Journal of

The Trail Boss

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.

Membership: 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.

Subscriptions. Correspondence concerning subscriptions, purchase price of single copies and back issues and related business should be addressed to the Executive Secretary, P. O. Box 5041, Portland, Oregon 97213. Subscriptions are accepted on a calendar year basis only. Subscription price is $8.00 per year in the U. S. and insular possessions, Canada and Mexico; $8.50 in other places. Checks should be made payable to the American Society of Range Management. Subscribers outside the United States are requested to remit by International Money Order or by draft on a New York bank.

Address Change. Notice of change of address should be received by the Executive Secretary prior to the first day of the month of Journal issue. Lost copies, owing to change of address, cannot be supplied unless adequate notice has been given.

Missing Journals. Claims for missing copies of the Journal should be sent to the Executive Secretary within 90 days of publication date. Such claims will be allowed only if the Society or the printing company is at fault.

Membership Dues. Dues for regular members are $8.00 per year in the United States, Canada and Mexico, $8.50 elsewhere. Student memberships are $4.00 per year. Life Memberships are $300. Dues include a subscription to the Journal. Remittance must be in U. S. funds.

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

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

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

News And Notes. Announcements about meetings, personnel changes and other items of interest to Society members should be sent directly to the Editor.

Printers. The Nebraska Farmer Company, 1420 P Street, Lincoln, Nebraska 68501.

IN THIS ISSUE

Drylot All-Concentrate Feeding—An Approach to Flexible Ranching
Gerald W. Thomas and Ralph M. Durham 179

Water Intake on a Sandy Range as Affected by 20 Years of Differential Cattle Stocking Rates.....*Edd D. Rhoades, Lowell E. Locke, et al.* 185

Chemical Control of Plains Pricklypear in Southeastern Wyoming
A. P. Thatcher, G. V. Davis, and H. P. Alley 190

Control of Yucca by Aerial Application of Herbicides.....*R. W. Bovey* 194

Herbage Production Responses to Pelleted Fenuron and Granular 2,3,6-TBA
Eugene E. Hughes and R. A. Darrow 197

Response of Grasses, Forbs, and Halfshrubs to Chemical Control of Chaparral in Central Arizona.....*Floyd W. Pond* 200

Gaseous Nitrogen Losses and Range Fertilization
Leroy H. Wullstein and C. M. Gilmour 203

A Method for Measurement of Forage Intake of Grazing Livestock Using Microdigestion Techniques.....*G. M. Van Dyne and J. H. Meyer* 204

Technical Notes:

Sagebrush Infested by Leaf Defoliating Moth.....*Dillard H. Gates* 209

Late-Spring Herbage Production on Shortgrass Rangeland....*Frank Rauzi* 210

Silver Sagebrush in Eastern North Dakota.....*Hugh E. Cosby* 212

Seedling Vigor of *Festuca arundinacea, Panicum virgatum,* and *Bothrichloa caucasia* **and Their Response to Added Nutrients**
Gordon Gullakson, L. E. Foote, and J. A. Jackobs 214

Management Notes:

An Oregon Range Sheep Story.....*E. William Anderson* 217

Range Seeding Introduced Grasses on Rootplowed Land in the Northwest Rio Grande Plain.....*Durwood E. Ball* 217

Book Reviews: The Matador Land and Cattle Co. *(Garlyn O. Hoffman);* **Livestock and Livestock Products** *(O. O. Thomas);* **From Prairie to Corn Belt** *(John W. Voigt);* **From Cab to Caboose** *(David G. Wilson);* **Conservationists and What They Do** *(Ralph T. Kotich);* **California Range Brushlands and Browse Plants** *(H. G. Reynolds);* **Annual Rings in Big Sagebrush,** *Artemisia tridentata (Odell Julander)*..... 220

Current Literature 224

News and Notes 227

With the Sections 230

Society Business 232

Letters to the Editor..... 235

Cover Photo—Oregon Range Sheep

Photo by E. William Anderson, see story under Management Notes, page 217.

Mesquite and brush had taken over once-lush grasslands. Chemicals were tried but failed. Then a group of dairymen and a rancher got together and had some small acreages rootplowed and seeded. Here are the results.

The Windthorst Story

Can rootplowing show a fast profit on small acreages? Four dairymen and one rancher near Windthorst, Texas, now have the answer.

Dairyman A. L. Vietenheimer, (above, left) is typical. He invested $557 to rootplow and reseed 75 acres. In 2½ months of the first year, he saved $750 in supplemental feed for a net "profit" of $193.

Another example: Cattleman A. L. Zotz, (above, right) had 50 acres rootplowed and seeded. Before plowing he couldn't carry 25 head on 150 acres without supplemental feed. After rootplowing he grazed 40 head and bought no feed. "I could have run 75," he says, "because 40 sure weren't keeping the sorghum almum down."

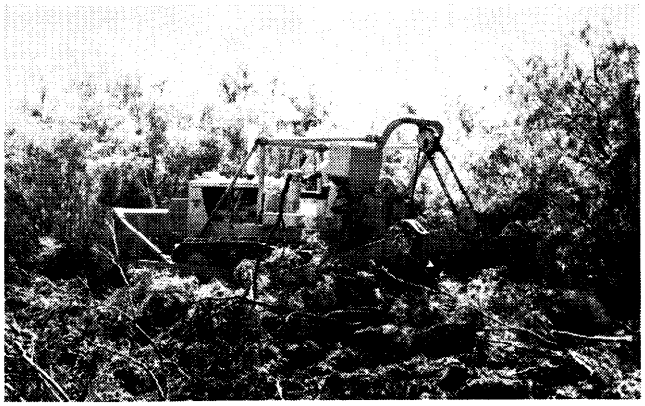
His total investment was $376.50. His winter feed bill alone would have been $400 for just 25 head.

In all cases, rootplowing produced a 95-98% mesquite kill. Chemicals had killed only the tops, as the photo, (above, left) shows.

Key to their success was cooperation: By pooling their acreages, the four had a total of 210 acres for rootplowing. This, combined with the small distances between jobs, made it economical for Conservation Contractor Carl Rumage to move in with his Cat D7 Tractor and do the work.

Thus by cooperating, each investor got back his original outlay almost immediately—and will continue to receive the dividends of improved grassland for years to come.

Could a small investment in range improvement yield the same kind of returns for you? Write for "From Brush to Grass" Box JR, Caterpillar Tractor Co., Peoria, Ill.



Carl Rumage rootplowing with his D7. Note the density of growth that severely limited grazing.

CATERPILLAR

Journal of
RANGE MANAGEMENT
Volume 17, No. 4
July, 1964

Drylot All-Concentrate Feeding—An Approach to Flexible Ranching

GERALD W. THOMAS AND RALPH M. DURHAM
Dean of Agriculture and Head, Department of Animal Husbandry, Texas Technological College, Lubbock, Texas

One of the major problems confronting the ranching industry is lack of an adequate year-round forage supply. This forage deficiency may be caused by drouth or a short growing season and may, or may not, be intensified by heavy grazing. Regardless of the cause, the problem of partial or full-feeding of livestock during these periods of forage deficiency is of major economic significance to the ranch operator. Maintenance of livestock in drylot during periods of feed shortage, utilizing all-concentrate rations, merits careful consideration by ranchers and research workers. During drouth periods, it may be desirable to remove livestock from the range, thus reducing needless "exercise" in the search for food, providing a means of salvaging that important base breeding herd, and at the same time, making it possible to "rest" the vegetation.

Results from recent experiments not only indicate that ruminants can perform satisfactorily on all-concentrate diets in drylots for long periods of time, but also that under certain conditions roughage may be a disadvantage even at low cost. It is hoped that this article will challenge range and livestock people to re-examine some old assumptions on the feeding of livestock. An additional objective is to stimulate more research on livestock maintenance in drylot and the use of the drylot as a research tool in designing grazing experiments.

Limitations in Standard Approach to Feeding

It is unfortunate that so much of our research on ruminant nutrition has not sufficiently explored the possibility of all-concentrate feeding. The majority of our feeding experiments have been based upon the assumption that, since ruminants are roughage eaters, rations should be designed around a roughage base. Furthermore, it has been generally assumed that roughage is inexpensive. Apparently researchers, for many years, have not questioned authoritative statements on this subject. For example, a publication of the National Research Council (1961) states: "The minimum requirement for roughage is 0.5 to 0.8 pounds for each 100 pounds of live weight in fattening cattle. Cattle receiving a full feed of grain and less than the minimum requirement for roughage are subject to bloat and other digestive disturbances. In most cases, it is desirable that the roughage be coarse and not finely ground, in order to achieve normal physiological activity in the gastrointestinal tract.—*The need for at least minimal amounts of roughage in cattle rations is recognized.*"[1]

In an attempt to help ranchmen plan for overwintering during the latest drouth, typical recommendations were published in popular ranch magazines. For example, in one magazine (Staff, 1964), the statement is made that "*. . . one pound of roughage per 100 pounds of body weight is the absolute minimum for proper digestive processes,*"—and "If you have no grass, minimum requirements for wintering a 1,000 pound cow, for example, would be 10 pounds grass hay, 14 pounds grain, and 1½ pounds high protein daily."

This alleged need for roughage is stressed in most of our accepted textbooks. Morrison's widely used "Feeds and Feeding" text (1951) states: "As a matter of scientific interest, numerous experiments have been conducted to find whether various farm animals can live on concentrates alone. *When cattle and sheep are fed concentrates alone, without any roughage, rumination usually ceases or is greatly decreased.*"[1]

A review of literature in scientific journals will rather forcefully indicate that most experiments have been designed around this "need" for some roughage. For example, recent feeding trials in Kansas (1961) showed greatest gains and greatest efficiency in favor of higher levels of concentrates, however, treatments were limited to a range

[1] *Italics added.*

from 1:1 to 1:5. These experiments are typical of many currently being reported in the literature. Only recently have a few investigators taken a new look at the all-concentrate approach to feeding in North Carolina (1963), South Dakota (1963), Texas (1963-64), and other locations.

In a preliminary report from North Carolina (Wise and Barrick, 1963), the statement is made that "Early studies indicate that feeding all-concentrate rations to cattle is within the realm of possibility," and that "Addition of hay in long or ground form, or in varying amounts, did not increase performance of fattening steers fed an all-concentrate diet based on ground shelled corn and urea, or on ground shelled corn and soybean oil meal." As a result of these new studies on feeding a modified statement has been incorporated in the recent USDA Bulletin entitled "Finishing Beef Cattle" (March, 1964), as follows:

"Formerly it was considered that at least 10-20 percent dry roughage equivalent was necessary for normal growth and fattening. Later studies show that all-concentrate rations properly supplied with minerals and vitamins produce satisfactory results."

Research on All-Concentrate Rations at Texas Tech

Studies of the possible value of all-concentrate rations for maintenance resulted from encouraging results when these rations were used for fattening steers, heifers, and lambs. Intensive studies at Texas Tech were initiated early in 1962 (Durham, 1962). To date, various experiments with this technique have included several hundred cattle and sheep. Time will not permit an adequate review of all of these experiments with full-feeding all-concentrate rations. However, several generalizations are pertinent to this report.

All concentrate diets are more biologically efficient than part-roughage diets according to Durham (1963). As a matter of fact, in the past two major experiments at Texas Tech using 474 cattle, it was concluded that roughage may have a negative value under West Texas conditions. In addition to the roughage, cattle also consumed more concentrates than on concentrates alone. Conversion ratios (feed per pound of gain) and cost of gain are shown in Table 1.

Both grain sorghum and barley have been tested as the grain base. Unpublished reports from California and South Dakota have indicated that bloat was sometimes a problem with barley rations. The basic ration used in most of the research at Texas Tech is as follows:

89% cracked milo
10% cottonseed meal
0.5% calcium carbonate
0.5% salt
plus 2200 units of Vitamin A per pound

In early studies, animals were started on the no-roughage rations with a "shock" treatment, that is, immediate access to self-feeders. This technique was rather trying for the livestock owner. Consequently, in later experiments, cattle were allowed 10 pounds of feed at 8:00 A.M. and 10 pounds of feed at 5:00 P.M. for two days and then given access to self-feeders. Mixing feed with about 10% cattle manure (from all-concentrate fed pens) has also been tested with success. It appears that all of these techniques are better than the standard practice of "gradual warming" with varying amounts of roughage, although some commercial feeders still prefer the gradual method.

The micro-organism population of the rumen is considerably different on all-concentrate rations. The change in kinds of bacteria is rather abrupt, usually less than 7 days, during which time the animal may suffer from indigestion (Kuhnley, 1963). While it is true that animals on all-concentrate diets do not "chew their cud," preliminary data indicate that the rumen is far from inactive. Kuhnley (1963) reported that the number of starch digesting bacteria on the all-concentrate rations is much higher than on rations containing standard roughage. These data indicate the pressing need for more basic knowledge of the process of energy exchange in the rumen and the contribution of each kind of micro-organism. Is it

Table 1. Comparisons of feed conversion and cost of gain in three major experiments using all-concentrate rations, 1963-64 studies at Lubbock, Texas.

Experimental Rations	Feed Conversion Feed per pound of gain (Lbs.)	Cost of Gain Per Hundred lbs. ($)
Experiment No. 1 (90 cattle)		
All-Concentrate Ration[1]	8.78	18.92
Silage "ad lib" plus 10% concentrate	15.08	22.79
Experiment No. 2 (240 cattle)		
All-Concentrate Ration	8.04	17.29
All-Concentrate plus 70 mg. Aureomycin	7.26	15.61
Concentrate "ad lib" plus 8 lbs. silage	9.27	18.90
Concentrate plus 10% cottonseed hulls	8.60	17.63
Experiment No. 3 (144 cattle)		
All-Concentrate Ration	7.23	15.54
Concentrate plus 10% cottonseed hulls	7.99	16.58

[1]Base ration—89% cracked milo, 10% cottonseed meal, 0.5% calcium carbonate, 0.5% salt, plus 2200 units of Vitamin A per pound.

possible that the addition of certain roughages promotes microbial activity that ties up or dissipates energy rather than contributing to the over-all process of converting feed to meat? Opportunities for research designed to "breed a better bug" are also apparent.

The rumen becomes extremely acid (pH 5) on all-concentrate diets. Rumen ulcers and hyperkeratosis are observed in most of the male cattle after about 100 days on feed (Harbaugh, 1963). Ulcers in females on similar diets appears to be less frequent and ulcers in sheep are uncommon. Also, from a study of 300 steers on all-concentrate diets, 71 percent had liver abscesses. The association of rumen ulcers and liver abscesses has been reported earlier by workers in Colorado. Various treatments have been tested at Texas Tech to reduce this problem including mycostatin, sodium bicarbonate, Aureomycin, antibiotic II, aluminum hydroxide and vitamin-tracemineral mixes. A significant reduction in percent bad livers was obtained from the Aureomycin treatment (from 72% to 38%). Other treatments had little effect (Ellis et al., 1963).

In spite of the ulcer and liver problems with full feeding all-concentrates, these rations appear to be efficient and economical. In the Texas studies, steers on all-concentrate rations had significantly higher marbling, conformation and carcass grade scores. The dressing percentage and rib-eye area were also significantly higher (McGinty, 1963). Studies of fattening heifers are also very encouraging. A labor study indicated that almost three times as much labor was involved in feeding a high-roughage ration (McGinty, 1963). These results pointed to the need for exploratory research on maintenance rations and to the possibility of applying this technique to a ranching operation.

Drylot Maintenance of Beef Cattle

Studies of drylot maintenance of beef cows compared with native range have been underway at the Spur Experiment Station in Texas since April, 1959. Results of these studies are reported in a recent paper by Marion, Robinson, and Riggs (1964). In these experiments silage was used as the base feed in drylot. Three levels of energy were obtained with combinations of grain and cottonseed meal. Silage was fed in the drylot at the rate of 40 to 50 pounds per head daily during the winter and 50 to 55 pounds during the breeding season. Range cattle received a supplement of cottonseed meal and grain sorghum. A summary of the 1963 results of the Spur tests is shown in Table 2.

Comparable costs for supplementation directly on the range and drylot production at Spur, Texas for a 1-year period were $44 to 50 per cow on pasture and $78 to 82 in drylot. Average percent calf crop and weaning weights were higher in the drylot. The levels of energy fed during the four years of this test have had very little effect on calving performance either on the range or in the drylot. These investigators concluded that present prices of grassland may run the ranchers investment per cow up to $1000 to 2000 whereas: "A satisfactory drylot for cows can be constructed at a cost of $30 to 50 per head and enough feed can be grown on one acre of irrigated land to support a cow and her calf for a year. . . . This will make it possible for small operators to use the drylot system to expand their production without having to purchase more land." (Marion, et al., 1964).

Drylot cow-calf research at

Table 2. Percent calf crop and weaning weights on pasture and in drylot at Spur, Texas (Data from Marion, et al., 1964).

	Pasture		Drylot	
Year	(Pct.)	(Wt. lbs.)	(Pct.)	(Wt. lbs.)
1960	72	423	66	435
1961	86	428	91	496
1962	91	493	97	479
1963	95	478	91	503
4-Yr. Av.	86	458	87	483

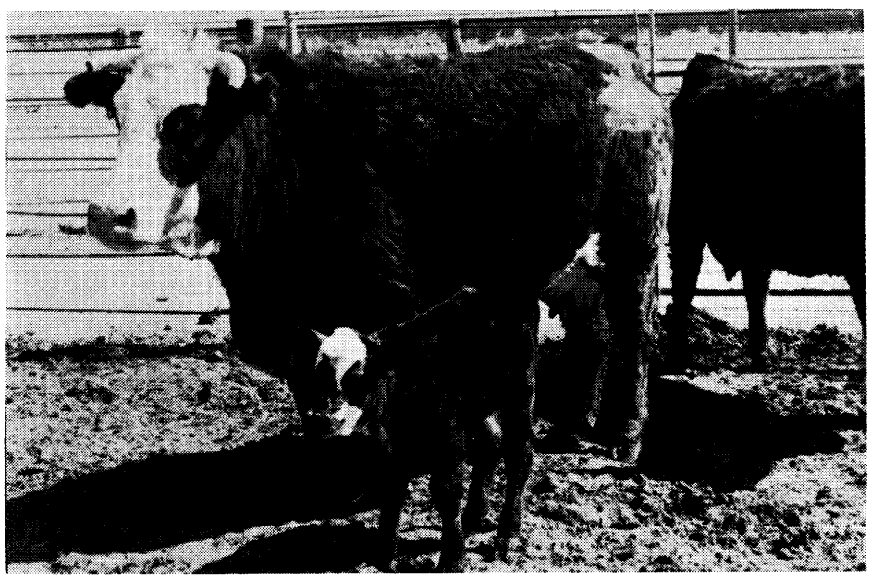


FIGURE 1. Calving results from cows raised in drylot on maintenance all-concentrate ration of 8 pounds per head per day have been encouraging. Note overall condition of cows and healthy young calf. Milk production has also been very satisfactory. Photo March, 1964.

Texas Tech was approached on a different basis than the Spur studies. The complete elimination of roughage in some of the treatments opens up more possibilities for reducing costs. Female cows have been held on a total of 6 pounds of all-concentrate feed per head per day and successfully bred and calved at the 8-pound level with no supplemental roughage. Early calving results look very promising for this feeding technique (Figure 1). Three rations were tested as follows:

(1) 8 pounds of all-concentrate per head per day.
(2) 6 pounds of all-concentrate, plus 2 pounds silage.
(3) Silage "ad-lib" plus 1 pound milo; 1 pound cottonseed meal plus vitamins and minerals.

The percent pregnancy for each of these treatments was the same (90%). The cows were calving at the time this report was prepared in March, 1964. No calving problems were observed and through early July, the cows seem to be milking satisfactorily.

In a prior experiment, calves were removed from the cows at 5 weeks of age and placed on a self-feeder with the standard all-concentrate ration. They have had excellent feed conversion (4 pounds feed per pound of gain) to 400 pounds. This procedure allows for good calf gains with less feed expenditure than if the calf were sucking, since the cows can be held on a low maintenance diet.

Grazing on manure in drylots or "coprophagy" is common in both sheep and cattle on limited all-concentrate rations (Figure 2). This is an interesting phenomenon and may contribute to the over-all efficiency of the feed. To date, no special health problems or adverse affects of coprophagy have been observed. The drylots where animals are on a maintenance ration have not been cleaned due to lack of accumulation of manure.

The cattle manure on the 89-10 ration has a protein content of approximately 19 percent. On the self-fed all-concentrate lots, manure has been removed, run through a hammer mill, and mixed back with the all-concentrate ration. This manure has been successfully fed to cattle (10% of ration), hogs (up to 40% of ration), chickens (up to 40% of ration), and catfish (Box and Durham, 1963).

Although there appear to be few, if any, reports in the literature on "coprophagy" in cattle, this may be more common than most of us realize. For example, Mr. Otto Wolfe in personal conversation in 1964, stated that the old cowboys of the Northern Plains observed that cattle survived hard winters by grazing on the droppings of horses.

The most recent study has been to bring pregnant cows directly from dry grass range, where they were receiving a protein supplement, and placing them on the 8-pound all-concentrate ration. Some adjustment the problems have been observed but the cattle are now doing well and calving in a satisfactory manner. More research is needed to ascertain the effects of sudden shifts to all-concentrate rations, but no insurmountable problems have developed to date in the studies at Texas Tech.

The economic implications of the all-concentrate drylot approach for cattle are very interesting. In Texas, the recommended ration ". . . If you have no grass . . ." (Staff, 1964), referred to earlier, would cost approximately 48 cents per cow per day as shown below:

10# grass hay @ $30 per ton	15.00 ¢
14# grain (sorghum) @ $2.00 per CWT	28.00
1½# cottonseed meal @ $3.50 per CWT	5.25
	48.25 ¢

It has been commonly understood that a mature cow will need approximately 20 pounds of alfalfa hay per day. With hay at $30 to 40 per ton, this cost would be 30 to 40 cents per day. In a recent publication of the American Grassland Council, Sell (1963) states: "Fifty to 80 pounds of corn or sorghum silage fed daily and supplemented with one pound of cottonseed or soybean meal will winter cows in good condition." This ration would likely cost over 30 cents

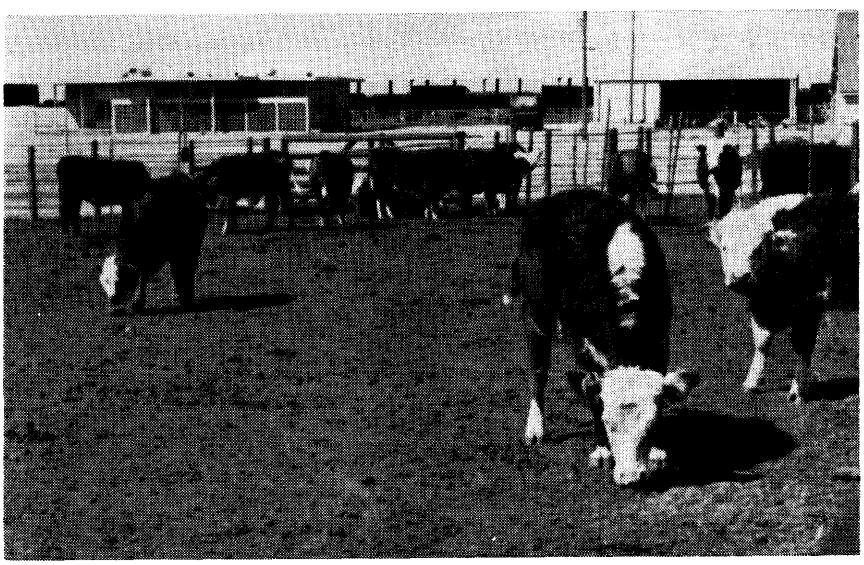


FIGURE 2. Grazing on drylots or "coprophagy" is common in both cattle and sheep on limited all-concentrate rations. These lots have never been cleaned due to lack of manure accumulation. Satisfactory performance of cattle under these conditions can be observed.

per day, although the price of the ingredients will vary from place to place.

The cost of the experimental ration used in the research at Texas Tech at the 8-pound per day level was approximately 18 cents, including additives. Even with a considerable change in the price of milo and cottonseed meal, the all-concentrate approach to maintenance looks promising from an economic standpoint.

Drylot Maintenance of Sheep

Studies were first initiated comparing the standard fattening rations with all-concentrate feed for lambs. In Experiment No. 1, ninety-six white-faced lambs of predominantly Rambouillet breeding were secured directly from the range near the Fort Stockton, Texas area and placed on self-feeders. Results were very good using a basic ration of 90% ground milo and 10% cottonseed meal. Each ton of this mix had 5 pounds of salt, and ½ pound of Vitamin A-10 added (Hudson, F. A., et al., 1963).

In Experiment No. 2, four rations were tested with another group of 96 crossbred lambs including checks on aureomycin, sodium bicarbonate, and cottonseed hulls. Five deaths were attributable to the type of feeding. General examination of slaughtered lambs at Texas Tech show ulcers in sheep rather infrequently compared to cattle. Feed conversion of the lamb feeding experiments was better on all-concentrates than on part roughage diets.

Table 3. Percent lamb crop three weeks after lambing under several experimental rations.

Ration	Lamb Percentage
(1) 1 pound all-concentrate[1] for first 90 days	98.1
(2) 1½ pounds all-concentrate[1] for first 90 days	107.7
(3) 2 pounds all-concentrate[1] continuously	92.6
(4) Self-fed all-concentrate[1]	80.3
(5) Silage supplemented with grain sorghum	90.0

[1]Base ration—89% cracked milo, 10% cottonseed meal with salt and Vitamin A.

Moving from these preliminary studies with lambs to drylot maintenance of ewes was the next step. At the Texas Tech Research Farm near Amarillo, a group of 172 ewes in late 1963 was divided into two groups. One group was placed in the drylot and allowed approximately 6 pounds of sorghum silage and 1 pound of milo grain daily. The other group was continued on pasture. Results of this study showed an advantage of the pasture ewes with regard to total fat lamb production (Hudson, 1964).

Subsequently, drylot studies were designed to check the performance of ewes on limited all-concentrate rations. Percent of lambs alive three weeks after the completion of lambing is shown in Table 3. The first two groups shown in Table 3 were raised to 2 pounds per day after 90 days (just before lambs were dropped) and maintained on this amount throughout the lambing season. This preliminary experiment was conducted in very poor quarters and some lambs died in all treatments due to adverse weather conditions. In spite of the variability of the results, the all-concentrate maintenance treatments were considered promising (Figure 3). At the 2 pound level of the 89-10 all-concentrate ration, the cost of feeding each ewe would be approximately 5 cents per day. In comparison, recent comprehensive studies in Mississippi of 14 different winter rations (all with some roughage) showed costs ranging from 6.3 to 13.3 cents per ewe per day (Essig, et al., 1964). Certainly these economic differences point to the need for more follow-up research.

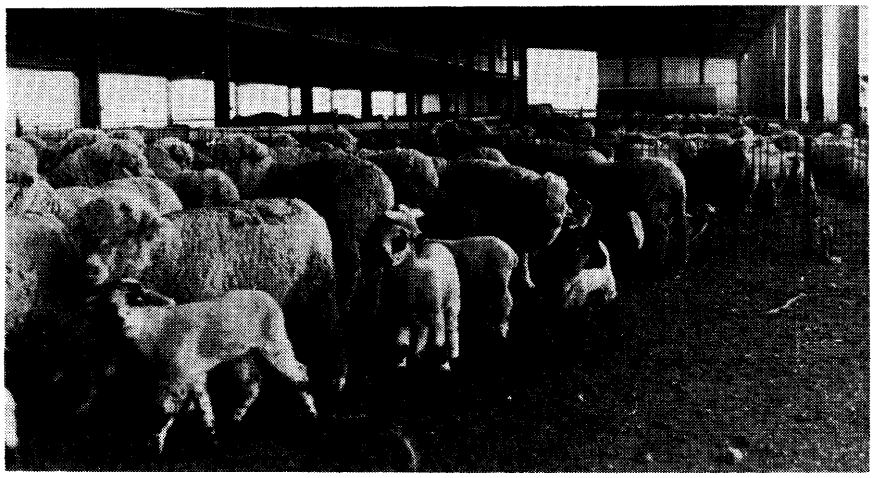


FIGURE 3. These are the first lambs that have been produced in the drylot with ewes receiving a total of 1.5 pounds of all-cencentrate feed per day for 90 days prior to lambing. Rations were increased to 2 pounds during lambing and ewes were on this ration at time of photo (March, 1964).

The Drylot as a Research Tool

One of the major objectives of this paper has been to emphasize the possibilities of the drylot as a research tool. If costs can be kept to a minimum, as appears likely with all-concentrate rations, the drylot can provide flexibility in the ranching operation. Even though drouth is a common occurrence in the West, ranchers frequently are in trouble because of forage deficiencies. Mr. A. P. Atkins, Oklahoma rancher, stated that "the key to successful management of our ranges is flexi-

bility . . ." (1964). He further pointed to the problem of "marrying a herd of cows." He stated that this type of stockman is the first to suffer from drouth and his winter feed bill often exceeds the value of a calf crop. A study in Texas by Bonnen and Ward (1955) also emphasized the disastrous effects of feed shortages during drouth. By 1954, which represented the halfway point of the Texas drouth of the fifties, some ranchmen on the Edwards Plateau had already been granted short-term credit amounting to 206 percent of the value of their livestock. With properly designed research, the drylot could be examined as a means of reducing financial losses during drouth or expanding the livestock operation where total forage is limited.

Using the drylot technique, grazing experiments, including deferred ration studies, might be designed with a minimum number of pastures or with multiple pastures serving as replications on highly variable range areas. The drylot can provide a means of controlled breeding, such as artificial insemination, and controlled pregnancy testing for culling purposes. Levels of nutrition of the females can be more adequately studied and apparent "waste" of vegetation on females during period of plentiful moisture reduced to a minimum. Early removal of calves might be analyzed as an economic factor in the ranching operation. The question might also be asked as to whether or not the rumen micro-organism populations could be standardized by all-concentrate feeding to aid in analysis of forages for digestibility or feeding value.

Summary

This paper is submitted with preliminary data on livestock maintenance in drylot for two primary purposes: (1) to challenge researchers and ranchmen to take a new look at some old assumptions on livestock feeding, and (2) to stimulate additional research on some promising leads with significant economic implications. It appears that authoritative statements on the "need" for roughage have limited our past approach to research on full feeding and on livestock maintenance. Results from recent experiments not only indicate that ruminants can perform satisfactorily on all-concentrate diets, but, also under certain conditions, feeding "cheap" roughage may not be economical.

By combining the information on all-concentrate feeding with the drylot maintenance technique, there appear to be good possibilities for providing flexibility in the ranching operation. During drouth periods, it may be desirable to pull livestock completely off the range, thus reducing needless "exercise," providing a means of salvaging the breeding herd and making it possible to "rest" the range or pasture. Both sheep and cattle have been studied under drylot maintenance conditions at Texas Technological College and lambing and calving operations have been considered successful.

New opportunities for the use of the drylot as a research tool have developed as a result of the economical use of all-concentrates for maintenance diets. It is hoped that this paper will stimulate additional use of this technique as a research tool.

LITERATURE CITED

ANIMAL HUSBANDRY RESEARCH DIVISION, ARS. 1964. Finishing Beef Cattle. USDA Farmers Bulletin 2196.

ATKINS, A. P. 1964. The Challenge of the Future as Viewed by a Rancher. Jour. Range Mangt. 17: 115-118.

BONNEN, C. A., AND J. M. WARD. 1955. Some economic effects of drouth on ranch resources. Texas Agr. Exp. Sta. Bull. 801.

BOX, T. W. AND R. M. DURHAM. 1963. Catfish feeding under intensive stocking rates. Texas Tech Reports on Agricultural Industry, Vol. 4, No. 2.

COMMITTEE ON ANIMAL NUTRITION. 1961. Nutrient requirements of beef cattle. National Academy of Sciences—National Research Council Publication 579.

DURHAM, R. M. 1962. A technique for feeding all-concentrate rations to cattle and sheep. Texas Tech. Reports on Agricultural Industry, Vol. 3, No. 2.

DURHAM, R. M. 1963. An overall appraisal of all-concentrate feeding. Livestock and Feeders Day Report, Texas Technological College.

ELLIS, G. F., JR., R. M. DURHAM, D. MCGINTY, AND R. STOVELL. 1963. All-concentrate rations for beef cattle. Texas Tech Reports on Agricultural Industry. Vol. 4, No. 2.

ESSIG, H. W., R. A. EDGAR, AND C. J. CHRISTIANS. 1964. Fourteen rations used in winter feed study for sheep. Mississippi Farm Research, 27(2).

HARBAUGH, F. G. 1963. Ulcers and liver abscesses in cattle. Livestock and Feeders Day Report, Texas Technological College.

HUDSON, F. A. 1963. All-concentrate rations—sheep feeding. Livestock and Feeders Day Report, Texas Technological College.

HUDSON, F. A. 1964. Intensified sheep management practices. Research Farm Review, Texas Tech. Research Farm Fourteenth Annual Field Day.

KUHNLEY, L. C. 1963. Micro-organisms in bovine rumen. Livestock and Feeders Day Report, Texas Technological College.

LEWIS J. K., J. E. NESVOLD, AND G. F. GASTLER. 1963. Wintering calves on a limited feed of barley with two methods of mineral supplementation. South Dakota Animal Science Mimeo Series 63-14.

MARION, P. T., E. D. ROBISON, AND J. K. RIGGS. 1964. Drylot maintenance of beef cows compared with pasture maintenance. Texas Agric. Exp. Station Report, Spur, Texas.

MCGINTY, DON. 1963. All-concentrate rations versus roughages for cattle. Livestock and Feeders Day Report, Texas Technological College.

MORRISON, F. B. 1951. Feeds and Feeding. Morrison Publishing Company, Ithaca, New York.

RICHARDSON, D., E. F. SMITH, F. H. BAKER, AND R. E. COX. 1961. Effects of roughage-concentrate ratio in cattle fattening rations on gains,

feed efficiency, digestion and carcass. Jour. Animal Sci. 20: 316-18.

SELL, O. E. 1963. Silage for beef cattle. *In* Quality Silage. Publ. by American Grassland Council, Box 26, Leola, Pa.

STAFF REPORT 1964. And the rains came—and they were late. Texas Farm and Ranch, Jan., 1964. Dallas, Texas.

WISE, M. B. AND E. R. BARRICK. 1963. All-concentrate rations for cattle. Research and Farming, Vol. 22, No. 2. North Carolina Agric. Exp. Station.

Water Intake on a Sandy Range as Affected By 20 Years of Differential Cattle Stocking Rates[1]

EDD D. RHOADES, LOWELL F. LOCKE, HOWARD M. TAYLOR, AND E. H. McILVAIN[2]

Research Agricultural Engineer, Chickasha, Oklahoma; Research Soil Scientist, Woodward, Oklahoma; Research Soil Scientist, Bushland, Texas; and Research Agronomist, Woodward, Oklahoma, respectively.

In the semiarid Southern Great Plains, forage production on a range site usually depends upon available soil moisture. In turn, available soil moisture depends upon (a) intensity, duration and frequency of precipitation; (b) water intake characteristics of the soil; (c) water retention and flow patterns within the soil profile; and (d) evaporation and transpiration characteristics of the soil surface and living vegetation.

Man has yet to exert significant control over precipitation within the Great Plains, but several investigators, Duley and Domingo (1949), Johnston (1962), Rauzi (1960), and Rauzi and Smika (1963), have shown that range conditions caused by grazing management will affect available soil moisture. Effects of grazing management and resultant vegetal cover on water intake and retention characteristics have not been studied previously for Pratt and similar sandy soils of the Southern Great Plains. This investigation determined the effects of heavy, moderate, and light stocking rates with beef cattle during a 20-year period upon water intake and water retention characteristics of Pratt loamy fine sand soil.

Location, Soil, And Vegetation

The study was conducted on the Southern Plains Experimental Range located in northwestern Oklahoma near Woodward. Average annual precipitation is 22.82 inches, but it has varied from 9.97 inches in 1954 to 42.61 inches in 1957. About 70 percent of the annual precipitation falls during the April through September growing season. High-intensity thunderstorms occur frequently. Wind velocities and summer temperatures are normally high, and annual evaporation from a free-water surface is about 72 inches.

The experimental range is located on rolling, stabilized sand dunes composed of a mixture of Pratt, Tivoli, and Otero soil series. This study was restricted to Pratt loamy fine sand soil, which is dominant on the study area and is a major soil in the Rolling Red Plains land resource area. It has a weak, fine-granular, single-grained structure that is very friable when wet and soft when dry. The soil contains less than 5 percent clay and has a pH of about 6.6 in all horizons to 6 feet. The freely drained, deep, sandy Pratt soils occur on undulating to hummocky upland plains of western Oklahoma, southwestern Kansas, and the Texas Panhandle.

Native vegetation of the area is dominated by an overstory of sand sagebrush *(Artemisia filifolia* Torr.) with an average canopy cover of 38 percent. The basal cover of grasses and forbs averages about 8 percent, and an annual average of approximately 1,000 pounds of oven-dry forage is produced per acre.

Procedure And Equipment

In 1940, the experimental range was divided into pastures that varied in size from 50 to 213 acres. Inside each pasture, a small area of about 3 acres was fenced to exclude grazing. Replicated treatments of heavy, moderate, and light stocking rates were initiated by putting beef cattle on these pastures in December 1941; therefore, nongrazed areas and areas that had been grazed continuously at each of three grazing intensities for 20 years were available. The average stocking rates, or grazing intensities, were: (a) nongrazed exclosure, (b) 22 acres per animal unit (light grazing), (c) 17 acres per animal unit (moderate grazing), and (d) 12 acres per animal unit (heavy grazing). Stocking rates were adjusted on basis of current year's forage production, and the rates were heavier than average in wet years and lighter during droughts.

In the fall of 1961, soil profiles were examined and sufficient

---

[1] *Contribution from the Soil and Water Conservation Research Division and the Crops Research Division, Agricultural Research Service, USDA, in cooperation with the Oklahoma Agricultural Experiment Station.*

[2] *Acknowledgment: The authors gratefully thank Ferris P. Allgood, Soil Scientist, and Jack E. Engleman, Range Conservationist, Soil Conservation Service, for selecting comparable Pratt soil profiles and determining range condition, respectively, on each study site.*

gently-sloping (1 to 4 percent) sites of Pratt loamy fine sand were selected to permit fenceline comparisons between grazing treatments. Twelve locations or three sites for each of four treatments were selectd to minimize site differences.

During the fall of 1961 and the spring of 1962, water-intake rates of the grassed areas between sagebrush plants were characterized by two procedures: First, a trailer-mounted, double-tower sprinkling infiltrometer, as described by Rhoades (1961), was used to obtain measurements on six replications of 120 minutes duration from each of the 12 locations and, second, water-intake rates were obtained using the double-ring recording infiltrometer (Lock et al., 1960), with a 2-inch head maintained in each ring. Four replications of 60 minutes duration were used on sites near those used with the sprinkling infiltrometer. In addition, the effects of individual sagebrush plants upon the water-intake rates in heavily grazed pastures were measured with both infiltrometers. In these latter tests, six rings were placed directly around sagebrush plants and six were placed in adjoining grassed areas.

Prior to each sprinkling infiltration test, gravimetric moisture samples to a 4-foot depth were obtained on areas outside, but near, the intake rings, Moisture samples were obtained inside the intake rings 24 to 30 hours after completion of each intake test. These moisture samples were used to approximate field capacity.

Soil bulk density was determined by using a 2.8-inch-diameter core sampler. Samples were obtained by 2-inch increments in the first foot of soil and by 4-inch increments near the middle of the second and third foot. Ten replications were used from the 0- to 6-inch depth and four replications from the 6- to 36-inch depth.

Soil penetration resistance measurements were made inside each sprinkled test plot 24 hours after sprinkling by using a modified Cornell recording penetrometer as reported by Terry and Wilson (1953).

Soil organic matter and nitrogen content were determined on samples obtained from duplicate pits at each of the 12 study sites. Samples were taken at 1-inch increments to the 6-inch depth and at 6-inch increments to the 24-inch depth. Organic matter was determined by the wet oxidation method and nitrogen content by the Kjeldahl method (Piper, 1950).

After completion of the infiltration tests, quantity of vegetation by species within infiltration rings was determined by clipping standing vegetation at the ground level (Figure 1). Litter and duff within each sprinkler ring were collected also. Samples were oven-dried and weighed. The basal cover—defined as percent of the ground area actually occupied by root crowns—was determined by the line-interception method for grass and forb species, and the foliage was determined for sagebrush (Parker and Savage, 1944). Each of the 12 study sites was evaluated as to current range condition.

Results And Discussion

Water Intake

The water-intake rates were inversely proportional to the grazing intensity; that is, as the grazing intensity increased, the intake rate decreased. Average water-intake rates obtained with the sprinkling infiltrometer for the 2-hour periods were 2.27, 3.64, 4.41, and 10.58 inches per hour for the grassed areas of the heavily grazed, moderately grazed, lightly grazed, and the nongrazed pastures, respectively. Correlation between grazing intensity and water intake for this 2-hour period was significant at the 1-percent level.

After the first few minutes, water-intake rates with the sprinkling infiltrometer on the grazed areas increased with time, but the rates on the nongrazed areas remained relatively constant (Figure 2). The reason for the increasing water-intake rate with time is not known, but possibly it is associated with soil-particle wettability as noted by Jamison (1945) and Letey et al. (1962).

FIGURE 1. Typical views of sprinkling infiltrometer plots. *Left*—In a nongrazed exclosure with all surface vegetation removed, note scarcity of basal cover. *Right*—In a heavily grazed pasture, 12 acres per animal unit, with all surface vegetation removed, note abundant basal cover.

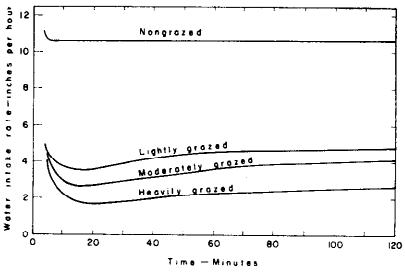


FIGURE 2. Average water intake rates obtained with the sprinkling infiltrometer.

The correlation of the infiltration rates with the sprinkler and the double-ring infiltrometers for the first hour of infiltration was highly significant. However, the intake rates with the double-ring infiltrometer ranged from 2.33 to 3.16 times greater than those of the sprinkling infiltrometer (Figure 3). Swartzendruber and Olson (1961), using the double-ring infiltrometer, found that the true infiltration rate may be overestimated. There are at least three reasons for the higher intake rates from the double-ring infiltrometer: First, a 2-inch head of water was used with the double-ring infiltrometer, but the head was negligible in the sprinkler tests; second, impact from the falling drops of water should compact the soil surface in the sprinkler tests but not in the double-ring tests; and third, the surface area was smaller with the double-ring than with the sprinkler, thereby increasing the chances for lateral flow of soil water. Results from the sprinkling infiltrometer approximate actual intake rates; however, results from the double-ring infiltrometer provide valuable comparative data.

The average water-intake rate under sagebrush in one of the heavily grazed pastures with the sprinkling infiltrometer was 8.66 inches per hour or only slightly less than in the nongrazed exclosures. This was about 2.2 times greater than the intake rate on the grassed area between sagebrush plants. Sagebrush canopies covered about 38 percent of the land surface on both the grazed and nongrazed sites; therefore, the water-intake rates were obtained from areas representing about 62 percent of the land surface. The intake rates for all grazing treatments shown in Figure 2 should be increased to be representative of the sites.

These data show that grazing intensity is an important range management factor in absorbing and utilizing maximum precipitation on Pratt loamy fine sand and similar sandy soils in the Southern Great Plains.

Other Soil Characteristics

Bulk Density.—Soil bulk densities of the nongrazed sites were significantly lower to the 3-foot depth than those of the grazed sites (Table 1). Conversely, the bulk density at the heavy stocking rate was higher than the other treatments at all depths, but only in the 4- to 6-inch and the 12- to 24-inch depths were there significant differences at the 5-percent level among the three grazing treatments. During sampling, a large number of insect and rodent burrows were found in the exclosures and under the sagebrush plants. These burrows and the lack of cattle traffic account for most of the lower bulk density of the nongrazed sites.

Water Holding Capacity.—When compared on a moisture content by weight basis, there were no apparent differences in field capacities associated with grazing intensities. Field Capacity—used here as total moisture held in the soil 24 to 30 hours after complete wetting of the soil profile—averaged from 8.3 to 9.5 percent by weight for the various stocking rates, but differences were insignificant. Permanent wilting point—used here as the lower limit of moisture held in the soil profile that is available for plant growth—based on previous tests, averaged about 2.0 percent moisture by weight for each stocking rate. Again the differences were insignificant. When the available soil moisture holding capacities were compared on a volumetric basis, the non-grazed sites retained significantly less available water in the 4-foot profile. The total amount of water needed to recharge the moisture reservoir of a 4-foot Pratt loamy fine sand profile was calculated at 4.90 inches for the nongrazed sites and 5.40 inches for the heavily grazed sites. This lower available water holding capacity on a volumetric basis is related to the lower bulk density of the nongrazed sites.

Penetrometer Pressure.—Penetration resistance of the soil

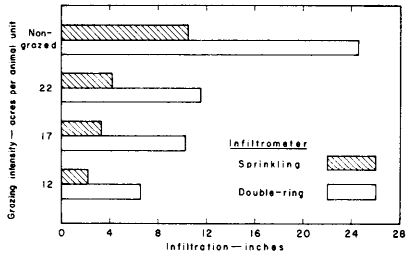


FIGURE 3. Comparison of total water intake during a one-hour period using two types of infiltrometers.

Table 1. Effect of differential stocking rates for 20 years on bulk density of Pratt loamy fine sand soil.

Treatment	Depth (inches) 0-2	2-4	4-6	6-8	8-10	10-12	12-24	24-36	Avg.
	G/cm³								
12 APAU[1]	1.55[a2]	1.73[a]	1.72[a]	1.63[a]	1.61[a]	1.68[a]	1.62[a]	1.62[a]	1.63
17 APAU	1.52[a]	1.68[a]	1.66[b]	1.62[a]	1.60[a]	1.60[ab]	1.56[b]	1.60[a]	1.59
22 APAU	1.52[a]	1.68[a]	1.63[b]	1.62[a]	1.59[a]	1.59[ab]	1.55[b]	1.59[a]	1.58
Nongrazed	1.44[b]	1.47[b]	1.56[c]	1.57[a]	1.53[b]	1.57[b]	1.41[c]	1.50[b]	1.48

[1]Acres per animal unit

[2]Comparable averages for each depth increment with different superscripts are significantly different at the 5-percent level

at field-capacity moisture, measured in pounds per square inch, was greatest on the heavily grazed sites and least on the nongrazed sites. Averages of 90 measurements per site to a depth of 12 inches were:

Stocking rate	Pressure, lbs. per sq. in.
Heavy	58.4[a] [3]
Moderate	37.9[bc]
Light	53.6[ab]
Nongrazed	24.3[c]

Although some of the average penetrometer pressures were significantly different, the reason for the reversal of the data from the lightly and moderately stocked sites is not known.

Organic Matter. — Although the differences in organic matter, due to stocking rate, were small and insignificant, there was slightly more organic matter in the top 2 feet of soil in the nongrazed plots than in the grazed plots. The organic matter content for all treatments averaged 0.95, 0.44, 0.34, and 0.26 percent for the 0- to 6-, 6- to 12-, 12- to 18-, and 18- to 24-inch depths, respectively.

Nitrogen Content. — Differences in soil nitrogen content due to stocking rate were essentially nonexistent. The nitrogen content for all treatments averaged 0.044, 0.026, 0.020, and 0.016 percent for the 0- to 6-, 6- to 12-, 12- to 18-, and 18- to 24-inch depths, respectively. These data differ greatly from those reported from North Dakota by Rogler and Smika (1962). They found that soil nitrogen in pastures heavily grazed for 46 years was higher than in the moderately grazed pastures. The North Dakota study was conducted on a silt loam soil with a nitrogen content about 10 times greater than the Pratt soil at Woodward.

[3] *Comparable averages with different superscripts are significantly different at the 5-percent level.*

Soil Loss.—Soil loss in the runoff water and in the splash from the sprinkling infiltrometer tests on slopes ranging up to 6 percent was essentially non-existent on all grazed and nongrazed sites. The runoff water was usually clear and free of soil material even on the heavily grazed sites.

Vegetation

Total quantity of all attached forage and all detached litter averaged 12,600 pounds per acre for the nongrazed, 5,900 pounds per acre for the lightly grazed, 5,500 pounds per acre for the moderately grazed, and 4,100 pounds per acre for the heavily grazed pastures (Table 2). This decrease in amount of vegetative cover associated with the increase in stocking rate is a major reason for the decrease in water-intake rates. However, the increase in soil bulk density with increasing stocking rate also contributed to the change in intake rates.

The untrampled and uneaten tall-grass production, 3,300 pounds, from the current and previous year's growth on the nongrazed plots plus the great quantity of litter and duff, 8,500 pounds, formed a protective mantle on the soil that far exceeded the covering on the lightly grazed plots. The correlation of range condition class and water-intake rate was highly significant.

The percent of basal cover increased as the stocking rate increased. With the increased grazing intensity, the taller grass species such as sand bluestem (*Andropogon hallii* Hack.), little bluestem (*A. scoparius* Michx.), switchgrass (*Panicum virgatum* L.), and sand lovegrass (*Eragrostis trichodes* (Nutt.) Wood) were replaced by the shorter sod-forming grasses including blue grama (*Bouteloua gracilis* (H.B.K.) Lag. ex Steud.), sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray), fall witchgrass (*Leptoloma cognatum* (Schult.) Chase), and sand paspalum (*Paspalum stramineum* Nash). The greatest basal cover of living vegetation was found in the heaviest grazed pastures, but these pastures contained the smallest quantity of litter and standing forage and possessed the lowest water-intake rate.

These tests indicate that soil bulk density and quantity of vegetal cover, which may change with time and are related to climatic conditions and to the degree of grazing use, greatly influence the ability of the land to absorb rainwater as it falls.

Rainfall and Useable Soil Moisture

Most rainstorms in the area produce less than 2 inches of rainfall; however, rains of high intensity and short duration result in excessive runoff from the Pratt soils. Expected rainfall intensity-frequency data, as compiled by Yarnell (1935), indicate that rainfall intensities of 5.04, 4.50, and 3.60 inches per hour for durations of 5, 10, and 15 minutes, respectively, are expected to occur at least once every 2 years in this area. Thus, one should expect substantial runoff on all of the grazed sites, but only rarely would runoff occur on the nongrazed sites. Observations during the 20-year differential grazing period showed that runoff actually did occur numerous times on all grazed areas. Much of this runoff accumulated in the depressional areas of the dune topography and aided the available moisture supply of the depressions.

Differences in moisture retention caused by changes in bulk density may slightly affect the total moisture supply of the sites. A small summertime rain that penetrates the soil will be more effective in producing plant growth on soil with a lower bulk density, because less of the infiltered water will be held near the soil surface where evaporation is more rapid. Therefore, a

Table 2. Vegetation, litter, and range condition class on sprinkled infiltration plots in relation to pasture stocking rates

Stocking rate	Standing vegetation						Litter						Total vegetation and litter	Range condition class
	Grass													
	Tall[1]	Short[2]	Total	Forbs	Sage	Total	Grass	Forbs	Sage	Manure	Duff	Total		
	(Pounds per acre, oven-dry)													
Heavy; 12 APAU[3]	50	1,550	1,600	T	50	1,650	650	40	260	40	1,460	2,450	4,100[a6]	Fair
Moderate; 17 APAU	230	1,340	1,570	10	T[5]	1,580	830	60	390	540	2,100	3,920	5,500[a]	Low good
Light; 22 APAU	100	1,270	1,370	30	50	1,450	1,140	180	630	0	2,500	4,450	5,900[a]	Good
Nongrazed	3,300[4]	300	3,600	50	450	4,100	1,800	600	1,270	0	4,830	8,500	12,600[b]	Excellent
(Basal density, percent of ground area)														
Heavy; 12 APAU	0.3	23.3	23.6	0.0	0.6	24.2[a]								
Moderate; 17 APAU	1.3	18.6	19.9	.1	.2	20.2[a]								
Light; 22 APAU	.5	10.9	11.4	.1	.4	11.9[b]								
Nongrazed	4.4	2.4	6.8	.1	1.3	8.2[b]								

[1]Sand bluestem, little bluestem, switchgrass, and sand lovegrass.
[2]All grass other than tall grass; predominantly sand dropseed, blue grama, sand paspalum, and fall witchgrass.
[3]Acres per animal unit.
[4]Includes dead standing vegetation from 1 or more years of age.
[5]Trace.
[6]Comparable averages with different superscripts are significantly different at the 5-percent level.

small rain on the lightly grazed sites may be more effective in producing plant growth than on the heavily grazed sites. However, limited observations show that the amount of rain that is intercepted and held for ready evaporation is proportional to the amount of vegetal cover. A large amount of infiltered water may be more effective in producing plant growth on the heavily grazed sites, because more of the water will be retained in the root zone. Differences in effective rooting depth of the plants growing on the various grazing-intensity sites and differences in quantity and intensity of each rainstorm may erase or enhance these moisture retention considerations.

Summary

Water relations for a Pratt loamy fine sand on the Southern Plains Experimental Range in northwestern Oklahoma were investigated after four levels of continuous cattle grazing had been imposed for 20 years. Water-intake rates were determined with a sprinkling infiltrometer and with a double-ring infiltrometer. In addition, the following measurements were obtained from each level of grazing: Soil moisture retention, bulk density, penetration resistance, organic matter, nitrogen content, vegetative cover, and basal cover.

Water-intake rates were inversely proportional to the grazing intensity, regardless of the type of equipment used to approximate intake rates. There was a high correlation between the intake rates measured with the sprinkling infiltrometer and the double-ring infiltrometer; however, the intake rates with the double-ring infiltrometer were about 2 to 3 times greater than those with the sprinkling infiltrometer.

Bulk density and penetrometer measurements showed that grazing compacted the soil. Therefore, grazing intensity affected the quantity of water retained at field capacity and at wilting point. The heavily grazed sites retained about 0.5 inch more water in a 4-foot profile than did the nongrazed sites.

Soil organic matter and nitrogen content decreased as depth of soil increased, but neither organic matter nor nitrogen content was significantly affected by stocking rate.

Soil loss in the runoff water and in the splash from the sprinkling infiltrometer tests was negligible, even on the heavily grazed sites.

A soil-protecting cover of about 6 tons of standing vegetation and litter per acre was found on the nongrazed sites, whereas 2 to 3 tons were found on the grazed sites. Quantity of vegetative cover, both living and dead, and range condition class were correlated with the water-intake rates. The short, sod-forming grasses predominated under heavy grazing and tall bunch grasses predominated on the nongrazed sites.

LITERATURE CITED

DULEY, F. L. AND C. E. DOMINGO. 1949. Effect of grass on intake of water. Nebr. Agr. Expt. Sta. Res. Bul. 159: 1-15.

JAMISON, V. C. 1945. The penetration of irrigation and rain water into sandy soils of Central Florida. Soil Sci. Soc. Amer. Proc. 10: 25-29.

JOHNSTON, ALEXANDER. 1962. Effects of grazing intensity and cover on the water-intake rate of fescue grassland. Jour. Range Mangt. 15: 79-82.

LETEY, J., J. OSBORN, AND R. E. PELISHEK. 1962. The influence of water-solid contact angle on water movement in soil. Bul. Internatl. Assoc. Sci. Hyd. 3: 75-81.

LOCKE, L. F., H. V. ECK, B. A. STEWART, AND H. J. HAAS. 1960. Plow-

pan investigations at the Great Plains Field Stations, Woodward, Oklahoma, and Mandan, North Dakota. U. S. Dept. Agri. Prod. Res. Rept. No. 40. Washington, D. C. 33 pp.

PARKER, K. W. AND D. A. SAVAGE. 1944. Reliability of the line interception method in measuring vegetation on the Southern Great Plains. Jour. Amer, Soc. Agron. 36: 97-110.

PIPER, C. S. 1950. Soil and plant analysis. Interscience Publishers, Inc., New York.

RAUZI, FRANK. 1960. Water-intake studies on range soils at three locations in the Northern Plains. Jour. Range Mangt. 13: 179-184.

RAUZI, FRANK AND DARRYL E. SMIKA. 1963. Water intake on rangeland as affected by simulated grazing and fertilization. Jour. Range Mangt. 16: 125-128.

RHOADES, EDD D. 1961. A mobile double-tower sprinkling infiltrometer. Jour. Soil and Water Cons. 16: 181-182.

ROGLER, GEORGE A. AND DARRYL E. SMIKA. 1962. A 46-year comparison of two intensities of grazing on the vegetation, beef production, and soil fertility of the Northern Plains Rangelands. Jour. Range Mangt. Abstract of Papers, 15th Ann. Meeting, Jan. 23-26.

SWARTZENDRUBER, DALE AND T. C. OLSON. 1961. Sand-model study of buffer effects in the double-ring infiltrometer. Soil Sci. Soc. Amer. Proc. 25: 5-8.

TERRY, C. W. AND H. M. WILSON. 1953. The soil penetrometer in soil compaction studies. Agr. Engr. 34: 831-834.

YARNELL, DAVID L. 1935. Rainfall intensity-frequency data. U. S. Dept. Agr. Misc. Pub. 204. 67 pp.

Chemical Control of Plains Pricklypear in Southeastern Wyoming

A. P. THATCHER, G. V. DAVIS, AND H. P. ALLEY
Range Conservationists, U. S. Soil Conservation Service, Casper and Torrington, Wyoming, and Assistant Professor, Department of Plant Science, University of Wyoming, Laramie

The invasion and increase of plains pricklypear *(Opuntia polyacantha)* has become an acute problem in many range areas of Wyoming. The Soil Conservation Service recently estimated that 1,500,000 acres were infested to such an extent that control measures are necessary to permit restoration of the excellent range condition class within a reasonable period. In many places it has increased from less than 2.5 percent of the total annual production, by weight, to over 60 percent.

Wyoming ranchers have long used such practices as burning, railing and blading in attempts to control the pricklypear. These methods ordinarily gave unsatisfactory control or were uneconomical. A review of range herbicide literature, (Thomas, 1956) (Hoffman et al., 1955) (Young, 1951) (Cornelius, 1951), and correspondence with researchers in this field, indicated that several herbicides might prove both effective and economically feasible.

Most herbicides are not readily absorbed by the plains pricklypear. The pads are covered with a thick cutin layer and the stomata, through which the herbicide might enter the vascular system, are open only at night (Daubenmire, 1956). Moreover, the herbicide must enter largely through stems (pads) since the true leaves are extremely small and present for only a short time during favorable moisture conditions in the spring. Therefore, to increase the absorption by the plant, the puncturing or other mechanical damaging of the pads, just prior to the application of herbicides, was considered as a means of getting more of the chemical into the vascular system.

Experimental Area

All of these field trials were established on the Morton ranch, 15 miles northwest of Douglas, Wyoming. This area receives an average of approximately 11 inches of precipitation annually. Elevation is about 5,000 feet above sea level. The trials were located on normal sandy loam soils (Sandy range site) where response of the vegetation in the Poor range condition class could be checked against response in the Good condition class. Plots were not grazed during the 1961, 62 and 63 growing seasons.

Associated species on the plots included needle and thread *(Stipa comata)*, western wheatgrass *(Agropyron smithii)*, sand dropseed, *(Sporobolus cryptandrus)*, blue grama *(Bouteloua gracilis)*, prairie junegrass *(Koeleria cristata)*, bottlebrush squirreltail *(Sitanion hystrix)*, Sandberg bluegrass *(Poa secunda)*, cheatgrass brome *(Bromus tectorum)*, sixweeks fescue *(Festuca octoflora)*, big sagebrush *(Artemisia tridentata)*, prairie pepperweed *(Lepidium densiflorum)*, tansey mustard *(Sophia pinnata)*, annual sunflower *(Helianthus annuus)*, curlycup gumweed *(Grindelia squarrosa)*, pale evening primrose *(Oenothera albicaulis)* and threadleaf sedge *(Carex filifolia)*.

Methods and Procedures

On June 1, 1961, 1x2 rod plots of pricklypear infested rangeland were treated with 2,4,5-Trichlorophenoxy acetic acid (2,4,5-T), 2,3,6 Trichlorobenzoic acid (2,3,6 TBA) and 2,4,5 Trichloropropionic acid (silvex) at various rates and combinations shown in Table 1. Each treatment was replicated three times. The object of this initial project was to select those herbicides and combinations most effective

for later use in larger scale trials.

Half of each plot was mechanically treated to injure the cactus plants prior to the chemical application. A cultipacker was pulled over the plants in such a manner that most of them were punctured, broken, or otherwise injured. Chemicals were applied with a hand-type boom sprayer immediately after mechanical treatment before the wounds could dry. The 2,4,5-T was applied at 2 and 4 pounds per acre (active) using all of the various combinations possible with 40 and 80 gallons of water and with 40 and 80 gallons of a 1:9 diesel oil-water emulsion. In addition, each of the above combinations was also applied with the X77 spreading agent. 2,4,5-T was also applied at a rate of 12 pounds per acre using 40 gallons of 1:9 diesel oil-water emulsion with the spreading agent.

2,3,6 TBA was applied at a rate of 2.5 and 5 pounds in 40 gallons of water per acre. A high rate of 10 pounds of 2,3,6 TBA per acre using 40 gallons of 1:9 diesel oil-water emulsion with the X77 spreading agent was also applied.

Silvex was applied at a rate of 2 and 4 pounds per acre using 80 gallons of water, with and without the X77 spreader. It was also applied at 12 pounds per acre using 40 gallons of 1:9 diesel oil-water emulsion per acre with the spreading agent.

The soil moisture was 8 to 10 inches deep at the time of application. Nearly all of the associated vegetation was green and growing. The true leaves were present on the pricklypear plants. The area, which had just experienced a severe prolonged drouth, received average precipitation during the 1961 growing season. Moisture conditions continued to be average or slightly above during the 1962 and 1963 seasons. Thus response of the associated vegetation could be studied in connection with the effects of herbicides on the pricklypear.

The second trial was initiated on June 27, 1962. Silvex (Kuron), which had proven to be most effective in controlling the pricklypear in the 1961 trials, was applied on larger plots to learn if the results could be duplicated. As shown in Table 2, it was applied at two and four pounds per acre using 40 gallons of water with the X77 spreading agent, on acre plots containing a

Table 1. Control of plains pricklypear in 1961 trials using 2,4,5-T; 2,3,6 TBA and silvex with various carriers with and without prior mechanical treatment.

Herbicides, Carriers and Rate of Application Per Acre	Control Observed September, 1962 Mechanically Treated	Control Observed September, 1962 No Mechanical Treatment	Control Observed September, 1963 Mechanically Treated	Control Observed September, 1963 No Mechanical Treatment
	— — — — — — percent — — — — — —			
12 lb. 2,4,5-T Per Acre				
40 gal. water, X77	100	90	95	80
4 lb. 2,4,5-T Per Acre				
80 gal. water	75	25	50	10
80 gal. water, X77	80	25	60	15
40 gal. water	70	25	50	5
40 gal. water, X77	80	15	60	10
80 gal. 1:9 oil-water emulsion	75	35	55	10
80 gal. 1:9 oil-water emulsion, X77	80	40	60	20
40 gal. 1:9 oil-water emulsion	85	35	70	25
40 gal. 1:9 oil-water emulsion, X77	85	40	70	35
2 lbs. 2,4,5-T Per Acre				
80 gal. water	55	10	40	5
80 gal. water, X77	65	15	45	5
40 gal. water	75	10	50	10
40 gal. water, X77	45	10	30	5
80 gal. 1:9 oil-water emulsion	70	15	50	10
80 gal. 1:93 oil-water emulsion, X77	70	15	50	15
40 gal. 1:9 oil-water emulsion	65	15	60	15
40 gal. 1:9 oil-water emulsion, X77	70	25	50	25
10 lb. 2,3,6 TBA Per Acre				
40 gal. 1:9 oil-water emulsion, X77	95	80	95	80
5 lb. 2,3,6 TBA Per Acre				
40 gal. water	90	30	85	45
2.5 lb. 2,3,6 TBA Per Acre				
40 gal. water	80	20	85	55
12 lb. silvex Per Acre				
40 gal. 1:9 oil-water emulsion, X77	100	100	100	100
4 lb. silvex Per Acre				
80 gal. water	95	85	90	70
80 gal. water, X77	95	80	95	75
2 lb. silvex Per Acre				
80 gal. water	80	60	80	50
80 gal. water, X77	85	60	90	40
Mechanically treated only	50		30	
Check Plots[1]		15		15

[1]Percent of plains pricklypear dying from natural causes.

Table 2. Control of plains pricklypear, 1962 trials with silvex in 40 gallons water and X77 spreader with and without prior mechanical treatments, on one-acre plots. Evaluated September, 1963.

Rates of silvex	Percent Control
2 lbs. no mechanical treatment	65
2 lbs. with mechanical treatment	90
4 lbs. no mechanical treatment	85
4 lbs. with mechanical treatment	99
Mechanical treatment only	25

considerable amount of pricklypear. These same rates also were applied on acre plots which had been mechanically treated. Another acre plot was mechanically treated only.

A cultipacker was used to mechanically treat the plots, as in the first experiment. Approximately 40 percent of the cactus pads were injured by either puncturing or breaking. The herbicide was applied within an hour after the mechanical treatment with a truck-mounted boom-type sprayer operating at 40 pounds p.s.i. Wind velocities less than 5 mph, moderate humidity and a temperature of about 80° F made conditions ideal for spraying. All of the vegetation was green and growing. There was ample moisture available for plant growth. The pricklypear was in the bloom stage and still held most true leaves.

Percent control as recorded from these trials were the average of three individuals making separate ocular estimates. The individual estimates did not vary more than 10 percent and in most cases were less than 5 percent.

Results and Discussion

Ocular estimates were made of the percent of plains pricklypear on the initial (1961) trials. The plots kill were read in September of 1962 and again in September of 1963. Thus the plot records show results through three complete growing seasons. Table 1 shows the observed control each year in this trial.

Table 2 shows the amount of control obtained on the acre plots established in 1962. The ocular estimates were made in September of 1963, after two growing seasons.

2,4,5-T.—The best pricklypear control was obtained using the 12 pounds per acre application; however, all of the associated vegetation was severely damaged. The 2 and 4 pound rates killed most of the forbs and brush species, but did not noticeably effect the associated grass species. 2,4,5-T applied at the 4 pound per acre rate gave the next best pricklypear control. The least control was obtained using the 2 pound rate.

All of the rates were most effective when used in combination with the mechanical treatment. 2,4,5-T without any mechanical injury resulted in a maximum of 40 percent control. Mechanical injury to the pricklypear plants approximately doubled the percent of control. Using a carrier of 1:9 diesel oil-water emulsion increased the percent control approximately 10 percent over the use of water alone. The spreading agent X77 also seemed to increase the effectiveness of the chemical. The amount of carrier applied per acre made little difference in the control obtained.

2,3,6 TBA.—A maximum of 95 percent control was obtained using a 10 pound per acre application on mechanically treated plots. The 2.5 and 5 pound rates also gave good initial control, but all of the associated vegetation was severely damaged, regardless of the type of treatment. The most severe damage occurred using the 10 pound rate. The plots were still nearly devoid of any vegetation, with the exception of some plains pricklypear, after three growing seasons.

Silvex.—Silvex applied on the initial trials at a rate of 12 pounds per acre, in a carrier of 1:9 oil-water emulsion with the X77 spreading agent added, resulted in complete control of the pricklypear. However, all of the associated vegetation, with the exception of *Carex filifolia,* was severely damaged. The 2 and 4 pound rates, applied with a water carrier, resulted in no damage to the associated grass species. Forbs and brush species were, however, completely killed.

Mechanically treating the plots increased the control percentage. Four pounds of silvex applied on the mechanically treated plot resulted in 90 to 95 percent control. The 2 pound rate resulted in 80 to 90 percent control. The application of chemicals without mechanical treatment reduced the effectiveness as much as 30 percent. The addition of the X77 spreading agent seemed to increase, somewhat, the effectiveness of the herbicide.

Two and 4 pound rates of silvex were superior to the other chemicals in the trial as they resulted a desirable pricklypear control and still did not damage the range grasses. These rates applied to the one-acre plots (1962 trials) again resulted in very good control. As shown in Table 2, the 4 pound rate applied with mechanical treatment resulted in nearly complete control (99 percent) of plains pricklypear. The 2 pound rate on the mechanically treated plot reduced the control received to 90 percent. Herbicides applied in the absence of mechanical treatment were less effective from 15 to 25 percent. The expanded 1962 trials largely confirmed results from the earlier smaller trials. Silvex did not damage any of the grass species in the associated vegetation; however, nearly 90 percent of the big sagebrush was killed, along with

most of the annual and perennial forbs.

Prior Mechanical Treatment.—Mechanically treating plains pricklypear, prior to applying herbicides, greatly increased the kill of pricklypear, except where high rates of chemicals were used. It was not determined whether the increased control resulted from an extra amount of herbicide entering the vascular system through the injured tissues, or from the physical damage to the plant, or a combination of both.

An appraisal of the initial trials, near the close of the second growing season, indicated approximately 50 percent of the plans pricklypear control could be attributed to mechanical injury. However, at the end of the third growing season (September 1963), the amount of pricklypear had increased to where only 30 percent of the cactus had been controlled. The 1962 trials showed that approximately 25 percent of the pricklypear was controlled by mechanical injury alone by the end of the second growing season.

Some of the pricklypear apparently died from natural causes during 1962 and 1963. Approximately 15 percent of the plains pricklypear was destroyed in the check plots. The area received an above normal amount of moisture during the 1962 and 1963 spring and early summer months. A number of insects, notably the pricklypear bug *(Chelinidea vittiger)* and Northern cochineal mealy bug *(Dactyloplus sp.)* invaded the numerous cactus patches. A number of pricklypear pads were observed to have been hollowed out by some insect.

There was evidence that the plains pricklypear would reinvade the rangeland if conditions were favorable. After three growing seasons, the 1961 trials showed an increase of 10 to 25 percent in the amount of pricklypear. The largest increases were on those plots with poor kills. As stated previously, these plots were established on poor condition rangeland where competition between the plains pricklypear and native perennial grasses would not be as great as on better condition ranges. No general increase was noticed on the 1962 acre size plots which were established on rangeland in good condition.

Summary

Field trials to chemically control plains pricklypair were conducted near Douglas, Wyoming during the spring seasons of 1961 and 1962. Results were recorded through three growing seasons. 2,4,5-T, 2,3,6 TBA and silvex were applied as sprays to plains pricklypear in various rates and with various kinds and amounts of carriers during the spring of 1961. Half of each plot was mechanically treated with a cultipacker so as to puncture or injure the pricklypear plant just prior to applying the herbicides. Silvex was generally superior to the others herbicides. In 1962, 2 and 4 pounds of silvex were applied to mechanically treated and non-mechanically treated acre-size plots. The results of these two trials can be summarized as follows:

1. Silvex proved to be superior to 2,3,6 TBA and 2,4,5-T when applied at 2 and 4 pounds per acre. These rates proved effective in controlling plains pricklypear and did not injure any of the desirable range grasses. These rates also effectively controlled the big sagebrush.

2. Prior mechanical injury of pricklypear plants greatly increased the effectiveness of all the herbicides except those applied at the 10 and 12 pound rates.

3. Mechanical injury alone contributed approximately 25 to 30 percent of the control.

4. 2,3,6 TBA damaged or killed most of the desirable range plants at all rates. The high rates of silvex and 2,4,5-T also damaged some of the desirable forage plants.

5. Approximately 15 percent of the plains picklypear control resulted from insect damage and other natural causes.

6. The estimated cost of applying 2 and 4 pound rates of silvex would be $8 to $14 per acre respectively which includes cost of mechanical injury and application of chemical.

LITERATURE CITED

CORNELIUS, D. R. ET AL. 1959. Handbook, Chemical Control of Range Weeds. U. S. Department of Agriculture, U. S. Department of the Interior, Range Seeding Equipment Committee. (Revised) 44 pp.

DAUBENMIRE, R. F. 1958. Plants and Environment, A Textbook of Plant Autecology. John Wiley & Sons, Inc., New York, N. Y. 424 pp.

HOFFMAN, G. O., WALKER, A. H., AND DARROW, R. A. 1955. Pricklypear Good or Bad. Texas Agricultural Extension Service Bulletin 806.

THOMAS, G. W., AND DARROW, R. A. 1956. Response of Pricklypear to Grazing and Control Measures, Texas Range Station, Barnhart. Texas Agricultural Experiment Station Progress Report No. 1873.

YOUNG, VERNON A. ET AL. 1951. Recent Developments in the Chemical Control of Brush on Texas Ranges. Texas Agricultural Experiment Station Bulletin 721 (Rev).

LANGUAGE AND WRITING

Recognition of language—its function and its subtleties—come more easily in speaking and listening than in writing . . . Writing creates an awareness of language for strengthening the instruments of thought . . . The uses of language affect the uses of mind.—*Jerome S. Bruner*

Control of Yucca By Aerial Application of Herbicides[1]

R. W. BOVEY
Crops Research Division, ARS, USDA, Department of Range and Forestry, Texas A & M University, College Station, Texas[2]

Yucca (*Yucca glauca* Nutt.), also commonly called soapweed, beargrass, or Spanish bayonet, is a generally undesirable perennial that occurs on thousands of acres of rangeland in Nebraska and surrounding states. The plant grows to a height of 1 to 3 feet and possesses many long, thick, sharp-pointed leaves with thready margins (Figure 1). Robison (1961) described yucca as a xerophytic plant with a large deep root system that serves as a storage organ for food reserves and moisture which enables the plant to survive drought. The sharp-pointed leaves form a rosette that resists excessive transpiration loss under adverse conditions.

Aerial application studies conducted by Robison (1961) in Texas revealed that 2,4,5-trichlorophenoxy acetic acid (2,4,5-T) and 2-(2,4,5-trichlorophenoxy propionic acid (silvex) gave the most consistent results of several herbicides applied. Treated areas produced an average of 1,831 pounds (oven-dry) of forage per acre compared to 846 pounds on untreated plots.

Preliminary yucca control studies were established by Shafer (1958) at Paxton, Nebraska. Herbicides used were 2-(2,4-dichlorophenoxy) propionic acid [2-(2,4-DP]), polychlorobenzoic acid (PBA), 2-(2-methyl-4-chlorophenoxy) propionic acid [2-(MCPP)], and silvex, applied by a ground sprayer. Silvex was most effective, giving 98 percent yucca control at 2 lb/A.

This study was conducted to determine the most effective herbicide, herbicide carrier, and spray volume needed for aerial control of yucca in western Nebraska.

Materials and Methods

Aerial applications of herbicides were made on a Dune sand soil for yucca control at Angora, Nebraska. The dunes are sharply rolling and separated in many places by steep slopes, varying from 30 to 100 feet in height. A small proportion is under active wind erosion in blow-out areas. Annual average temperature is approximately 48° F. Mean annual precipitation is 15.5 inches with the majority occurring in spring and summer.

Initial applications were made on June 5, 1958, with a Piper Super Cub. Each plot consisted of three flight strips, each 33 feet wide and 440 feet long (1 acre). Herbicide treatments consisted of the propylene glycol butylether (PGBE) ester of silvex at 1 and 2 lb/A in combination with nine herbicide carriers. One lb/A of the PGBE ester of 2,4,5-T in a 1:1 oil-water emulsion was included for comparison. Herbicide rates, carriers, and spray volumes per acre were applied as follows:

1. One lb/A 2,4,5-T in a 1:1 oil-water emulsion at 2 gpa
2. Two lb/A silvex in No. 2 diesel oil at 2 gpa
3. Two lb/A silvex in water at 2 gpa
4. One lb/A silvex in water at 2 gpa
5. Two lb/A silvex in a 1:1 oil-water emulsion at 2 gpa
6. Two lb/A silvex in a 1:4 oil-water emulsion at 5 gpa
7. One lb/A silvex in water at 5 gpa
8. Two lb/A silvex in water at 5 gpa
9. Two lb/A silvex in No. 2 diesel oil at 5 gpa
10. Two lb/A silvex in water at 10 gpa

Yucca control observations were made in October, 1958, and June, 1959. Final control evaluations were made in September, 1960, on 10 yucca clumps selected at random in each plot by determining whether they were dead or alive. Percentage kill figures were then derived from these counts.

In 1960, a second set of one-acre plots was sprayed at Angora with a Piper Super Cub as before. Treatments of PGBE ester of silvex at 1, 2, and 4 lb/A. were applied in No. 2 diesel oil at 5 gpa total solution when yucca was flowering. Plots were

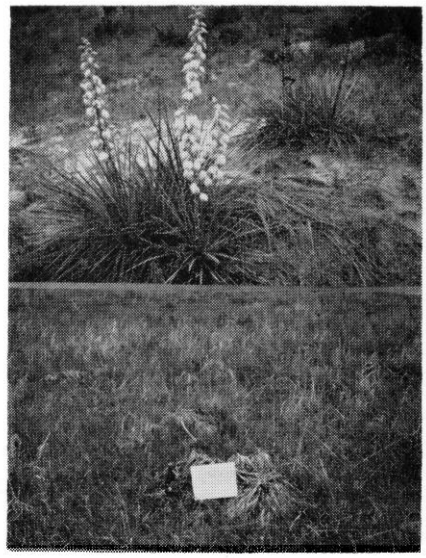


FIGURE 1. *Top*—Yucca in flower at Angora, Nebraska. June 18, 1963. *Bottom*—Control of yucca by application of single treatment of 2 lb/A silvex applied in No. 2 diesel oil at 5 gpa., June 17, 1960; photograph June 18, 1963. Note luxuriant native grass growth on treated area.

[1] *Published with the approval of the Director as Paper No. 1464, Journal Series, Nebraska Agricultural Experiment Station. This research work was partly financed by the Nebraska Department of Aeronautics, Lincoln, Nebraska.*

[2] *Formerly Instructor in Agronomy, Dept. of Agronomy, Nebraska Agricultural Expt. Sta., Lincoln, Nebraska.*

treated initially on June 17, 1960. Repeat treatments on June 20, 1961, were the same herbicides and rates as original ones superimposed on one-half of the same plots. Percentage kill was determined by randomly selecting 15 yucca clumps in each plot and assigning a kill rating to each clump in a range of 0-10. No control was given a value of 0; complete kill, 10. The values obtained were converted to percentage kill.

A third experiment using different herbicide carriers and spray volumes was applied on June 20, 1961, to study their influence on yucca kill. Two lb/A of the PGBE ester of silvex was selected as the herbicidal treatment. Number 2 diesel oil, water, and water plus a surfactant (Multifilm X-77) were the three carriers used. Spray volumes were 2 and 5 gpa. Each plot was 2 flight strips (66 feet) wide and 240 feet long. Each treatment was replicated. Percentage kill was determined by randomly selecting 20 yucca plants or clumps in each plot which were evaluated in a similar manner for the June, 1960, study. After control evaluations were made the plots were retreated on June 18, 1962, with treatments identical to those applied in June, 1961.

Results and Discussion

Observations made in October, 1958, four months after applications of silvex at Angora, Nebraska, revealed silvex at 2 lb/A applied in No. 2 diesel oil at 5 gpa gave most effective control. Silvex at 2 lb/A in No. 2 diesel oil at 2 gpa was considered the second most effective treatment. Silvex, at 2 lb/A, applied in a 1:1 oil-water emulsion at 2 gpa and silvex at 1 lb/A in water at 5 gpa, were ranked third. In June, 1959, 2 lb/A silvex applied in No. 2 diesel oil at 5 gpa remained the most effective yucca control treatment, with an estimated 35 percent kill. The remaining yucca plants were very chlorotic and had not produced flower stalks. The next best treatment was silvex at 2 lb/A applied as a 1:1 oil-water emulsion at 2 gpa. The estimated kill was 30 percent with mostly chlorotic plants remaining. All other treatments produced less injury and kill. The plots receiving 1 lb/A of 2,4,5-T showed no apparent control. Evaluations of the plots on September 16, 1960, are presented in Table 1. Silvex at 2 lb/A, applied in No. 2 diesel oil at a total spray solution of 5 gpa, remained the most effective treatment at 80 percent control. Silvex, at 2 lb/A applied as a 1:1 oil-water emulsion, was also a relatively effective treatment.

The 1960 studies aimed to determine what rate of silvex was most effective with the No. 2 diesel oil carrier at 5 gpa. Results in Table 2 show that most effective control was obtained with silvex at 2 and 4 lb/A. Some regrowth, mostly small isolated shoots, took place the first year following treatment. Based on an actual plant volume or weight basis, control was better than indicated by values given in Table 2. It was difficult, one year after treatment, to predict if yucca regrowth would increase. In the study established in June, 1958, considerable regrowth occurred 2 years after a single treatment of silvex. With this information, retreatment was considered desirable for the plots treated in 1960. By retreating one-half of each plot with original treatments, single and repeat applications could be observed. Yucca control evaluations made in June, 1962, 2 years after original treatment, revealed 95 percent

Table 1. Percentage kill of yucca from single application of 2,4,5-T and silvex in combination with herbicide carriers and volumes per acre at Angora, Nebraska. Treatments June, 1958; evaluated, September, 1960.

Herbicide and carrier	Herbicide	Kill[1]
	(Lb/A)	(Pct)
2,4,5-T + 1:1 emulsion at 2 gpa	1	0
Silvex + No. 2 diesel at 2 gpa	2	30
Silvex + water at 2 gpa	2	60
Silvex + water at 2 gpa	1	30
Silvex + 1:1 emulsion at 2 gpa	2	70
Silvex + 1:4 emulsion at 5 gpa	2	50
Silvex + water at 5 gpa	1	10
Silvex + water at 5 gpa	2	30
Silvex + No. 2 diesel oil at 5 gpa	2	80
Silvex + water at 10 gpa	2	30

[1]Percentage kill was derived by evaluating at random ten plants. If any regrowth occurred following treatment, plants were considered alive.

Table 2. Percentage kill[1] of yucca after single and repeated applications of silvex in No. 2 diesel oil at spray volume of 5 gpa.

		Time after application					
		Single application			Repeat application		
Herbicide	Lb/A	3 mo.	1 yr.	2 yr.	1 yr.	2 yr.	3 yr.
		(Percent)					
Silvex	1	67	45	76	87	75	74
Silvex	2	84	75	95	94	95	98
Silvex	4	91	70	95	98	94	86

[1]Percentage kill was determined by evaluating 15 yucca plants in each plot. A kill evaluation based on total top kill was assigned each plant with no top kill given a value of 0; and complete top kill with no regrowth as 10. Values for each plot were averaged and converted to percentage kill.

control was obtained when 2 and 4 lb/A silvex were used as a single application. Plots treated with 4 lb/A silvex showed no increase in yucca kill over those treated with 2 lb/A silvex. The 1 lb/A rate of silvex gave 76 percent yucca control. There were no major changes in control values from 2 to 3 years after a single application of silvex from June, 1962, to June, 1963.

Additional herbicides were applied in June, 1961, to study the influence of carriers and spray volumes on yucca kill in more detail (Table 3). No significant differences were found between the 2 and 5 gpa spray volume treatments. No 2 diesel oil tended to be superior to other carriers at 2 and 5 gpa in combination with 2 lb/A silvex as a single application. Evaluations of repeated applications of silvex showed improved yucca control in all plots.

Table 3. Percentage control[1] of yucca one year after single and repeat applications of 2 lb/A silvex in No. 2 diesel oil, water, and water plus surfactant carriers at spray volumes of 2 and 5 gpa.

Herbicide and Carrier	Single application	Repeated application
	— — — — (Percent) — — — —	
Silvex + water at 2 gpa	85	98
Silvex + water + surfactant[2] at 2 gpa	69	97
Silvex + No. 2 diesel oil at 2 gpa	87	98
Silvex + water at 5 gpa	70	99
Silvex + water + surfactant[2] at 5 gpa	86	98
Silvex + No. 2 diesel oil at 5 gpa	93	99

[1]Percentage kill was determined by evaluating 20 yucca plants in each plot.
[2]Alkylaryl polyoxyethelene glycol (Multifilm X-77 at 0.1%).

Summary and Conclusions

Preliminary studies of yucca control by aircraft applications revealed that silvex applied at 2 lb/A in No. 2 diesel oil at 5 gpa total spray solution gave the best yucca kill from a single application of all herbicides, carriers, and spray volumes used. A substantial amount of yucca regrowth was found in all plots two years following treatment indicating retreatment was necessary for best control.

In June, 1960, studies were conducted to determine the most economical and effective silvex rates to use in combination with No. 2 diesel oil. Results revealed that 2 lb/A of silvex gave as much yucca kill as 4 lb/A. Repeat applications one year after initial treatment did not improve control. Some yucca regrowth occurred in all plots. Total regrowth was considered small and lacked regenerative vigor as indicated in counts taken 1, 2, and 3 years after treatment.

In a herbicide carrier-spray volume study established in June, 1961, no differences were found in yucca kill between 2 and 5 gpa spray volume treatments. No. 2 diesel oil applied as the silvex carrier tended to produce the best yucca kills from a single application. Repeated applications of identical treatments did increase kill.

For most economical and satisfactory results, yucca in western Nebraska should be treated with a single application of 2 lb/A silvex using No. 2 diesel oil as the carrier. Retreatment is expensive, consequently repeated applications should be made only if necessary. Sufficient regrowth to necessitate retreatment may not occur until several years after initial treatment.

LITERATURE CITED

ROBISON, E. D. 1961. Aerial application of herbicides for the control of yucca. Proc. 14th Ann. Southern Weed Conf.

SHAFER, N. E. 1958. Use of aircraft in agriculture. Ann. Rpt. of Project 12-20. Nebraska Agr. Expt. Sta., Lincoln, Nebraska.

NOTICE TO ALL MEMBERS

New application cards and brochures citing new dues rate have been distributed to Sections. Please **destroy** all old brochures and application cards in your possession and, if you need them, order new from your Section Secretary.

Herbage Production Responses to Pelleted Fenuron and Granular 2,3,6-TBA

EUGENE E. HUGHES AND R. A. DARROW[1]
Range Conservationist (Research) Agricultural Research Service, USDA, Los Lunas, New Mexico, and Chief, Crops Division, U. S. Army Biological Laboratories, Fort Detrick, Maryland

Introduction

In an effort to extend the scope of control measures for undesirable plants, granular or pelleted forms of certain herbicides have been developed. These formulations may be applied on the soil surface where they will be carried into the soil by rainfall and enter the plant roots. This type of herbicide may be used on grasses as well as on other plants. Brush control research has been directed toward the use of these new granular or pelleted chemicals, particularly 3-phenyl-1, 1-dimethylurea (fenuron), and 2,3,6-trichlorobenzoic acid (2,3,6-TBA). Little is known of the tolerance of native range grasses to soil herbicides, especially to the higher rates of application.

In an effort to supply information on the effects of these granular herbicides on grasses and the duration of toxicity under varying soil conditions, this study was designed to measure the effects of soil surface applications of fenuron and 2,3,6-TBA at different rates and dates of application on native forage production on three range sites.

Review of Literature

Most of the research in selective control by granular herbicides has dealt with pre-emergence weed and grass control. Carlson (1954) stated that in tests on pre-emergence weed control in sugar cane (*Saccharum officinarum* L.), rates up to 5 pounds per acre of 3-chlorophenyl 1-1, 1-dimethylurea (monuron) did not harm the crop. Cristoph and Fisk (1954) studying the stage of growth at which plants were affected, tested monuron on barley (*Hordeum vulgare* L.) and soybeans (*Glycine max* [L.] Merr.) at rates up to 2 pounds per acre. They found that 30 percent of the barley plants treated before early jointing were killed. At 0.75 pound per acre there was some leaf dieback and at 0.25 pound there was no apparent effect. Darrow and McCully (1958), studying the effect of applications of fenuron pellets on post oak (*Quercus stellata* Wang.) and blackjack oak (*Quercus marilandica* Muenchh.), found that at 4 pounds of active material per acre desirable perennial grasses apparently were not damaged.

Previous studies with 2,3,6-TBA have been conducted principally with foliage spray applications. Work by Furtick, et al[2] involved the use of 2,3,6-TBA for post-emergence treatment of grasses. Their results showed that both 1- and 2-pound rates completely controlled tall fescue (*Festuca arundinacea* Schreb.), ryegrass (*Lolium* spp.), orchardgrass (*Dactylis glomerata* L.), and red fescue (*Festuca rubra* L.). A progress report by Buchholtz presented to the North Central Weed Control Conference in 1956[3] showed that the formulation X-80, a polychlorobenzoic acid, controlled 90 percent of perennial quackgrass (*Agropyron repens* [L.] Beauv.) at a 4-pound-per-acre rate. Darrow (1957) reported that 2,3,6-TBA when applied as an oil spray, at a 2- to 4-pound rate, is about equal to 1.5 pounds of 2, 4, 5-T or 2-(2,4,5,-TP) esters when used for control of oak and associated woody species.

Methods and Materials

The study area was on the Range and Forestry Area of the Texas Agricultural Experiment Station, approximately 2.5 miles southwest of College Station. The vegetation consisted of post and blackjack oaks with various shrubs and areas of pure grassland interspersed. This study was conducted in such open grassland areas on three range sites: sandy upland, prairie upland, and bottomland, as described by Nord (1953).

The soils are red and yellow podzolic with friable to dense subsoils or claypan soils. The sandy upland soil is a Tabor fine sandy loam and has a topsoil depth of 6 to 10 inches with very slowly permeable subsoil of mottled clay. The dominant grass is little bluestem (*Andropogon scoparius* Michx.)

The prairie upland soil is Houston-Hunt clay with an 18-inch layer of yellowish-brown or gray clay grading downward to an olive or brownish-yellow calcareous clay subsoil which is only slowly permeable. Upon drying, this soil cracks deeply. Texas needlegrass (*Stipa leucotricha* Trin. & Rupr.) and sideoats grama (*Bouteloua curtipendula* [Michx.] Torr.) inhabit this site.

Bottomland soils are Gowen clay loam, derived from transported materials. The type is fri-

---

[1] *This work was carried out by the senior author in 1957 while serving as research assistant at the Texas Agricultural Experiment Station, College Station, Texas, under the co-author, then Professor of Range Management at that location. Work was in partial fulfillment for a master's degree in Range Management at Texas A. & M. College, College Station, Texas.*

[2] *Technical Service Data Sheet, H-63. March 3, 1956. American Chemical Paint Co.*

[3] *Hooker Electrochemical Co. Progress Report. 1957.*

able to firm, very hard when dry, sticky when wet, with the upper 2 feet darkened by humus. The soil exhibits practically no development because of its young age. Brownseed paspalum (*Paspalum plicatulum* Michx.) is the dominant grass.

Precipitation during the study at Easterwood Airport within a mile of all three sites is shown by 15-day periods in Table 1.

Hand-broadcast surface applications of ⅛-inch extruded pellets of fenuron and 2,3,6-TBA 8/15 granules were made on three dates, December 15, 1957, February 15, 1959, and April 15, 1958, on each of the three range sites. Treatments on each date were fenuron at 4, 6, 8, 10, and 12 lb/A and 2,3,6-TBA at 6, 9, 12, and 15 lb/A on an active ingredient basis, and none (check).

Table 1. Precipitation from December 15, 1957, to June 1, 1958, Easterwood Airport, College Station, Texas.

Period	15-day total	Accumulated total
	(Inches)	
Dec 15-Jan 1	2.61	2.61
Jan 1-Jan 15	1.37	3.98
Jan 15-Feb 1	1.68	5.66
Feb 1-Feb 15	.66	6.32
Feb 15-Mar 1	2.06	8.38
Mar 1-Mar 15	.40	8.78
Mar 15-Apr 1	1.18	9.96
Apr 1-Apr 15	.59	10.55
Apr 15-May 1	3.58	14.13
May 1-May 15	1.98	16.11
May 15-June 1	.01	16.12

The experiment consisted of square rod plots in a randomized block design with three blocks on each site. A five-foot buffer zone was left between adjacent plots to minimize the marginal effects of herbicide treatments.

In June, 1958, at the end of the study, herbage was clipped from 8 randomly selected square-foot subplots in the center 15.5x15.5 feet of each plot. Samples were oven-dried at 70° C for 24 hours and weighed.

Results

On the sandy upland site herbage production was not greatly affected by application of herbicides (Table 2). No major differences in production attributable to treatment occurred. Although there was some variation in the means of subplots, analysis of variance of treatment means showed no significant differences in the means for months, treatments, or the interaction of month and treatment.

On the prairie upland site 2,3,6-TBA appeared to reduce herbage production more than fenuron. Treatments of 2,3,6-TBA at the higher rates in April and February greatly reduced grass yields. Effects of fenuron were not consistent but there was a trend toward reductions from the December to the April applications. These decreases were more pronounced and more consistent than on the other sites. Analysis of variance showed a highly significant difference among months, treatments, and the month-treatment interaction. A significant interaction between month and treatment indicated that the treatments made in one month differed in effect from those in the next (Table 2). All treatments show this interaction.

Applications of 2,3,6-TBA at 9 pounds per acre and higher in February and April definitely lowered herbage production on this site.

On the bottomland site treatments with 2,3,6-TBA caused a significant reduction in herbage production. Fenuron and 2,3,6-TBA treatments applied in February and April show a trend toward reduced herbage production when compared to December treatments. Differences were not statistically significant.

Table 2. Herbage production from fenuron and 2,3,6-TBA treated plots clipped on June 1, 1958.

Site	Month of application	Fenuron (lb/A) 4	6	8	10	12	2,3,6-TBA (lb/A) 6	9	12	15	None (Check)	Monthly means
		(100 lbs. per Acre)										
Sandy Upland	December	18	13	13	16	13	21	12	9	11	10	14
	February	15	17	12	20	7	12	11	7	11	10	12
	April	13	9	16	13	13	12	12	15	10	13	13
Treatment means		15	13	14	16	11	15	11	10	11	11	
Prairie Upland	December	14	13	14	12	12	14	12	11	9	12	12a
	February	11	11	11	11	11	10	6	7	4	9	9b
	April	9	10	8	5	10	8	10	4	5	12	8c
Treatment means		11d	11d	11d	9c	11d	11d	9c	7b	6a	11d	
Bottomland	December	12	6	11	7	12	9	7	8	10	10	9
	February	7	11	7	8	10	7	10	8	8	17	9
	April	7	9	7	12	3	8	9	6	6	15	8
Treatment means		9b	9b	9b	9b	8ab	8ab	8ab	7a	8ab	14b	

[1]Means followed by the same letter or letters are not significantly different at the 5% level.

Discussion

Differences in reduction of herbage production from application of herbicides on the three range sites are probably due to soil differences and/or possibly to a differential response of species. This effect could have been due to leaching of the chemical below the root zone before spring growth began. The sandy upland and bottomland sites have lighter soils (sandy and clay loam), while the prairie upland site has a clay soil. Darrow, et al (1959) reported that tests with fenuron on tree species growing on calcareous and heavy-textured soils have been relatively ineffective, but those on sandy and medium-textured soils gave promising results. This would indicate that fenuron moves down readily in light-textured soils but does not on heavy soils. Persistence of the herbicides in the clay soil could have been a factor.

Reductions in yield at the various sites may be related to the time elapsing between treatment and when the grasses make their growth — warm or cool-season species. Significant reductions in yield were not noted on the sandy upland site (characterized by little bluestem, a warm-season species) and bottomland site (characterized by brownseed paspalum, also warm-season), while highly significant reductions were noted on the prairie upland site from February and April applications. The prairie upland site is characterized by Texas needlegrass, a cool-season grass. This grass was green and growing at the time of the February and April applications, whereas grasses on the other sites were just beginning to grow in April. This could have resulted in greater absorption of herbicide by grasses on the prairie upland and consequently a reduction in production. Also, possibly the Texas needlegrass is more susceptible to these herbicides.

Summary and Conclusions

Two herbicides, pelleted fenuron and granular 2,3,6-TBA, were hand-broadcast on prairie upland, shallow upland, and bottomland sites to evaluate yield responses of native grasses.

Neither herbicide affected herbage production on the sandy upland site. However, heavy rates of 2,3,6-TBA decreased production on both prairie upland and bottomland sites characterized by clay or clay-loam soils. A greater reduction resulted on the prairie upland site having a cool-season grass, Texas needlegrass, Fenuron also showed a trend toward reduced yields of the bottomland site.

No date of application reduced herbage application significantly on the sandy upland site, but there was a highly significant effect on the prairie upland site. February and April applications produced greater reductions than the December applications. The later applications also tended to give lower yields on the bottomland site.

LITERATURE CITED

CARLSON, A. E. 1954. Applications of substituted urea herbicides. Agr. Chem. 9(6): 44-45, 155-157.

CRISTOPH, ROY J. AND EMMA L. FISK. 1954. Responses of plants to the herbicide CMU. Bot. Gaz. 116: 1-14.

DARROW, R. A. 1957. Trichlorobenzoic acid and associated herbicides in the control of weedy plants in Texas. Proc. 10th Southern Weed Conference, pp. 132-138.

DARROW, R. A. AND W. C. MCCULLY. 1958. Pellet applications of fenuron for the control of post and blackjack oaks. Texas Agr. Exp. Sta. P.R. 2041. 4 pp.

DARROW, R. A., W. C. MCCULLY AND E. E. Hughes. 1959. Woody plant and grass responses to granular applications of fenuron and chlorinated benzoic acids. Proc. 12th annual Southern Weed Conference.

NORD, E. C. 1953. A study of the Range and Forestry Experimental Area for the purpose of developing a range management plan based on condition classes by site. Unpubl. M. S. thesis. Agr. & Mech. College of Texas, College Station, Texas.

Range Management Definitions

BY JACOB KATSIR
Visiting Student from Israel to Utah State University, 1960

Range Management—The art and science of being almost bankrupt, but never passing this point.

Research—The search for truth, but only the truth which you have found before starting the experiment.

SCS Cooperative Agreement—The agency will do what the farmer wants and the farmer will do as he pleases.

BLM Range Condition Formula—The quantity of the vegetation multiplied by the quality divided by the erodability and compaction of the soil will give range condition.

Forest Service Multiple Use—The three main uses of forests are: timber production, timber production, and timber production.

Determining Carrying Capacity—The art of answering permitee's questions without getting a nervous breakdown.

Response of Grasses, Forbs, and Halfshrubs to Chemical Control of Chaparral in Central Arizona

FLOYD W. POND
Range Conservationist, Rocky Mountain Forest and Range Experiment Station,[1] Fort Collins, Colorado

Chaparral occupies about 6 million acres in Arizona and western New Mexico. The main body of the type begins near Silver City, New Mexico, and extends as a relatively narrow, discontinuous band across Arizona to Seligman.

Grazing by livestock and game is an important use of chaparral. Numerous grasses, forbs, and halfshrubs are present in the type. The amount and kind of understory varies with shrub density, climate, soil type, and past use. Fair amounts of grass are produced between the shrubs in some areas, and many shrubs are grazed, especially in winter. Where interspaces are essentially bare and palatable shrubs are scarce, forage production is low. In such areas, increases in forage might be expected if the unpalatable shrubs were killed. This study, begun in 1954 on the Sierra Ancha Experimental Forest, reveals some effects of killing shrubs and trees in the chaparral on production and cover of associated grasses, forbs, and halfshrubs.

Chaparral commonly occurs on the broken, rough slopes of the mountainous masses just south of the Mogollon Rim. The type extends into the edge of the pine at higher elevations (6,000+ feet) and mingles with desert-shrub species at lower elevations (3,500 feet). Soils, generally poorly developed, are of several parent materials — granite, diabase, quartzite, schist, and basalt. Rainfall, generally varying with elevation, ranges from 14 to 25 inches.

The type is usually dominated by one or two shrub species, although mixtures of many species are found on some sites. Structure of the flora and dominance are generally influenced by differences in soils, slope, elevation, and precipitation. More than 50 shrub species have been found in the type, but the usual dominant is shrub live oak (*Quercus turbinella*). Other common species are skunkbush sumac (*Rhus trilobata*), sugar sumac (*R. ovata*) and desert ceanothus (*Ceanothus greggii*). Species that often are dominant locally include hairy mountainmahogany (*Cercocarpus brevifolius*), birchleaf mountainmahogany (*C. betuloides*), pointleaf manzanita (*Arctostaphylos pungens*) and Pringle manzanita (*A. pringlei*). Wright silktassel (*Garrya wrightii*) and hollyleaf buckthorn (*Rhamnus crocea*), though common, are important mainly because of animal preference.

Literature Review

Little work has been done in the chaparral of Arizona, on the effect removing the shrub overstory has on native grasses and halfshrubs. Removing overstory trees and shrubs, however, has resulted in increased understory growth in other vegetation types. Several workers, among whom are Mueggler and Blaisdell (1958), Blaisdell (1953), Pechanec and Robertson (1944), and Hyder (1954), have found that killing big sagebrush overstory releases understory vegetation and results in two- to five-fold increases in usable forage. Similar results are reported from other shrubby or weed-tree types: mesquite (Parker, 1943); juniper (Arnold and Schroeder, 1955) and post oak (Koshi et al, 1954). In the California chaparral, a type somewhat similar to that in Arizona, Biswell (1954), Love and Jones (1947), and Burcham (1959), are among those who advocate conversion of chaparral to grassland to increase forage production and watershed efficiency.

History of the Study Areas

The study was made on four small watersheds (9.07 to 19.52 acres in size) called the Natural Drainages, located on the Sierra Ancha Experimental Forest about 40 miles north of Globe, Arizona. The four watersheds are designated A, B, C, and D and lie side by side facing east (Figure 1). Slopes average 15 to 25 percent, and elevations from 4,525 to 4,970 feet. Annual rainfall averages about 20 inches; 65 percent falls October through May, and 35 percent June through September.

Two distinct soils are present. Soil on the upper slopes was derived from diabase rock; it is deep and sandy. On the lower slopes is a shallow, quartzite-derived soil, heavier in texture than the diabase soil. Vegetation on the diabase soil consists primarily of shrubs and halfshrubs. Though shrubs are also dominant on the quartzite soil, islands of grass are common there.

The Natural Drainages were closed to livestock grazing from 1934 to 1938. From 1939 to 1954, the effect of grazing on water production was studied on the watersheds. Each fall cattle grazed about 80 percent of the grass on the more accessible slopes on Drainage A and about 40 percent on Drainage D. Areas of dense brush and steep topog-

[1] *Forest Service, U. S. Department of Agriculture, with headquarters at Fort Collins, Colorado, in cooperation with Colorado State University. Research reported was conducted in cooperation with Arizona State University at Tempe, Arizona.*

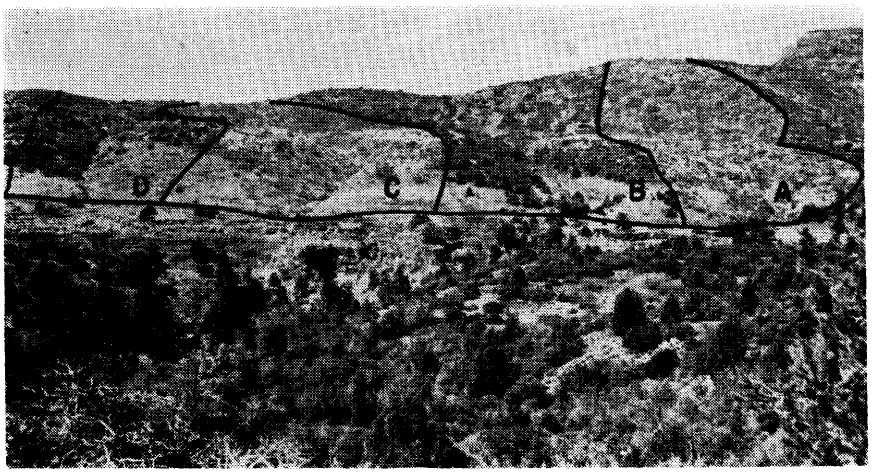


FIGURE 1. The four Natural Drainages on the Sierra Ancha Experimental Forest 4 years after initial chemical treatment of shrubs on Drainages A and C.

raphy were seldom grazed on either watershed. Drainages B and C were held as ungrazed check areas. From 1955 until the end of the study in 1959, livestock were again excluded from all watersheds.

Methods

To determine the response of understory vegetation to chemical control of chaparral, all shrubs and trees on Drainages A and C were sprayed with herbicides while Drainages B and D were held as check areas.

During the summer of 1954, the basal 6 inches of each living shrub and tree on Drainage C was sprayed with a 6.6 percent solution of 2,4-D and 2,4,5-T in diesel oil until the outer bark was saturated. Halfshrubs were not sprayed. Though the first treatment killed most of the plants sprayed, surviving shrubs on Drainage C were resprayed in 1956 and 1958. Trees and shrubs on Drainage A were sprayed in similar manner in 1955 and resprayed in 1957.

Measurement of plant cover.— To facilitate sampling, each drainage was type-mapped according to dominant vegetation, aspect, and soil derivation. Although 8 types were represented, the present study is concerned only with the 3 types that had a shrub overstory:

Shrub, south-facing slope, quartzite soil

Shrub, north-facing slope, quartzite soil

Shrub, east-facing slope, diabase soil

In 1950, ten 40-foot line transects were randomly located in each vegetation type in each drainage. Crown- and basal-intercepts of plants along those transects were recorded in August 1954, 1957, and 1959 in the manner described by Canfield (1942).

Measurement of herbage production. — Estimates of herbage production were made in 1959. Five mechanically spaced 9.6-square-foot plots were located near 5 of the 10 line transects in each type. Current production of grasses was determined by the weight-estimate method (Pechanec and Pickford, 1937). One of the five plots on each transect, randomly chosen, was clipped and the herbage weighed as part of a double sampling procedure (Wilm et al. 1944).

Forbs were not estimated because the work was done in November after most forb herbage had dried, broken up, and blown away. All growth of halfshrubs was estimated because old growth could not be distinguished readily from new growth.

Changes in Vegetative Cover

Grasses. — In 1954, the basal cover of all grasses on proposed treatment areas of quartzite soils was almost the same as that on check areas (Figure 2). In 1957 and 1959, grass cover on treated areas was about three times that on check areas. Increases on north and south slopes were comparable. Side-oats grama *(Bouteloua curtipendula)* alone was responsible for much of the basal cover change following treatment, although other grasses also contributed. No significant changes in grass cover were detected on sprayed or unsprayed areas of diabase soils during the entire study period. Any small changes that may have occurred were obscured by variation in cover.

These data suggest that grass cover, especially that of side-oats grama, may increase rapidly following shrub control on quartzite soils, but little or no change may be expected on diabase soils. The fact that grassy openings are common on the shallow, clayey quartzite soils but are infrequent on the deep, sandy diabase soils tends to support this observation.

Halfshrubs. — Crown cover of halfshrubs increased substantially on both soils following chemical control of shrubs. The greatest actual increase, however, was on diabase soils (Figure 2). The principal species were Wright eriogonum *(Eriogonum wrightii),* rough menodora *(Menodora scabra)* and two species of *Lotus,* shrubby deervetch *(L. rigidus)* and Wright deervetch *(L. wrightii).* No appreciable change in cover occurred on unsprayed areas during the study. The significant increase of halfshrubs following shrub kill indicates that both soils are well adapted for growing these plants.

Forbs.—Crown cover of forbs was greater on the diabase than the quartzite soils. Forbs apparently increased on all treated areas between 1954 and 1959

(Figure 2) although these differences were not significant.

Production Increases

Grasses.—Grass production in 1959 was over twice as great on quartzite soils on which shrubs had been controlled as on comparable check areas (Figure 3). This significant difference was due to increased production of side-oats grama on the sprayed areas. The response of grass production to shrub control was similar on north and south aspects.

On diabase soils, grass production on sprayed areas averaged 172 pounds per acre in 1959 compared with 56 pounds on check areas. The difference was not significant, however, because of extremely high variation among transects. Production of side-oats grama was slightly higher on treated than on untreated areas, but production on either area was low compared to that on quartzite soil. At the end of the study, total grass production on diabase soil was about half that on quartzite soil where chaparral had been controlled.

Halfshrubs.—On quartzite soil, production of halfshrubs on sprayed areas was little different from that on unsprayed areas in 1959 (Figure 3). Indicated differences were not significant.

In contrast, on diabase soil, production of halfshrubs on sprayed areas averaged 274 pounds per acre, 13 times the production on check areas. This was nearly three times the production on quartzite soil.

If a good stand of grass is desired, control of halfshrubs may be necessary, even though some halfshrubs may provide forage for deer and livestock. Cover of half shrubs was still increasing at the end of the study wherever shrubs had been controlled. Like the shrubs, they probably compete with the grasses.

In practice, halfshrubs will likely be controlled along with shrubs. Basal application of chemicals to shrubs is not economically feasible, as costs are well over 100 dollars per acre. Chemical control of shrubs on large areas will likely be done with airplanes or helicopters; chemicals that kill shrubs will probably kill most halfshrubs in the chaparral.

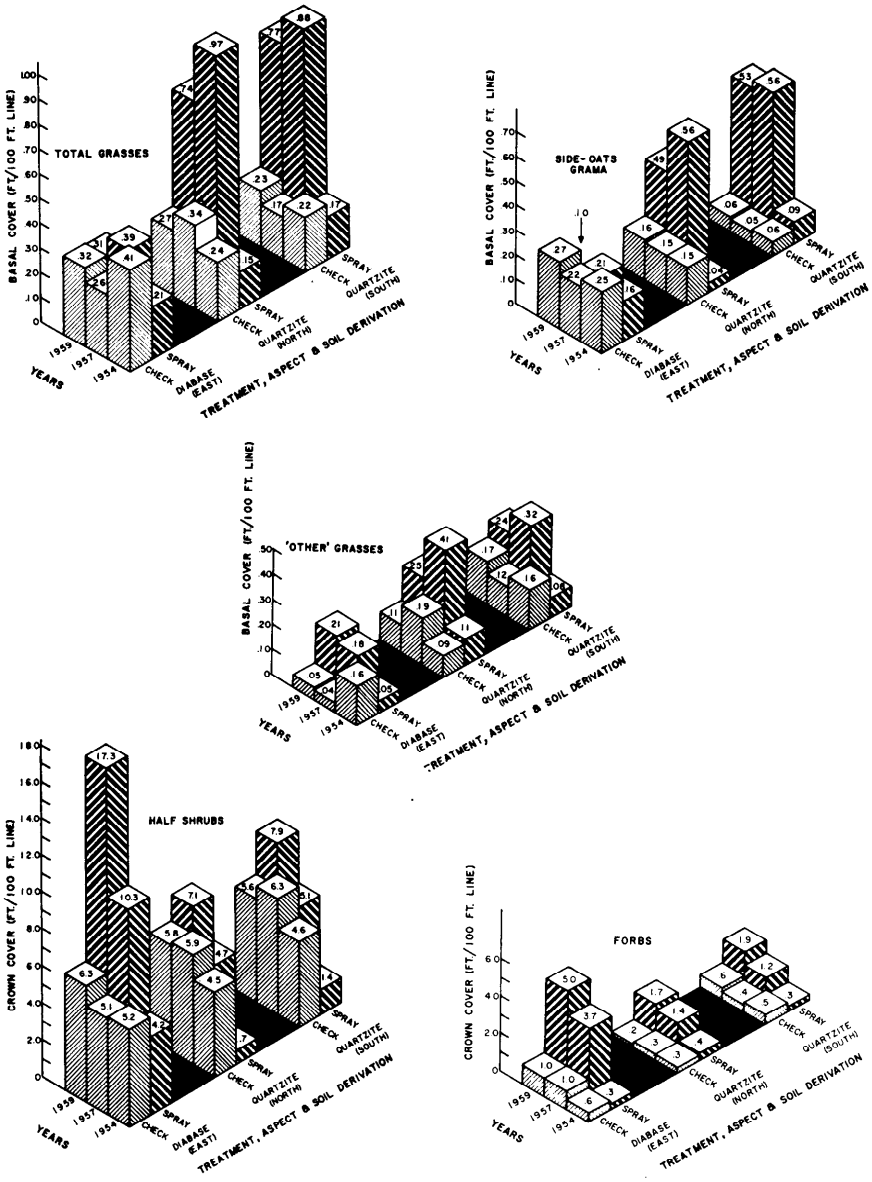


FIGURE 2. Basal cover of grasses, and crown cover of forbs and halfshrubs in 1954 before shrubs were controlled, and in 1957 and 1959 after control.

Summary

Responses of grasses, forbs, and halfshrubs following chemical control of chaparral were ob-

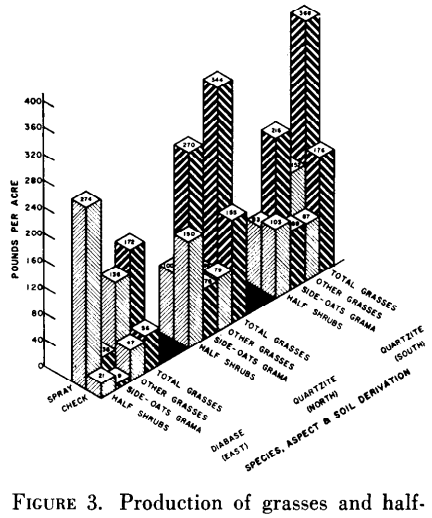


FIGURE 3. Production of grasses and halfshrubs in 1959, 5 years after initial chemical treatment to control shrubs.

served from 1954 to 1959 on the Sierra Ancha Experimental Forest in central Arizona. Study areas were classified and results were presented according to dominant vegetation, aspect, and soil origin.

Soils derived from quartzite were shallow and contained considerable amounts of clay. Islands of grass were present in the chaparral on this soil before treatment. Following shrub control with herbicides, the cover of all understory vegetation on quartzite soil increased, but increase in grass cover was quickest and most spectacular. Halfshrubs and forbs increased less rapidly but continuously. Increase in grass production was also greater on this soil.

Soils derived from diabase were deep and sandy. They supported no islands of grass in the chaparral. Here, halfshrubs increased greatly in cover and production following control of overstory shrubs. Grasses showed little if any response, while forbs increased in cover somewhat more than on quartzite soils.

These findings indicate that chaparral-control sites for increased grass production should be selected carefully. Certain soils may not favor grass growth, and other plants not killed by herbicides may become dominant.

LITERATURE CITED

ARNOLD, JOSEPH F. AND WILLIAM L. SCHROEDER. 1955. Juniper control increases forage production on the Fort Apache Indian Reservation. U. S. Forest Serv. Rocky Mountain Forest and Range Expt. Sta. Sta. Paper 18. 35 pp.

BISWELL, H. H. 1954. The brush control problem in California. Jour. Range Mangt. 7:57-62.

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

BURCHAM, L. T. 1959. Planned burning as a management practice for California wildlands. Calif. Div. Forestry, Sacramento, Calif. 21 pp.

CANFIELD, R. H. 1942. Sampling ranges by the line interception method. U. S. Forest Serv. Southwestern Forest and Range Expt. Sta. Res. Report 4. 25 pp.

HYDER, DONALD N. 1954. Spray to control big sagebrush. Ore. Agr. Expt. Sta. Bul. 538. 12 pp.

KOSHI, PAUL T., ROBERT A. DARROW, AND WAYNE G. MCCULLY. 1954. Forage production in oak woodland as influenced by removal of tree cover. Texas Agr. Expt. Sta. Prog. Rpt. 1661. 4 pp.

LOVE, R. M. AND BURLE J. JONES. 1947. Improving California brush ranges. Calif. Agr. Expt. Sta. Cir. 371. 39 pp. (revised 1952)

MUEGGLER, WALTER F. AND JAMES P. BLAISDELL. 1958. Effects on associated species of burning, rotobeating, spraying, and railing sagebrush. Jour. Range Mangt. 11:61-66.

PARKER, KENNETH W. 1943. Control of mesquite on Southwestern ranges. U. S. Dept. Agr. Leaflet 234. 8 pp.

PECHANEC, JOSEPH 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.

PECHANEC, JOSEPH F., A. PERRY PLUMMER, JOSEPH H. ROBERTSON, and others. 1944. Eradication of big sagebrush *(Artemisia tridentata)*. U. S. Forest Serv., Intermountain Forest and Range Expt. Sta. Res. Paper 10. 23 pp.

WILM, H. G., DAVID F. COSTELLO, AND G. E. KLIPPLE. 1944. Estimating forage yield by the double-sampling method. Jour. Amer. Soc. Agron. 36:194-203.

Gaseous Nitrogen Losses and Range Fertilization

LEROY H. WULLSTEIN AND C. M. GILMOUR
Research Fellow and Professor respectively, Department of Microbiology
Oregon State University

Various routes of soil nitrogen loss have been proposed but it is apparent in the literature that the mechanisms involved are incompletely understood. This is particularly true with regard to non-enzymatic losses in soils of slight or moderate acidity. Under these conditions and where gas analysis is lacking it becomes most difficult to assess the real nature of the apparent losses encountered.

Using direct methods for analysis, Wullstein et al. (1963) and Wullstein and Gilmour (1964) demonstrated (in vitro) that appreciable nitrogen loss, as nitric oxide, from moderately acidic soil results from the reaction of potassium nitrite with certain reduced metals. Undoubtedly, such losses previously had been attributed to other mechanisms. It is fair to say that at least part of the misunderstanding can be traced to technological problems. It is also fair to emphasize that extreme caution should be exercised when interpreting the nature of nitrogen losses, especially when these losses are based only on mineral nitrogen deficits! Proper laboratory assay (to include the determination of gaseous nitrogen products) can prevent undue conjecture and, where the mechanism(s) of loss can be firmly established, justify efforts to find suitable control measures.

If range fertilization becomes a common practice, range managers may encounter gaseous nitrogen losses of economic significance. It is suggested that the effective control of any such losses would require both laboratory and field studies.

LITERATURE CITED

WULLSTEIN, L. H. AND C. M. GILMOUR. 1964. Non-enzymatic gaseous loss of nitrite from clay and soil systems. Soil Science. (In press)

WULLSTEIN, L. H. AND C. M. GILMOUR AND W. B. BOLLEN. 1963. Gaseous loss of soil nitrogen by chemical and microbial pathways. Abstracts of the American Society of Agronomy. 34.

A Method for Measurement of Forage Intake of Grazing Livestock Using Microdigestion Techniques[1]

G. M. VAN DYNE[2] AND J. H. MEYER

Research Nutritionist and Professor, Animal Husbandry Department, University of California, Davis, California

Knowledge of quantitative forage intake by grazing animals is basic to range management. Forage intake is measured only with difficulty, and few data are available. Two recent monographs (Agricultural Board, 1962; Joint Committee, 1962) discuss measurement of digestibility of range forage, fecal output, and utilization (i.e., disappearance) of herbage. Measurement of range forage intake requires, however, a concomitant evaluation of forage digestibility and fecal output. Range herbage disappearance may be proportional to, but is greater than forage consumption by livestock because of herbage losses such as those due to weathering and trampling, and forage consumption by insects and rodents. A review of textbooks on range management, animal nutrition, and animal production reveals only one which gives estimates of quantitative forage intake by range livestock. Stoddart and Smith (1955) quote figures of daily range forage intake by cattle, but give no data on intake by sheep.

This article presents a new technique of determining forage intake based on in vitro or in vivo microdigestion of forages and compares this method to existing methods.

Review of Literature

An ideal method for determining forage intake by grazing animals would be 1) accurate and precise, 2) applicable to individual animals, 3) applicable to all types of forage, and 4) based on easily determined chemical components. It should not depend upon dry-lot digestion trials of harvested range herbages.

Ratio Techniques

Ratio techniques, depending upon the presence of an indigestible indicator in the forage, have been used in combination with total fecal collection to measure forage intake (Agricultural Board, 1962; Joint Committee, 1962). Lignin (Garrigus, 1934; Harris et al., 1952), chromogens (Cook and Harris, 1951), and silica (Smart et al., 1960) have been the most commonly used naturally occurring indicators in range studies.

Disadvantages of the lignin ratio procedure, according to Milford (1957), are 1) lignin is not a distinct chemical entity, 2) impurities may become attached to lignin during chemical analysis, 3) methods of lignin analysis are tedious and expensive, 4) selective grazing can introduce high errors in sampling of forage actually consumed, 5) lignin may be partially digestible, and 6) changes in chemical composition of lignin may occur in the digestive tract. Furthermore, moisture in forages and high drying temperature may induce a nonenzymatic browning reaction in which products of carbohydrate degradation condense with protein (MacDougall and DeLong, 1942; Van Soest, 1962). This leads to positively biased estimates of lignin content. Conner et al. (1963) indicated range forage samples collected by ruminal fistulated cattle had a positive bias due to a nonenzymatic browning reaction. Although there are many disadvantages to the lignin ratio procedure, it has remained the most widely used method in range investigations in the United States (Cook et al. 1954, 1961, and 1962).

Chromogen has been used as a naturally occurring indicator in range forages; however, it has been found unsatisfactory by Cook and Harris (1951) with plants high in ether extract and by Van Dyne (1960) because of low and variable levels in winter range forage. Silica is another naturally occurring indicator which has been used in digestibility trials and which could be used for estimating forage intake if an accurate estimate can be made of dietary silica content. Even slight soil contamination of herbage or fecal samples causes variable and invalid results with this indicator. With the use of esophageal fistulated animals (Van Dyne and Torell, 1964), however, the silica content of the forage plus soil contaminants consumed can be accurately estimated.

One shortcoming of these indicator techniques is that estimates of forage intake usually are based on amount and composition of feces of one group of animals and the dietary composition of another group. Thus, only one valid estimate of intake is available, and there is no measure of reliability. These techniques are advantageous because they do not require harvesting of range herbages for dry-lot digestion trials and they are applicable to both cattle and sheep.

[1] *Acknowledgment is expressed to H. F. Heady, G. P. Lofgreen, and W. C. Weir for their interest and suggestions in this work, which was supported in part by Regional Research Project W-34—Range Livestock Nutrition. Computational time was supported in part by N.I.H. Grant FR-00009.*

[2] *Present address: Radiation Ecology Section, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.*

Other Methods

Fecal nitrogen index. — The fecal nitrogen index procedure originated by Lancaster (1949) has been used to determine forage intake in grazing studies in New Zealand, Australia, Africa, and Great Britain. This procedure requires that herbage be cut and fed to animals in dry-lot digestion trials to develop equations to relate fecal nitrogen content to organic matter digestibility of the forage or to the ratio of organic matter in the forage to that in the feces (Arnold and Dudzinski, 1963).

The assumptions in this technique are that 1) the pasture herbage cut and fed to the animals is similar in composition to that selected by the grazing animal, and 2) the pen-fed and grazing animals digest the pasture material to the same extent. The principal advantage of the fecal index procedure is that a qualitative estimate of the diet of the grazing animal is not required. The difficulty with this procedure under most range conditions is the impracticability of obtaining enough representative herbage with which to conduct the dry-lot digestibility trials. Although the technique is applicable to both sheep and cattle, and may be used in all seasons, separate seasonal regression equations relating fecal nitrogen to the feed-to-feces ratio are required for high accuracy (Greenhalgh and Corbett, 1960). Furthermore, the fecal nitrogen index procedure gives estimates of forage intake for groups of animals rather than for individual animals.

Nitrogen balance.—Pasture intake by grazing sheep was calculated from nitrogen balance by Beeston and Hogan (1960). These workers reasoned that a mature wether, whose weight was not varying appreciably, stored nitrogen only in the wool; therefore, nitrogen intake would be equal to the amount in the urine, feces, and wool. This method has two requirements which limit usage. It requires 1) long-term studies to overcome variations in excretion rate and 2) an assumption of nitrogen content stored in the wool.

Metabolic fecal fraction.—Dry matter intake by grazing animals can be calculated from a metabolic fecal fraction, according to Owen (1961). He found a high direct correlation between dry matter intake and a fecal fraction which dissolves in O.2N HCl in 18 hr. This procedure, not thoroughly tested, is subject to the disadvantages inherent in fecal nitrogen index techniques.

Weight balance. — Allden (1962) used animal weight balance in a 1-hour period of grazing to estimate herbage intake of sheep harnessed for collection of feces and urine. Insensible weight loss was estimated from harnessed sheep not permitted to graze. Short-term measurements of forage intake are not applicable to range conditions where the grazing activity of an animal varies widely during the day.

In summary, the above methods do not meet all the requirements for determining forage intake of grazing animals. A new method for estimating forage intake is discussed below.

Methods

Relation between digestibility and intake.—In order to illustrate how intake can be based on microdigestion of forages, it is necessary to show the relationship between digestibility and intake. Further details are given by Van Dyne (1963b).

By definition, the dry matter digestion coefficient (D_{dm}) is:

$$D_{dm} = \frac{F-E}{F} \cdot 100 \qquad (1)$$

where F is the amount of forage consumed and E is the amount of feces produced. Because an indigestible indicator occurring in the forage is quantitatively recovered in the feces then:

$$D_{dm} = 100 - 100 \cdot \frac{I_F}{I_E} \qquad (2)$$

where I_F and I_E are the concentrations of the indicator in the forage and feces, respectively. If dry matter digestibility is known, forage intake can be calculated from total excretion and digestibility of dry matter:

$$F = \frac{100 \cdot E}{100 - D_{dm}} \qquad (3)$$

Similarly, digestibility of any nutrient (D_i) can be related to the quantity of forage and feces (F and E) and to the composition of the nutrient in the forage and feces (F_i and E_i):

$$D_i = 100 - 100 \cdot \frac{E \cdot E_i}{F \cdot F_i} \qquad (4)$$

Because the ratio of excreta to forage equals the ratio of indicator concentrations in forage and feces, the digestibility of any nutrient (D_i) may be obtained without total fecal collection:

$$D_i = 100 - 100 \cdot \frac{I_F}{I_E} \cdot \frac{E_i}{F_i} \qquad (5)$$

Application of this equation is difficult because it requires a naturally occurring indigestible indicator in the forage. It will be shown in the following section how a knowledge of microdigestion may be used in lieu of assumptions about indigestibility of naturally occurring indicators.

Microdigestion and intake. — Assuming a correlation between microdigestion (digestion of a small sample in part of the digestive tract) and macrodigestion (digestion of a large sample through the entire animal) of a given nutrient, the relationship of the nutrient in the forage to that in the feces may be shown by an equation analogous to (3). The microdigestion of cellulose (c) will be used for purposes of illustration.

The amount of forage grazed (F) is easily determined if the

amount of cellulose grazed ($F \cdot F_c$) is known. The amount of cellulose grazed may be calculated from the amount of cellulose excreted ($E \cdot E_c$) if an estimate of cellulose digestion (D_c) is available:

$$F = \frac{100 \cdot E \cdot E_c}{100 \cdot F_c - F_c \cdot D_c} \quad (6)$$

Prediction of macrodigestion from microdigestion. — Digestibility values determined by 48-hour microdigestion procedures are near, but not necessarily equal to, the macrodigestion of cellulose. Thus, there are two main ways of using digestibility estimates determined by micromethods to calculate forage intake: 1) assuming the microdigestion of cellulose equals macrodigestion and 2) adjusting the microdigestion estimate for differences between micro- and macrodigestion before using it to calculate forage intake.

If microdigestion and macrodigestion are assumed equal, then equation (6) is used directly to calculate forage intake. If microdigestion and macrodigestion are not assumed to be equal, then an adjustment is necessary.

In order to equate micro- and macrodigestion, one or more standard forage samples should be included in each microdigestion trial (Van Dyne, 1963a; Tilley and Terry, 1963). This permits adjustment of microdigestion estimates of range forages in terms of the standard:

$$\text{"Adjustment ratio"} = \left(\frac{\text{microdigestion of range forage}}{\text{microdigestion of standard}}\right)_{\text{when inocula were from grazing animals}} \quad (7)$$

This ratio is then multiplied by the microdigestion value for the standard sample when it was digested by inocula from animals fed the standard forage on dry-lot:

$$\text{"Adjusted microdigestion estimate"} = \text{"Adjustment ratio"} \times \left(\text{microdigestion of standard}\right)_{\text{when inocula were from animals fed standard forage}} \quad (8)$$

A regression equation is needed to interrelate macrodigestion values of the standard forage by conventional total collection procedures (Y) and microdigestion of the standard forage (X) when inocula were from animals fed the standard forage:

$$\text{Macrodigestion of standard} = a + b\left(\text{microdigestion of standard}\right)_{\text{when inocula were from animals fed standard forage}} \quad (9)$$

where a and b are the constants of a linear regression equation. The "adjusted microdigestion estimate" is used as the X value to calculate a "predicted macrodigestion estimate":

$$\text{"Predicted macrodigestion estimate"} = a + b\left(\text{"Adjusted microdigestion estimate"}\right) \quad (10)$$

In practice, these steps are combined into one equation to calculate the predicted macrodigestion estimate which is used with equation (6) to calculate forage intake.

Results and Discussion

Numerical Example and Application

To show the application of this procedure for determining forage intake, data are taken from an experiment conducted with cattle and sheep on a mixed annual grass-forb range in a scattered-oak woodland on the Hopland Field Station in Mendocino County in northern California (Van Dyne, 1963b). In midsummer, 1961, this dry annual range had about 1220 lb/acre total herbage available. Cellulose content was determined in samples of forage collected with five esophageal fistulated steers and seven esophageal fistulated sheep over a 5-day period. Total fecal output was collected from nine ruminal fistulated steers and nine ruminal fistulated sheep during a 7-day period following a 7-day preliminary period. Cellulose content was determined in these fecal samples. The ruminal fistulated animals also provided inocula for the microdigestion estimates of cellulose by nylon bag technique (in vivo) and by artificial rumen procedure (in vitro). Both microdigestion fermentations were of 48-hour duration. The same animals were fed alfalfa in a dry-lot digestion trial during which both macrodigestion and microdigestion were determined. The alfalfa was used as the standard forage sample for microdigestion in all periods. These data are given in the upper half of Table 1. Simple linear regression equations interrelating macrodigestion and microdigestion of cellulose under dry-lot conditions are footnoted in that table.

Predicted macrodigestion estimates were calculated with use of equations (7) through (10). An example of the calculations for sheep with artificial rumen technique follows:

$$\text{Predicted macrodigestion} = 59.6\% - 0.11\left(\frac{39.8\%}{52.5\%}\right) \bullet (58.8\%) = 53.5\%$$

This predicted estimate was used in equation (6) to predict forage intake:

$$\text{Predicted forage intake} = \frac{(37.35\%) \bullet (1.05 \text{ lb/24 hr}) \bullet (100)}{(100) \bullet (41.03\%) - (41.03\%) \bullet (53.5\%)} = 2.05 \text{ lb/24 hr}$$

A comparison is made of estimates of forage intake calculated by various procedures in Table 2. Lignin ratio estimates of forage intake are by the usual procedures (Agricultural Board, 1962). Forage and fecal lignin contents are footnoted in Table 2. Predicted macrodigestion estimates of forage intake are taken from and explained in Table 1. Microdigestion per se was used with equation (6) to calculate intake. Further and more detailed comparisons of estimates of intake are given by Van Dyne and Meyer (1964).

All estimates of forage intake calculated from microdigestion, adjusted or nonadjusted, were slightly greater for both sheep and cattle than were estimates of forage intake calculated from lignin ratio. In many instances there was little difference between the predicted macrodigestion estimate and the forage estimate determined from microdigestion per se. But in other instances, e.g., cattle by artificial rumen technique, there was ap-

Table 1. Example of calculation of forage intake from microdigestion data, forage and fecal composition, and fecal output.

Item	Units	Sheep	Cattle
	— — — Required information — — —		
Forage cellulose	% organic matter	41.03	42.64
Fecal cellulose	% organic matter	37.33	34.37
Fecal output	lb/24 hr, organic matter	1.05	6.66
Microdigestion of range forage, range diet			
Cellulose by nylon bag method	%	56.2	52.0
Cellulose by artificial rumen	%	54.8	61.4
Microdigestion of standard forage, range diet			
Cellulose by nylon bag method	%	58.8	56.3
Cellulose by artificial rumen	%	57.9	58.5
Microdigestion of standard, standard diet			
Cellulose by nylon bag method	%	61.8	59.9
Cellulose by artificial rumen	%	58.8	54.5
	— — — Calculated results — — —		
"Adjusted microdigestion" of range forage			
Cellulose by nylon bag method	%	59.1	55.3
Cellulose by artificial rumen	%	55.7	57.2
"Predicted macrodigestion" of range forage[1]			
Cellulose by nylon bag method	%	53.8	54.6
Cellulose by artificial rumen	%	53.5	53.3
Predicted forage intake			
from nylon bag data	lb/24 hr, organic matter	2.07	11.82
from artificial rumen	lb/24 hr, organic matter	2.05	11.50

[1]The regression equations used to predict macrodigestion (Y) of cellulose from microdigestion (X) were developed under dry-lot trials with the standard forage; they were, for nylon bag and artificial rumen technique respectively, Y=66.2–0.21X and Y=59.6–0.11X.

preciable difference between the nonadjusted and adjusted values.

These data are given primarily to show that estimates of forage intake calculated from microdigestion are within expected limits for forage intake by livestock on these dry annual ranges. The 24-hr shrunk weight of the sheep averaged about 98 lb and the shrunk weight of the cattle averaged about 710 lb during this sampling period. Thus, the average of estimates of forage intake, calculated from microdigestion of cellulose, were about 2.18 and 1.64 lb forage daily/cwt body weight, respectively, for sheep and cattle.

Critique of New Procedure

This procedure holds special promise for calculating the forage intake by individual animals. Estimates of forage composition, fecal output and composition, and microdigestion can be obtained individually from bifistulated animals (as illustrated by Van Dyne and Torell, 1964). Thus, forage intake estimates can be made on an individual rather than on a group basis, as is done usually in lignin ratio or fecal nitrogen index procedures.

Forage intake, calculated from microdigestion, is based on accurately analyzed constituents, such as cellulose in forage and feces. This procedure does not require assumptions about indigestibility of naturally occurring indicators and does not require harvesting of range forages for dry-lot digestion trials. The procedure is applicable to both cattle and sheep. It is useable on all types of ranges in all seasons, since microdigestion estimates may be obtained easily by nylon bag or artificial rumen technique under range conditions (Van Dyne, 1962 and 1963a).

Table 2. Comparison of estimates of daily forage intake calculated from lignin ratio, predicted macrodigestion, and microdigestion per se.

Technique	Sheep	Cattle
	lb. organic matter intake per head	
Lignin ratio[1]	1.83	11.24
Predicted macrodig.		
nylon bag	2.07	11.82
artificial rumen	2.05	11.50
Microdig. per se		
nylon bag	2.18	11.18
artificial rumen	2.16	13.91

[1]Sheep and cattle diets contained 13.7 and 14.1% lignin, respectively, on organic matter basis. Feces contained 23.9 and 23.8%, respectively.

Determining forage intake from microdigestion requires more effort than the chromogen or the lignin ratio techniques, but less effort than the fecal nitrogen index procedure. In comparison to the lignin ratio technique, the procedure is especially valuable under conditions wherein lignin may be partially digested, e.g., in immature forages or in browse by game animals (Smith et al., 1956). Similar to the lignin, chromogen, or silica ratio procedures, the new method requires an accurate sample of the forage grazed.

Summary and Conclusions

Existing methods for determining forage intake are reviewed with regard to their applicability under range conditions.

A new procedure for determining forage intake by grazing animals is described. This procedure involves: 1) determination of the digestion value of range forage and standard forage samples using micromethods with inocula from grazing animals; 2) prediction, by use of a regression equation, of macrodigestion from microdigestion of range forage,

adjusted to microdigestion of a standard sample; and 3) use of the predicted macrodigestion estimate, composition of range forage, and composition and amount of feces to calculate forage intake.

The new procedure, based on microdigestion, eliminates the necessity of assuming indigestibility of naturally occurring indicators, e.g., lignin or chromogens. The new procedure also obviates harvesting range herbages for dry-lot digestion trials, as is required in the fecal nitrogen index technique.

LITERATURE CITED

ALLDEN, W. G. 1962. Rate of herbage intake and grazing time in relation to herbage availability. Proc. Australian Soc. Animal Prod. 4:163-166.

AGRICULTURAL BOARD — NATL. ACAD. SCI., NATL. RES. COUNCIL, AND AMER. SOC. RANGE MANGT. 1962. Basic problems and techniques in range research. Natl. Res. Council Publ. 890. 341 pp.

ARNOLD, G. W. AND M. L. DUDZINSKI. 1963. The use of fecal nitrogen as an index for estimating for the consumption of herbage by grazing animals. Jour. Agr. Sci. 61:33-43.

BEESTON, J. W. U., AND J. P. HOGAN. 1960. The estimation of pasture intake by the grazing sheep. Proc. Australian Soc. Animal Prod. 3: 79-82.

CONNER, J. M., V. R. BOHMAN, A. L. LESPERANCE, AND F. E. KINSINGER. 1963. Nutritive evaluation of summer range forage with cattle. Jour. Animal Sci. 22:961-969.

COOK, C. W. AND L. E. HARRIS. 1951. A comparison of the lignin ratio technique and the chromogen method of determining digestibility and forage consumption of desert range plants by sheep. Jour. Animal Sci. 10:565-573.

COOK, C. W., J. E. MATTOX, AND L. E. HARRIS. 1961. Comparative daily consumption and digestibility of summer range forage by wet and dry ewes. Jour. Animal Sci. 20: 866-870.

COOK, C. W., L. A. STODDART, AND L. E. HARRIS. 1954. The nutritive value of winter range plants. Utah Agr. Exp. Sta. Bul. 372.

COOK, C. W., K. TAYLOR, AND L. E. HARRIS. 1962. The effect of range condition and intensity of grazing upon daily intake and nutritive value of the diet on desert ranges. Jour. Range Mangt. 15:1-6.

GARRIGUS, W. P. 1934. The forage consumption of grazing steers. Proc. Amer. Soc. Animal Prod. pp. 66-69.

GREENHALGH, J. F. D. AND J. L. CORBETT. 1960. The indirect estimation of the digestibility of pasture herbage: I. Nitrogen and chromogen as faecal index substances. Jour. Agr. Sci. 55:371-376.

HARRIS, L. E., C. W. COOK, AND L. A. STODDART. 1952. Range nutrition techniques. Jour. Animal Sci. 11: 181-190.

JOINT COMMITTEE — AMER. SOC. AGRON., AMER. DAIRY SCI. ASSOC., AMER. SOC. OF ANIMAL PROD., AND AMER. SOC. RANGE MANGT. 1962. Pasture and range research techniques. Comstock Publ. Assoc., Ithaca, New York. 242 pp.

LANCASTER, R. J. 1949. The measurement of feed intake by grazing cattle and sheep: I. A method of calculating the digestibility of pasture based on the nitrogen content of faeces derived from the pasture. New Zealand Jour. Sci. Tech. 36: 15-20.

MACDOUGALL, D. AND W. A. DELONG. 1942. Effect of initial drying temperature on the apparent lignin content of plant tissues. Canad. Jour. Res. (B) 20:40-48.

MILFORD, R. 1957. The usefulness of lignin as an index of forage consumed by ruminants. p. 79-85. *IN:* Ligninfication of plants in relation to ruminant nutrition. Proc. Symp. in Canberra, Australia. Div. Plant Ind. CSIRO. 108 pp.

OWEN, J. B. 1961. A new method of estimating the dry matter intake of grazing sheep from their faecal output. Nature 192(4797):92.

SMART, W. W. G., JR., G. MATRONE, W. O. SHEPHERD, R. H. HUGHES, AND F. E. KNOX. 1960. The study of the comparative composition and digestibility of cane forage (*Arundinaria* spp.). N. Car. Agr. Exp. Sta. Tech. Bul. 140.

SMITH, A. D., R. B. TURNER, AND G. HARRIS. 1956. The apparent digestibility of lignin by mule deer. Jour. Range Mangt. 9:142-145.

STODDART, L. A. AND A. D. SMITH. 1955. Range management. McGraw-Hill Book Co., Inc., New York. 2nd Ed. 433 pp.

TILLEY, J. M. A. AND R. A. TERRY. 1963. A two-stage technique for the *in vitro* digestion of forage crops. Jour. Brit. Grassland Soc. 18:104-111.

VAN DYNE, G. M. 1960. Range investigations. *IN:* Annual Prog. Rep. West. Reg. Res. Proj. W-34, Mont. Agr. Exp. Sta. pp. 9-60.

VAN DYNE, G. M. 1962. Micro-methods for nutritive evaluation of range forages. Jour. Range Mangt. 15:303-314.

VAN DYNE, G. M. 1963a. An artificial rumen system for range nutrition studies. Jour. Range Mangt. 16: 146-147.

VAN DYNE, G. M. 1963b. Forage intake and digestion by cattle and sheep on a common dry foothill annual range. Ph.D. Dissertation. Univ. Calif., Davis, 399 pp.

VAN DYNE, G. M. AND J. H. MEYER. 1964. Forage intake by cattle and sheep on dry annual range. Jour. Animal Sci. (manuscript submitted).

VAN DYNE, G. M. AND D. T. TORELL. 1964. Development and use of the esophageal fistula: a review. Jour. Range Mangt. 17:7-19.

VAN SOEST, P. J. 1962. The estimation of forage protein digestibility and determination of the effects of heat-drying upon forages by means of the nitrogen content of acid-detergent fiber. Agr. Res. Serv. Mimeo. 16 pp.

TECHNICAL NOTES

SAGEBRUSH INFESTED BY LEAF DEFOLIATING MOTH

DILLARD H. GATES
Range Management Specialist, Oregon State University, Corvallis, Oregon.

A native sagebrush defoliating insect (*Aroga websteri*, Clark) has infested vast areas in the sagebrush-grass (*Artemisia-Agropyron*) areas of eastern Oregon and adjacent states (Figure 1). Some small infestations of *Aroga* were noted in Malheur County, Oregon, in the summer of 1961. These infestations were observed closely in 1962 by county agent George Bain, the author, and others. It was estimated that approximately 10 to 15 thousand acres of sagebrush were killed in Malheur County in 1962, as a result of this infestation. Other small local infestations with some brush kill were also noted throughout eastern Oregon during 1962.

The infestation seemed to explode in the spring of 1963. It is conservatively estimated that over 12 million acres of sagebrush in Oregon alone were infested to some degree with this insect. While the *Aroga* is generally widespread, the degree of infestation and the effects of vary considerably. Old, stagnant stands of sagebrush seem to be most heavily damaged. Sagebrush growing along borrow pits, in swales, or in positions of more favorable moisture seem better able to resist infestation. It is a common sight to see vigorously growing sagebrush along the road and just across the fence literally miles of the shrubs black as a result of the *Aroga* activity.

It is difficult or impossible at this time to properly assay the damage to the sagebrush resulting from the *Aroga* infestation. Some sagebrush that was hit very heavily early in the spring of 1963 later made some regrowth. Other sagebrush did not. It is a moot question as to whether this fall regrowth will contribute to the death of infected plants through a continued use of carbohydrate reserves.

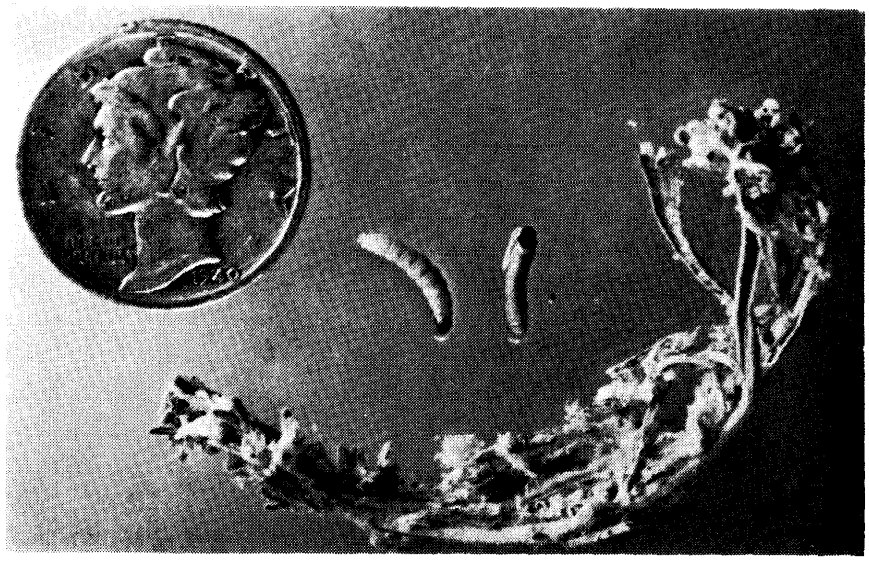


FIGURE 1. Larvae of *Aroga websteri*, Clark. (Photo by R. R. Kindschy, BLM, Vale, Oregon).

Although some plants will be able to stage a comeback, final evaluation of the results of this year's infestation of *Aroga* will have to be postponed. However, it is probably reasonable to assume that there are thousands or hundreds of thousands of acres of sagebrush that will be dead as a result of defoliation.

There is some disagreement as to just which species of sagebrush are affected by *Aroga*. Positive identification of *Aroga* on big sagebrush (*A. tridentata*), low sage (*A. arbuscula*), black sage (*A. nova*), and silver sage (*A. cana*) has been made in Oregon. There are some reports that *Aroga* also has been found on bitterbrush (*Purshia tridentata*) and other valuable browse species. However, there are other insects with similar habits of the *Aroga* that have been found and identified on these other species and there may be a considerable amount of confusion. The author has not found *Aroga* on any plants except the sagebrush species.

According to Henry,[1] *Aroga* has the following life cycle. The adult moth lays eggs in the late summer or early fall on small cracks in the bark of sagebrush or on the leaves. In approximately 2 weeks small larvae are hatched. These larvae mine into the leaves of the sagebrush plant and over-winter. In the spring when conditions become favorable for the larvae to work, they continue to mine the leaves (Figure 1). Leaves are cut off from the plant and pulled into little groups by webs from the larvae. The larvae then build cocoons within this small group of leaves and web (Figure 2). In the latter part of June or July the larvae go into the pupal stage. In approximately 2 weeks the adult moths emerge.

Since *Aroga* is a native insect, it would be expected that it has its own host of parasites. Entomologists at Oregon State University have reported that based on 75 samples, they find that parasitism upon the

[1] *Henry, John, M. S. Thesis, University of Idaho, 1960.*

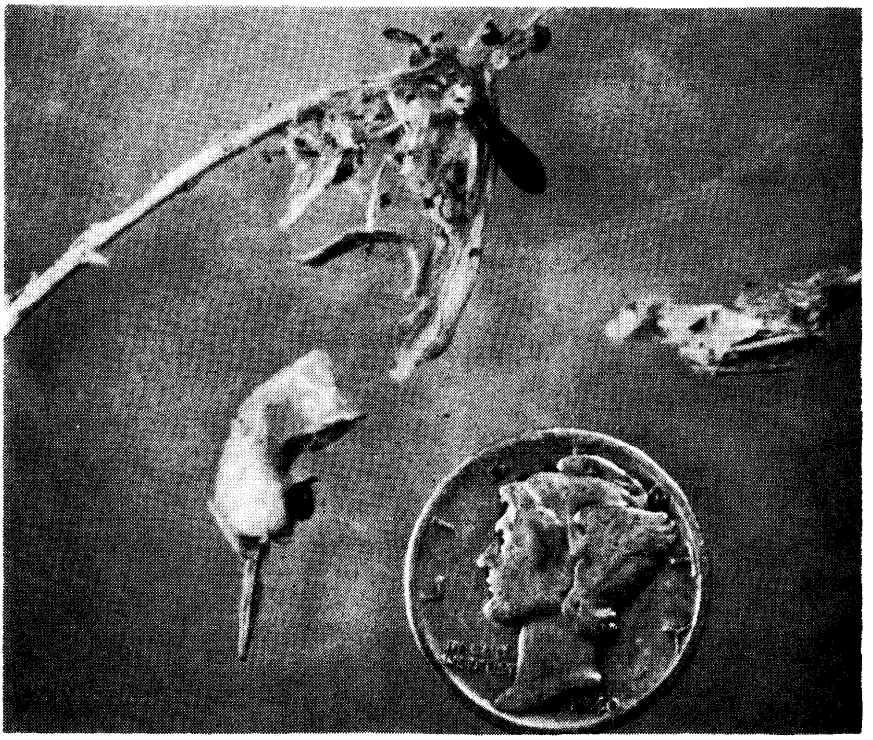


FIGURE 2. Pupa of *Aroga websteri*, Clark at top. Eggs enclosed in webbing at lower left. (Photo by R. R. Kindschy, BLM).

Aroga in some samples is approximately 50 to 70 percent. There appear to be two types of parasites; one works on the larva and the other works on the pupa. The effects of the parasites on the *Aroga* population for 1964 and subsequent years is unknown.

This widespread infestation of *Aroga* and subsequent damage to sagebrush has important ecological and range management implications. In areas of heavy sagebrush where desirable understory species are lacking, a heavy sagebrush kill may result in an increase of less desirable weeds.

Where there are sufficient understory grasses to take advantage of the removal of the sagebrush, nothing but good should come as a result of removal of sagebrush. Such areas should be managed to take maximum advantage of the sagebrush removal. However, on areas without sufficient desirable forage grasses as understory, the removal of the sagebrush may result in more serious range deterioration. Range seedings should be given major consideration where possible. The Bureau of Land Management has recognized the management and improvement implications of this *Aroga* infestation. Private land operators are being advised to do so.

LATE-SPRING HERBAGE PRODUCTION ON SHORTGRASS RANGELAND[1]

FRANK RAUZI
Soil Scientist, Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., Laramie, Wyoming.

Herbage production on the shortgrass plains varies from year to year. Thus it is difficult either to predict herbage production or to recommend stocking rates that are not detrimental, especially in drought years. The amount and time of precipitation, other climatic conditions, and grazing use have definite influences on the kinds and amounts of herbage produced.

Dahl (1963), found on a sandhills range in Colorado, that grass yields

[1] *Contribution from Northern Plains Branch, Soil and Water Conservation Research Division, Agricultural Research Service, USDA, and the Wyoming Agricultural Experiment Station. Published with approval of the Director as Journal Paper No. 223.*

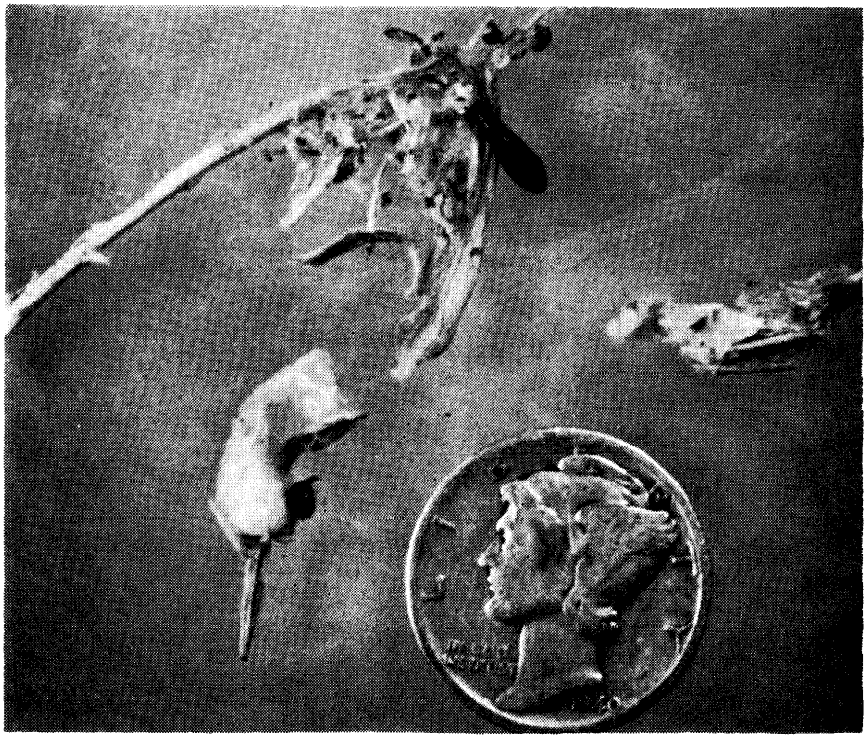


FIGURE 2. Pupa of *Aroga websteri*, Clark at top. Eggs enclosed in webbing at lower left. (Photo by R. R. Kindschy, BLM).

Aroga in some samples is approximately 50 to 70 percent. There appear to be two types of parasites; one works on the larva and the other works on the pupa. The effects of the parasites on the *Aroga* population for 1964 and subsequent years is unknown.

This widespread infestation of *Aroga* and subsequent damage to sagebrush has important ecological and range management implications. In areas of heavy sagebrush where desirable understory species are lacking, a heavy sagebrush kill may result in an increase of less desirable weeds.

Where there are sufficient understory grasses to take advantage of the removal of the sagebrush, nothing but good should come as a result of removal of sagebrush. Such areas should be managed to take maximum advantage of the sagebrush removal. However, on areas without sufficient desirable forage grasses as understory, the removal of the sagebrush may result in more serious range deterioration. Range seedings should be given major consideration where possible. The Bureau of Land Management has recognized the management and improvement implications of this *Aroga* infestation. Private land operators are being advised to do so.

LATE-SPRING HERBAGE PRODUCTION ON SHORTGRASS RANGELAND[1]

FRANK RAUZI

Soil Scientist, Soil and Water Conservation Research Division, Agricultural Research Service, U.S.D.A., Laramie, Wyoming.

Herbage production on the shortgrass plains varies from year to year. Thus it is difficult either to predict herbage production or to recommend stocking rates that are not detrimental, especially in drought years. The amount and time of precipitation, other climatic conditions, and grazing use have definite influences on the kinds and amounts of herbage produced.

Dahl (1963), found on a sandhills range in Colorado, that grass yields in the spring were significantly influenced by the total precipitation of the previous two years. Also, the amount of grass produced by early August could be predicted from the depth of moist soil on April 15. At the Manyberries Range Experiment Farm in southeastern Alberta, Smoliak found that the May-June precipitation was highly correlated with annual forage production and that pre-seasonal precipitation was not significantly correlated with range forage production. Rogler and Haas (1947) found that the amount of soil moisture from the preceding fall and precipitation during the current season were important factors affecting the yield of a native mixed prairie in North Dakota. Thus the amount of native herbage produced may be influenced not only by the current season's precipitation, but by the previous year's rainfall as well.

Native vegetation on the shortgrass plains consists principally of perennial shortgrasses and midgrasses with some annual grasses as well as annual and perennial forbs. The midgrasses generally obtain most of their growth in the early spring and summer. The shortgrass species start growth in late spring and continue through the summer if moisture is not limiting.

Range readiness in the spring is usually judged by observing indicator plants or the general appearance of the range. To determine the amounts and kinds of vegetation present in late spring on native shortgrass rangeland, a study was initiated in the spring of 1959 at the Archer Substation near Cheyenne, Wyoming. The results for a 5-year period are reported herein.

Study Area

The major soil on the upland site of the experimental pastures is Altvan fine sandy loam. The native vegetation is characteristic of the shortgrass plains. The principal shortgrass species are blue grama *(Bouteloua gracilis)* and buffalograss *(Buchloe dactyloides)*. Western wheatgrass *(Agropyron smithii)* is the principal midgrass. Sixweeks-fescue *(Festuca octoflora)* is the dominant annual grass. Other cool-season grasses and forbs are minor.

Approximately 75 percent of the annual precipitation is received dur-

[1] *Contribution from Northern Plains Branch, Soil and Water Conservation Research Division, Agricultural Research Service, USDA, and the Wyoming Agricultural Experiment Station. Published with approval of the Director as Journal Paper No. 223.*

ing the April 1 to September 30 growing season. Precipitation during the growing season varies from less than 6 in. to over 17 in. The 50-year average annual and seasonal precipitation is 14.93 and 11.72 in., respectively.

Procedure

The upland site on two native shortgrass pastures was studied. One had been moderately grazed since 1945. The other had been heavily grazed from 1945 to 1954 and lightly grazed thereafter. The animals used on these pasutres were ewes and their lambs from the Experiment Station flock. The moderately grazed pastures had been stocked at the rate of 2.40 acres per ewe and lamb; the lightly grazed units at 3.70 acres.

Caged plots 2 ft. square, harvested the previous fall for determining current year's herbage production were clipped in the spring. Thus only the current spring growth was harvested. The herbage was clipped at ground level; separated into midgrass, shortgrass, annual grass, and forbs; air-dried; weighed; and computed on a per-acre basis. The average leaf heights of 10 randomly selected blue grama and western wheatgrass plants were measured. Clipping and leaf-height measurements were initiated on May 27, 1959, and thereafter during the month of May except in 1961, when these measurements were made on June 6.

Results and Discussion

The kind and amount of herbage harvested in late spring varied. Only traces of annual grass and forbs were present in 1959 and 1963. During the other three years (1960, 1961 and 1962) annual grass and forbs accounted for 6 to 19 percent of the total vegetation produced on the moderately grazed pasture and from 2 to 9 percent on the lightly grazed pastures. Six-weeks-fescue, the principal annual grass, appears to be correlated with the abundance of fall moisture. Hylton and Bement (1961) state that the density of six-weeks-fescue may be predicted by careful examination of temperature and moisture conditions during August, September, and October preceding the summer growing season. They also found that the density of six-weeks-fescue was slightly influenced by grazing intensities.

During the 5-year period the amount of perennial grass averaged 286 and 231 pounds per acre, respectively, on the moderately and lightly grazed pastures (Tables 1 and 2). This difference was not significant, but the difference in the amount produced in different years was significant at the 0.05 level of probability.

Difference in the amount of midgrass produced between the moderately and lightly grazed pastures was statistically significant at the 0.01 probability level. The 5-year average shows nearly three times more midgrass on the moderately grazed pasture than on the lightly grazed. This difference may be accounted for in that the lightly grazed pasture is still recovering from past heavy grazing use.

There was no significant difference between the amount of shortgrasses produced on the moderately and lightly grazed pastures, but there was a statistically significant difference at the 0.01 level for the amount of shortgrasses produced among years. Averages of 158 and 184 pounds per acre of the shortgrass were produced on the moderately and lightly grazed pastures, respectively, over the 5-year period. The slightly greater amount of shortgrass on the lightly grazed pasture is accounted for by the abundance of buffalograss, which had resulted from the 10-year period of heavy grazing (Lang, et al., 1956).

Average leaf heights of blue grama and western wheatgrass for the moderately grazed pasture are shown in Table 3. They were 1.1 in. for blue grama and 4.5 in. for the western wheatgrass. Heights of both grasses were greater in 1961, the later date of measurement.

The greatest amount of herbage produced in the spring was not always associated with the best moisture conditions between April 1 and date of harvest; this indicated that the previous year's fall moisture was an important factor (Table 4). Herbage production among years was

Table 1. Air-dry herbage from moderately grazed pasture, Archer Substation 1959-1963.

Year	Harvest Date	Mid Grass	Short Grasses	Annual Grasses	Forbs	Total
		(Pounds per Acre)				
1959	5/27	52	172	T[1]	T[1]	224
1960	5/23	72	208	11	7	298
1961	6/6	148	93	46	11	298
1962	5/25	197	190	28	5	420
1963	5/17	170	127	T[1]	2	299
[1]Trace	AV.	128	158	17	5	308

Table 2. Air-dry herbage from lightly grazed pasture. Archer Substation 1959-1963.

Year	Harvest Date	Mid Grass	Short Grasses	Annual Grasses	Forbs	Total
		(Pounds per Acre)				
1959	5/27	59	135	T[1]	T[1]	194
1960	5/23	24	256	8	20	308
1961	6/6	38	142	6	9	195
1962	5/25	87	264	7	1	359
1963	5/17	26	120	T[1]	2	148
[1]Trace	AV.	47	184	4	6	241

Table 3. Leaf height of blue grama and western wheatgrass on moderately grazed pasture in spring, Archer 1959-1963.

Year	Harvest Date	Blue Grama	Western Wheatgrass
		(Inches)	
1959	5/27	1.1	4.0
1960	5/23	1.2	4.8
1961	6/6	1.5	5.8
1962	5/25	1.0	4.6
1963	5/17	0.7	3.5
	AV.	1.1	4.5

Table 4. Effect of precipitation and time of harvest on herbage produced (air-dry) on moderately grazed pasture, Archer 1959-1963.

Year	Fall Harvest Caged Plots	Left, end of Season	Produced in Spring	Precipitation
	— — (pounds) — —			(inches)
1959	357	256	224	2.37
1960	388	192	298	2.70
1961	786	310	298	7.38
1962	620	328	420	1.54
1963	564	411	299	0.82
AV.	543	299	308	2.96

highly variable and appeared to be dependent upon the interaction of several factors. From 30 to 164 percent more herbage was harvested in the fall than in the spring. In 4 of the 5 years more than half of the herbage was produced by late spring.

The five year study period was too short for obtaining reliable correlations and regression equations for predictive purposes. Seventeen years (1947-1963) of precipitation and clipping data were available from the pastures moderately grazed. From these data correlations and regressions were determined.

The May-June precipitation when correlated with perennial grass yields gave a highly significant correlation coefficient of 0.675. This compares to 0.859 found by Smoliak (1956). The April through August precipitation when correlated with perennial grass yield resulted in a highly significant correlation of 0.745, which is higher than that for May-June precipitation and grass yields. Although statistically significant, only 46 and 56 percent of the variation in perennial grass yields is accounted for by variation in precipitation.

The regression equations derived from the relationship of perennial grass yield to the May-June and April through August precipitation are $Y = 195 + 57.77\ X_1$ and $Y = 70.18 + 43.54\ X_2$, where X = May-June and X_2 = April-August precipitation (Figure 1). Also shown for comparison is the regression line developed by Smoliak.

A test of homogenity of the regression coefficients calculated by Smoliak and for the moderately grazed pastures at the Archer Substation showed no significant difference. Thus, a given increase of May-June or April through August precipitation results in a comparable increase of herbage at both locations.

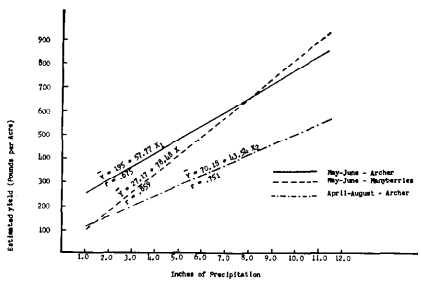


FIGURE 1. Estimated yield for various amounts of precipitation, perennial grasses at Archer and total herbage at Manyberries.

On the basis of yield from the caged plots from the moderately grazed pasture, 39 to 73 percent of the annual herbage produced was left at the end of the grazing season. This indicates that the rate of stocking for the upland site was approximately moderate four years out of the five, if the rule of thumb—leave half and graze half—is observed. The criterion used for the proper degree of utilization was to leave an average of 1.2 and 0.9 in. of height on blue grama at the end of the grazing season on the lightly and moderately grazed pastures, respectively.

Summary

A study to determine the kinds and amounts of native vegetation present in late spring on native shortgrass rangeland was conducted at the Archer Substation in Wyoming during the years 1959 through 1963. Clipping studies were conducted in late May on a pasture moderately grazed since 1945 to 1954 and lightly grazed thereafter.

Nearly three times more midgrass was produced on the moderately grazed pasture than on the lightly grazed pasture. Recovery of the pasture grazed lightly since 1955, previously heavily grazed, is slow and not reflected in the clipping data. Observations show that midgrasses are increasing, but the abundance of buffalograss and prevailing climatic conditions have not been conducive to the rapid reestablishment of the desirable species. There was no significant difference in the amount of short or warm-season grasses produced between the moderately and the lightly grazed pastures.

During the 5-year period there was wide variation in the amount of herbage produced and amount of precipitation. Average total herbage for the 5-year period was 308 and 241 pounds per acre, respectively, for the moderately and lightly grazed pastures.

May-June and April-through-August precipitation when correlated with yields gave highly significant correlation coefficients of 0.675 and 0.754, respectively. Regression equations developed from the moderately grazed pasture data were not statistically different from the equation developed by Smoliak at Manyberries in Alberta, Canada.

LITERATURE CITED

DAHL, B. E. 1963. Soil moisture as a predictive index to forage yield for the sandhills range type. Jour. Range Mangt. 16:128-132.

HYLTON, L. O. JR. AND R. E. BEMENT. 1961. Effects of environment on germination and occurrence of six-weeks-fescue. Jour. Range Mangt. 14:257-261.

LANG, ROBERT L., OSCAR K. BARNES, AND FRANK RAUZI. 1956. Shortgrass range grazing effects—on vegetation—on sheep gains. Wyo. Agric. Exp. Sta. Bul. 343.

ROGLER, GEORGE A., AND HOWARD J. HAAS. 1947. Range production as related to soil moisture and precipitation on the Northern Great Plains. Journ. Amer. Soc. Agron. 39:378-389.

SMOLIAK, S. 1956. Influence of climatic conditions on forage production of shortgrass rangeland. Jour. Range Mangt. 9:89-91.

SILVER SAGEBRUSH IN EASTERN NORTH DAKOTA

HUGH E. COSBY

Soil Conservation Service, U.S.D.A., Minot, North Dakota.

The range of sagebrush (shrubs of the genus *Artemisia)* is usually shown to include only the Southwest part of North Dakota as roughly limited to the north and east by the Missouri River. Only two shrub species of this important rangeland genus occur in the state, namely *A. tridentata* Nutt. (big sagebrush) and *A. cana* Pursh (silver sagebrush). Silver sagebrush has the wider distribution of the two species.

Outliers of silver sagebrush have

SILVER SAGEBRUSH IN EASTERN NORTH DAKOTA

HUGH E. COSBY
Soil Conservation Service, U.S.D.A., Minot, North Dakota.

The range of sagebrush (shrubs of the genus *Artemisia)* is usually shown to include only the Southwest part of North Dakota as roughly limited to the north and east by the Missouri River. Only two shrub species of this important rangeland genus occur in the state, namely *A. tridentata* Nutt. (big sagebrush) and *A. cana* Pursh (silver sagebrush). Silver sagebrush has the wider distribution of the two species.

Outliers of silver sagebrush have

been observed as far east as the 98th meridian, some 140 miles east of the Missouri River. Stevens (1950) describes it as being "frequent from the Missouri River west, rarely occurring east of the Missouri River." He further reports that it occurs locally at Valley City, Jamestown, and in the Pembina Mountains. Beetle (1960), shows the distribution of this species as being in that portion of North Dakota lying south and west from the Missouri River. He also reported occurrances of this species in Barnes and Cass Counties of North Dakota.

The furthest east advancement of the Missouri River in North Dakota is about one half way between meridians 100 and 101. Along the 98th meridian are three areas of similar soil formation which contain silver sagebrush as a conspicious part of the vegetation.

One area containing silver sagebrush (Figure 1, *top*), is within the Pembina Mountains, in Cavalier County, near the Canadian border and less than 50 miles from the Minnesota border. The area is approximately 3 miles long, but less than ¼ mile wide at the widest point and probably containing less than 100 acres. The area lies within sections 25 and 36, T-164 R-58; section 31, T-164 R-57 and sections 6, 7, and 8, T-163, R-57.

The soils are heavy Chernozem, devoped from clayey till and heavy colluvial-alluvial material derived from Creteaceous shale. Glacial stones and boulders occur in the area. There are three buttes of Pierre shale rising above the surrounding clays.

FIGURE 2. A plant of silver sagebrush in Section 15, T-140, R-58, near Valley City.

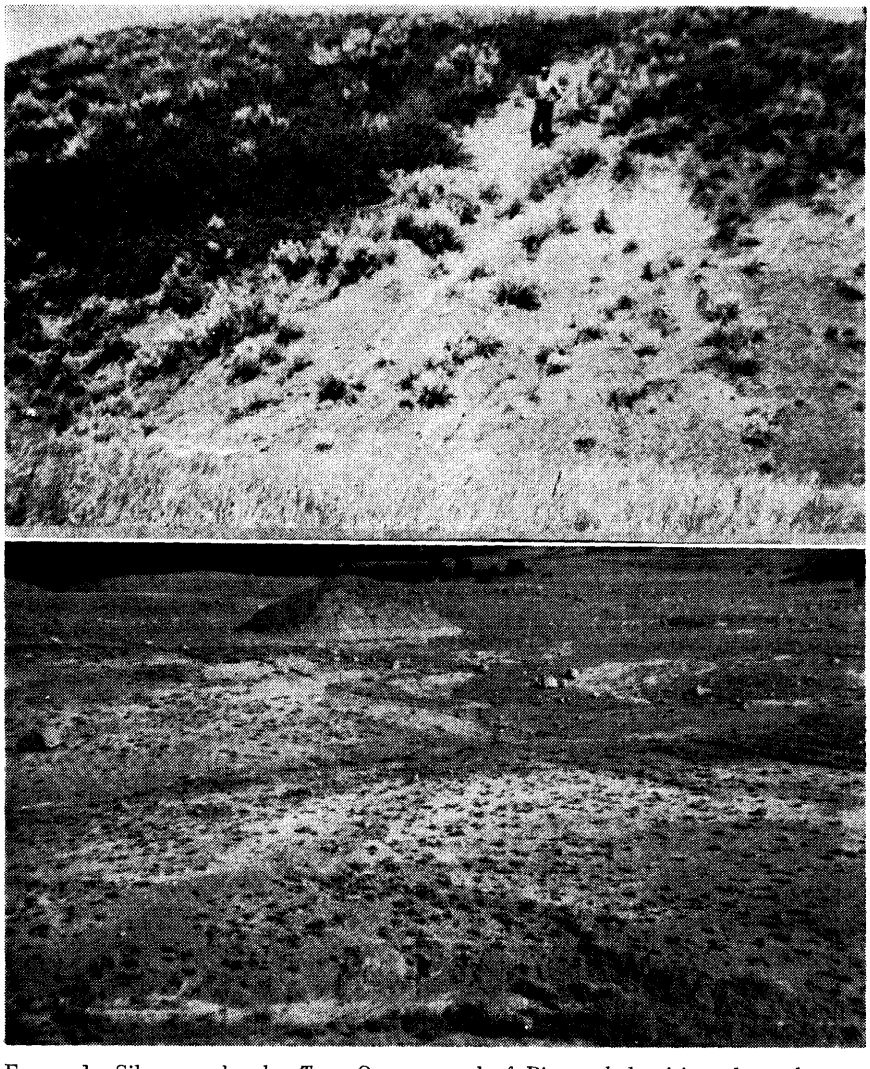


FIGURE 1. Silver sagebrush. *Top*—On a mound of Pierre shale rising above the surrounding colluvial clays, Section 36, T-164, R-58, in the Pembina Mountains. *Bottom*—On clay soils derived from Pierre shale in Section 16, T-145, R-58 in Griggs County. Till soil has eroded away but granite stones and boulders remain on the surface.

Almost due south of this location, a distance of about 115 miles, is a similar one in section 16, T-145, R-58 in Griggs County, near the Cheyenne River (Figure 1, *bottom*). This area of about 60 acres is derived from Pierre shale parent material. Glacial soils have been eroded away but glacier-deposited stones and boulders are strewn over the clays and shales. Occasional mounds of Pierre shale rise above the surrounding landscape.

Also along the Cheyenne River breaks in Barnes County, about 30 miles further south, occasional silver sagebrush plants occur on outcrops of shale and on colluvial clays (Figure 2). Scattered plants can be seen along the hillside in the SE¼ of section 22, T-140, R-58, across the river east of Valley City.

Silver sagebrush is virtually absent on glacial till plains and glacial moraines lying between these areas and the Missouri River but the writer has observed it on clay soils near Krueger Lake in northern Sheridan County.

LITERATURE CITED

BEETLE, A. A. 1960. A Study of Sagebrush, Wyo. Agri. Expt. Sta. Bul. 368, 83 pp.

STEVENS, O. A. 1950. Handbook of North Dakota Plants. Knight Printing Co., Fargo, N. Dak. 224 pp.

SEEDLING VIGOR OF *FESTUCA ARUNDINACEA*, *PANICUM VIRGATUM*, AND *BOTHRICHLOA CAUCASIA* AND THEIR RESPONSE TO ADDED NUTRIENTS[1]

GORDON GULLAKSON, L. E. FOOTE AND J. A. JACKOBS

Former Undergraduate Research Assistant, Former Graduate Research Assistant, and Professor of Crop Science, Department of Agronomy, University of Illinois, Urbana, Illinois.

This experiment was undertaken as one of a series of studies at the University of Illinois, in an attempt to find more desirable means of establishing vegetation on cut and fill areas along highways. These areas consist of subsoils of low fertility and/or poor physical characteristics which present very unfavorable growing conditions. Great seedling vigor and the resulting rapid establishment which secures the soil from erosion is extremely important in the stabilization of these areas.

Seedling growth and vigor of tall fescue (*Festuca arundinacea*), switchgrass (*Panicum virgatum*) and Caucasian bluestem (*Bothrichloa caucasia*) were compared on three soils of varying chemical and physical composition, with and without added fertilizer. Tall fescue is a grass originally found in cool, humid regions and the other two species are warm, humid and semi-humid grasses. Tall fescue is grown extensively and does best in heavy soils with a high humus content, but is widely adapted and is grown under irrigation on desert soils which have a low humus content (Hoover, et al., 1948; Fergus, 1952; Hallowell, et al., 1960). Switchgrass is a vigorous, native, perennial, sod-forming grass that occurs throughout the United States under a wide variety of climatic conditions. It grows in all types of soil, but thrives best in moist lowlands when the soil is of relatively high fertility (Hoover, et al., 1948). Caucasian bluestem is grown in the U.S.S.R., England, and the United States and is reported productive, persistent under use, aggressive and winter-hardy. It was introduced into the United States in 1929 from the Botanical Gardens, Tiflis, Georgia, U.S.S.R. (Celarier and Harlan, 1955).

Plummer (1943) emphasized the importance of the initial root growth of grasses in their ability to compete with other vegetation. Ability to take up and utilize soil nutrients is also important in plant competition. Evans (1960) found that the principal competitive factors in the annual grassland species he studied was the ability to take up and use soil nitrogen. The relative requirements for nitrogen and phosphorus are also very important. The order of increasing nitrogen and phosphorus requirements has been shown to be (1) *Aristida* species, (2) *Andropogon scoparius* and (3) *Panicum virgatum*. This is the relative order in which the three species invade abandoned fields (Rice, et al., 1960).

Materials and Methods

The soils used in this study varied widely in physical properties and nutrients and were designated A, B and C. Soil A was a black silt, clay loam topsoil used in the Agronomy Greenhouse at the University of Illinois. Soil B was a red, sandy loam subsoil and Soil C was a light grey colored clay. Both were collected from roadside banks in Illinois. Soil B had only scattered plants growing at the site and the Soil C site was bare of vegetation. Table 1 presents soil test values and the textural analyses (Laverty, 1962; Bouyoucos, 1951). Tall fescue, Caucasian bluestem and switchgrass were grown alone and in combination of all three. The fertility treatments were none and a complete fertilizer. All combinations of these gave 24 treatments (4 x 2 x 3), replicated three times.

Table 1. Soil test values and textural analysis of the three experimental soils.

Item	Soil A	Soil B	Soil C
pH	5.8	6.9	7.9
P_2	55	27	24
P_1	25	17	4
Lbs. K Available/A.	232	216	148
% Sand	13.0	77.0	3.0
% Silt	53.0	8.0	39.5
% Clay	34.0	15.0	57.5
Textural Classification	Silty, clay loam	Sandy loam	Clay

Treatments with added nutrients received a 10-10-10 fertilizer at the rate of 800 p.p.m. which equals 80 p.p.m. of N_2, P_2O_5, and K_2O. The soil was placed in six-inch clay pots which were set in clay watering saucers. The moisture moved up through the soil by capillary action. Soils A and B became moist to the top in one to two days but Soil C remained dry in the top ½ to ¾ inches. Cellophane was then placed over each pot containing Soil C, enabling the soil to become moist to the surface. All seeds were pregerminated in order to eliminate differential emergence interference by the soils. A germinated seedling was planted in a small hole and the soil was gently pressed back around the plant. Extra seedlings were planted in each pot. Since Soil C crusted rapidly when exposed, cellophane was placed over the pots containing this soil during the middle of the first two days. In combination treatments, the seedlings were planted in a systematic arrangement to facilitate identification. After one week, the seedlings were thinned to nine plants per pot. The species grown in combination were thinned to three plants of each species per pot.

Plant heights, from the soil surface to the tip of the tallest and/or longest leaf, were taken at the end of one week and at five-day intervals thereafter until the 42nd day. On the 42nd day after planting, the top growth was harvested and oven-dried. The roots were washed free of soil and dried. Root and top dry weights in grams were taken. In the combination treatments, the tops of each species were harvested separately. No attempt was made to separate the roots according to species. Due to the presence of the combination or competition treatment, all values were placed on a per plant basis. An analysis of variance was run and the data were subjected to an orthogonal single degree of freedom analysis. All results discussed are significant at the 5% level of probability. The data from within the combination treatments were analyzed both collectively with the other treatments

[1]*The work was sponsored by the U. S. Department of Commerce, Bureau of Public Roads, and the Illinois Division of Highways.*

and separately by the single degree of freedom method.

Results and Discussion

Fertilizer increased the growth rate (plant height) about equally after 12 days, whether species were alone or in combination. Root and top weights were also increased by fertilizer (Table 2). These results were expected. Fertilizer had a much greater effect on the top weight and final height of Caucasian bluestem than on switchgrass or tall fescue. Without fertilizer, tall fescue had the greatest seedling vigor while Caucasian bluestem had the greatest response to fertilizer (Figures 1 and 2). The response of tall fescue and switchgrass to fertilization was about equal (Figure 1). Tall fescue showed greater vigor than switchgrass under all the experimental conditions. When fertilized, Caucasian bluestem showed more vigor as reflected in top weights at the end of the experiment and in height after the 22nd day.

Table 2. The effect of fertilizer on root and top growth (weight in grams per plant, oven dry, average of three soils).

Treatment	Tops	Roots
Fertilizer	.210	.074
No fertilizer	.072	.035

The species grown in combination had a greater average height and produced a greater weight of root material per plant (.069 g. vs. .048 g.). Both tall fescue and switchgrass grew taller when grown in combination than when grown alone (Figure 3). Caucasian bluestem had about the same height whether grown alone or in combination. From this there is an indication that both tall fescue and switchgrass were able to obtain nutrients not available to the other species. Caucasian bluestem, on the other hand, appeared to be able to obtain nutrients only from the same sources as tall fescue and/or switchgrass. The dry top weights indicate that tall fescue was the most vigorous species when grown in combination; that Caucasian bluestem was the most vigorous when grown alone; and switchgrass was least vigorous under all conditions (Figure 3). Height does not seem to have been a good measure of vigor in switchgrass. The final height of switchgrass was greater than that of Caucasian bluestem and almost equal to the height of tall fescue (Figure 3). However, the top weight of switchgrass was much less than that of the other species.

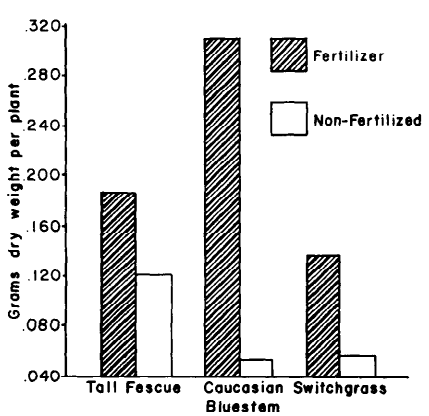


FIGURE 1. Top weights of the three species with and without fertilizer.

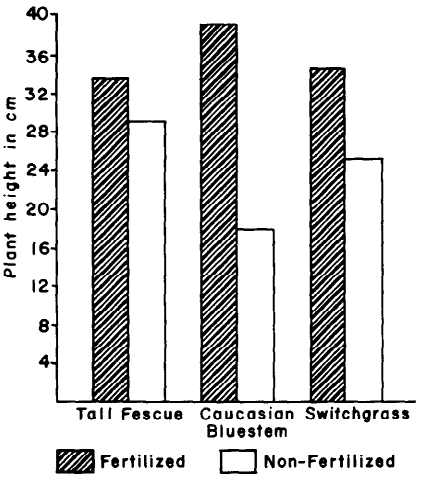


FIGURE 2. Final height as affected by additional nutrients.

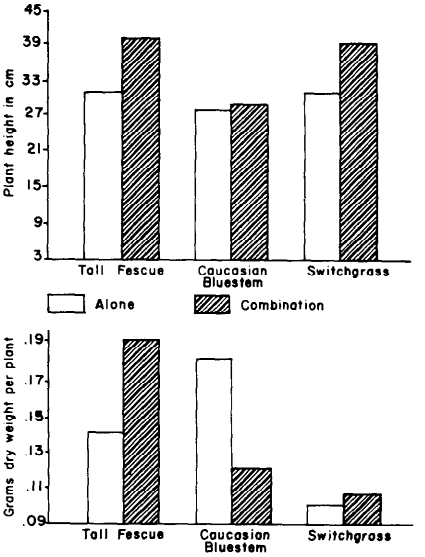


FIGURE 3. Final height and top weight of species grown alone and in combination.

In the fertile soil, Soil A, the grasses grew relatively better alone than in combination. However, in Soils B and C, where the physical and/or chemical characteristics of the soils were more likely to be the limiting factor, the species grew better in combination (Table 3). This would also point to a differential ability of the species to obtain nutrients under adverse conditions.

The addition of fertilizer increased the shoot/root ratio (fertilized 2.87 vs. non-fertilized 2.45). Similarly, on the fertile soil, Soil A, the ratio was greatest (3.04 vs. 2.47). When the species were grown in combination, the ratio was reduced (2.22 vs. 2.80). Thus, in combination, the relative amount of root growth was increased. Since both top weight and height were also increased, this would tend to show that intra-species competition for nutrients was greater than inter-species competition. Caucasian bluestem produced relatively more root material (i.e., had a lower shoot/root ratio) than did switchgrass. The ratios were 2.47 and 3.09, respectively. Fertilizer had a relatively greater affect in increasing the shoot/root ratio on the poor soils than on the fertile topsoil (Table 4).

Caucasian bluestem was least vigorous at the start but during the experiment it grew faster under some conditions and overtook both of the other species when grown alone. When grown in combination, it

Table 3. Top weight per plant of grasses grown on fertile topsoil and on infertile subsoil, alone and in combination (grams, oven dry).

Soil	Grown in combination	Grown alone
Soil A	.118	.143
Soils B and C	.157	.111

Table 4. Shoot/root ratios as affected by soil fertility and additional fertilizer.

Soil	Added Fertilizer	No Added Fertilizer
Soil A	2.93	3.16
Soil B and C	2.83	2.09

equaled or surpassed switchgrass by the end of the experiment.

The difference in ability of the species to respond to "favorable" physical and chemical characteristics of different soils as well as the differing ability of species to "overcome" unfavorable conditions is shown further in Figure 4. On the sandy loam soil, where fertility was a limiting factor, Caucasian bluestem grew more rapidly than switchgrass whether in combination or not. However, on Soil C, where either a physical or a chemical condition other than lack of N, P or K was present, switchgrass grew as well or better.

Each species exhibited differing ecological traits which can be used to help place the species in a "niche." Tall fescue had the greatest seedling vigor during the early part of the experiment and continued to be the most vigorous under fertile soil conditions, Soil A, whether added nutrients were present or not. Tall fescue thus did best on the "heavy" fertile soil which contained the most nitrogen. As shown in this experiment, there are good reasons why tall fescue is so widely used in bank stabilization and in pastures, why it invades Kentucky bluegrass (*Poa pratensis*) and other sod areas, and why stands of tall fescue tend to remain relatively pure.

Caucasian bluestem has an ability to respond to added nutrients and and to make rapid growth in the late seedling stages. These factors, and its seemingly lower intra-species competition, would tend to make it adaptable to single species seedings. Also, its low shoot/root ratio and relatively large root development, plus rapid growth rate under high fertilization, suggest that it may be a good species to use in stabilizing areas where the soils are excessively erosive.

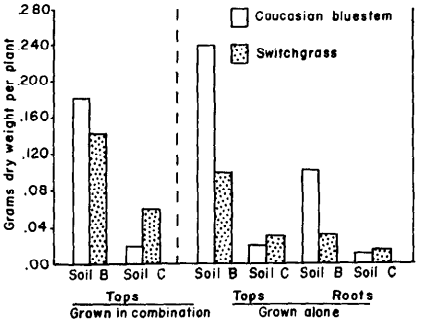


FIGURE 4. The contrasting top and root weights of Caucasian bluestem and switchgrass on Soil B, a sandy loam, and Soil C, a clay.

Switchgrass, with its ability to endure under adverse conditions and in association with other species, seems ecologically well adapted in the tall grass prairies.

Summary

Seedling vigor of three grass species on three soils of varying fertility and physical condition were compared under two fertility treatments—alone and in combination of all three.

1. Caucasian bluestem responded more to added nutrients than tall fescue and switchgrass.

2. When grown in combination, the average plant height of tall fescue and switchgrass was greater than when the two species were grown separately. The average weight of the fescue plants was greater. The increases were achieved without a reduction in the competing species, Caucasian bluestem. Thus, during the seedling period, the associated grass species produced more plant material than each grass component grown separately.

3. When nutrients were added, Caucasian bluestem had the greatest seedling vigor after the 22nd day of the experiment.

4. Tall fescue had greater vigor on unfertilized soils than did the other two species.

5. The growth of Caucasian bluestem was repressed relatively more by adverse physical and/or chemical properties of a soil (even when N, P and K were added) than was the growth of the other two species.

6. Tall fescue produced more dry matter per plant in mixtures than in pure stands.

LITERATURE CITED

BOUYOUCOS, G. J. 1951. A recalibration of the hydrometer method for making mechanical analysis of soils. Agron. Jour. 43:434-438.

CELARIER, R. P. AND J. R. HARLAN. 1955. Studies in old world bluestem. Okla. Agr. Exp. Sta. Tech. Bull. T-58.

EVANS, R. A. 1960. Differential responses of thee species of annual grassland type to plant competition and mineral nutrition. Ecol. 41:305-310.

FERGUS, E. N. 1952. Kentucky-31 fescue, culture and use. Ky. Agr. Exp. Cir. 497.

HALLOWELL, E. A., et al. 1960. Introduced grasses and legumes, pasture and range plants. Phillips Petroleum Co., Bartelsville, Okla.

HOOVER, M. N., M. A. HEIN, W. A. DAYTON AND C. O. Erlanson. 1958. The main grasses for farm and home. *In* Grass. Yearbook of Agriculture. 639-700.

LAVERTY, J. C. 1962. The Illinois method determining available phosphorus in soils. Dept. of Agron. Univ. of Illinois. AG-1861.

PLUMMER, A. P. 1943. The germination and early seedling development of twelve range grasses. Jour. Amer. Soc. Agron. 35:19-39.

RICE, E. L., W. T. PENFOUND, L. M. ROHRBAUGH. 1960. Seed dispersal and mineral nutrition in succession in abandoned fields in central Oklahoma. Ecol. 41:224-228.

MANAGEMENT NOTES

AN OREGON RANGE SHEEP STORY

E. WILLIAM ANDERSON
Oregon Range Specialist, Soil Conservation Service, U. S. D. A. Portland, Oregon

Big, rangy cross-bred ewes. Suffolk bucks. Mutton-type lambs. This month's cover photo shows animals typical of Oregon's range-sheep operations.

Sheep have a bad reputation generally for being the cause of range destruction in eastern Oregon and other portions of the West. Certainly, much devastation was caused by the multitudes of sheep that criss-crossed back and forth enroute from one seasonal range to another. Common sense however, forces acknowledgement of the hordes of cattle and horses that shared the range for forage year after year. The cumulative impact of excessive livestock numbers of all kinds was particularly destructive in the vicinity of winter headquarters and other areas of concentration.

Not all sheep outfits are characterized by depleted range. Range will recover under sheep use. The Hinton & Ward sheep ranch in Wasco

country, Oregon is a prime example.

The photo depicts this ranch's private rangeland, most of which rates in Good and Excellent condition class. Bluebunch wheatgrass *(Agropyron spicatum),* Sandberg bluegrass *(Poa secunda)* and Idaho fescue *(Festuca idahoensis)* are the major plants of the range sites. This range has been used for spring and fall grazing by sheep for 26 years to the personal knowledge of the photographer and probably has been grazed by sheep for more than seventy years. Note the excellent understory of Sandberg bluegrass, the primary forage plant for sheep on this kind of range. The soil is Shaniko silt loam which consists of 24 to 30 inches of loess over Columbia River basalt under an annual precipitation of about 14 inches.

The area of the photo is about five miles west from the little town of Shaniko. In the spring of 1901, the Columbia Southern Railroad reached Shaniko from the Dalles, Oregon and as a result, Shaniko exploded with activity and business. Thousands of cattle and sheep were trailed long distances from the John Day and High Desert areas to this interior shipping point. Shaniko for a time was the largest interior shipping point for wool in the United States. Grazing pressures in the neighborhood of such a concentration surely must have been severe. The history of Shaniko indicates that the Hinton-Ward range probably was grazed heavily during those days. Fenced, and grazed judiciously, this range now represents an expansive area of what the country probably looked like originally.

Obviously, it is the kind of management rather than the class of grazing animal that accounts for range deterioration or improvement in the bunchgrass country of Oregon.

RANGE SEEDING INTRODUCED GRASSES ON ROOTPLOWED LAND IN THE NORTHWEST RIO GRANDE PLAIN

DURWOOD E. BALL

Range Conservationist, Soil Conservation Service, USDA, Uvalde, Texas

In the early days of rootplowing to control brush in the Rio Grande Plain of Texas, it was apparent that reseeding was needed. There was evidence of poor results from seeding with native grasses immediately following rootplowing. Also, adapted native grass seed was generally unavailable, and its use would have nearly doubled the cost. There usually seemed to be an adequate native grass seed source on the ground, but often, following severe soil disturbance with a rootplow, there would be an influx of weeds, and the native grasses were slow to establish the desired cover.

The costs of this type of brush control required the use of grasses that would establish quickly to provide ground cover and competition to resprouting or germinating brush species, and furnish a means of obtaining an early return on the investment. Rootplowing costs may be affected by size and density of brush, texture of soil. and topography. The average cost of rootplowing is $10.00 an acre. Seeding mixtures have most often been two pounds of buffelgrass *(Pennisetum ciliare)* and one pound of blue panicum *(Panicum antidotale)*. This provides approximately 25.5 germinal seed units per square foot at a seed cost of $2.70 per acre based on current seed prices.

There are about 6,500,000 acres of rangeland in the northwest Rio Grande Plain of Texas. This area extends from the Rio Grande River on the west to Atascosa County on the east, and from the Edwards Plateau Hill Country on the north to La Salle County on the south (Figure 1). The average rainfall decreases from 26 inches on the east to 13 inches on the west. During the period from 1953-1960, approximately 300,000 acres were range seeded following brush control. This has

FIGURE 1. Location of Study Area.

involved over 1,300 separate seedings. Rechenthin (1956) estimated that some form of brush control has been carried out by ranchers on three million acres in south Texas in the past ten years. "The seriousness of the brush problem is evident by the effort and money with which ranchers are attempting to halt and beat back the invasion that is crippling their industry" (Carter 1958).

Methods

Many different seeding methods have been used, the earliest being hand broadcasting. This method proved unsatisfactory because of the poor distribution of seed, and it required another trip over the land, usually by horseback. Airplane seedings were complicated by the seeding mixture of clean and chaffy seed, as well as the timing of the operation so seeding could be done before rain crusted the surface of the soil. Several "shaker-box" type of seeders were used. These depended on vibration from the tractor, or rootplow, as a means of seed release. This type was unsatisfactory, since seed mixtures were difficult to use and because many seed fell on soil that was still turbulent from the rootplow, causing them to be covered too deeply. A cyclone type seeder was used to some extent. It was usually operated by a small electric motor, which used the tractor's battery as a source of power. These worked reasonably well except for the difficulty in using mixtures of clean and chaffy seed. The most widely used at present are seeders which use an air blast for seed distribution. Some of the planters use the exhaust from the tractor, while others have a blower mounted on the tractor.

Since seeding has not been successful in all instances, the steps taken following seeding failures and techniques to reduce the chance for failure are of prime importance. In 1956 and 1957 it became evident that some areas would require reseeding. A modified rootrake was then used for the dual operation of seedbed preparation and planting. This equipment has proved successful as a follow-up method on seeding failures and for seeding immediately following rootplowing. Another implement, the rolling brush chopper, was modified for range seeding. It chops the dead brush and regrowth, breaks up clods, levels the land to a degree, and generally prepares a more desirable seedbed than is left by the rootplow alone. The best results appear to be when it is used immediately following the rootplowing.

Results

Two introduced grasses, blue panic and buffelgrass, reached prominence in their ability to germinate and grow on a loose seedbed. Although these grasses have done well, they do not always produce a stand of grass. Results have varied, depending on range sites (Table 1), climatic conditions, time of seeding and the condition of the seedbed. Evaluations of seedings were made by U.S. Soil Conservation Service technicians located in the area.

The overall average of successful stands of grass is 50 percent or 66 percent of the area seeded. Often good stands of native grasses were obtained through natural recovery (Figure 2, top). These are not included in the count. Principal native species that recovered in this instance are spike bristlegrass (*Setaria*

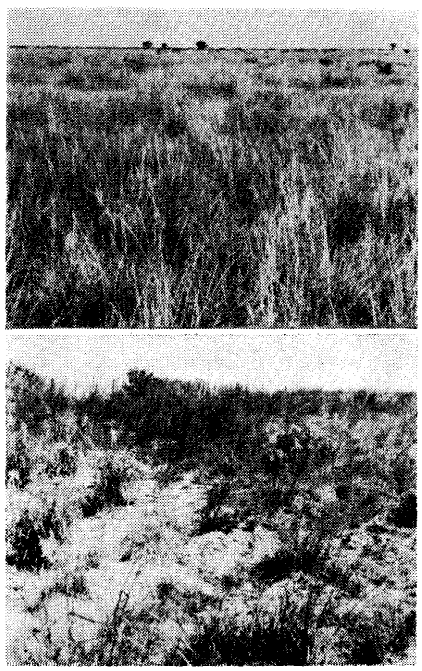


FIGURE 2. *Top*—Clay Flat Range Site. Native grass recovery the third year following the brush control operation. Seeded grasses failed to establish. *Bottom*—Rolling Hardland Range Site. A seeding failure, with scattered bunches of blue panicum and heavy weed growth in background.

Table 1. Area and number of seedings and successful stands by sites.

Site	Area Seeded			Plantings		
	Total	Stands		Total	Stands	
	— (Acres) —		(Pct)	(Number)		(Pct)
Clay Loam	96,442	70,437	73	405	259	64
Clay Flat	14,905	5,032	34	120	29	24
Shallow Ridge	11,828	10,165	86	34	30	88
Loamy Bottomland	18,102	10,460	58	94	59	63
Sandy Loam	66,205	33,840	51	386	147	38
Gravelly Ridge	49,289	45,597	93	44	32	73
Shallow	450	235	52	12	7	58
Saline Clay	24,359	14,535	60	112	40	36
Vega	264	264	100	1	1	100
Tight Sandy Loam	7,057	3,625	51	30	18	60
Deep Sand	1,190	500	42	14	8	57
Rolling Hardland	23,366	16,597	71	20	13	65
Tight Bottomland	3,835	1,150	30	18	5	28
Saline Bottomland	607	59	10	6	1	17
High Lime	1,124	336	30	10	2	20
TOTALS	320,550	212,833	66	1,312	658	50

leucopila), curly mesquitegrass *(Hilaria belangeri)*, pink pappusgrass *(Pappophorum bicolor)*, Arizona cottontop *(Trichachne californica)*, and Halls panicum *(Panicum halli)*.

There has been marked difference in successful seedings by range sites. In the drier part of the study area around Del Rio, Texas, in the Devil's River Soil Conservation District, about 10,000 acres of Shallow Ridge Range Site, Zapata soils, were seeded following rootplowing. Of the 29 different seedings, 28 were successful. In comparison, the average for the Clay Flat Range Site, Montell clays, was 24 per cent successful stands (based on 120 seedings, of which 29 were successful). A seeding success for this purpose is defined as one where satisfactory stand of the seeded grass is obtained from a grazing management standpoint (Figure 2, bottom). Some of the seedings were partially successful, but it was not felt in these instances that there was a sufficient stand of the seeded grass on which management could feasibly be based.

Successful seedings on the Bottomland Range Site, Frio soils, varied from 13 percent at Tilden, Texas, to 81 percent at Del Rio, Texas. Failure at Tilden may have been due in part to weed infestations following winter rains. The heavier clay soils in higher rainfall consistently gave poorer results than the same soil type in the more arid sections.

There are approximately 768,000 acres of the Sandy Loam Range Site within this area. Some 66,000 acres have been seeded following brush control. The Carrizo Springs Work Unit area has realized an 84 percent successful stand on this site. However, the average for the site over the entire area has been only 38 percent. Significantly, most of the successful stands were obtained during drouth years having little winter rainfall (Figure 3).

Observations are that the spread of blue panic seedlings following the initial seeding is very slight after the first two years. Buffelgrass, however, usually spreads rapidly. Native grass species begin to re-establish and often fill the gap after 2 or 3 years. The introduced grasses then become less in relative abundance to the native grasses and on most sites decline in amount.

The principal factors relating seeding success to time of seeding are rainfall and temperature following the seeding. Norris (1961) indicates that the main problem in establishment is the rapid drying of the surface soil before the seed can germinate and develop roots. The evaporation rate varies from approximately 59 inches on the eastern side of the outlined area to 75 inches on the western side. It is relatively high during the early stage of seedling establishment (Bloodgood, D. W., R. E. Patterson, and R. L. Smith, Jr., 1954).

FIGURE 3. Sandy Loam Range Site. This area successfully seeded to buffelgrass following rootplowing.

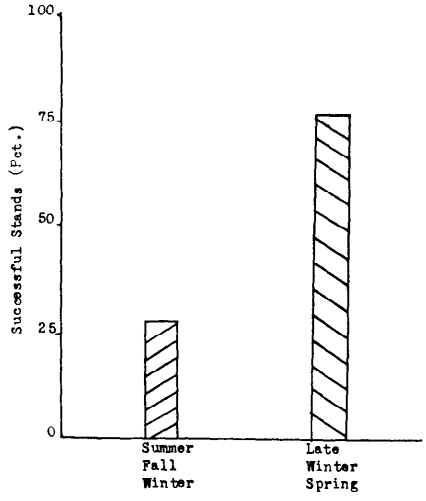


FIGURE 4. Late winter-spring seedings made three times more stands than did summer-fall-winter seedings.

Late fall and winter rains, an unusual condition that has occurred frequently in recent years, are favorable for growth of winter annuals. These annual weeds have a suppressing effect on young grass seedlings the following spring, accounting for some seeding failures. Of 55 different seedings, 18 of which were made during the summer-fall and early winter, only 27.7 percent were successful (Figure 4). The remainder were made in late winter and early spring; of these, 75.6 percent were successful. Late winter and early spring rootplowing can often kill the weed infestation, and the probability of rain in the spring and early summer is good.

Where seeding efforts have failed and natural succession is allowed to take place, weed infestation has been heavy. Two of the most severe and most persistent weeds have been russian thistle *(Salsola kali)* and prairie coneflower *(Ratibida columnaris)*. Under the condition of adequate winter moisture for establishment of these weeds, they have dominated the site for as long as three years in limited areas.

Summary and Conclusion

A survey was made of 1,312 range seedings, covering 320,550 acres, to evaluate introduced grasses, the effects of range sites on seedling establishment, and the effects of time of seeding. From this study the following conclusions may be made:

(1) The shallow, gravelly and clay loam range sites have consistently given the best results on range seeding with introduced grasses following rootplowing. The heavier clay soils that tend to remain cloddy have resulted in the poorest stands of grasses.

(2) As rainfall increases, the effects of range site differences are more pronounced. Generally, as the rainfall increases, the seeding failures increase and the permanence of blue panicum and buffelgrass decreases. Weed infestation is most severe and is more of an adverse factor in grass seedling establishment when sufficient early winter moisture is received to establish weeds.

(3) Native grass recovery and reestablishment increases with time and with the decline of the introduced species.

(4) Late winter and early spring seedings following rootplowing have been more successful than mid summer-fall seedings.

(5) Unsuccessful seedings can be reworked and seeded with a high degree of success.

Brush control is needed on much of the rangeland in this area, most of which, if rootplowed by methods presently used, will be reseeded with introduced grasses. Careful consideration should be given to the time

of range seeding, the method of seedbed preparation, the kinds and amounts of seed, and the method of seed distribution.

By observation, it may be concluded that deferment following seeding is prerequisite to a successful stand. Stands of seeded grasses are seldom obtained and maintained without deferment and limitation of use to a reasonable degree.

LITERATURE CITED

BLOODGOOD, D. W., R. E. PATTERSON AND R. L. SMITH, JR. 1954. Water evaporation studies in Texas. Texas Agr. Exp. Station Bull. 787. 83 pp.

CARTER, M. G. 1958. Reclaiming Texas brushland range. Jour. Range Mangt. 11:1-5.

NORRIS, M. J. 1961. Range seeding problems for central Texas. 1961 Conservation Workshop, College Station, Texas.

RECHENTHIN, C. A. 1956. Rooting. chopping, control brush. American Cattle Prod. 38: 9-11.

BOOK REVIEWS

The Matador Land And Cattle Company. By W. M. Pearse. *University of Oklahoma Press, Norman, Oklahoma. 244 pages. 1964. $5.95.*

This is the true story of the rise and dispersion of one of the great cattle empires of Texas. The ranch was named Matador by one of the original owners who was an enthusiast in Spanish literature. The ranch lies in the northwest part of Texas with the Matador division in Motley County some 150 miles west of Wichita Falls and about 135 miles southeast of Amarillo. The Alamositas division was some 35 miles west of Amarillo. Until the early 1870's, this area was inhabited by plains Indians and not suited for inhabitance by white men. Herds of buffalo roamed and grazed the nutritious, abundant grasslands. The Indians were driven from the area in 1874 under the command of Colonel Ronald Mackenzie.

The first headquarters of the Matador Ranch was a buffalo hunters dugout located at Ballard Springs. The ranch was established by H. H. Campbell in 1879 with the first cattle purchase made in December. By 1882 the Matador claimed a range covering 1,500,000 acres. Campbell was financed by Colonel A. M. Britton who retained power of attorney for the ranch organization.

Foreign investment companies were looking to the American cattle industry as a means of new investments. In 1882 Col. Britton approached the Dundee, Scotland, businessmen, who employed Thomas Lawson to appraise the properties. Lawson reported, "The ranches seem to me to be quite capable of carrying at least 80,000 cattle . . . and graze them well. It has abundant supply of water, convenient for grass, and ample shelter for stock during hard weather; is at an elevation where nights are cool and cattle can rest; at a latitude where winters are comparatively safe. It is without a doubt one of the best watered, sheltered and healthiest ranches in Texas." Lawson placed evaluation on the land, improvements and livestock between $1,200,000-$1,300,000. The Scots entered an agreement with Britton on September 28, 1882. The holdings were purchased for $1,250,-000.

The headquarters was moved from Ballard Springs to Dundee, Scotland. Campbell was retained as superintendent but he was more of a cowman than one to make formal reports to the Dundee office. Each year one director and the secretary made a trip from Scotland to the ranch.

By 1884 it was apparent that the size of the Matador was less than assumed originally. This caused the board of directors to acquire desirable lands adjoining the Matador and secure grass leases in an effort to reduce overstocking rather than reduce the herd. In 1885 land procurement began with the rights to graze cattle on public domain lands at 9 cents per acre per year.

Property line fencing began in 1884 with the first fence between the Matador and the Espuela Cattle Company. With outside boundaries enclosed, fencing was begun on the interior land. The first wire for subdivision was defined as dull-barbed, wide-ribbon wire.

Steers and spayed heifers were marketed at four to five years old as heavy beef. Until a railhead was developed, the cattle were driven to central markets. In 1885 railheads were developed at Colorado City and Wichita Falls. Cattle from the southern part of the Matador were driven to Colorado City while those on the northern part were moved to Wichita Falls.

The great drouth and blizzards of 1886-1887 caused Campbell to search for water and grass. The cow herd was reduced at a $3 per head loss. The grass distant from water was unused while around watering places it was trampled out. Well digging and dam building got underway to restore water for better range grazing. Many foreign owned cattle companies went out of business in the 1880's but not the Matador. The directors reduced the dividends and wrote off a loss of 8,500 head to weather in 1886. Upgrading cattle began as early as 1885. The Matador had the reputation of having the best grade and registered Hereford cattle of any ranch.

Campbell organized Motley County and located the county seat of Matador one mile northeast of Ballard Springs. In 1891 Murdo Mackenzie, a Scotsman, was named manager, a position he held until 1937 at which time his son, John Mackenzie, was appointed general manager until the sale of the Matador in 1951.

The land expansion northward began in 1892 and continued until the Matador Land and Cattle Company operated the following divisions: Matador 1882-1951; Wyoming Western Ranches 1895-1904; White Deer Pasture, Texas, 1893-1895; 1898-1902; Alamositas, Texas,

1902-1951; South Dakota Cheyenne River Indian Reservation 1904-1914; Montana 1913-1928; and Canadian 1905-1921. In the Matador and Alamositas Divisions, the company directors determined in the 1920's that range conditions were good enough that the land exploration could be reduced and was completed in 1928. The drastic change from raising large calf crops in Texas and maturing beef on northern grass had to be made because of increasing expenses and the disadvantage of selling heavy beef. The public had turned to lighter weight beef.

In 1883 the company owned 374,717 acres with herds numbering 76,600. By 1890 land increased to 444,657 acres and 97,781 head of cattle. The lowest herd numbers were 46,144 in 1935, another bad drouth period, while the acreage was 878,748. In 1951 the Matador Ranch land involved 808,000 acres with a cow herd of 46,746.

The Company was sold in 1951 to a group of New York businessmen. This marked the last of the foreign owned cattle companies in Texas.

The railroad came to the Matador in 1910 during the great westward expansion of railroads. The quest for farming land before World War I brought still another era to the Matador Ranch. The Matador made land available for farming around Roaring Springs. In 1913 the exploration for oil began on the ranch. The company hired a geologist in 1916 to make a survey of all the divisions for prospects of oil development.

The author does not depict the conditions of the vegetation vividly. There is some mention of small mesquite trees in reports of the directors' visits to the ranch. When the greatest invasion of mesquite took place is not fully explained. A review of the photographs showing range landscape indicates that the range was open grassland in 1883. Around the headquarters at Ballard Springs in 1884, photographs show some small sprangling mesquite trees about three feet tall. In 1928 a range scene indicates that the landscape was covered with mesquite trees taller than the high grade Hereford cattle. In 1949 the mesquite had so increased in density that it was restricting grazing.

I recommend that every person interested in the development of a cattle ranch in Texas and the men that made it read this book. While *The Matador Land and Cattle Company* is perhaps not the most exciting account of the ranch and cattle development in Texas, Dr. Pearse relates the true picture of the ranching development of the Rolling and High Plains of Texas. He does not try to include all of the picturesque things that most people consider as going along with the cattle ranching industry. Personal stories and colorful details are omitted. Primary value of this volume is as a reference, based on the Matador Ranch records now in the archives of Texas Technological College. *Garlyn O. Hoffman,* Texas A&M University, College Station, Texas.

Livestock And Livestock Products. By Theodore C. Byerly. *Prentice Hall, Inc., Inglewood Cliffs, N.J. 422 pages. 1964. $10.00.*

Dr. Byerly has written an authoritative book, broad in scope, and yet specific in detail for all major livestock species. Dr. Byerly is a skillful writer, having the art of expressing much in few words. This book should serve well as a college text in Animal Science and source of information on animal breeding, nutrition, feeding, health, marketing, and livestock products.

The first three chapters discuss the history of livestock production in the United States — from the colonial period to the purebred livestock era. The effect of environment on livestock production is well presented.

Three chapters are devoted to the principles of heredity, livestock breeding, and reproduction, followed by a chapter on lactation. Dr. Byerly states, "Heredity establishes the capacity for performance; the environment, including nutrition, climate, management, and disease, determines the actual performance within the capacity fixed by heredity". The basic concepts of heredity and breeding for the various species of animals are well presented and illustrated, from the discussion of "cytological basis of heredity" to "systems of mating". The chapter on livestock breeding briefly covers origins of the various species, gives some criticism of breeds, describes methods of breeding and performance testing. The chapter on reproduction describes reproductive organs, artificial insemination, growth and development of the embryo, pregnancy tests, and reproductive efficiency. The physiology of milk production is presented in a chapter on lactation.

Nutrition and the feeding of livestock are presented in three chapters. Digestion and metabolism, assimilation, and basic principles of nutrition are given. Nutrient requirements of the various species are discussed, documented by daily nutrient requirement tables from the National Research Council. The livestock feed supply and its utilization, the place of range forage in livestock production, the value of proper use of range, and the importance of range improvement are emphasized. The composition of feed, the use of feed additives, and the services of the commercial feed industry are discussed. The chapter on "feeding livestock" presents management and feeding practices for beef and dairy cattle, sheep, swine, poultry, laboratory animals, and fur bearers. Short chapters are also devoted to feeding horses and goats.

The quality of livestock and livestock products, their utilization, and marketing are treated in three chapters. The development of standards and measurements of quality in meats and wool are presented. The regional differences in food use of livestock products are described and illustrated. Marketing livestock, seasonality in livestock slaughter, market demand, transportation, storage, and livestock losses from handling are discussed.

In the last chapter on "Costs and Returns from Livestock Farming", Dr. Byerly emphasizes efficiency of production.

This book covers the subject matter clearly and thoroughly. Dr. Byerly has used 129 tables and 34 figures to document this book of lasting importance to students and livestock producers. *O. O. Thomas,* Montana State College, Bozeman, Montana.

From Prairie to Corn Belt. By Allan G. Bogue. *University of Chicago Press, Chicago, Illinois. 310 pages. 1963. $6.95.*

The author concerns himself with a portion of the mid-continental grassland area embodied in the

states of Iowa and Illinois, formerly known over all as the true prairie region. The book is studded with factual detail such as census statistics relating to origins or nativity of the settlers, crop production, acreages, taxation, law, domestic animal populations, etc.; and yet these usually dry statistics are carefully and effectively interwoven in descriptive and explanatory narrative so as to read with the absorbing appeal of a novel. The Homestead Act, organization of claim clubs by squatters to prevent land grabs by speculators and claim jumpers, recalls the basis of much modern TV drama. Stories of the effort and cost of breaking the sod and of the development of the steel plow are very real.

The temporary determining factors of the environment which kept the settler tied to the forest and how he overcame this control to move into the grassland are told. It is of great interest to read of the human motivations and of the trials and errors of crop and animal production. Stories concerning improvement of corn recalls boyhood memories of Indian corn, yellow dent, white corn, and the colorful red variety known as the bloody butcher. The improvement of livestock, hogs, beef, and draft animals is also told in colorful language which is also scientifically accurate in its detail.

Professor Bogue calls himself an agricultural historian, but he is more than this as is revealed in this book. We should have more historians of his type who can present the temporal and spatial background clearly and colorfully, and who also have the broad gauge to add to this backdrop the factual details and interpretation that present a completely integrated picture. The book is an outstanding effort to explain what the region was, what went on there, and how it became what it is. *From Prairie to Corn Belt* is a fine synthesis of history, geography, economics, agriculture, sociology, and other studies. — *John W. Voigt,* Southern Illinois University, Carbondale, Illinois.

From Cab to Caboose. By Joseph A. Noble. *University of Oklahoma Press, Norman, Oklahoma. 205 pages. 1964. $6.95.*

This book, amply illustrated and written by a man who spent fifty years with the Santa Fe Railway, has little to do with the science and art of range management. By locale, however, in the southern portion of Colorado and southwestern Kansas to west Texas, the descriptions of events and early life in railroading parallel the developmental throes of the livestock industry.

Mr. Noble's story begins with an accounting of experiences on survey crews in the early 20th century with anecdotes on life in the great out-of-doors and continues on through his progression of jobs with the company. He states in his preface that this book "is neither a history nor a treatise on railroad engineering." Although the book does cover certain areas which would be unfamiliar to the range man, the philosophies and human psychologies expressed are familiar whether they be in reference to railroading or any other vocation.

Mr. Noble retired as chief engineer of the Western Lines in 1958. Perhaps one of the concluding paragraphs best exemplifies his forte. "The struggle to accomplish something, the feeling of belonging—to be part, however small, of a powerful and respected organization, to see the results of your work, and to believe that it has been of some value to the common human effort —these I think, are some of the things that give lasting satisfaction to the average human being."—*David G. Wilson,* University of Arizona, Tucson, Arizona.

Conservationists And What They Do. By C. William Harrison. *Franklin Watts, Inc., 575 Lexington Avenue, New York 22, New York. 190 pages. 1963. $3.95.*

This book fills a need for youth interested in career opportunities in conservation. It would be an excellent reference for junior and senior high school students in the career development stage. The reader is given a basic understanding of the need for wise use of our natural resources.

The author points out that not until the first quarter of this century did the United States begin to realize that it must conserve what is left of its natural resources or face disaster. Depletion of the country's arable land, its forests, its animal life, and its water supply present the nation with a problem that must be solved.

Conservation, says the author, is not a career in itself, but many jobs. The government and private industry offer the conservation-minded young person the chance to take part in a vital work. Government offers careers in forestry, soil and wildlife conservation, flood control, biological research, and allied services. Lumber companies, pulp and paper corporations, agricultural associations, farmers' cooperatives, sportsmen's clubs, the fishing industry, chemical firms, and other private organizations offer the opportunity for conservation work.

In addition to describing the work done by government and industry, the author lists the necessary qualifications for those interested in the field of conservation and suggests schools and colleges where the applicant can receive training in his chosen field. *Ralph J. Kotich,* Colorado State University, Fort Collins, Colorado.

California Range Brushlands And Browse Plants. By Arthur W. Sampson and Beryl S. Jespersen. *California Agric. Expt. Sta. Ext. Serv., Berkeley. Manual 33, 162 pages, illustrated. November 1963. $2.00.*

This is another outstanding publication by the "father of range management" that summarizes present knowledge of California brushland and its individual species with regard to their characteristics, use, and management.

The main objective of the manual is to present information on the techniques of converting wild brushlands to more desirable forage plants. It is directed at an audience of: range technicians, who desire more detailed information of California brushlands and browse; stockmen and sportsmen, who are interested in the identification and use of browse; and students of range management and related fields who, as a part of their education and training, must have basic knowledge of taxonomy, ecology, and importance of browse plants.

The manual is divided into two parts. Part I concerns biological and management considerations with regard to: major brushland communi-

ties and their soils, foraging animals and their use of browse, nutritional levels of browse plants, and techniques for brushland improvement. Part II is an appraisal of individual browse species.

The authors recommend a soil-vegetation survey prior to undertaking improvement of any brushland area. Trends in chemical composition of individual browse species are presented as a basis for planning the satisfaction of the nutritional requirements of foraging animals. Coverage of food habits, requirements, and overlap in use of livestock and big game provides a background for coordinated brushland development.

The authors' outlook for improvement of California brushlands is hopeful. Range improvement is considered to be economically sound on about 9 million acres of brushland with an average increase in grazing capacity of 15 to 20 percent. On a select 3 million acres, grazing capacity can, however, be increased by 50 to 60 percent. The outlook for reestablishing bitterbrush on depleted deer winter ranges is concluded to be practical and desirable, even though costly. Among the different methods recommended for brushland improvement are tested techniques for controlled burning, use of machinery, application of chemicals, and biological approaches.

A recognition key for individual browse species is preceded by a glossary in layman's language. A brief description is given of each family and genera of browse. For each species there is a concise text, a distribution map, and a black and white line drawing. The artist is to be complimented on the excellent illustrations of identifying characteristics. Species appraisal is concerned with distribution, economic value, and rating as browse.

All in all, the manual is a scholarly job that should prove a valuable reference for technicians, an instructional aid for teachers, a learning device for students, and a general reference manual for lay people. Anyone working in livestock or big-game management should consider acquisition of this manual for his library. — *H. G. Reynolds,* Rocky Mountain Forest and Range Experiment Station, Tempe, Arizona.

Annual Rings In Big Sagebrush *(Artemisia tridentata).* By Charles Wesley Ferguson *is a 95-page booklet published by the University of Arizona Press, Tucson, 1964.*

The typography and illustrations are excellent. The author, with training and experience in dendrochronology, presents this study of sagebrush rings with skill and clarity. He defines and applies the concepts and techniques of tree ring analyses to advantage in interpreting and explaining sagebrush growth and stem structure.

Detailed descriptions of annual growth rings and causes of abnormalities serve as a refresher for one's fading knowledge of wood technology. Terms are clearly defined at the beginning of the text, and the layman will find no difficulty in following the story of sagebrush rings.

The study was based on sagebrush collections from New Mexico, Arizona, California, and Nevada, which included a wide range of sagebrush sites. Very old plants of sagebrush were compared with master chronology charts from trees of the same general area. Use chronology charts of the older sagebrush plants and of trees in a given area combined with crossdating, enabled the estimating of total ages of stems with eroded centers.

The unique method of determining the years since death of old sagebrush stems by chronological interpretations, permitted the study of sagebrush stands to be extended back 20 or more years beyond the age of present live plants in the stand. The presentation and description of deterioration classes of dead sagebrush, from 0 to 50 years, may be useful in ecological interpretations of sagebrush ranges. An interesting phase of this study was the determination of early height growth rates of old sagebrush plants by dividing the length of stem sections by the difference in pith dates of the two ends of the sections.

Range and wildlife habitat managers will find the short sections on climatological and ecological applications of shrub ring growth studies interesting.

After reading "Annual Rings in Big Sagebrush" you will no longer wonder at the lobed and extremely eccentric cross sections of sagebrush or at the presence of the pith on the outer edge of some cross sections. You may also have more confidence in your own attempts to determine the age structure of sagebrush stands.

For anyone interested in browse range and the tracing of the history of shrub stands by age studies, this booklet is a high priority item and should occupy a readily accessible place in your bookcase. *Odell Julander* Intermountain Forest and Range Experiment Station, Provo, Utah.

CURRENT LITERATURE

Edited by Meredith Morris, Charles Terwilliger, Jr., and Graduate Student-Faculty Seminar members, Range Management Department, Colorado State University, Fort Collins, Colorado.

RANGE AND PASTURE MANAGEMENT

Blackmore, L. W. Chemical renovation of pastures in southern Hawke's Bay and Northern Wairarapa. *New Zeal. Jour. Agr. 108(2): 122-125; 129-135. Feb. 1964.* (Dept. of Agr., Dannevirke, N.Z.)

Brown, Paul L. Legumes and grasses in dryland cropping systems in the northern and central great plains: A review of the literature. *U.S. Dept. Agr. Misc. Publ. No. 952, 64 pp. Mar., 1964.* (Soil and Water Conserv. Res. Div., ARS, USDA)

California Division of Forestry. Activity in range improvement. *Ann. Rpt. 1963, 17 pp. Mar., 1964.* (Dept. Conserv., Div. For., 301 State Office Bldg. No. 1, Sacramento, Calif. 95814)

Cook, C. W. and L. A. Stoddart. Spring grazing critical to desert ranges. *Utah Farm and Home Sci. 25(1): 6-7; 25-26. Mar., 1964.* (College Forest, Range, and Wildlife Mangt., Utah State Univ., Logan)

Crampton, Beecher. Promising range forage and wildland cover crops from University plant introduction nurseries. *Calif. Agr. 18(3):12-13. Mar., 1964.* (Agron. Dept., Univ. Calif., Davis)

Day, Richard and E. N. Gladish. Perennial grasses aid resources management. *Calif. Div. Forest Range Improvement Studies No. 13, 10 pp. Sept., 1963.* (Dept. Conserv., Div., Forest, 301 State Office Bldg. No. 1, Sacramento, Calif. 95814)

Dotzenko, A. D. and K. E. Henderson. Performance of five orchardgrass varieties under different nigen treatments. *Agron. Jour. 56 (2): 152-155. Mar.-Apr., 1964.* (Dept. Agron., Colo. State Univ., Fort Collins)

Jameson, D. A. and T. N. Johnsen. Ecology and control of alligator juniper. *Weeds 12(2):140-142. Apr., 1964.* (Rocky Mtn. Forest and Range Expt. Sta., Ariz. State College, Flagstaff)

Joppa, L. R. and C. W. Roath. A comparison of Kenmont, Alta, and other fall fescue varieties in Montana. *Mont. Agr. Expt. Sta. Bul. 582, 11 pp. Jan., 1964.* (Mont. Agr. Expt. Sta., Mont. State College, Bozeman)

Komarek, E. V., Sr. The use of fire in wildland management. *Ariz. Watershed Symposium, Ann. Proc. 7:23-30. Sept., 1963.* (Tall Timbers Res. Sta., Tallahassee, Fla.

Wolf, Dale D. and Dale Smith. Yield and persistence of several legume grass mixtures as affected by cutting frequency and nitrogen fertilization. *Agron. Jour. 56(2):130-133. Mar.-Apr., 1964.* (Dept. Agron., Wis. Agr. Expt. Sta., Madison)

RANGE AND LIVESTOCK ECONOMICS

Anonymous. How many units will a ranch carry? . . . that depends. *West. Livestock Jour. 42(15):38-44. Feb., 1964.*

Boykin, C. C., J. R. Gray and D. D. Caton. Ranch production adjustments to drought in eastern New Mexico. *N. Mex. Agr. Expt. Sta. Bul. 470, 41 pp. Dec., 1962.* (N. Mex. State Univ., Univ. Park)

Cotner, Melvin L. Optimum timing of long-term resource improvements. *Jour. Farm Econ. 45(4): 732-748. Nov., 1963.* (Dept. Agr. Econ., Mich. State Univ., East Lansing)

Knetsch, Jack L. The influence of reservoir projects on land values. *Jour. Farm Econ. (46(1):231-243. Feb., 1946.* (Resources for the Future, Inc., 1755 Mass. Ave., N.W., Washington 36, D.C.)

Roberts, N. Keith and E. Boyd Wennergren. Blocking State owned grazing lands could benefit both lessees and schools. *Utah Farm and Home Sci. 25(1):13-15. Mar., 1964.* (Dept. Agr. Econ., Utah State Univ., Logan)

Shiflet, Thomas N. Profitability of rice and native grass on a deep-peat fresh water marsh soil. *Jour. Soil and Water Conserv. 18(6): 244-245. Nov.-Dec., 1963* (SCS, USDA, Lake Charles, La.)

Throsby, C. D. Thesis summary: Dynamic programming and the economics of pasture improvement. *Austral. Inst. Agr. Sci. Jour. 29(4):242. Dec., 1963.* (Univ. of Sydney, Australia)

Wilcox, Walter W. How much farm program benefits are lost to farm operators via capitalization into land values? *Jour. Farm Econ. 46(1): 246-247. Feb., 1964.* (Library of Congress)

CHEMICAL COMPOSITION OF PLANTS AND ANIMAL NUTRITION

Alder, F. E., J. C. Tayler and J. E. Rudman. Hexoestrol implantation of steers fattened at pasture. I. Effects on growth and herbage intake. *Anim. Prod. 6(1):47-56. Feb., 1964.* (Grassland Res. Inst., Hurley, Berkshire, England)

Burton, Glenn W., F. E. Knox and D. W. Beardsley. Effect of age on the chemical composition, palatability and digestibility of grass leaves. *Agron. Jour. 56(2):160-161. Mar.-Apr., 1964.* (CRD, ARS, USDA, Coastal Plains Expt. Sta., Tifton, Ga.)

Conner, J. M., V. R. Bohman, A. L. Lesperance and F. E. Kinsinger. Nutritive evaluation of summer range forage with cattle. *Jour. Anim. Sci. 22(4):961-969. Dec., 1963.* (Nev. Agr. Expt. Sta., Univ. of Nev., Reno)

Hall, O. Glen, Atalla Said Mohammed and H. A. Fribourg. Comparative nutritional value of some bermudagrasses as determined with rumen microorganisms. *Tenn. Farm and Home Sci. Prog. Rpt. 49:10-13. Jan.-Mar., 1964.* (Anim. Husb. Vet. Sci. Dept., Univ. of Tenn., Knoxville)

Watkins, W. E. and W. W. Repp. Influence of location and season on the composition of New Mexico range grasses. *N. Mex. Agr. Expt. Sta. Bul. 486, 33 pp. Mar., 1964.* (N. Mex. State Univ., Univ. Park)

RANGE ECOLOGY AND PLANT CLASSIFICATION

Bergerson, F. J. and A. B. Costin. Root nodules on *Podocarpus lawrencei* and their ecological significance. *Austral. Jour. Biol. Sci. 17 (1): 44-48. Feb., 1964.* (Div. of Plant Industry, CSIRO, Canberra)

Bolen, Eric G. Plant ecology of spring-fed marshes in western Utah. *Ecol. Monog. 34(2):143-166. Spring, 1964.* (Utah Coop. Wildlife Res. Unit, Utah State Univ., Logan)

Kapadia, Z. J. and F. W. Gould. Biosystematic studies in the *Bouteloua curtipendula* complex. III. Pollen size as related to chromosome numbers. *Amer. Jour. Bot. 51(2):165-172. Feb., 1964.* (Dept. of Biology, Tex A&M Univ., College Sta.)

Nixon, E. S. and Calvin McMillan. The role of soil in the distribution of four grass species in Texas. *Amer. Mid. Nat. 71(1):114-140. Jan., 1964.* (Chadron State College, Chadron, Nebr.)

Potter, Loren D. and Duane L. Green. Ecology of ponderosa pine in western North Dakota. *Ecology 45(1):10-23. Winter, 1964.* (Biol. Dept., Univ. of N. Mex., Albuquerque)

Salisbury, Frank B. Soil formation and vegetation on hydrothermally altered rock material in Utah. *Ecology 45(1):1-9. Winter, 1964.* (Dept. of Bot. and Plant Path., Colo. State Univ., Fort Collins)

Schuster, Joseph L. Root development of native plants under three grazing intensities. *Ecology 45(1): 63-70. Winter, 1964.* (Southern Forest Expt. Sta., USFS, Nacogdoches, Tex.)

Waring, R. H. and J. Major. Some vegetation of the California coastal redwood region in relation to gradients of moisture, nutrients, light and temperature. *Ecol. Monog. 34(2):167-215. Spring, 1964.* (School of Forestry, Univ. of Calif., Berkeley)

PLANT PHYSIOLOGY AND GENETICS

Dwyer, Don D., W. C. Elder and G. Singh. Effects of height and frequency of clipping on pure stands of range grasses in north central Oklahoma. *Okla. Agr. Expt. Sta. Bul. B-614, 10 pp. Aug., 1963.* (Okla. State Univ., Stillwater)

Evans, L. T. Inflorescence initiation in *Lolium temulentum* L. V. The role of auxins and gebberellins. *Austral. Jour. Biol. Sci. 17(1):10-23. Feb., 1964.* (Div. of Plant Industry, CSIRO, Canberra)

Evans, L. T. Inflorescence initiation in *Lolium temulentum* L. VI. Effects of some inhibitors of nucleic acid, protein, and steroid biosynthesis. *Austral. Jour. Biol. Sci. 17 (1):24-35. Feb., 1964.* (Div. of Plant Industry, CSIRO, Canberra)

Evans, L. T. and I. F. Wardlaw. Inflorescence initiation in *Lolium temulentum* L. IV. Translocation of the floral stimulus in relation to that of assimilates. *Austral. Jour. Biol. Sci. 17(1):1-9. Feb., 1964.* (Div. of Plant Industry, CSIRO, Canberra)

Hoveland, C. S. Germination and seedling vigor of clovers as affected by grass root extracts. *Crop Sci. 4(2):211-213. Mar.-Apr., 1964.* (Dept. Agron. and Soils, Auburn Univ., Auburn, Ala.)

Muzik, T. J. and W. G. Mauldin. Influence of environment on the response of plants to herbicides. *Weeds 12(2):142-145. Apri., 1964.* (Wash. Agr. Expt. Sta., Pullman)

Negbi, M. and D. Koller. Dual action of white light in the photocontrol of germination of *Oryzopsis miliacea. Plant Physiol. 39(2):247-253. Mar., 1964.* (Dept. of Bot., Hebrew Univ., Jerusalem, Israel)

Stoddart, J. L. Seed ripening in grasses. I. Changes in carbohydrate content. *Jour. Agr. Sci. 62: 67-72. Feb., 1964.* (Welsh Plant Breeding Sta. Aberystwyth)

LIVESTOCK MANAGEMENT

Elder, W. M. Needs, opportunities and rewards in beef cattle improvement. *Amer. Soc. Farm Managers and Rural Appraisers 28 (1):47-49. Apr., 1964.* (Elgin, Ill.)

McCormick, W. C., W. H. Marchant and B. L. Southwell. Effect of stocking level on gains of steers grazing coastal bermudagrass. *Ga. Agr. Expt. Sta. Mimeo. Ser. N.S. 183, 12 pp. Jan., 1964.* (Anim. Husb. Res. Div., ARS, USDA, Tifton, Ga.)

Nicholson, H. H. The treatment of timber milk-vetch poisoning among cattle and sheep. *Canad. Jour. Anim. Sci. 43(2):237-240. June, 1963.* (Canada Dept. of Agr., Kamloops, B.C.)

RANGE SOILS

Barrows, H. L. and V. J. Kilmer. Plant nutrient losses from soils by water erosion. *Adv. Agron. 15:303-316. 1963.* (U. S. Dept. Agr., Beltsville, Md.)

Kellogg, Charles E. Planning soil use for both individual and public goals. *Jour. Soil and Water Conserv. 19(1):3-6. Jan.-Feb., 1964.* (SCS, USDA, Washington, D. C.)

Parker, C. A. Talks: Biological nitrogen fixation and nitrogen status of soils. *Austral. Inst. Agr. Sci. Jour. 29(4):250. Dec., 1963.* (Inst. of Agr., Univ. of W.A., Nedlands, Australia)

Peterson, J. B. The relation of soil fertility to soil erosion. *Jour. Soil and Water Conserv. 19(1):15-19. Jan.-Feb., 1964.* (Dept. of Agron., Purdue Univ., Lafayette)

Webber, L. R. Soil physical properties and erosion control. *Jour. Soil and Water Conserv. 19(1):28-30. Jan.-Feb., 1964.* (Dept. of Soil Sci., Agr. College, Guelph, Ontario, Canada)

Wiese, A. F. and R. G. Davis. Herbicide movement in soil with various amounts of water. *Weeds 12-(2):101-103. Apr., 1964.* (Tex. Agr. Expt. Sta., S.W. Great Plains Field Sta., Brushland, Tex.)

RANGE-WILDLIFE RELATIONSHIPS

Christensen, Glen C. Exotic game bird introductions into Nevada. *Nev. Fish and Game Comm. Biol. Bul. No. 3, 66 pp. 1963.* (Nev. Fish and Game Dept., Reno)

Thomas, J. R., H. R. Cosper and W. Bever. Effects of fertilizers on the growth of grass and its use by deer in the Black Hills of South Dakota. *Agron. Jour. 56(2):223-226. Mar.-Apr., 1964.* (Research Soil Scientist, Newell, S. D.)

METHODS AND TECHNIQUES

Best, K. F. and J. L. Thompson. A tractor mounted experimental plot sprayer. *Weeds 12(1):62. Jan., 1964.* (Expt. Farm, Res. Branch, Canada Dept. of Agr., Swift Current, Saskatchewan)

Cook, C. W. Symposium on nutrition of forages and pastures: Collecting forage samples of ingested material of grazing animals for nutritional studies. *Jour. Anim. Sci. 23(1):265-270. Mar., 1964.* (Utah Agr. Expt. Sta., Utah State Univ., Logan)

Wilson, J. Warren. Errors resulting from thickness of point quadrats. *Austral. Jour. Bot. 11(2):178-188. Dec., 1963.* (Div. Plant Ind., CSIRO, Reg. Pastoral Lab., Deniliquim, N.S.W. Australia)

GENERAL

Beetle, Alan A. and Alvin Young. American prehistory and range management. *Univ. Wyo. Publ. 28(1):1-6. July, 1963.* (Grad. School, Univ. Wyo., Laramie)

Cliff, Edward P. Grazing to continue says forest chief. *Amer. Cattle Prod. 45(9):6. Feb., 1964.* (FS, USDA, Washington, D. C.)

Fee, Art. The longhorns. *Amer. Cattle Prod. 45(11):8-10. Apr., 1964.* (Amer. Nat'l Cattlemen's Assoc., Denver)

Fisher, Joseph L. Changes in conservation due and overdue. *Jour. Soil and Water Conserv. 18(6): 219-222. Nov.-Dec., 1963.* (Resources for the Future, Inc., Washington, D. C.)

Intermountain Forest and Range Experiment Station. Ann. Rpt. 1963. 58 pp. (F.S., USDA, Ogden, Utah)

NEW PUBLICATIONS

FIRE LINES—A new processed publication — "Notes concerning controlled burning and the ecological effects of fire." Number 1 is dated March, 1964. "Published at irregular intervals by Tall Timbers Research Station, Route 1, Box 110, Tallahassee, Florida." Roy Komarek, Editor, says "We will welcome any contributions (keep them informal and as short as possible) concerning controlled burning and fire ecology in any field of land management, research, education or experimentation."

TOMORROW'S WILDERNESS — A beautiful but disappointing book. The title is so promising and the 12 pages of lovely nature photos so attractive that the reader feels: "This is going to be a joy." Then at last on page 22 is the first hint of the let-down—this book is but the proceedings of the Eighth Wilderness Conference apparently held in San Francisco is some recent year. Then you wade through 262 pages of speeches and discussion, trying to find out what the words are all about other than to "preserve" more and more wilderness. You turn to the end of the book for a summary or highlights, only to find: "The conference was concluded with a summary by Dr. T. Eric Reynolds, . . . The summary is omitted here because the book reports the full conference . . ." So, back to the bulk of pages, one finds the topics "Our Wilderness Today, This Vulnerable Earth, Ways to Preserve the Irreplaceables, and The Practical Politics of Wilderness Preservation."

Many can readily agree with Dr. Fairfield Osborn when he states: ". . . wilderness is of eternal value to human life." Osborn make sense when he discusses the topic "Tomorrow's Wilderness—How Much for How Many?" He concludes that the Sierra Club and other conservation organizations can: "Help awaken . . . a general consciousness in our country that an even larger population is undesirable . . . that this decision is of the individual and thus of the nation . . . Continue unendingly the battle for the preservation of wilderness . . . Encourage individual owners of property to donate suitable lands . . . Sponsor and encourage educational programs designed to reach the widest possible audiences . . ." This does not answer to your editor's satisfaction the questions: "What good is a wilderness to a million people if only a few see it?" "How many hundred people can walk across an acre of wilderness in a year before it is no longer wilderness (i.e., waste paper, beer cans and vandalism)?"

One can conclude that the natural-born lover of the wild, the range man, must keep in touch with this powerful group if only to participate in the educational program to include appreciation of the beauties of the pastoral scene and the satisfying activities connected with it. The book is edited by Francois Leydet, 264 pages, 28 pages of photographs, published by the Sierra Club, San Francisco. $5.75. *R.S.C.*

THE YEAR OF THE GORILLA—A book for enjoyable and informative reading. George B. Schaller and his wife, Kay, spent some two years of travel and observation in East and Central Africa. Most interesting was the year in Kabara in the Congo, literally living with mountain gorillas, family creatures, shy but curious. Altogether they studied and tablulated data for some 10 gorilla groups at Kabara. Congolese independence brought changes in the people and the forest, but the author has hopes that the gorillas will adapt to the new order (perhaps more readily and peacefully than the people). 260 pages, illustrated with pen and ink sketches and photographs, The University of Chicago Press, 1964. $5.95.

TECNICA PECUARIA EN MEXICO—is a scientific journal whose first issue appeared in 1963 and is published biannually. It is the official journal of the Instituto Nacional de Investigaciones Pecuarias, a dependency of the Ministry of Agriculture of Mexico. The purpose of this journal is to present the results of research being conducted in Mexico to those persons engaged in animal production and related activities. It is also distributed to Universities and libraries in most countries of the world. Though the reports published are generally of a highly technical nature it is intended that the information they contain be of value in the understanding and resolution of problems facing the animal industry particularly in Mexico.—*Dr. John A. Pino,* Mexico, D.F.

NEWS AND NOTES

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

GRAZING ASSOCIATIONS

Assistant Secretary of Agriculture *John A. Baker* dedicated 112,000-acre grazing area in Montana on May 2. Three new grazing associations formed by 70 ranchers in Blaine County will add $320,000 a year to area's economy and strengthen family ranches in county, said *Baker.* He was principal speaker at dedication in Chinook, Mont., of Silver Bow, Wood Coulee & Elloam Grazing Associations. The 3 associations, with Farmers Home Administration financial help, have bought or leased the land.

GRASS HYBRIDS

USDA reports hybrid grasses with highly desirable forage qualities have been produced experimentally by crossing crested wheatgrass with the common weed quackgrass. Dr. Douglas R. Dewey, plant geneticist of USDA's Agricultural Research Service, is working in cooperation with the Utah Agricultural Experiment Station at Logan to develop a hybrid grass for practical use. He is attempting to produce a stable hybrid having the vigor and leafiness of quackgrass, and the drought resistance and better seed quality of crested wheatgrass. Such a grass could provide valuable forage and cover growth in the intermountain rangelands, and its area of adaptation might extend into the northern and central great plains.

RESOURCES CONFERENCES

The 1964 Western Resources Conference was held at Boulder, Colorado July 14 to 17. Sponsored by the University of Colorado, Colorado State University, and Colorado School of Mines, the topics included outdoor recreation, water pollution, cooperation or conflict in use of water, and a final session on oil shales. Proceedings will be published by University of Colorado Press.

American Forestry Association has issued a Conservation Program for American Forestry, endorsed by its members. The preamble points out: "A continuing upsurge in population, the expansion of industry, and the prospective growth of the nation's economy all presage greatly increased demands for wood, water, recreation, minerals, forage, wildlife and all other goods and services that forest, range, and all wild lands can supply." The program encompasses 20 key goals, grouped under the headings of Protection, Resource Management, Research and Surveys, Assistance to Landowners and Processors, Education, Land Ownership, Utilization, and World Forestry.

The 64th annual meeting of the Society of American Foresters will be held September 27-30 in Denver. *Philip A. Briegleb* is president of the Society and general chairman is *D. S. Nordwall,* U.S. Forest Service regional forester at Denver. Depicting multiple use values of the Rocky Mountain region will be *Fred Kennedy,* regional forester at Albuquerque, N. Mex. *Harry Woodward,* director of Colorado Game, Fish, and Parks Department, will speak about outdoor recreation and *Herbert B. McKean,* director of research at Potlatch Forest Industries, Inc., will discuss forestry research. Technical sessions include forest economics and policy, education, fire, management, mensuration, products, recreation, wildlife management, range management, silviculture, and watershed management.

Professional conservationists from throughout North America will gather in Jackson, Mississippi, August 23-26, to participate in the 19th Annual Meeting of the Soil Conservation Society of America. "Time, Space and Demand for Natural Resources" is the theme. *Douglass Craig,* of the U. S. Forest Service, Atlanta, Georgia, and chairman of the Annual Meeting Program Committee, has arranged for papers to be presented by authorities in many fields. Among those who will appear on the program will be *Dr. Joseph Fisher,* President of Resources for the Future, Inc. and *Marion Monk,* President of the National Association of Soil and Water Conservation Districts.

PUBLISHER HONORED

May issue of the California Section Newsletter reports that a highlight of the annual University of California Beef Cattle Day at Davis, March 26, was presentation of a citation to *Western Livestock Journal* publisher *Nelson R. Crow* in recognition of his half-century of editorial service to the livestock industry and for his support of agricultural research. *James H. Meyer,* Dean of the University's College of Agriculture, made the presentation on behalf of the University. It seems appropriate to add that *Mr. Crow* has been a staunch supporter of range research and good management for many years. His inspiring banquet speech at the annual meeting of the California Section last November will be long remembered.

HOUSLEY TO FLAGSTAFF

New Supervisor of the Coconino National Forest is *Ray M. Housley,*

Jr., as announced by Southwestern Regional Forester *Fred H. Kennedy* of the U.S. Forest Service. *Housley* transferred from the Regional Office Division of Range and Wildlife Management to Flagstaff in April. *Housley* graduated from the Colorado State University School of Forestry in 1952. He has held positions as Assistant District Forest Ranger, District Forest Ranger, and Staff Officer on National Forests in Arizona and New Mexico, *Housley* succeeds *Jay H. Cravens* who has been assigned to the Washington Office of the Forest Service in the Division of Watershed Management. *Ray* is Chairman of the Division of Range Management of the Society of American Foresters and is a member of ASRM.

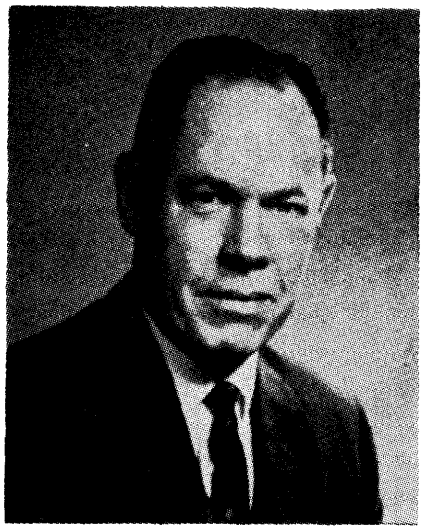
HARRIS BACK TO RESEARCH

Appointment of *Robert W. Harris* as chief of the Division of Watershed Management Research was announced by *Philip A. Briegleb,* Director of the Pacific Northwest Forest and Range Experiment Station in April. *Harris* will be responsible for the development of watershed studies in Oregon and Washington, aimed at increasing water yield without floods, preventing erosion on forest and rangelands, and restoring stability to eroded watersheds. A graduate of University of Idaho school of forestry, *Bob* began his Forest Service career with seasonal employment in Idaho in 1939, and subsequently was at the Rocky Mountain Forest and Range Experiment Station at Fort Collins, Colo. After completion of postgraduate study at New York State college of forestry in 1942, he spent four years in the Marine Corps, returning to the Rocky Mountain Station in 1946.

The following year he transferred to La Grande, Oregon, to do cattle grazing research on the Starkey Experimental Forest and Range. He was placed in charge of the La Grande unit in 1955 and was promoted to the Division of Range Management in Washington, D.C., in 1957. He moved to Portland in 1959 to become chief of the Division of Station Management. *Harris* is the author of numerous publications on range inventories and cattle management on western ranges, and is a member of the Society of American Foresters and ASRM.

DUNFORD TO BERKELEY

Earl G. Dunford in June assumes the post of assistant director for administration of watershed, range, and wildlife habitat research at the Pacific Southwest Forest and Range Experiment Station at Berkeley, Calif. He has been chief of the Division of Watershed Management Research at the Forest Service experiment station in Portland, Ore., since 1952. *Dunford* is a native of Seattle,



Wash. He received a degree in forestry from the University of Washington, and a Master degree in forestry from Yale.

TEXAS TECH

Two Texas Tech students have been selected as the recipients of the Hunter Scholarships in Range Management. The awards are made annually to a junior and a senior student who have demonstrated high potential in range and and shown a need. *Kenneth Ray McAdams,* senior from Hale Center, received the cash award. He will graduate in May and join the staff of the University of Nevada as a research assistant where he will work toward a masters degree. The junior selected was *Tommy Welch,* Seagraves. *Tommy* has accepted summer employment with the Oregon State University where he will serve as a field assistant on one of their research projects at Vale, Oregon.

Edwin Forrest, Lubbock County, Texas, rancher, recently donated 20 head of Hereford cattle to Texas Tech to establish a research fellowship in range management for a Mexican student. The cattle are being used in experimental feeding work by *Ralph Durham* and *Thad Box.* The cattle later will be sold to establish the fellowship fund. The student will be selected from applicants from all Mexican agricultural schools. The student will be expected to select a problem that will prepare him for range research upon his return to Mexico.

John Malechek, senior range management student at Texas Tech, has accepted a position as research assistant at Colorado State University. A native of San Angelo, *Malechek* was named the outstanding senior range management student at Texas Tech by the Texas Section of the American Society of Range Management. He is serving as secretary to the Texas Tech Chapter. At Colorado, *Malechek* will work on grazing preferences of cattle on the U.S. Forest Service's Manitou Experiment Station. He will use fistulated cattle to determine animal diets under different grazing intensities.

UNIVERSITY OF WYOMING

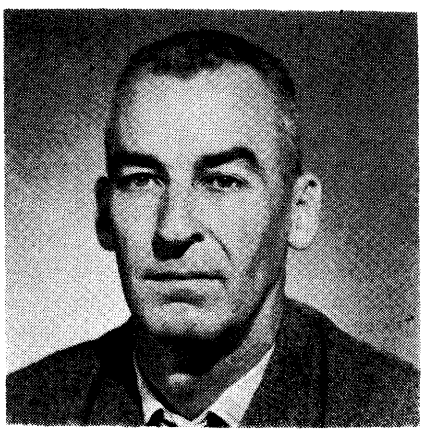
A ten-day field trip climaxed four years of agricultural study for 24 Wyoming University students in March. The future range and ranch managers visited experiment stations and field research facilities at the Jornada Experimental Range near Las Cruces, New Mexico, and La Campana near Chihuahua, Mexico. The trip was part of University course work in field applications of range-management techniques. The students were all majors in animal and plant science divisions of the College of Agriculture.

Traveling with the students were *Paul Stratton,* Wyoming University animal science division head, *Archie Reid,* Wyoming University Plant

Ecologist, *Morton May,* Range Management specialist, and *Alan A. Beetle,* Plant Specialist.

WILSON NOW CONSULTANT

Dr. David G. Wilson, on the staff of the University of Arizona the past 11 years in Range Management, is now associated with *Gordon Shillingburg,* Scottsdale, in the Arizona Feed Consulting Service, established in 1960. The company, with offices at Scottsdale, sells no products but solely consulting services to owners of all types of livestock—specializing in range, feedlot and dairy cattle, but also active with sheep, swine, horses, poultry and even domestic pets. *Mr. Shillingburg,* an animal nutritionist, specializes in nutrition of animals in confined quarters, while *Dr. Wilson's* experience and training have given him a wide knowledge of range cattle management, range plants, and the management of rangelands.



Dr. Wilson is a native of Washington state. He received his B.S. degree from the University of Idaho, his master's and doctor's degrees from Texas A & M University. As an active member of the Arizona Section, ASRM and its past president, "Dave" Wilson is well known to all Arizona Cattlemen, going to his new post with an acqaintanceship which should be most helpful.

Shillingburg's bachelor of science degree at the University of Arizona was in animal science, with minors in veterinary medicine and agronomy. His master's degree from the University of Arizona was in animal nutrition and in statistics at Oklahoma State University. Arizona Feed Consulting Service has offices at Scottsdale, with laboratory and feed analysis facilities in Phoenix and research facilities at Casa Grande. *Dr. Wilson* will continue his residence in Tucson.

OREGON SHORT COURSE

Range management in Oregon got a shot in the arm as a result of a short course at Corvallis, February 17-21. The course, organized by *Dr. Dillard H. Gates,* was attended by 14 county agents from eastern Oregon and 19 range conservationists, foresters, and others from the Bureau of Land Management, Forest Service, Soil Conservation Service, Bureau of Indian Affairs, and Oregon State Game Commission. Also, many graduate students from the range program at Oregon State University attended various sessions. Materials presented and instructors were: Range Plant Identification and Review of Taxonomic Principles, *Dr. Dillard H. Gates,* Range Management Specialist, Oregon State University; Plant Physiology—How Range Plants Grow—Grazing

Oregon county agents and Federal agency land managers attending Oregon range management short course.

Responses, *Dr. Don Hedrick,* Professor of Range Management, Oregon State University; Plant Ecology—Community Concepts, Habitat Types, Management Implications, *Dr. C. E. Poulton,* Professor of Range Ecology, Oregon State University; Range Site Guides—Their Development and Use, *E. William Anderson,* Range Conservationist, SCS, Portland; Range Surveys on the National Forests, *Andrew Wright,* U.S.F.S., Portland; Range Surveys on Bureau of Land Management Lands, *Carl McCrillis,* BLM, Portland; Range Improvements—Selection of Sites—Doing the Job, *Joe Mohan,* Range Conservationist, Forest Service, Prineville; Range Nutrition—Caring for the Range Animal the Year Around, *Dr. Bob Raleigh,* Squaw Butte Experiment Station, Burns; Multiple Use—Its Use and Abuse, *Dr. C. E. Poulton;* and Range Management—Importance of Planning, *Dr. Dillard H. Gates.* Informal evening discussions were also held.

It is the intention of Oregon State University Extension Service to continue with some kind of range short course next year.

DYKSTERHUIS RETIRES

Dr. Edsko J. Dyksterhuis ("Dyk") retired from federal Civil Service after 30 years as rangeman, forester, and conservationist, to accept a professorship in range ecology at Texas A&M University. He was among the select group of professional rangemen who traveled the western rangelands whole summers at a time with saddle and pack horses, dry groceries, rifle, sour-dough jug, and Dutch oven, sometimes making hachure maps as he went; but, who later conducted range field operations with benefits of jet to jeep

transportation, aerial photo-maps, and automatic data processing.

Dyk received the B.S. degree from Iowa State University in 1932 and the Ph.D. degree from the University of Nebraska in 1945. Born in 1908 on a farm near Hospers in northwest Iowa, he farmed with his father for two years before enrolling at Iowa State College. There he met and married Margarett A. Cox of Ames. They have three grown children.

As forester and range examiner with the U.S. Forest Service, *Dyk* worked in Utah, Arizona, and New Mexico until 1938 and in Texas, Arkansas, Missouri, and Kansas until 1943. He then became Range Conservationist in the U.S. Soil Conservation Service, working in Texas, Oklahoma, Arkansas, and Louisiana.

Since 1949 he has been Washington-Field Range Conservationist with the SCS for the region including Wyoming, Montana, Nebraska, and the Dakotas, with offices in Lincoln. Nebraska.

Author of papers in numerous scientific journals and stockman's magazines, he also served three months in Washington, D.C., helping to prepare Senate Document No. 199 "The Western Range" (Norris Report); participated in the Ford Foundation's Mid-century conference on "Resources For the Future"; the Sixth International Grassland Congress; and the Ninth International Botanical Congress. He has held visiting professorships at Montana State University and Kansas State University. He is perhaps best known for development of a quantitative ecological approach to inventory and management of rangelands, now widely taught and in daily practical use by stockmen and federal agencies.

He has served as Director of ASRM; as Chairman of the Committee on Applied Ecology and as Councilman for the Ecological Society of America; as Member of the Natural Resources Council of America; as translator of Netherlands language botanical papers for *Biological Abstracts;* and as Botanical Associate Editor for *Ecological Monographs.*

He is a Charter Member of the Soil Conservation Society of America; is a member of Sigma XI and the New York Academy of Sciences; received the Mercer Award of the Ecological Society, is a member of the Society of American Foresters, and the Texas Academy of Science.

Here is the first verse of "A Tribute to *Dyk*" written by *Bob Ross* for presentation during the testimonial dinner for *Dyksterhuis* at the Annual Meeting in Wichita.

Here's to you, Dyk, you've made a deep track.
It's plain and clear as we look back.
Your ecological thinking has caused many a change.
You've cut a big swath in the field of range.
Your methods of determining range sites and condition
Are used from coast to coast all over the Nation.
Your contribution to range is international in scope—
At home and abroad you've brought ranchers hope.

STOESZ RETIRES

Dr. A. D. Stoesz, Head Plant Materials Technician for the U.S. Soil Conservation Service, and a member of the American Society of Range Management, retired April 30 after 29 years of government service, and 10 years of teaching at the University of Minnesota and North Dakota State College. He began his career with the SCS at Mandan, North Dakota, as Nursery Manager in 1935. From 1937 to 1954 he was Chief of the Regional Nursery Division for the Northern Great Plains with headquarters at Lincoln, Nebraska. In 1954 he moved to Washington, D.C., to become Head Plant Materials Technician. *Dr. Stoesz* is a native of Minnesota. He has a B.A. degree from Bluffton College in Ohio, and Master and Doctorate degrees from the University of Minnesota. He has contributed much toward developing techniques for collecting, testing, and evaluating plants, many of which are now in use on America's range lands.

BIEDERMAN RETIRES

According to the Texas Farm and Ranch News, *Henry Biederman,* Editor of *The Cattleman,* official publication of the Texas and Southwestern Cattle Raisers Association, announced that he is retiring at the end of the Association's fiscal year, February 29. *Biederman* became editor of *The Cattleman* in March 1943 and has held that position for 21 years. He stated that he had been considering retirement for some time in order that he may have more leisure for other activities such as travel and writing. He intends to devote some time to preparation of articles on many phases of the livestock industry with which he has been closely identified all his life. Since he assumed editorship of *The Cattleman,* it has increased substantially in circulation, size, prestige and importance until today it ranks as one of the top publications in its field.

WITH THE SECTIONS

ARIZONA

The Section held its annual winter meeting January 16 and 17 at Tucson. The first day meetings were held at the Student Union, University of Arizona. The second day was a field trip to the Santa Rita Experimental Range.

New officers were installed by *President Tom Rigden;* they are: *R. G. "Pat" Gray,* president; *C. C. "Bud" Cooper,* vice-president; *Duane Miller,* Councilman North; and *Clark Martin,* Councilman South. *Hank Wall* and *Paul Riggs* are holdover councilmen. After a general business meeting an interesting discussion on the program theme "What is Range Management," was presented from the viewpoints of an old timer, *Slim Ellison* whose speech was read by *Barry Freeman;* a technician, *Bill Fleishman;* the 1963 Arizona Range Man of the Year, *Billie Riggs;* and an educator, *Dr. D. G. Wilson.* A question and answer period followed under the direction of *Dr. R. R. Humphrey.* A banquet under toastmaster *W. G. McGinnies* that evening was attended by over 100 members, wives and friends. Awards chairman *Jim Finley* presented 1964 awards to: *Ernest Chilson,* rancher, Arizona Range Man of the Year, and *Dr. R. R. Humphrey,* Range Technician of the Year.

The trip to Santa Rita Experimental Range south of Tucson showed ranchers, range technicians and friends range research being carried out by the Forest Service, Agricultural Research Service, University of Arizona and the Soil Conservation Service. Research pro-

grams included: Reseeding in Dry Years vs. Wet Years, Burning and the Effects of Fire, Mesquite Control and Grazing Management, Range Forage and Rumen Sampling,

Arizona Section field tour to Santa Rita Experimental Range. *Top*—Discussion of mesquite control and grazing management. *Bottom*—Discussion of range forage and rumen sampling during lunch stop.

Mesquite Control and Reseeding, and Control of Oak-Chaparral and Desert Shrubs. The tour and program was admirably planned and handled by *Dave Wilson, Ervin Schmutz, Clark Martin* and *Dwight Cable.*

The Section plans a joint summer meeting with the Arizona Cattle Grower's Association, probably in early August.

CALIFORNIA

The annual spring field tour was held in Mono-Inyo Counties of eastern California on May 21 and 22, 1964. President *Cy McKell* reports a whopping total of 105 people signed the registration book, breaking all past attendance records. Guests included nineteen students from California Polytechnical College at Pomona and six from Fresno State College.

The tour consisted of eight outstanding demonstrations, two range revegetation projects, high Sierra packer operations, range fire break construction, Canada thistle and willow control, elk herd management and research, irrigation conservation, and cattle ranching on city of Los Angeles lease lands. The program committee was made up of *Dean Smith,* farm advisor, U. of California; *John Clark,* California Division of Forestry; *Jack Beer,* California Department of Fish and Game; *Herb Wall,* S.C.S.; *Paul Lane,* City of Los Angeles; *Jim Garner,* B.L.M.; *Hatch Graham* and *Ed Schneegas* (Chairman), Inyo National Forest. At the evening banquet, *Mr. Wilfred Partridge,* local cattle rancher for the past thirty years, gave an entertaining talk on the history of the livestock business in the Owens Valley. Eighty-six persons attended.

On the final day the Inyo County Cattlemen's Association sponsored a delicious barbecued beef lunch, prepared and served by the Cow-Belles.

California Section meeting, May, 1964. *Top—Ray Brubaker,* BLM, explains improvement practices on new Resource Conservation area. *Bottom*—Viewing range reseeding with crested wheatgrass following application of 2,4-D, Inyo National Forest.

COLORADO

The Colorado Section scholarship was presented to *Adrian Fischer* at the Section meeting held at Colorado State University on February 22, 1964.

At the Colorado Section breakfast in Wichita, *Mrs. Larry Riorden* was presented with a trophy for her interest in the American Society of Range Management. *Sue* has attended nine of the last ten national meetings of the Society and has missed very few of the section meetings and field trips.

KANSAS-OKLAHOMA

The Section planned a spring meeting at Oakley, Kansas, June 5-6. It was to include visits to the Pyramid Ranch, range overseeding on "go-back" land, and variety tests following establishment by seeding.

NEBRASKA

The Nebraska Section and the Nebraska Beef Cattle Improvement Association have agreed to try a joint program for printing and mailing their newsletters. The NBCIA newsletter is prepared by that organization but is printed and mailed along with the Section newsletter. Both newsletters are mailed to all members of both organizations.

John Vallentine announces that the 1964 Nebraska Range Camp for 50 young men 14 to 18 years old will be held at the 4-H Club Camp, Halsey, August 9-15.

Warren Fairchild announces that action has been taken to give grass a prominent place in Nebraska's upcoming Centennial observance.

NEVADA

Forty members gathered for the 13th annual meeting of the Section on January 9 and 10 at Fallon.

Ed Dimick, SCS Range Conservationist from Elko, discussed the range site-soil correlation studies in

Nevada Section Officers, *l* to *r, Fred Harris,* outgoing president; *Royal Holl,* incoming president; *Ted Longseth,* president elect; zone councilmen, *Paul Tueller* and *Carroll Donner;* and *Mike Kilpatrick,* secretary-treasurer.

Elko, Eureka, and Lander Counties. Only by knowing the soil resource can the problems of rangeland management be solved. A strong positive correlation has been shown among soil and precipitation, elevation, slope, parent material, and vegetation.

Roger Smith, Ruby Valley rancher, stated a major problem facing the range users today is the importation of beef. *John Carpenter,* Elko rancher and sheep grower, stated that the imported meat should be diverted by some means to the impoverished and poverty-stricken nations of the world. *John* went on to say that a greater effort should be made to get technical information into the hands of the ranchers and that continued research would give many of the answers to range and livestock problems.

The deadly effects of halogeton to livestock, both sheep and cattle were discussed. Ranchers have suffered small as well as large losses due to this weed. *Dr. Joe Robertson,* University of Nevada, Reno, reported that much is known about how to manage livestock to protect them from this poisonous plant, but with these recent losses, much more needs to be known.

Dr. Dick Eckert, ARS, Reno, presented a slide talk on the spraying of cheatgrass and other increaser and invader plants. He said research shows killing of cheatgrass can be very effectively done with chemicals. Studies on greasewood sites revealed that tall wheatgrass and Great Basin wildrye can be established after eradication of the greasewood by sprinkler irrigating until the roots tap the water table.

Donald Heinze, University of Nevada graduate student, Reno, revealed that heavy-late grazing of crested wheatgrass produced the most AUMs per acre with the least damage to vegetation and soil. Early-heavy grazing produced the least AUMs and caused trampling damage to the soil and plants.

Fred Harris, Elko, presided over the business meeting. The *Charles E. Fleming* scholarship award was made to *Barry Davis* of Smith Valley, Nevada. *Mike Kilpatrick,* Range Extension Specialist from the University of Nevada, reported that arrangements for the 1965 National Convention in Las Vegas were progressing.

Royal Holl, BLM, Las Vegas, is the incoming president. The newly elected officers include *Ted Longseth,* Southern Pacific Railroad, Reno, president-elect and *Dr. Paul Tueller,* University of Nevada, *Robert Hadley,* rancher from Carlin, and *Jack Cooper,* Nevada Fish and Game Commission, Ely, zone councilmen.

The summer range camp's outstanding boy, *Cliven Bundy,* Bunkerville, was the guest of the Section for the meeting. *Charles Saulsiberry,* SCS, Cedarville, California was given the outstanding rangeman-of-the-year award.

The Section's spring field trip was planned for June 18 and 19, 1964 in the vicinity of Austin, Nevada. Program includes a tour of several Forest Service seedings and brush control projects, a night at the summer range camp and a look at a meadow restoration project and cheatgrass control and seeding study conducted by the ARS.

NEW MEXICO

Section members were invited to participate in the Pecos Wilderness Ride, starting at the Mountain View Ranch at Cowles on May 16. The Wilderness is on the Santa Fe National Forest.

The Spring meeting of the Section was held in the Cimarron area June 11-12, with *W. C. Littrell* of the Philmont Scout Ranch as Program Chairman.

Fred Kennedy, chairman of the scholarship program, announced that some 40 members contributed $372 to the fund and that fifteen applications were received from graduating seniors from high schools all over the state.

PACIFIC NORTHWEST

The Summer Range Tour was scheduled for June 18-19 in Lake County, Oregon, with the South Central Oregon Chapter as hosts. Material for the illustrated program was assembled by *George Lea,* BLM District Manager in Lakeview.

SOUTHERN

The Section is already busily planning for the 1966 Annual Meeting of ASRM to be held in New Orleans at the Jung Hotel, February 1-4.

McNeese State College in Lake Charles, Louisiana, announced that starting in September, 1964, the school will offer sufficient range management and related courses for graduating students to qualify as range conservationists under Civil Service.

TEXAS

The Section Tour of the Experimental Ranch in Throckmorton County was held on May 8, with the theme "Research to Practice." About 150 ranchers, technicians, students, researchers, and educators toured the pastures, observed beef cattle, and heard about grazing and range improvement work on the ranch. *Dr. W. J. "Dub" Waldrip* is manager of the 11 section range, which is a cooperative venture between Swenson Land and Cattle Co. and Texas A&M, with field supervision from the Spur Station.

SOCIETY BUSINESS

MORE REPORTS ON 1963 ACTIVITIES

Range Management Education Council

The Fifth Annual meeting of the Range Management Education Council was held in Wichita, Kansas February 10 and 11 prior to the Annual meeting of ASRM. The Council was organized in 1960 with delegates from 14 institutions of higher learning offering a bachelor of science degree in range management. Currently, there are 18 member institutions in the United States. The University of Chihuahua, Mexico, is an Associate Member. Institutions offering range management training short of the requirements for the baccalaureate degree adopted by the

council may become Associate Members. The objectives of the council are:

"to promote high standards in the teaching of range management, to advance professional ability of range managers, provide a medium for the exchange of ideas and facts among range management schools, to provide liaison between teaching departments and organizations and agencies in affairs relating to range education and employment standards, and in other ways to foster wider understanding of the problems of range education."

In pursuing these objectives, the Council has engaged in the following activities among many others.

1. In 1961, the Council completed a detailed analysis of the range management curricula of the fourteen member institutions which was published in the Journal of Range Management 14:301-314.
2. In 1962, after two years of careful deliberation, the Council adopted current minimum requirements for professional training in range management, which were published in the Journal 15:181. Following favorable review by the Professional Standards Committee, the Board of Directors of the American Society of Range Management in September, 1962 voted to "approve, adopt, and support" these minimum standards for a Bachelor of Science degree in range management.
3. In 1963, after a round table discussion of educational and professional standards in an open meeting with members of the Professional Standards Committee of the American Society of Range Management and representatives of the Civil Service Commission and federal agencies that employ range management graduates, the Range Management Education Council passed a resolution recommending that ". . . federal agencies employing range trained men request the Civil Service Commission to expedite the reevaluation and strengthening of the requirements for professional employment in range management to a level recommended by the Council and by the Society as published in the Journal 15:181."
4. During 1963 and at the 1964 annual meeting, the Council, especially the executive committee, spent considerable time in discussion and in correspondence with the heads of federal research agencies regarding proposed standards for the new Range Scientist roster. These discussions resulted in greater unanimity of thought in the council and better understanding of the aims and objectives of the council by the federal research agencies.
5. Since 1961, a committee of the Council has been working on the problem of unification of course names and course contents in range management. Since range management courses are administered in different schools by departments of agronomy, animal science, botany, and forestry as well as range management, the subject matter of range management has been organized into courses in many different ways under many different titles. The committee's activities have been directed toward developing and suggesting titles for course outlines in various subject matter areas. Subject matter areas discussed at the 1964 annual meeting included range ecology, range analysis, range forage values, and range economics. The aim of the committee is not complete uniformity but mutual understanding and self improvement.

The deliberations of the council this year as well as in previous years emphasize one central fact. The most critical problem facing the range management profession today is the lack of recognition of range management as a science and as a profession. The present low Civil Service Standards for the Range Conservationist roster are graphic evidence of this lack of recognition on a national level. In our own colleges and universities range management is so poorly recognized that the Department of Health, Education and Welfare has been unable to obtain complete information on range management enrollment. Many people seem to consider range management simply as an area of work rather than a profession in which men apply scientific principles to complex problems of land use. The poor image of range management as a profession appears to be the main reason for failure to attract more capable students into the range management field.

With full recognition of this problem, the Range Management Education Council has set up 8 working committees which are to report at the next annual meeting.

The Range Management Education Council is working closely with the Board of Directors of the American Society of Range Management, its Interim Committee on Educational Requirements of Hiring Agencies, *Joe A. Wagner,* Chairman, and its Education Committee, *C. H. Wasser,* Chairman.

Our immediate goal is full recognition of range management as a science and a profession. Our long range goal is the development of excellence in our profession.—*James K. Lewis,* Chairman.

PUBLIC RELATIONS COMMITTEE

The new public relations committee proposed the following statement of objectives:

Objectives of ASRM public relations will be to critically view the opportunities that exist to properly inform the public on the Society, to secure understanding, approval, and cooperation, determine ways to take advantage of these opportunities, and then do something about it. There is need to do a better job of informing people on what the ASRM is and what it is doing to emphasize the vital importance of the range resource and its use. Molding favorable public opinion by means of an appropriate information campaign is a primary function of the ASRM public relations program.

The committee submitted 18 recommendations to the Board of Directors at Wichita. It is hoped that the 1964 Committee can carry out many of the proposed public relations contacts through the Sections and agencies. The scope of ASRM public relations is broad. Activities on a national level will be carried out by the Public Relations Committee. Other members of the Society will be asked to assist with specific activities.—*Wayne Kessler,* Chairman.

INTERNATIONAL RELATIONS COMMITTEE

The Committee held four meetings during 1963. Among other activities, comments were made to Chairman Hedrick on the tentative special subcommittee report on overseas technical advisors in range. Also names of possible recipients of the Spanish Summaries of the Journal for 1962 were sent to Dr. Thad Box.

The subcommittee on recruitment

of range men for overseas work presented a memorandum including suggestion to place a contact at the Annual Meeting. A suggestion has been made that we endeavor to determine who among our Society members are on overseas assignments and keep in touch with them.

No effort was made to develop a list of overseas people who visited the U.S.A. to study or observe range management. If the Society is to maintain contact with such men, it will be necessary to develop a list early in the year for submission to the various Sections and try to keep it current during the year. The International Agricultural Development Service, U.S.D.A., is willing to try in 1964 to obtain more range personnel for training than during 1963. If this evolves a greater effort will need to be made to keep in contact with these range people.

Developments in 1963 established better contact witih the FAO than in previous years. Dr. Roald Peterson, a member, is now Chief, Pasture and Fodder Crops Branch, FAO, in Rome. Two of his main assistants, C. Kenneth Pearse and E. J. Woolfolk, will be looking after Near East and southern South America work respectively.

Word reached the committee from two sources, one in Pakistan and one in Israel, with regard to the possibility of developing a Section of the Society in the Near and Middle East.

Working closely with the National Capital Section, plans have been formulated for local members to entertain overseas range visitors when they come through Washington.—*W. R. Chapline,* Chairman.

1964 COMMITTEE ACTIVITIES

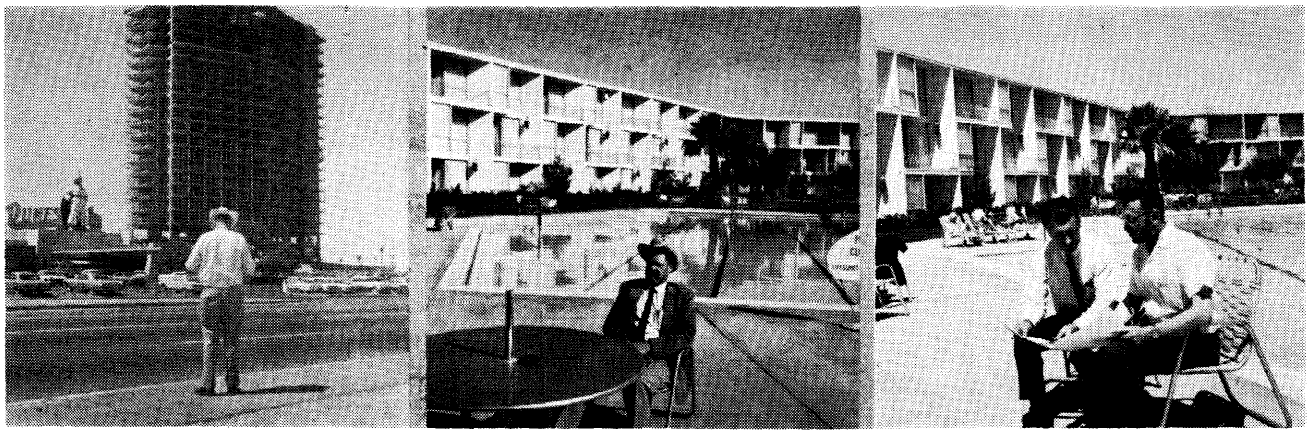
The Committee on International Relations met in Washington, D.C. on April 6, with *W. R. Chapline* as chairman. Other members attending were: *Milton Norland,* IADS; *O. L. Mimms,* AID; *L. L. Roux,* So. African Embassy; *Roy C. Dawson,* FAO; and *George E. Bradley,* ORAD, Secretary.

Positive action was taken on all the seven items on the agenda:

1. Review of resolutions passed by the Board of Directors at the last Annual Meeting:
   a. Society support of Alliance for Progress Program.
   b. Stimulate participation in the International Grassland Congress at Sao Paulo, Brazil.
2. What can this Committee do to stimulate interest in international affairs at the Annual Meeting? Consider development of recommendations to the Board of Directors for the next Annual Meeting.
3. Report from the Subcommittee on "Recruitment of Qualified Personnel for Service in Other Countries."
4. Reorganize and reconstitute subcommittee investigating the distribution of publications and information material to other countries.
5. Consider the advisability of developing recommendations to the Board of Directors for a Committee to analyze the Society dues for members in other countries.
6. Should we maintain a list of persons from other countries studying range management in this country.
7. What can this Committee do to stimulate interest and present advantages of this Society?

The Nominations Committee, Leon Nadeau, Chairman, is lining up a fine list of candidates for national ASRM offices to be elected this fall.

Arrangements for the next Annual Meeting are going forward. It will be held in the Dunes Hotel, Las Vegas, Nevada, February 9-12, 1965 (see photos).



Site of 1965 Annual Meeting, the Dunes Hotel, Las Vegas. *Left* and *Center,* Program Chairman Danny Freeman; *Right,* President Wayne Kessler and Royal G. Holl of Local Arrangements Committee. Comment: "These guys are planning Las Vegas Convention?"

PLAN NOW TO ATTEND THE NEXT ANNUAL MEETING IN LAS VEGAS, NEVADA, DUNES HOTEL, FEB. 9-12, 1965

LETTERS TO THE EDITOR

Letters may be accepted for publication which contribute to the objectives of the American Society of Range Management. The Society however, assumes no responsibility for statements and opinions by contributors.

Dear Bob:

After it was announced in the Journal that Society dues would increase from $8 to $10 in 1965 for regular members, I have interrogated members as to their reactions. Most of them have indicated that they anticipated this would have to be done at some time in the future because of general rising operational costs for everything. Of course, each of us is desirous of keeping costs to a minimum and, generally, we regret the upward trend of everything except income.

Some members may develop the attitude that the Range Society is too expensive; that it is costing too much to run it. Before these members break ties with the Society, common sense dictates a comparison with comparable organizations in order to establish a basis for judgment. One good comparison follows:

When the Society of American Foresters reached a membership of 4,340 in 1938, it had a budget of $36,860 and a full-time staff of eight (8) people, which included a full-time Executive Secretary. (Jour. For. 61 (10): 722, 1963).

When the American Society of Range Management attained 4,372 members in 1963, it was operating on a budget of $23,925. We had then, and still have, three (3) part-time employees, which include the Executive Secretary, a clerk-stenographer, and the Editor of the Journal. For 1964, during which the membership might reach 5,000, the budget has been increased to $34,652. The increase is divided about equally between (1) more reasonable part-time salaries for our employees, (2) increased costs of publishing the Journal, and (3) increased special projects which help the Society grow.

Actually, a comparison of services currently given the Sections of the respective Societies will show that A.S.R.M. extends more services from the head office than does S.A.F.

With a comparison of this type, including full realization as to what the years 1938 and 1963 mean, cost wise, one can only conclude that the Directors were none too soon in taking a realistic look at the structure of the Society in its business activities. We need to keep the Society growing in stature and expanding in scope. This cannot be done with a weak business structure.

Discussions of increased dues among members and with prospective members should take this situation into account, in my opinion.

Best personal regards,

Sincerely
E. William Anderson
Portland, Oregon

Dear Sir:

I'm real concerned about our national "Journal". Our ranchers, even some of our technicians, find it real hard to read. I realize that it is a scientific publication but we have people in our organization (ranchers) who are scientists in their own right. They have learned their profession by hard knocks and it is hard for them to read this. It is not applicable to their own ranches or situations. I know it is real easy to criticize but to offer something constructive, I'm at a loss to do so.

Sincerely
R. G. "Pat" Gray
Globe, Arizona

Dear Bob:

There are a number of things which could be done to improve the Journal without particularly changing cost or altering format and at the risk of being repetitious and a crank I am, once again, suggesting a couple of my pet peeves:

(1) a simple card file would prevent repetition in the "Current Literature" section and allow expanded coverage.

(2) a special editor on nomenclature could prevent misspellings, use of archaic names, and use of wrong names. You could cross reference in footnotes different names for identical plants which result from honest differences in opinion.

Sincerely yours
Alan A. Beetle
Laramie, Wyoming

Range Society Summer Meeting, July 30 – August 1, 1964

Hotel Fermont, Chihuahua, Chih., Mexico
Single Room, $7.20-8.80; double $8.80-10.40

The Mexico Section has promised a fine meeting with surprises.

Buses depart from El Paso, Texas, or Ciudad Juarez every hour for Chihuahua. Daily flight 201 Aeronaves de Mexico leaves Juarez 3:30 PM (2:30 PM El Paso time), arrives Chihuahua 4:30 PM. Or if you are driving, take paved highway from Juarez to Chihuahua. Many fine side trips or excursions available by highway, bus or air from Chihuahua.