Mr. Troughton's book is another excellent contribution in the Commonwealth Agricultural Bureaux Series. It blends simplicity with technicality, practicality with theory, and basic botany with applied plant sciences. It could well be the textbook in a "grass roots" course for the undergraduate student of botany and is an essential reference source for the mature investigator. It is an excellent example of straight-forward reporting.

The book consists of 4 parts—(1) Description of Underground Organs, (2) Factors Influencing Growth, (3) The Effect of the Plant upon the Soil, and (4) Methods Employed in the Study of Underground Organs. The underground organs of herbage grasses are described morphologically, anatomically and ontogenetically; growth and development are treated; distribution of roots in the soil is covered; genetic variations are recorded; the physiology of the plant that bears upon the carbohydrate and protein content, and upon the mineral nutrition, of the underground parts receives attention; and the exudates from roots that have been reported, as well as their effects, are critically considered.

The section entitled "Factors Influencing Growth" is essentially physiological ecology. Whether interested in the purest aspects of his discipline or concerned with applying the basic facts of root ecology to agricultural or to range management practices, the ecologist will find a wealth of sound information in the section of this book (about one-third of its contents) devoted to the factors that influence the growth of the underground organs of the herbage grasses. Factors considered include soil temperature, pH, light received by the shoot, defoliation of the plant, root pruning, mineral nutrition, and the interactions of plants growing together. The reports of research basic to a proper evaluation of competition, stratification, plant succession, and site improvement in communities of which grasses are a part are especially significant for the field ecologist or range manager.

The effect of the plant upon the soil is considered in three categories, (1) soil organic matter, (2) structure, and (3) soil erosion. Each of these subjects is treated comprehensively insofar as reporting the results of pertinent investigations, but it is a matter of regret to this reviewer that the effect of herbage grasses upon the soil is compared almost exclusively to that of other cultivated plants or to conditions prevailing on arable lands without vegetation. Some coverage of the literature on roots of plants in natural communities would have made comparative information available to both the agriculturist and the student of natural pastures and rangeland.

The student of underground plant organs wants the desired but difficult direct observation of growth, development, and distribution, but often settles for some practical method of indirect measurement and location of the organs under study. Troughton's review and synopsis of methods of studying underground organs in their natural conditions and positions run the gamut from King's (1892, 1893) isolation and washing of soil prisms to the modern use of radio-active tracer materials. No one seriously concerned with root ecology should fail to read this terse yet comprehensive section of Troughton's book.

There is an appendix consisting of a seven-page table that summarizes on a world-wide basis the known weights of roots (lbs. of dry material per acre) produced by swards. Maximum, minimum, and mean weights per species per location are given, as well as age of sward, type of management, depth of measurement, and authority for the determination. This may prove to be valuable information for ecologists, if translatable into productivity values that can be used for comparisons with other plant communities.

The bibliography contains 692 references pertinent to the subject. This alone justifies the book, for the articles cited are truly cosmopolitan. The index includes page references to 71 genera and 156 species of grasses. The typography and binding are of excellent quality. The book is notably inexpensive by American standards. It has a place in the library of all serious students of the basic problems of grassland and pasture ecology. The specialist in root ecology cannot be without it.—*John F. Reed,* University of New Hampshire, Durham, New Hampshire.

America's Natural Resources. Edited by Charles H. Callison. *The Ronald Press Company, New York. 211 pages. 1957. $3.75.*

As this volume is being reviewed (July, 1957) word came in concerning some embattled pioneers along the Colorado. Their pioneering was possible because upstream dams, built at public expense, had controlled the floods on the lower river. To get the products of floodplain cultivation to market they bridged the shallow river, with private capital and private initiative, for private gain. And now they are in trouble *because the motor boat enthusiasts of that area can't squeeze under their bridge.* There could be no clearer commentary on the complexity of interest, pressure and power in the contemporary use of our natural resources.

The present volume is intended to bring the average voter up to date on the conservation of renewable resources. It is sponsored by the Natural Resources Council of America and edited by an official of the

National Wildlife Federation; the eleven chapters are, with their authors: Conservation: An Ecological Approach—Shirley W. Allen; Renewable Resources and Human Populations — Fairfield Osborn; Soil — Firman E. Bear; Water—H. G. Wilm; Grasslands—David F. Costello; Forests — Henry Clepper and Lowell Besley; Wildlife—Joseph J. Shomon; Fish—Albert S. Hazzard and William Voigt, Jr.; Parks and Wilderness — Howard Zahniser; Land Use Principles and Needs — Edward H. Graham; Needed A Natural Resources Policy—Ira N. Gabrielson.

Books-of-many-authors, no matter how competent the various authors may be, suffer from the perennial handicaps of repetition, poverty of example, superficiality and uneven coverage. To the specialist these stand out, lowering his opinion of the volume's usefulness. But this is not a book for the specialist. According to the jacket statement, "This is a book that will be valuable to readers in many situations—to the voter, the farmer, the teacher, the legislator, the leader of public opinion." The average intelligent voter will learn a great deal by studying its pages. He would learn more, perhaps, if he didn't have to read between the lines so often. For example, it is an undoubted fact that many an acre of grassland is overgrazed. Some of the worst abuse is found on those lands where the grazing rights are let on a system of competitive bidding. The low bidder must make his proft and he often leaves the range in worse condition than he found it. This simple and practically universal fact should be of real concern to the intelligent voter, since many State lands are let on this basis. Dr. Costello covers some of this ground as follows: "On Indian Service lands, permission to graze is granted by tribal councils or by families. Leases to outsiders are granted through competitive bidding. State-owned lands are generally leased to private operators, and little control is exercised over use of the land . . . lands which have reverted to counties through tax delinquency are usually leased to the highest bidder without restriction as to grazing use." These statements are, of course, quite true, but this reviewer feels that while they spell mismanagement to a technician, the reader for whom this book was intended will have to be *told* that they spell mismanagement, and why, or he will never grasp the situation. As in this example, there are many messages in the volume which will slip by the average citizen because they are to be found between the lines.

In a few places the necessary brevity of the treatment leads to statements which are apparently misleading. For example, Mr. Shomon, in discussing the characteristics of the ideal State Fish and Game Department says (p. 126)), "Good departments with well-rounded programs usually exhibit the following structural characteristics: Freedom from pressures, political or otherwise—etc." Actually, the almost universal commission system, found in many good State Fish and Game Departments, is a mechanism for translating public opinion into administrative policy. Public opinion is a political pressure. It is impossible to conceive of a State Department, no matter how good, free from pressure, when it is pressure which shapes policy. This is a matter of concern to the voting citizen. He should be informed of his real opportunity to influence wildlife affairs.

In general, this book is a lucid presentation of a complex subject. It will fulfill its purpose admirably up to a point—the point of action. The average citizen for whom it is intended should be fired up to do something constructive. He will find little guidance here on how to go about it. Most people have no idea of how they may, as voters, influence local and national policy on the use of renewable resources. Perhaps in another edition the authors could give some pointers on the proper function of an informed public in the conservation field. It would be a logical extension of the present useful volume.—*R. D. Taber,* Montana State University, Missoula, Montana.

Grassland Seeds. W. A. Wheeler and D. D. Hill. *D. Van Nostrand Company, Inc., New York. 734 pages. 1957. $12.50.*

Occasionally someone produces an outstanding book that everyone in a given field must own in order to keep up to date. In the grass field, such a book is D. Van Nostrand's new volume — "Grassland Seeds" by Wheeler and Hill.

Senior author, W. A. Wheeler, is the dean of American grass seedsmen, having spent well over half a century in helping develop and strengthen the U. S. seed business.

D. D. Hill, head of the Farm Crops Department, Oregon State College, is a foremost western seed production authority.

Twelve dollars and fifty cents is a big price for a book, but for this new grass seed encyclopedia it is remarkably little.

Wheeler and Hill collaborated with many other leading grass and legume seed authorities who either have contributed special chapters or provided the authors with important foundation material. Years of profound investigation have been required to assemble the informative facts given in this 734-page volume which is illustrated with over 200 excellent photographs, sketches, and diagrams. All phases of the seed business are treated.

Numerous detailed chapters are set forth in three main parts as follows:

Part I—Grassland Seeds—The Key to a Permanent Agriculture. Seed Formation and Germination. Good Stands for Good Seed. Testing Field Seeds. Insect Pollination of Legumes. Insects Injurious to Field Seeds. Disease Problems in Field Seed Production and Distribution. Treatment of Field Seeds for Disease Control. Legume Seed Innoculation. Seed Production of Grassland Crops. Harvesting and Threshing Forage Seeds. Processing Field Seeds. Drying and Storing Field Seeds. Certification of Field Seeds and Foundation Seed Program. Marketing Field Seeds. International Trade in Field Seeds. Estimating Field Seeds Crops. Evolution of the Field Seed Industry.

Part II — Alfalfa. True Clovers. Soybeans, Cowpeas and Velvetbeans. Southern Legumes. Sweetclovers, Vetches, Trefoils and Field Peas. Timothy, Orchardgrass, Smooth Bromegrass, Tall Fescue, and Meadow Fescue. Other Northern Grasses. Wheatgrasses and Wildrye. Western Grasses. Southern Grasses, Great Plains Grasses. Sorghums, Sudangrass, Johnsongrass, and Millets.

Part III includes a glossary of terms, significant grass seed statistics, and other important facts pertaining to the history and operation of the grass seed industry.

This work is truly a great contribution to American agriculture and will be welcomed by all engaged in the grass trade. It is a triumphant scientific accomplishment in a specialized phase of grass and forage culture that has been poorly understood by scientists and laymen. It is a singular contribution to grassland literature, as nothing like it before has been available.

The authors have drawn their subject matter from the latest scientific knowledge available and have presented an amazing mass of facts in pleasant readable narrative that will appeal to seedsmen, researchers, producers, teachers, and students.

The seed trade is a composite of many integrated sciences and enterprises, several of which are highly specialized industries combining the specialties of research, production, and merchandising. To give thorough coverage to their broad thesis, Wheeler and Hill have included eleven chapters by such authorities as:

1. C. J. Willard—"Good Stands from Good Seed"
2. Frank E. Todd—"Insect Pollination of Legumes"
3. Arlo M. Vance—"Insects Injurious to Forage Seeds"
4. John R. Hardison—"Disease Problems in Forage Seed Production and Distribution"
5. K. W. Kreitlow—"Treatment of Forage Seeds for Disease Control"
6. L. W. Erdman—"Legume Seeds Innoculation"
7. Albert M. Mangelsdorf, James Henderson, and G. Burns Welch —"Processing Field Seeds"
8. J. W. Simons—"Drying and Storing Field Seeds"
9. Wilbur H. Youngman—"International Trade in Field Seeds"
10. George C. Elder—"Estimating Field Seed Crops"
11. John J. Martin—"Sorghums, Broomcorn, Sudangrass, Johnsongrass, and Millets"

B. W. Allred, Soil Conservation Service, Washington, D. C.

Meditations of a Forester. By Elmer Shaw. *Shaw-Craft Creations, Ft. Collins, Colorado. 1957. 48 pages. Paperbound, $1, clothbound, $2.*

Book review editors like books; otherwise they would not want their jobs. However, there is a great difference in books. New ones inevitably arouse curiosity, but not all of them under close scrutiny leave one with the same pleasurable feeling. "Meditations of a Forester," however, provides the reader with a rare combination of verse, prose and drawings. Neither should one overlook the sprinkling of humor.

Mr. Shaw gathers his original creations, previously published in a number of periodicals and papers, into one volume that will be cherished by readers interested in the outdoors and the pathos, humor and deep insights into a man's soul which this close association with nature brings. The contents are grouped into five categories entitled: Meditations of a Forester; Tomorrow's Dream; Life unto the Stars; Songs from Within; and Spice is Nice.

The general interest of this volume is easily represented by some quotations from Part I. Page 17 includes a short poem entitled "Unfolding Wings" that questions how wild birds could foretell their long flights, and a comparable one for humans—"Are we different—you and I? How far timeward can we fly Into the dawn's eternal sky?" (Seems almost prophetic in view of man's recent developments in conquering space.) This poem is followed by two quips: "Let there be questions; the mind punctuated with periods is slow to progress."; and "Young Researcher: 'Resource management begins in the minds of men.' Old Rancher: 'Yes, but don't let it end there'!"

This volume is heartily recommended for readers who may have only a few odd moments at their disposal, yet want to enjoy them fully. —*D. W. Hedrick,* Oregon State College, Corvallis, Oregon.

On December 10-12, 1956, the Technical Committee for Regional Project W-25, Ecology and Improvement of Brush Infested Lands, met at the University of Wyoming, Laramie. Over 30 specialists attended the meeting. Shown here is part of the group examining a stand of black sagebrush *(Artemisia nova)* on the plains near Laramie. Left to right are K. J. DIEM, Wyoming; L. A. STODDART, Utah; K. A. VALENTINE, New Mexico; A. M. SCHULTZ, California; GENE PAYNE, Montana; E. W. TISDALE, Idaho; A. A. BEETLE, Wyoming; C. E. POULTON, Oregon; R. R. HUMPHREY, Arizona; and J. H. ROBERTSON, Nevada.

CURRENT LITERATURE

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

RANGE PLANTS

Forage value, chemical composition, ecology, physiology, systematics, genetics

Coats, R. E. Coastal Bermuda grass in Mississippi. *Miss. Agr. Exp. Sta. Bul. 549. 10 pp. Mar. 1957.* (Miss. Agr. Exp. Sta., State College)

Craigmiles, J. P. and J. M. Elrod. Browntop millet in Georgia *(Panicum fasciculatum). Ga. Agr. Exp. Sta. Leaflet. 4 pp. Apr. 1957.* (Ga. Agr. Exp. Sta., Athens)

Dudley, D. I. Performance of summer hay and grazing crops, Denton, 1954-56. *Tex. Agr. Exp. Sta. Prog. Rpt. 1943. 4 pp. Apr. 1957.* (Texas Agr. Exp. Sta., College Station)

Hady, F. T. and S. A. Engene. Distribution of grasslands in Minnesota. *Minn. Agr. Exp. Sta. Bul. 439. 27 pp. Mar. 1957.* (Minn. Agr. Exp. Sta., Univ. Farm, St. Paul)

Hosaka, Edward Y. Trefoils in Hawaii. *Univ. of Hawaii Ext. Circ. 367. 10 pp. Feb. 1957.* (Univ. of Hawaii, Honolulu)

Hosaka, Edward Y. Palatability and nutritive value of forages. *Univ. of Hawaii Ext. Circ. 381. 6 pp. Sept. 1957.* (Univ. of Hawaii, Honolulu)

Hunt, H. F. and R. L. Lang. Forage-volume changes in Wyoming's Red Desert. *Wyo. Agr. Exp. Sta. Bul. 346. 18 pp. Jan. 1957.* (Wyo. Agr. Exp. Sta., Laramie)

Offutt, M. S. and J. D. Baldridge. Inoculation studies related to breeding for resistance to bacterial wilt (*Xanthomonas lespedezae*) in lespedeza. *Mo. Agr. Exp. Sta. Res. Bul. 603. 47 pp. March 1956.* (Mo. Agr. Exp. Sta., Columbia)

Phillips Petroleum Company. Poisonous grassland plants, section 4 of a series; pasture and range plants. *25 pp. Dec. 1957.* (Phillips Petroleum Co., Bartlesville, Okla.)

Schwartzbeck, R. A. Legume tests in the Winter Garden area, 1956-57. *Tex. Agr. Exp. Sta. Prog. Rpt. 1950. 4 pp. Apr. 1957.* (Tex. Agr. Exp. Sta., College Station)

Staten, R. D. Alfalfa production in Texas. *Tex. Agr. Exp. Sta. Bul. 855. 24 pp. Apr. 1957.* (Texas Agr. Exp. Sta., College Station)

Wallace, A. T. Hairy indigo, a summer legume for Florida. *Fla. Agr. Exp. Sta. Circ. S-98. 7 pp. June 1957.* (Fla. Agr. Exp. Sta. Gainesville)

Washington Agricultural Experiment Stations. Performance of grass and legume varieties in Washington, 1956. *Wash. Agr. Exp. Sta. Circ. 267. Rev. 27 pp. May 1957.* (Wash. Agr. Exp. Sta., Pullman)

RANGE AND PASTURE MANAGEMENT

Management plans, utilization, condition, maintenance

Albee, Leslie R. Grass and cattle in balance. *Soil Conservation 23(4): 83-85. Nov. 1957.* (S. C. S., Rapid City, S. Dak.)

Johnson, J. R. Georgia grazing system and feed production program. *Better Crops with Plant Food 41(7): 26-28. Aug.-Sept. 1957.* (Univ. Ga., Athens)

Joint Committee on Grassland Farming. Grassland — Livestock Handbook. Rev. Ed. *48 pp. Nov. 1957.* (Am. Petroleum Inst., 50 West 50th St., New York 10)

Marshall, S. P. Value of oat pasture for dairy cattle. *Fla. Agr. Exp. Sta. Bul. 584. 20 pp. Apr. 1957.* (Fla. Agr. Exp. Sta., Gainesville)

Neal, E. M., R. A. Hall and J. H. Jones. Feed and grazing management in farm slaughter heifer production. *Tex. Agr. Exp. Sta. Prog. Rpt. 1965. 3 pp. June 1957.* (Texas Agr. Exp. Sta., College Station)

RANGE IMPROVEMENT

Artificial revegetation, noxious plant control, mechanical improvements, fertilization

Brown, B. A. and R. I. Munsell. Clovers in permanent grassland as influenced by fertilization. *Conn. Agr. Exp. Sta. Bul. 329. 35 pp. Oct. 1956.* (Conn. (Storrs) Agr. Exp. Sta., Storrs)

Downs, J. A. Management is key to range seeding. *N. Mex. Extension News 37 (11) 6-7. Nov. 1957.* (S.C.S., Albuquerque)

Green, Lisle R. and Jay R. Bentley. Seeding and grazing trials of *Stipa* on foothill ranges. *Calif. For. & Range Exp. Sta. Res. Note 128. 9 pp. Sept. 1957.* (Calif. For. & Range Exp. Sta., Univ. of Calif., Berkeley)

Kay, B. L., J. E. Street and C. W. Rimbey. Nitrogen carryover on range. *Calif. Agr. 11 (10): 5, 10. Oct. 1957.* (Univ. of Calif., Davis)

Leonard, O. A. Effect of phenoxy herbicide concentrates applied to cuts of sprouting tree species. *Weeds 5 (4): 291-303. Oct. 1957.* (Univ. Calif., Davis)

Peterson, K. R. and C. S. Walters. Report on project 301-C; preservative treatment of fence posts with toxic oil solutions by cold-soaking, dipping, and brushing. *Ill. Agr. Exp. Sta. Forestry Note 73. 4 pp. Mar. 1957.* (Ill. Agr. Exp. Sta., Urbana)

Reynolds, H. G. and F. H. Tschirley. Mesquite control on Southwestern rangeland. *U. S. Dept. Agr. Leaflet 421. 8 pp. Oct. 1957.* (Rocky Mtn. For. & Range Exp. Sta., Ariz. State College, Tempe)

Terwilliger, Charles, Jr., and Joseph E. Jensen. Analysis of range reseeding results, Springfield land utilization project, Baca County, Colorado. *Colo. Agr. Exp. Sta. Gen. Series Paper 666. 16 pp.* (Colo. Agr. Exp. Sta., Fort Collins)

Walters, C. S. and K. R. Peterson. Report on project 301-A; preservative treatment of fence posts by cold-soaking in pentachlorophenol-fuel-oil solutions. *Ill. Agr. Exp. Sta. Forestry Note 70. 4 pp. Feb. 1957.* (Ill. Agr. Exp. Sta., Urbana)

Wiese, A. F. and H. E. Rea. Control of heavy stands of Johnsongrass on dryland areas of the high plains. *Tex. Agr. Exp. Sta. Prog. Rpt. 1955. 2 pp. May 1957.* (Texas Agr. Exp. Sta., College Station)

RANGE LIVESTOCK MANAGEMENT

Production, feeding, pests and diseases, history

Baird, D. M. and O. E. Sell. Oral and implanted stilbestrol for growing-fattening beef cattle on winter pasture and in dry lot. *Ga. Agr. Exp. Sta. Mimeo. Ser. (n. s.) 32. 18 pp. Jan. 1957.* (Ga. Agr. Exp. Sta., Athens)

Berry, W. T., H. O. Kunkel and J. K. Riggs. Variations in voluntary consumption of a urea-molasses mixture by mature, pregnant and lactating Brahman cows self-fed Johnsongrass hay or cottonseed hulls. *Tex. Agr. Exp. Sta. Prog. Rpt. 1956. 4 pp. June 1957.* (Texas Agr. Exp. Sta., College Station)

Chapman, H. L. and R. M. Hooker. Aureomycin and stilbestrol for cattle fattened on pasture. *Fla. Everglades Exp. Sta. Mimeo. Rpt. 57-8. 3 pp. Mar. 1957.* (Fla. Everglades Exp. Sta., Belle Glade)

Cox, R. F. and T. D. Bell. Feeding range lambs in Kansas. *Kans. Agr. Exp. Sta. Bul. 387. 56 pp. Mar. 1957.* (Kans. Agr. Sta., Manhattan)

Cox, R. F., T. Donald Bell and H. E. Reed. Sheep production in Kansas. *Kans. Agr. Exp. Sta. Bul. 348. 62 pp. Rev. June 1957.* (Kans. Agr. Exp. Sta., Manhattan)

Cowan, R. L., E. Keck and R. W. Swift. Observations on dry matter losses from a covered and uncovered trench silo. *Pa. Agr. Exp. Sta. Prog. Rpt. 150. 7 pp. May 1956.* (Pa. Agr. Exp. Sta., University Park)

Crenshaw, W. W., G. W. Pipes, H. L. Ruppert and C. W. Turner. Indications of normal pituitary and thyroid function in dwarf beef animals. *Mo. Agr. Exp. Sta. Res. Bul. 621. 24 pp. Feb. 1957.* (Mo. Agr. Exp. Sta., Columbia)

Dollahite, J. W. and W. V. Anthony. Malnutrition in cattle on an unbalanced diet of mesquite beans. *Cattleman 44 (5): 30-31, 48, 52. Oct. 1957.* (Texas Agr. Exp. Sta., College Station)

Erwin, E. S., C. B. Roubicek, L. Rosenblatt and F. Prichard. Tallow, barley and stilbestrol for steers fed green-chopped alfalfa. *Ariz. Agr. Exp. Sta. Rpt. 156. 14 pp. June 1957.* (Ariz. Agr. Exp. Sta., Tucson)

Kercher, C. J., N. W. Histon, P. O. Stratton and L. C. Parker. Animal tallow as a part of the winter ration for sheep. *Wyo. Agr. Exp. Sta. Mimeo. Circ. 68. 8 pp. Feb. 1956.* (Wyo. Agr. Exp. Sta., Laramie)

Loeffel, Wm. J. Grain sorghum as feeds for beef cattle and hogs. *Nebr. Agr. Exp. Sta. Bul. 439. 35 pp. Aug. 1957.* (Nebr. Agr. Exp. Sta., Lincoln)

Marion, P. T., C. E. Fisher and E. D. Robinson. Ground mesquite wood as a roughage in rations for yearling steers. *Cattleman 44 (6): 34-38. Nov. 1957.* (Texas Agr. Exp. Sta., Spur)

Marion, P. T., C. E. Fisher and J. H. Jones. Stilbestrol and antibiotics in rations for yearling steers. *Tex. Agr. Exp. Sta. Prog. Rpt. 1952. 4 pp. Apr. 1957.* (Texas Agr. Exp. Sta., College Station)

Neel, W. W. Results of a test with systemic animal insecticide for the control of cattle grubs. *Miss. Agr. Exp. Sta. Inform. Sheet 566. 2 pp. June 1957.* (Miss. Agr. Exp. Sta., State College)

Peacock, F. M., W. G. Kirk and M. Koger. Factors affecting the weaning weight of range calves. *Fla. Agr. Exp. Sta. Bul. 578. 12 pp. Oct. 1956.* (Fla. Agr. Exp. Sta., Gainesville)

Shelton, M., T. C. Cartwright and W. T. Hardy. Relationships between performance-tested bulls and the performance of their offspring. *Tex. Agr. Exp. Sta. Prog. Rpt. 1958. 3 pp. May 1957.* (Texas Agr. Exp. Sta., College Station)

RANGE AND LIVESTOCK ECONOMICS

Land utilization and administration, production costs, marketing, ranch organization

Anthony, W. B., J. K. Boseck, R. R. Harris, P. F. Parks, E. M. Evans and H. W. Grimes. From beef calf to fat steer in ten months on oat grazing and dry lot feeding. *Ala. Agr. Exp. Sta. Prog. Rpt. Ser. 67.* 4 pp. June 1957. (Ala. Agr. Exp. Sta., Auburn)

Branson, R. E. The consumer market for beef. *Tex. Agr. Exp. Sta. Bul. 856. 27 pp. Apr. 1957.* (Texas Agr. Exp. Sta., College Station)

Lafferty, D. G. Production items, costs, and returns for winter oats on livestock farms in the Arkansas Ozark area. *Ark. Agr. Exp. Sta. Rpt. Ser. 66. 13 pp. May 1957.* (Ark. Agr. Exp. Sta., Fayetteville)

Livesay, E. A. and C. J. Cunningham. Native Hampshire type ewes *vs* western Corriedale type ewes for (a) lamb and wool production; (b) longevity. *W. Va. Agr. Exp. Sta. Bul. 398. 13 pp. Apr. 1957.* (W. Va. Agr. Exp. Sta., Morgantown)

Myers, K. H. An economic appraisal of green chop feeding. *Pa. Agr. Exp. Sta. Prog. Rpt. 170. 8 pp. Apr. 1957.* (Pa. Agr. Exp. Sta., State College)

Plaxico, J. S. and J. L. James. Beef cattle; seasonal price movements and price differentials, Oklahoma City Market. *Okla. Agr. Exp. Sta. Bul. B-486. 30 pp. Feb. 1957.* (Okla. Agr. Exp. Sta., Stillwater)

Rhodes, F. J., E. R. Kiehl, N. B. Wilson, D. E. Brady, and E. B. Birmingham. Consumer preferences and beef grades; theoretical basis and empirical study, development and testing of a model. *Mo. Agr. Exp. Sta. Res. Bul. 612. 46 pp. Sept. 1956.* (Mo. Agr. Exp. Sta., Columbia)

Stubblefield, T. M. Evaluation of livestock market news in Arizona. *Ariz. Agr. Exp. Sta. Rpt. 153. 7 pp. Apr. 1957.* (Ariz. Agr. Exp. Sta., Tucson)

Tieken, A. W. and J. G. McNeely. Marketing Texas goats. *Tex. Agr. Exp. Sta. Bul. 844. 15 pp. Dec. 1956.* (Tex. Agr. Exp. Sta., College Station)

RANGE EDUCATION AND RESEARCH

Bibliographies, methods, equipment

Blincoe, C. Environmental physiology and shelter engineering with special reference to domestic animals. 40. Design and testing of a hair measurement beta-gauge. *Mo. Agr. Exp. Sta. Res. Bul. 616. 20 pp. Oct. 1956.* (Mo. Agr. Exp. Sta., Columbia)

Dale, H. E., G. J. Burge and S. Brody. Environmental physiology and shelter engineering with special reference to domestic animals. 39. Environmental temperature and blood volume. *Mo. Agr. Exp. Sta. Res. Bul. 608, 20 pp. July 1956.* (Mo. Agr. Exp. Sta., Columbia)

Fisher, D. A., J. J. Kolega and W. C. Wheeler. An evaluation of the energy required to cut forage grasses and legumes. *Conn. (Storrs) Agr. Exp. Sta. Prog. Rpt. 17. 12 pp. Jan. 1957.* (Conn. (Storrs) Agr. Exp. Sta., Storrs)

Kibler, H. H. and S. Brody. Environmental physiology shelter engineering with special reference to domestic animals. 38. Influence of diurnal temperature cycles on heat production and cardiorespiratory activities in Holstein and Jersey cows. *Mo. Agr. Exp. Sta. Res. Bul. 601. 28 pp. Feb. 1956.* (Mo. Agr. Exp. Sta., Columbia)

Roubicek, C. B., R. T. Clark and O. F. Pahnish. Range cattle production. 6. Maternal factors; a literature review. *Ariz. Agr. Exp. Sta. Rpt. 146. 49 pp. Jan. 1957.* (Ariz. Agr. Exp. Sta., Tucson)

Roubicek, C. B., R. T. Clark and O. F. Pahnish. Range cattle production; a literature review. 7. Genetics of cattle. *Ariz. Agr. Exp. Sta. Rpt. 149. 31. Mar. 1957.* (Ariz. Agr. Exp. Sta., Tucson)

Roubicek, C. B., R. T. Clark and O. F. Pahnish. Range cattle production; a literature review. 8. Effects of climatic environment. *Ariz. Agr. Exp. Sta. Rpt. 154. 20 pp. Apr. 1957.* (Ariz. Agr. Exp. Sta., Tucson)

VanKeuren, R. W. and H. L. Ahlgren. A statistical study of several methods used in determining the botanical composition of a sward: I. A study of established pastures. *Agron. Jour. 49 (10): 532-536. Oct. 1957.* (Irrigation Exp. Sta., Prosser, Wash.)

Wallace, A. T., G. B. Killinger, R. W. Bledsoe and D. B. Duncan. Design, analysis and results of an experiment on response of Pangolagrass *(Digitaria decumbens)* and Pensacola Bahiagrass *(Paspalum notatum)* to time, rate and source of nitrogen. *Fla. Agr. Exp. Sta. Bul. 581. 30 pp. Feb. 1957.* (Fla. Agr. Exp. Sta., Gainesville)

Yeck, R. G. and H. H. Kibler. Environmental physiology and shelter engineering, with special reference to domestic animals. 37. Moisture vaporization by Jersey and Holstein cows during diurnal temperature cycles as measured with a hygrometric tent. *Mo. Agr. Exp. Sta. Res. Bul. 600. 18 pp. Feb. 1956.* (Mo. Agr. Exp. Sta., Columbia)

CURRENT LITERATURE EDITORS

The March edition of Current Literature is the final contribution to this section prepared by G. W. TOMANEK and JOHN LAUNCHBAUGH. The special thanks of the Editor are extended to these men for their fine efforts in the preparation of the material for this section of the Journal. LEE A. SHARP, University of Idaho, Moscow, Idaho, will take over as Current Literature editor.

RANGE WOMEN

Two of the fairer sex were listed as charter members in Volume I, Number 1, of the Journal of Range Management. These were Susie Abe (1:41) [1] and Ada Hayden (1:49). Unforunately neither would be present today. Susie Abe was responsible for a subscription for Washington State College and as such represents the host of librarians in the West through whose technical service most of the new range information is disseminated.

Ada Hayden was botanist at Iowa State College. She was particularly active as Secretary of the Grassland Research Foundation (3:161) and served for the American Society of Range Management on its National Grassland Area Committee (3:269) during 1950. That same year she attended the annual meeting of the Society in San Antonio, Texas. There should be more like her. Notice of her death appeared in the Journal of Range Management (4:197-198).

In 1953 the Arizona section (6: 452) was proud to ask "Can any other section boast a higher percentage of ranchers or two women members?" Perhaps we should wonder why there are not more? In the Journal (6: 5) it has been stated that "when we educate a woman we are apt to be educating a family." Most of the sections have had women members from time to time. Mrs. Jean Sears graduated from the University of Wyoming in 1956 with a major in range management.

The service of many women who were not actually Society members has been acknowledged frequently in the Journal, *e. g.* Mary Fulton, wife of a President, whose photos appeared (3:248, 249, 251 and 4:294, 295, 296, etc.); Imogene Campbell (now deceased, 7:191) who wrote book reviews (3:234, 5:275) and assisted editor Campbell in the publication of early volumes of the Journal; Helen Boyd, librarian (6:212) and book reviewer (5:37); Alice Marriott, whose book *"Hell on horses and women"* was reviewed in the Journal (6:354); Frances Bonner, laboratory technician (6:39, 7:41); and Mrs. J. L. Doherty, hostess (9: 246).

Special mention could be made of many other individual contributors to Society affairs: Margaret Heseman (now Mrs. Powell) and Victoria Field who helped to start the Wyoming Section Scholarship fund (6: 370); Mrs. Edith Clements about whom an article has appeared in the Journal (6:6); Katherine Esau whose book was reviewed by the Journal (6:436); and Mrs. Aven Nelson, for whom *Calhounia* (7: 218).

Perhaps a permanent committee of the American Society of Range Management could be formed, composed mainly or wholly of rangewomen, to present reports and recommendations on feminine affairs in the Society. — *A. A. Beetle, Society Historian.*

[1] *Volume: page references to the Journal of Range Management*

THE DEPOSITORY-LIBRARY

On July 29, 1952, the executive board of the Society approved the establishment of a Depository-Library at Utah State University. The objectives were stated to be as follows:

(1) To provide a safe and permanent place for the deposit of books, manuscripts, periodicals, published papers, reprints, valuable notes, photographs, theses, films, and microfilms.

(2) To provide the membership with a reference library for research or other work.

In the period that has elapsed since its establishment, the Depository-Library of the American Society of Range Management has developed to the extent that it now occupies 36 feet of 8-tier library shelving. Approximately 860 books or bound volumes and about 15 shelves of reprints are included.

Most of the material now held in the Depository has been donated by members of the Society. The Depository contains all the usual items found on library shelves including books, public documents, and periodicals. It is somewhat unique in the possession of many separate reprints of extremely interesting and valuable articles dealing with range management. These have been bound into an open series which currently consists of 46 volumes.

But like Topsy who just grew and the pasture that went wild, the Depository-Library has in certain respects grown in all directions. This would seem to be inevitable when donations and gifts are solicited from individuals of such diverse interests as are found among the members of the American Society of Range Management. The result has been the inclusion within the Depository-Library of titles that have only slight relationship to the field of range management. Vigorous screening is necessary.

Examples of material in the Depository-Library are the following:

(1) Books: *Plant Competition, Range and Pasture Management, Die Vegetation der Erde, Fresh Water from the Ocean, Sheep Shearing, Range Plant Handbook, U. S. D. A. Yearbook of Agriculture, Fruit Growing, Patent Office Reports 1859-1860, Federal Register-1886, U. S. Census Bureau Reports.*

(2) Periodicals: *Conservation, U. S. Fish and Wildlife Service Reports, Roosevelt Wildlife Bulletin, Journal American Society of Agronomy, Journal of Range Management, Journal of Forestry* (incomplete), *Soil Science* (incomplete), *Western Livestock Journal, Farm Journal, Ecology* (incomplete).

All periodicals that were not bound when donated to the Depository-Library have been bound in attractive green leatherette binding. The same binding is being used for the Range Reprint series.

Titles included in the Range Reprint series are illustrated by the following: *The Recovery of Vegetation at Kodiak, Wood Structure of Ryania, Can Bighead of Sheep be Prevented, Longevity of Pollen and Stigmas of Grasses, Small Refuges for Waterfowl, Nature and Structure of the Climax.* There should be something here for any element of our membership.

Very few theses have been sent to the Depository-Library. The University of Nevada has been most consistent in this respect. It is hoped that other schools will encourage graduate students of range management to prepare a copy of their theses for the Depository-Library.

At the inception of the Depository-Library, it was anticipated that it would become a center of information from which any member of the Society could request the loan of published works. To date there has been one request for assistance from the Depository-Library.

Photographs, slides, microfilm, maps and similar materials were to be deposited. No material of this nature has been deposited. No copies of the two most recent range management textbooks are in the library.

The nature of material that is being received by the Depository-Library may be discerned (in part) from the following list of titles that have been received since June of 1957: *Ethylene Dibromide Emulsion Spray for Control of the Mountain Pine Beetle in Lodgepole Pine, Crown Development: An Index to Stand Density, Intermountain Infiltrometer, Effects of Plowing and Seeding on some Forage Production and Hydrologic Characteristics of a Subalpine Range in Central Utah, Silvical Characteristics of Quaking Aspen, Weather Station Records not an Accurate Guide to Temperatures Lethal to the Shoot Moth, How Long does it take to Grow Pine Pulpwood or Sawtimber in North Carolina, Boletin Informativo, Farm Management, Journal American Society of Range Management, Western Browse Research, Veld XVII, Forage Production of Summer Ranges Following Application of 2,4-D to Kill Big Sagebrush (Artemisia tridentata)* (Thesis U. S. U.).

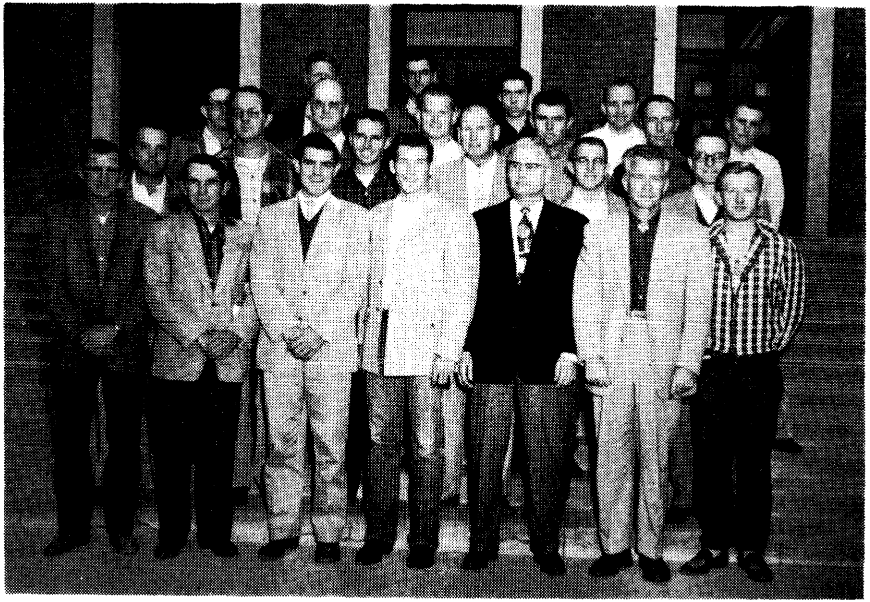
In order to achieve the objectives stated at the establishment of the Depository-Library, it is necessary that greater interest be shown by members of the Society, particularly in regard to the nature of materials being donated and to possibilities of using the resources that are now available. If the Depository-Library is to grow as a closely-knit unit, a policy as to what should and should not be included needs to be established. Irregular and incomplete runs of periodicals can become more bothersome than useful. Some thought should be given to maintenance of the periodicals.—*D. L. Goodwin, Utah State University.*

WITH THE SECTIONS

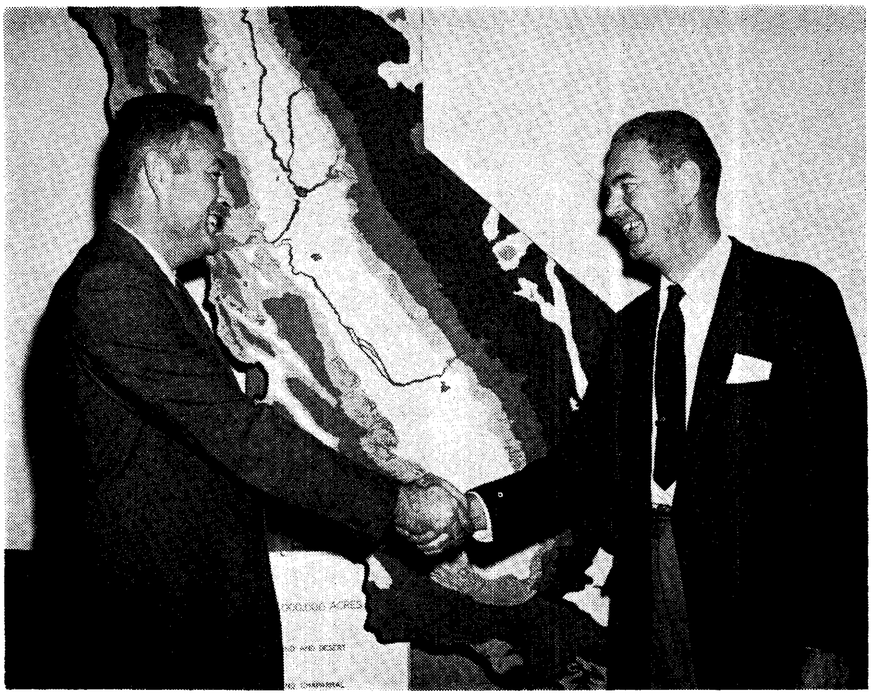
ARIZONA

Newly elected officers of the Arizona Section are:
Chairman: WAYNE KESSLER
Vice Chairman: D. K. WINGFIELD
Councilmen: MILTON SECHRIST and ROBERT V. BOYLE. Hold-over Councilmen include WILLIAM I. SCHROEDER and EARL E. HORRELL.
The 1958 officers were installed at a special Arizona Section breakfast at the time of the National meeting in Phoenix, January 30, 1958.

The University of Arizona Chapter of the Arizona Section was officially launched on January 15, 1958. There are 32 charter members of the student Chapter, and the Chapter expects to grow to around 50 members in the next few months. There are now 40 range management majors at the University. At the first Chapter meeting GEORGE GLENDENING, past Chairman of the Arizona Section, installed the officers and spoke on the history and purpose of the American Society of Range Management.—*Wayne Kessler*.



Pictured here are some of the charter members of the University of Arizona Chapter of the Arizona Section of the American Society of Range Management. First row, *left to right:* A. W. LEITHEAD, S. R. ALBERT, B. L. BRANSCOMB, T. O. WHEELER, A. G. NELSON, R. R. HUMPHREY, R. E. MOSES. *Second row:* W. WALLACE, C. W. FERGUSON, J. S. TIXIER, L. P. HAMILTON, B. POWERS, M. COTNER. *Third row:* K. MITCHELL, E. M. SCHMUTZ, D. R. KINCAID, R. E. YOUNT, J. BURRELL, J. K. SMALLHOUSE. *Back row:* D. D. JONES, C. R. YOUNG, C. BIRKEMEYER, V. P. OGUREK.



WAYNE E. BIEHLER *(left)*, past chairman of the California Section, congratulates the 1958 incoming chairman, R. MERTON LOVE.

CALIFORNIA

Officers of the California Section for 1958 are:

Chairman: R. MERTON LOVE
Vice Chairman: BILL DASMAN
Secretary-Treasurer: WALTER HOWARD
Councilmen: NORMAN J. FARRELL and CHARLES E. CARLSON are the newly elected members of the Council. LYLE GREEN and B. KAY are members of the Council retained for another year.

The annual meeting of the California Section was held at the University of California, Davis on December 20 and 21, 1957, with 112 people registering. Arrangements for the meeting were made by JAMES E. STREET. A total of 21 excellent papers, assembled by K. A. WAGNON, were given on range fertilization, soil vegetation surveys, snow management and other hydrologic research, control burning techniques to clear brush on rangelands, digestion trials with deer, measurements of forage production, reseeding, pelleting roughage for livestock, nutritional value of forage, saltbush seed treatments to improve germination, nutritional values of alfalfa hay as affected by cultural practices, molybdenum problem, deerbrush, Medusa-head control, and lupine poisoning and the wry-neck problem in range cattle. At the banquet R. MERTON LOVE gave an interesting talk on New Zealand, where he spent the past year on a Fulbright and sabbatical leave to study rangelands in that country.—*Walter E. Howard.*

COLORADO

New Colorado Section officers installed at the annual meeting of the Section are:

Chairman: A. C. EVERSON
Vice Chairman: R. J. GREFFENIUS
Secretary-Treasurer: DWIGHT SMITH
Councilmen: ROBERT SEARWAY and MELVIN COLEMAN.

The annual meeting of the Colorado Section was held at Glenwood Springs on November 23, 1957. Highlight of the afternoon business meeting and formal program was an illustrated lecture by MR. DEAN MAHAFFEY, appraiser, of Grand Junction. MR. MAHAFFEY reviewed the political and land-use history of the San Juan Basin area, particularly as it affected the Indians. Three-dimension color slides, concluding the lecture, were spectacular illustrations of the subject.—*Dwight R. Smith.*

NATIONAL CAPITOL

A luncheon meeting was held in the South Agricultural Building on January 14, 1958. Retiring chairman ROYALE K. PIERSON reported on last year's activities. The following new officers were installed for 1958.

Chairman: W. O. SHEPHERD, Forest Service, USDA.
First Vice Chairman: L. L. ROUX, South African Embassy
Second Vice Chairman: T. L. AYRES, Agricultural Conservation Program Service, USDA
Secretary-Treasurer: R. W. HARRIS, Forest Service, USDA
Councilmen: R. W. GRIFFITH, Fish and Wildlife Service, USDI; EVAN L. FLORY, Bureau of Indian Affairs, USDI; and M. A. HEIN, Agricultural Research Service, USDA.

Section membership totalled 78 as of January 15, 1958. — *Robert W. Harris.*

NORTHERN GREAT PLAINS

Officers of the Northern Great Plains Section for 1958 are:

Chairman: WALTER R. HOUSTON, Miles City, Montana
Vice Chairman: LLOYD R. GOOD, Dickinson, North Dakota
Secretary-Treasurer: STERLE E. DALE, Forsyth, Montana
Councilmen: SYLVESTER SMOLIAK, Manyberries, Alberta; FRED S. WILLSON, Bozeman, Montana; and MEL AASTON, Regina, Sask. Holdover Council members include M. D. BURDICK, Bozeman, and PETE HILL, Powderville, Montana.

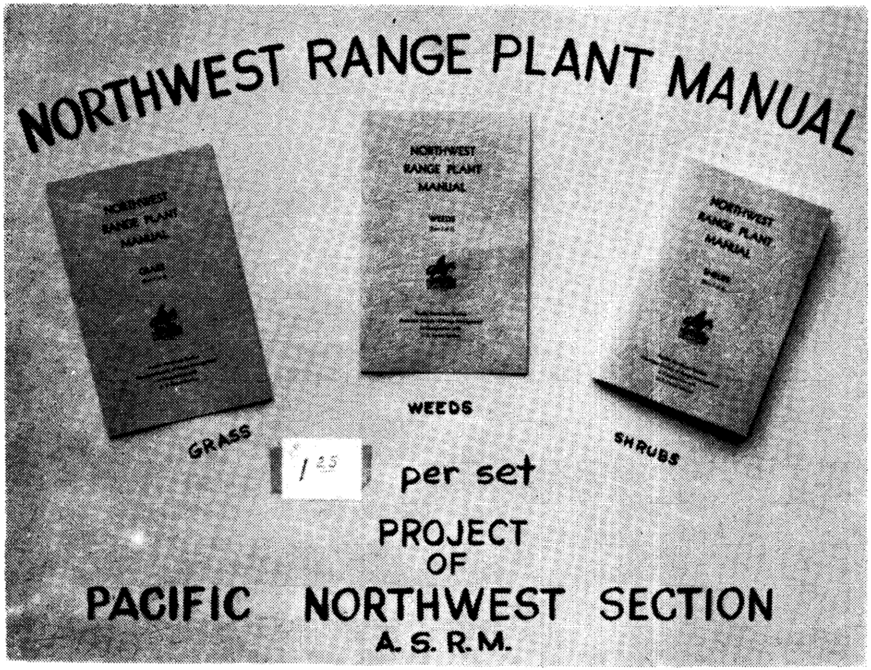
Total membership in the Section as of December 12, 1957, was 131, a gain of 26 percent over the previous high of 104 last year. The summer meeting of the Section is tentatively scheduled for Glasgow, Montana, probably in July.

PACIFIC NORTHWEST

Officers of the Pacific Northwest Section for 1958 are:

Chairman: BILL MEINERS
Vice Chairman: READE BROWN
Councilmen: GRANT HARRIS and WAYNE WEST. Carryover Council members are BILL ANDERSON, DON HEDRICK, TOM WALLACE, and HUGH NICKLESON.

The 9th annual meeting of the Pacific Northwest Section was held



Display of the Pacific Northwest Section's new pocket-size plant manuals. These keys cover the principal grasses, weeds, and shrubs in the Pacific Northwest area. Designed for use by non-technical as well as technical range managers, the keys are available from the Executive Secretary at $1.25 per set.

at Bend, Oregon, December 2-3, 1957. One hundred twenty-two members and friends of the Section registered for the meeting.

The theme of the program was "Perplexing problems in range management." Panel discussions explored possible solutions to problems arising from multiple use of forested lands. Various aspects of coordinated land management were presented. Many of the presentations were illustrated by slides.

Sixty boys attended the Oregon Range Camp at Tupper Guard Station in the Umatilla National Forest. Fifty-eight boys attended from 16 Oregon counties, and 2 visited from the State of Nevada. Harvey Brown of LaGrande was winner in overall competition, and Mike Clark was tops in range condition and trend judging. Neither of the boys attended the Bend meeting because of conflicting school activities.

The Washington Boy's Range Camp hosted 28 boys at Conconully, Washington. Jerry Jallo was winner of overall competition in the Washington camp. Darwin McIntosh and Alan Kitt tied for second place honors. Jerry Jallo attended the annual meeting as guest of the Section and gave an interesting report on camp activities.

The Pacific Northwest Section unveiled their new Range Plant Identification booklets being published by the Section. The set of three booklets, Grass, Weeds, and Shrubs, are now available to anyone interested. Address the Executive Secretary and enclose a check or money order for $1.25.

The 1958 summer tour of the Section will be held at Kamloops, British Columbia, July 11-12. — *Wayne W. West.*

NEWS AND NOTES

1,059 Visitors at Phillips Demonstration Ranch

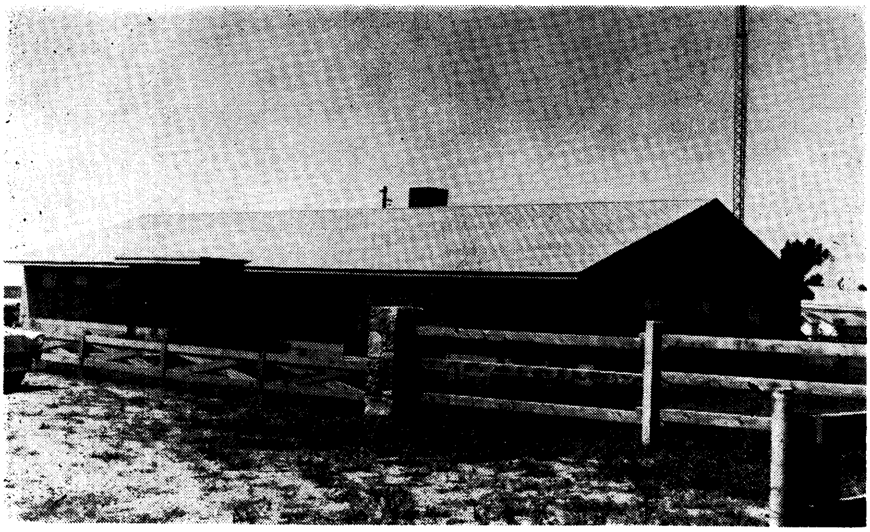
The rolling, bluestem grasslands of Phillips Agricultural Demonstration Project (PADP), near Foraker in colorful north central Oklahoma, attracted a total of 1,059 visitors from 13 states and South Africa between January and August 1957.

Started in 1952 by the Phillips Petroleum Company, the project was originally to be used for the demonstration of fertilizer materials on introduced grasses and legumes. This also included studies on the best ways of establishing tame pastures which would increase beef production on the nations' ranches. Today, the project has broadened to include also a complete ranch management program which incorporates the proper grazing management of 33,000 acres of bluestem grassland.

Such important guests as farmers, ranchers, and vocational agriculture instructors have exchanged ideas with members of the Soil Conservation Service, the Extension Service, Farm Home Administration, and foreign dignitaries. Aside from valuable discussions on range planning, visitors examined the nursery where over 200 different species of range and pasture plants are grown. They studied native pastures which are summer rested and tame pastures which have been developed on old cropland. Of particular interest were the results of different rates of nitrogen fertilizer application on total forage production of both native and introduced grasses. The groups also were shown 400 steers which were grazed on various test pastures and weighed individually for beef gain results.

Students Attracted

In June, a college course for two hours' credit in Range Management was conducted at the Project. The



This attractive guest house is used as headquarters for visitors who come to the Phillips Demonstration Project to observe and to study range management and the many demonstrational projects.

study was directed by professors from Oklahoma State University at Stillwater, Kansas State College at Manhattan, and Fort Hays Kansas State College at Hays. The students who attended the two-week affair were candidates for Master's Degrees from their respective schools. College professors, and authorities from the Soil Conservation Service and experiment stations report rewarding gains in analyzing the problems of successful range management which is so essential to ranchers in increasing beef production. The outcome was so impressive that a similar course has been set up for 1958.

The range course was unique in the fact that this was the first time college professors from various schools had pooled their efforts with others in the field to offer a special, advanced course of such scope away from their respective campuses and experiment stations.

The underlying purpose of the course was to give both student and teacher an opportunity to study range management on an operating cattle ranch. Morning classroom study with lectures, plant specimens, herbarium sheets, and various visual aids was coupled with afternoon work in the field. A major phase of the range study was the identification and classification of grasses and legumes; range sites as related to the growth of various range vegetation was another important topic. Out of this workshop atmosphere came valuable correlation of ideas and on-the-spot experience in which each individual had an opportunity to develop his thinking on plant flora and practical range management.

Plans to develop the project into an outdoor classroom where sound and economical ranch management can be developed are already laid. In this, the second year of operation on the broadened program, the increase in project visitors indicates the rising interest of agricultural people in grassland management.

Extensive Grasshopper Infestation

Grasshoppers have been found on some 18,700,000 acres of rangeland in 16 western States, as a result of late summer and fall Federal-State surveys, the U. S. Department of Agriculture reports. The most widespread infestations were found in Texas, Montana, California, and Colorado.

Judging from the number of grasshoppers present this year, there are areas in the Texas Panhandle totalling some 6 million acres that should be watched closely in the spring of 1958. Montana has almost 5 million acres of rangeland in the same category, California more than 3 million, and eastern Colorado about 1.5 million. Smaller trouble spots occur in adjoining areas of Washington, Oregon, and Idaho, and in Wyoming, Utah, Nevada, New Mexico, Nebraska, and South Dakota.

Surveys next spring for newly hatched grasshoppers will provide a final index of grasshopper populations and identify areas where control during the 1958 growing season will be essential to prevent severe losses.

BENTON THOMASON *(left)*, Northwest District Supervisor, Vocational Agriculture, State Office, Stillwater, and W. D. SUMNER *(center)*, Tri-County President, Vocational Agricultural Instructors, Ames, study a pasture of native grass with project manager DICK WHETSELL. THOMASON and SUMNER were among a group of 16 vocational agricultural instructors who studied at PADP last year.

New Range Publications from Oregon State

A new series of range publications has been established by the Range Management Program at Oregon State College. They will be published as "Miscellaneous Papers" in the Agricultural Experiment Station under the heading, "Range Studies." Range papers appearing in this group will carry information on range and hill pasture research in Oregon.

The purpose of this series is to supply technical workers with complete data on research not otherwise available in journal articles or station or technical bulletins. Journal readers who want to be placed on the mailing list should address their inquiries to: Range Management, Withycombe Hall 302, Oregon State College, Corvallis, Oregon.

Titles of the first two papers are: No. 1—"Response of tall fescue *(Festuca arundinacea)* nonirrigated pastures to fertilizer treatments", and No. 2—"Influence of spring clipping treatments on August regrowth of tall fescue *(Festuca arundinacea)*." The third paper, to be completed before the end of 1958, will cover detailed methodoloy involved in synecological studies.

New Appointments at Montana State

DONALD E. RYERSON has been appointed as assistant professor and assistant (research) in range management at Montana State College, Bozeman. He received his B. S. (1949) and M. S. (1955) degrees from Montana State College and has completed his residence requirement for the Ph. D. degree at Texas A & M College. MR. RYERSON will have major responsibility for instruction in elementary range management courses, and for instruction and research in renovation practices.

GEORGE M. VAN DYNE has been appointed as instructor and assistant (research) in range management at Montana State College, Bozeman. He received his B. S. from Colorado State University in 1954 and his M. S. from South Dakota State College in 1956. He taught range management courses at Colorado State University last year while CHARLES TERWILLIGER was on leave of absence for advanced study. MR. VAN DYNE will have major responsibility for research and instruction in range nutrition and range measurements.

Oklahoma to Hold National Land Judging Contest

The Seventh National Land, Pasture and Range Judging School and Contest will be held at the Oklahoma City Fairgrounds on May 1 and 2, 1958. There is a division for almost every member of the family. It includes a contest for 4-H Club and FFA members, adults, women and girls, and college students.

The objective of this national event is to increase interest in soil and water conservation, pasture development and range management. In addition, the school is designed to improve the people's skills and develop new attitudes toward the better side of conserving our natural resources, particularly soil and water.

The first day, May 1, is a training school and the second day is for the contest. There will be two divisions —one for land judging and another for pasture and range judging. People may enter in one or both. The prizes total more than $2,500 in cash and, in addition, plaques, medals and trophies will be awarded.

For further details, brochures, or bulletins, write to EDD ROBERTS, Extension Soil Conservationist, Extension Service, Oklahoma State University, Stillwater, Oklahoma.

The paintings of grasses and forbs shown in this booklet are products of the art department of McCormick-Armstrong Company. These paintings have been faithfully reproduced in natural color by our craftsmen and presses.

It has been a privilege to work with Phillips Petroleum Company on the books in this program.

McCORMICK-ARMSTRONG CO., INCORPORATED
1501 E. Douglas
WICHITA, KANSAS