Journal of

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American Society of Range Management

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

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

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Journal of
RANGE MANAGEMENT
Volume 19, Number 3
May, 1966

Editorial

WHAT IS RANGE MANAGEMENT?

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Since our professional society has been in existence for nearly two decades it seems appropriate to critically examine and reflect upon what we mean by the term, range management. This question is prompted by the innate desire of most of us to maintain a propriety and dignity befitting our profession. In order to do this and keep in step with modern trends, many of us have identified ourselves with "range science" during the past ten years. Whenever this name change more nearly reflects our present activities it has been worthwhile. However, in this attempt to gain identity and respect the question is: Have we unconsciously short-changed our profession in applied science or technology?

I'm afraid that I've been as guilty as anyone in the attempt to impress my campus colleagues with the importance of science in range management. In this attempt I've failed to recognize that we have a responsibility just as important as the science aspect; i.e., how can we, with the help of the best scientific facts available, manipulate the forage resource for the maximum overall benefit of humanity. True, this requires a tremendous scientific understanding in the interaction of soils, plants, and animals, but one cannot effectively manipulate these resources without application of scientific findings which is basically technology.

This importance of technology and its relationship to the sciences has, for me at least, been clarified by the Yale chemist, Harold G. Cassidy, in the American Scientist, September, 1963. He wrote on the subject "The Muse and the Axiom." Members of the Range Society can take heart in his statements. For example, "Technologies unite the humanities and the sciences." He describes three activities — analytic, synthetic, and application to practice—that are carried on in the sciences, humanities, technologies, and philosophies by their practitioners. "Analytic activities are those of reporting, collecting, separating, and distinguishing. Synthetic are those of generalizing and ordering. The third activity—that which closes the circle—the activity which applies the generalizations to practice, serves as a test of their validity at the same time that it serves the uses of life. The sciences and humanities are in part characterized by the dominant role of analytic and synthetic activities; . . . the technologies by the major emphasis upon application to practice. But, in all of them, *all three activities* are pursued (the italics are mine): this is why they are of equal stature, and they belong in the college or university."

Aren't we short-changing our profession in limiting a definition of range management to science and art? Isn't it more appropriate in view of the developing body of knowledge at our disposal to include technology in our definition? It seems to be a normal and logical, evolutionary development to go through a series of steps in which art changes from a dominant to subordinate role. If so, aren't we entering a new phase with a greater sense of predictability in applying our scientific knowledge to our range management problems? Which means that technology is becoming more important and the art in range management less so. When viewed in this light a revision of the definition of range management may be long overdue.

To avoid the criticism of raising questions and not providing any answers I'm suggesting consideration of the following definition of range management which I've used and found suitable in teaching an introductory course: "Range management is the manipulation of the soil, plant, and animal complex used by grazing animals." This management is based on the best scientific information available on these complexes which occur largely on uncultivated land, where native plants are predominant, and where other natural resource values—watershed, forestry, wildlife, recreation, etc.—may be important. With minor changes such as the substitution of arable for uncultivated, improved for native, and the deletion or addition of other land uses, this definition also fits pasture management as well. More important, perhaps, is the stress on technology which is the final test of the value of our scientific findings in obtaining better use of the range resource.

Greater Profit from Livestock in the Intermountain West with Efficient Ranch Management[1]

FORREST M. WILLHITE AND ALBERT R. GRABLE
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Highlight

Livestock producers are in serious economic difficulty because forage and livestock management have changed very little over the years. If ranchers are to meet the challenge of the cost-price squeeze, they must integrate improved livestock management with more efficient use of their range and meadows. This consists of increasing the quality and quantity of forage to give larger rate of gain on more calves over a longer period of time. It is possible to achieve a severalfold increase in meat production per unit of land and livestock resources.

The livestock producer, in particular the cow-calf operator, must greatly increase his income to meet the challenge of the cost-price squeeze. According to Colorado Agricultural Statistics, (1964) ". . . this was a difficult year for the Colorado stockmen, . . . gross income realized from the sale of livestock and livestock products declined 4% . . ." and "at the same time, production expenses climbed even higher." Ranchers have several alternatives — actually several "horns" to their dilemma. Some of the alternatives are vertical integration with feeders and retailers, government subsidy, sale of land and cattle, or more efficient management of their resources. The cattle industry has rejected direct subsidy. Vertical integration has occurred on a very limited scale. With great reluctance many ranchers, especially the smaller ones, have been forced to sell. Operators who expand their holdings with the hope of improving their income, but retain the same level of efficiency, may find themselves in worse economic difficulties than before. The last alternative is increased efficiency in production — more salable meat per unit of land or livestock with a reasonable expenditure of capital. Many ranchers are unwilling to change because they feel that alternatives to present management practices are too difficult or costly.

The purpose of this paper is to present some alternatives and to show how present ranch management might be changed for greater profit from soil, water, and livestock resources. These are not the only alternatives and they may not be the *most* profitable. The discussion is directed toward cow-calf operators in the high-altitude areas of the West, but the principles are valid for any livestock producer. This paper was written to invite challenge from the people who actually produce livestock—the farmers and ranchers.

Current Ranch Management

Overall ranch management in the mountain meadow areas has changed little in the last 50 years. Practices are built around the pattern of nature which provides green grass in the spring for rapid growth of young animals. In general, livestock spend about 150 days (from June to October) on summer range, mostly public domain, about 180 days on the home ranch on hay, and about 30 days on spring or aftermath pasture from hay meadows. Calves are usually dropped from April through May and are sold for feeders sometime between October and December. Some calves are carried over and sold as yearlings or are kept for replacements. Weaning percentages are probably about 80. A survey of the West made in 1954 (Ensminger et al., 1955), showed 77% of the cows giving birth and 67% of the cows weaning calves.

Cattle numbers in the mountain meadow areas are difficult to determine accurately, but are believed to have increased slightly on most ranches. Cattle allotments on public lands have declined over the years. Decreases in range allotments have been offset by increased forage production from newly irrigated lands and from "improved" native meadows. In 1935 the acreage of wild hay in Colorado was 354,000; in 1962 it was 282,000. Yields of wild hay have been about 1 ton/acre for many years, but yields from different kinds of "improved" meadows range from 1.5 to 2.5 tons (Colorado Agriculture Statistics, 1950, 1964). Increased use of fertilizer in recent years also has contributed to greater livestock numbers. Date of meadow harvest, depending on climatic conditions, ranges from late July to late September and has changed very little over the years. Many ranchers harvest from mid-August to mid-September and most find it necessary to use protein supplements to offset the poor quality forages that result from late harvest.

Result of Current Management Practices

Production through the years has remained rather constant as is shown by the average weight of weaner calves sold for feeders at Denver and Omaha from 1935

[1] *Contribution from the Northern Plains Branch, Soil and Water Conservation Research Division, Agricultural Research Service, USDA, and the Colorado Agricultural Experiment Station. Scientific Journal Series 1038, Colorado Agricultural Experiment Station.*

[2] *The senior author is also Associate Agronomist, Colorado Agricultural Experiment Station.*

to 1957. The values in Table 1 were calculated from numbers and total weights reported by the Denver Record Stockman and The Omaha Daily Journal Stockman. The sample represents about 5 to 10% of the total calves sold at these markets. Many calves undoubtedly were from plains and dryland areas but this in no way affects the points to be made in this paper. Average weights were essentially constant over the 23 years. As expected, weights slightly increased with late sale. The average weaner weight for the whole period was 348 and 372 lb at Denver and Omaha, respectively. Records of direct sales of 7,322 weaners at the Gunnison County Mountain Meadow Research Corporation from 1960 to 1964 show an average weight of 375 lb for October through December. Stevens and Agee (1962), working with 35 Wyoming ranchers with an average cow herd of 340, found an average weaning weight of 360 lb in 1959. Assuming a 65-lb birth weight on May 1 and an average date of sale on November 15, the weaners sold at Denver gained 1.4 lb and at Omaha 1.5 lb/day (200 days). Calves from Gunnison gained 1.6 lb (partially due to less shrinkage than at central markets) and calves in Wyoming gained 1.5 lb/day. The range of average calf weights at Denver was from 336 to 371 lb and at Omaha 342 to 380 lb over the 23-year period. Very likely this weight range partially reflects range and moisture conditions. Over a large area, for a long period, management has established a constant gain of about 1.4 lb/day. Most ranchers are very pleased when their weaner calves average 400 lb, or 1.7 lb/day; yet Menter (1963) says, "I am forced to produce this heavier calf (500 lb), because I can no longer make a good profit on a 400 lb average."

Additional information that management has not been changed perceptibly was noted in the 1951 to 1960 weights of long-yearlings sold at Denver which were 690 and 620 lb for steers and heifers, respectively. Steer weights by years ranged from 670 to 712 and heifer weights ranged from 602 to 638 lb during this 10-year period. Average weight of all yearlings in all years was 670 lb on November 1. At Gunnison from 1961 through 1964, 1184 yearlings sold directly to feeders averaged 610 lb. The 35 ranchers considered by Stevens and Agee (1962) produced yearlings (mostly steers) with an average sale weight of 657 lb. Again assuming a 65-lb birth weight on May 1 and an average date of sale on November 15, average daily gain of the yearlings was essentially constant at 1.0 lb/day.

Since the number of cattle units per acre of land and weaning percentages have increased little, and rate of gain of calves and yearlings is essentially constant, beef production per unit of land or livestock has remained constant over the last 30 years. The analysis by Stevens and Agee (1962) of the ranchers in Wyoming shows that existing management practices resulted in a profit in 1959 less than $9.00 per cattle unit for large ranches; small ranches actually lost $1.13 per cattle unit. Return on investment was 6.5% from the large ranches and 4.9% from the small ranches, and for all ranches ranged from 13.4 to 2.8%. As they point out, "Cattle prices were favorable in 1959 compared with the past 10-year period." (Average price per pound of all beef sold was nearly 25¢ in 1959.) With the low cattle prices and high operating costs of recent years, is it any wonder the cattle industry is in financial difficulty? According to Gronewoller, Colorado State University farm management specialist, about $105 is needed today to produce a weaner calf worth $75 to $108 (Denver Post, November 14, 1965).

Table 1. Average weight in pounds of weaner calves sold through the Denver and Omaha Central Markets from October through December from 1935 to 1957.

Year	No. of calves sampled Denver	No. of calves sampled Omaha	Ave. wt. Denver	Ave. wt. Omaha	Year	No. of calves sampled Denver	No. of calves sampled Omaha	Ave. wt. Denver	Ave. wt. Omaha
1935	4155	1795	382	364	1947	8840	2720	346	379
1936	5956	2605	338	342	1948	10074	3099	348	369
1937	4115	3343	349	370	1949	9347	3608	342	356
1938	4899	4668	371	360	1950	11248	3605	350	389
1939	5503	6354	361	358	1951	3228	4632	354	379
1940	7928	6553	356	371	1952	5343	12911	352	370
1941	7535	4503	362	381	1953	5801	11377	343	373
1942	9004	5381	348	371	1954	5635	8665	336	373
1943	10201	2783	347	380	1955	3612	7387	360	377
1944	14495	3723	338	374	1956	2014	4253	360	376
1945	12577	4236	336	367	1957	2765	4253	355	382
1946	17931	3173	338	374	Avg. Years	7487	5362	348	372

Weight by months at Denver

Period	October No. calves	October Ave. wt.	November No. calves	November Ave. wt.	December No. calves	December Ave. wt.
1935-40	8829	336	14626	364	7624	374
1941-50	47547	338	50381	349	13324	350
1951-57	8438	340	13161	350	6902	354
All	64814	338	78168	352	27850	358

Solutions Suggested by Research

Forage Management.—Increasing hay and pasture production from present levels of 1 or 2 tons/acre to 4 to 6 tons can be accomplished by nearly all ranchers. The amount of increase depends on several factors, but among the most important are water control and fertilizers. Water control is necessary and desirable for improving stands of desirable forage species, especially legumes. On most meadows water control implies some degree of land leveling, which must be followed by reseeding. Examples of 4 to 6 tons of hay produced on properly irrigated legume and grass-legume meadows have been reported, even at elevations of 6000 or 8000 ft. (Lewis, 1957; Willhite, 1963; Fulcher, 1960.) The total cost of meadow improvement may often be paid for by production of grain or cereal hays during the first two years.

Assuming good stands of desirable species and a moderate degree of water control, fertilizers can be used effectively. Again, examples of 4- to 6-ton yields are available. At altitudes below 8000 ft two harvests per season plus frequent reapplication of fertilizer are necessary. Nitrogen fertilizers must be applied before each growing period. To obtain maximum yields at altitudes over 8000 ft, hay must be cut about August 1, which permits regrowth of about 0.5 ton/acre for late fall pasture. However, fertilizers are not a "cure-all" or magic wand. As shown by Willhite (1963), improper use of nitrogen fertilizer can result in reduced profit. This occurs because calf production per cow does not necessarily increase just because hay yield increases; twice as much low-quality, late-cut hay will carry twice as many cows, but at the same level of efficiency. Hence, ranchers who are losing money now likely will continue to lose money. Some gain in resource efficiency is possible in many cases with increased size (Stevens and Agee, 1962). Quality of forage, as well as quantity, must be increased for the cow-calf or yearling operators to derive full benefit from fertilizer.

For young growing animals forage quality primarily means crude protein content. Protein content declines steadily throughout the growing season, particularly after flowering of grasses and legumes. (Nearly all nutrient element and vitamin contents decline with maturity, and deficiencies are critical in certain areas.) Crude protein in grasses drops from about 16% at early leafy stage to 5% at maturity; clovers will contain somewhat greater levels. However, neither is good feed at full maturity. Therefore, the progressive decline in nutritive value of forages must be balanced against progressive increase in yield. As discussed by Willhite (1963), this can be accomplished without reduced yield, and at lower altitudes, with increased yield. Furthermore, changes in amount and quality of feed must be integrated with animal requirements for maximum gain. This is true whether referring to range, irrigated pastures, or hay.

Livestock Management.—How can producers improve livestock efficiency? People disagree on the solution. Ensminger et al. (1955) say, "Selection of breeding stock on the basis of production records is the only logical way to achieve this goal (greater efficiency of production)." Baker (1963), on the other hand, states, "Within the animal sciences themselves, nutrition and its application has played the most important role to date in improving cattle production practices. The limits of animal improvements are set by our knowledge of nutrition and its use." Without a doubt these individuals recognize the importance of both breeding and nutrition. However, improvements in breeding, consisting primarily of the use of bulls with "better" conformation, obviously has not increased daily rate of gain or beef production per unit of land or livestock in the area served by the Denver and Omaha Markets. Therefore, "nutrition and its use" must be the limiting production factor for existing conditions. Referring to feedlot operations, Beeson (1963) states, "Over the past 50 years, the rate of gain in beef cattle has increased about 42% and feed efficiency 30% by improvement in cattle rations." This implies that calf and yearling performance on meadows and ranges can also be improved with better nutrition.

Research has shown the potential. In a 5-year experiment at Hayden, Colorado, on improved meadows and pastures producing 4 to 5 tons of forage/year, calves gained 2.1 lb/day from birth to weaning (550 lbs at 230 days). Cows and calves received only hay and pasture plus salt and minerals (Willhite and Grable, 1965). Others have shown that calves and yearlings are capable of gaining 2.0 lb/day with ample pasture or excellent quality hay (Burson et al., 1961; Bogard et al., 1963; Van Keuren and Heinemann, 1958). Robertson and Torell (1958) and Johnson (1953) obtained daily rates of gain of 2.0 lbs or more on range when quantity and quality of feed was not limiting. Obviously, cattle have great potential. In its simplest form, the problem of maximum production is how to maintain a maximum rate of gain over the longest possible time with the largest possible number of calves per unit of land and livestock. Livestock efficiency can be improved only with an increase in one or more of the three factors—rate of gain, duration of gain, and number of calves per cattle unit.

Early performance of calves is determined largely by milk flow of dams, which in turn is determined largely by nutrition. This is illustrated by data of Renbarger et al. (1964) who fed Hereford dams at 4 different nutritional levels. Milk production was 8.2, 9.4, 9.7, and 10.7

lb/day on the different rations. Daily rate of gain from birth (March) to weaning (October) for calves from the respective groups was 1.36, 1.47, 1.54, and 1.62 lb. Moreover, more dams fed on a high plane came into heat and bred back earlier than those on lower planes of nutrition. Birth weights of calves are greater when dams are well fed, increasing from about 65 lb with late-cut hay to about 80 lbs with early-cut hay. Examples of nutritional differences in birth weights are given by Wiltbank et al. (1962) and Wallace and Raleigh (1964). However, dams should not be overly fat at parturition of calves.

Milk flow and calf size can be adjusted to forage quantity and quality to increase calf performance throughout the year. When calves are first dropped, many cannot use all the milk produced by their dams. With present management practices of calving in May and going on range in June, the milk flow from the dam, forage quality, and often quantity, are difficult to integrate. Generally, by the time the calf is big enough to use a large supply, flow of milk and quality of forage are far below requirements. The net result is daily gains similar to those reported for yearling heifers by Johnson (1963): 2.4 lbs in June, 1.8 lbs in August, 1.4 lbs in September, and 0 in October. Robertson and Torell (1958) reported even earlier declines in rate of gain of yearling steers and heifers. Calves are buffered to some extent against such sharp declines in gain by milk from their dams, but calf gain must drop sharply also. No data are available, but it is suspected that daily gain of calves and yearlings on aftermath growth of the native hay meadows during the late fall is also very low. The stubble remaining after harvest is usually harsh and sere; very few meadows are refertilized after harvest and frequently no fall irrigation is practiced. In fact, good quality fall pasture is almost nonexistent and feeding of hay and supplements does not usually start until snowfall. Late calving, low-quality and, frequently, insufficient feed, account for low weaner and yearling weights shown previously.

The answer to this state of affairs is earlier calving and timely management of feed and livestock. Calves dropped in early spring usually have all the milk available that they can drink, even with late-cut hay, and by May or June they are large enough to eat early pasture and consume the greater milk flow that coincides with the first green feed. In addition, calves will be larger and hence better able to survive when turned onto range in June. Calf mortality between birth and weaning in the West is about 12% (Ensminger et al., 1955).

Earlier calving in the high-altitude areas will require more shelter and labor. However, shelters need not be elaborate or costly and the labor demand for early calving practices will occur during a slack season. Simple pole-type structures that can be easily moved from place to place may be used for hay and calf shelters. Four or five extra calves and a saving of 10% of the forage will buy considerable shelter. These costs will be offset by the need for fewer bulls. Since breeding season would occur while cattle are in breeding pastures on the home ranch, 1 bull per 40 or 50 sows would be sufficient whereas 1 bull per 20 or 25 cows is needed on the range.

Pregnancy testing and calving records will also pay dividends. In 1954 only 25% of the barren cows in the U. S. were culled and replaced (Ensminger et al., 1955) which means 15% of all the mature cows were "free boarders."

To halt the decline in rate of gain that occurs in late summer and fall, additional quality feed must be supplied. This can be accomplished by feeding supplements to livestock on the range, earlier roundup, and late fall pasture on the ranch, or some combination of these practices. However, summer range is often inaccessible, and livestock are widely dispersed, so supplementation may not be feasible. Range improvements such as reseeding and rotational grazing provide more forage, but little can be done to halt forage maturation and decline in crude protein content. Therefore, to prevent declining rate of gain, livestock must be gathered earlier. Meadows on the ranch can provide pasture (or hay) to maintain high growth rates of the calves and yearlings.

Thus, research suggests a program of improvement based on earlier calving and sustained growth rate of young animals coupled with improved forage management. The net result is more calves and yearlings per cow unit and longer periods of rapid growth. In addition, greater yields of forage will permit increasing herd size, but this generally should come only after obtaining greater efficiency. Research shows that improvements are possible. The economic situation dictates that they must come. How much longer can the industry support 15% free boarders and 80% calf crop, zero production for 10 to 20% of the year, and in many cases a net loss on every unit of production?

Integrated Forage and Livestock Management.—Many combinations of management practices may be used to improve livestock performance and resource use. Perhaps the simplest way to demonstrate the value of some of these practices is to show results of combinations that might be used. Four examples are shown in Table 2. Others could be used. Calculations are based on net hay consumption of

Table 2. Examples of four different management combinations for cow-calf operations on high-altitude meadows and associated range.

	Management Practices[1]			
	1	2	3	4
Lb. of hay and pasture/acre	2600	9600	9600	9600
Acres of meadow/cow	2.33	0.92	1.03	1.16
Days on hay	183	183	199	199
Days on range	151	0 or 151	0 or 75	0
Days on meadow pasture	31	182 or 31	166 or 91	166
Lb. of weaner/cow	278	278	540	570
Lb. of weaner/acre of meadow	119	302	524	492

[1] One refers to existing management practices.
Two assumes only an increase in forage production.
Three assumes an increase in forage production plus earlier calving, longer feeding, earlier roundup from range, and greater weaning percentage.
Four is the same as three except no range is available and weaning percentage increases further.

22 lbs dry weight/day and pasture and/or range consumption of 29 lb/day for each mature cow or cow-calf combination. In calculating the pounds of weaner beef produced annually per acre of meadow, the quantity of forage needed to produce a dam as well as the forage consumed by the cow-calf pair must be considered. Using the above values for forage consumption and assuming (1) a dam first calves as a 1000-lb, 2-year old, (2) dams produce 10 calves, and (3) a bull services 20 cows, it is estimated that about 2000 lbs of forage/year must be charged to each calf for production of its dam.

Practice No. 1 illustrates the result of existing management. Dams consume 4000 lbs of late-cut hay from November 15 to May 15 and 900 lbs of aftermath pasture from October 16 to November 15. Therefore, after prorating a share of the 2000-lb correction for production of the dam (1170 lbs), 2.33 acres of meadow are needed for each cow. From May 16 to October 15, cattle are on range. It is assumed that sufficient range is available to match meadow production (65 animal unit days/acre of ranch meadow). Together, ranch and range will carry 43 cows and 2 bulls for each 100 acres of meadow. Average calving date is May 1; 200 days later, 80% of the cows wean 347-lb calves for a production level of 278 lb of beef/cow and 119 lb/acre of hay meadow.

Practice No. 2 assumes no change in management except use of commerical fertilizer or legumes to increase yields of late-cut hay from 2600 to 9600 lb/acre. Range resources are fixed at the same level as in Practice No. 1, so some of the increased forage production on the ranch can be used for 151 days of summer pasture for extra cows (66 head/100 acres of meadow). Net pounds of weaner per cow does not change but production of beef per acre increases from 119 to 302. (Actually, production per cow will increase slightly because legumes and fertilizer will increase the quality of late-cut as well as early-cut forages, but the increase in quality is much smaller with late-cut harvest.)

Practice No. 3 incorporates both improved forage and livestock management. Forage production is increased as in Practice 2, but hay is cut earlier to improve quality. Regrowth is used for hay or late pasture. Cows are fed hay for 199 days to maintain high growth rates of calves in the fall. Part of the herd goes to range at the same stocking rate, but only for 75 days, so that irrigated pasture on the ranch is needed for either 91 or 166 days for cows on range and pasture, respectively; daily gain remains at or near 2.0 lb. Cows are bred 60 days earlier than in Practices 1 and 2 to more nearly match the calves' protein needs with forage production and quality. Calves are weaned at 260 days at a weight of 600 lbs (80-lb birth weight). Weaning percentage is 90 instead of 80 because all calves are born before going to range and are on range only half as long as with the first two practices. Beef production increases to 540 lb/cow and 524 lb/acre of meadow.

Practice No. 4 is exactly as in 3, except no range is available. Weaning percentage increases to 95% because livestock are under close scrutiny at all times. Production per cow increases slightly because of greater weaning percentage but production per acre drops slightly because no range is available.

Is Efficient Ranch Management Practical?

The examples above show that production of forage and beef can be greatly increased. Similar increases have been obtained experimentally and could be obtained in all ranch operations. Gross returns from various practices are easy to evaluate—simply multiply market price by saleable product. On the other hand, determining the costs of efficient management is difficult. Economic data are limited. Every ranch presents a new set of variables. However, some economic analysis is possible.

Comparison of practices 1 and 2 shows only the effect of increasing forage yields. Production per animal unit did not increase. Some ranchers can increase forage production by 6000 or 7000 lb/acre by water control and 200 lb/acre of N per year (about $24), or by introducing adapted legumes in well-drained land (about $15/acre). Irrigation can often be improved by more frequent changing of water. Haying costs will nearly double because of a second harvest but cost per ton will decrease (Fulcher, 1960, p.22). If these are the only costs, 183 lb/acre of additional beef is certainly economical with present cattle prices. However, most ranchers will need an initial investment of at least $50/acre, and possibly twice that much, plus annual costs, to put their land in shape for controlled irrigation and fertilization (Fulcher, 1960; Sitler and Rehnberg, 1954). Now the margin of 183 lbs of beef looks smaller, although still profitable. If, on the other hand, all practices are integrated as in Practices 3 and 4, the margin is about 400 lb/acre of extra beef per year. Even if calves sell for 20¢/lb and increases in forage yields are only half of those projected, capital investments on meadow improvements appear to be economically feasible. A more complete analysis is needed to evaluate all facets of efficient management.

The preceding discussion shows that improved management results in heavier weaners and yearlings. Some ranchers express reluctance to produce heavier calves because feeders discriminate against them with lower prices. The cow-calf and yearling operators feel they must continue to produce light calves with low-quality forage and inefficient management so that feeders can show greater efficiency with high-quality forages and concentrates. Riggs (1958) cites evidence "that cattle which make a continuous maximum gain to a given weight are more efficient converters of nutrients than those fed at levels which do not permit such rapid development." He later states, "Weights of 100 lbs for each month of age at weaning are being achieved though not too commonly. This type of production probably represents the ultimate economy in converting low cost feeds to highly desirable human food."

Many ranchers who raise yearlings feel that high growth rates for calves and yearlings during winter are uneconomical because gain during the next summer grazing period might be low. This is not necessarily true. For overwintering calves, Wallace et al. (1962) found that gain increased with crude protein intake, and gain on pasture or range the following summer was not reduced until winter gain exceeded 1.6 lb/day. Even then the decline was not great. Moreover, net profits were greater from calves wintered on a high nutritional plane than from those on low-quality meadow hay. With average daily gains of 2.0 lbs, a yearling can be produced in 12 instead of 18 months, thus, saving the feed necessary to carry these animals for 180 days. No protein supplements are needed with early-cut forage management, a considerable saving for many ranchers.

Who is to reap the benefits from growth potential of young beef cattle? Carroll et al. (1964) discuss the question: "The cattle feeder can expect more profit from retarded cattle that exhibit compensatory growth and he frequently will pay more for them; however, the cattle producer generally cannot produce retarded cattle just for the higher price. Unless the producer intends to reap the benefits of compensatory growth himself, he should consider supplementing weaned calves for continuous growth, because at no later period in their lives will they respond with larger live-weight gains in return for the feed."

Perhaps feeders should encourage ranchers as a means of protecting their supply of raw product and also a means of improving their own efficiency. The recent change by the U.S.D.A. to permit younger, leaner animals to reach a higher grade may have a profound influence on the outcome of this problem. With proper management of water, forage, and livestock, and maybe a short period of feeding home-grown concentrates, ranchers can produce a 750- to 800-lb steer for slaughter at one year of age.

All available evidence indicates that the increases in efficiency of beef production projected in Table 2 are possible. Economic analyses of ranches and discussions with bankers and ranchers indicate increased efficiency is necessary. The examples were developed to show the potential of land and water resources for livestock production—to show that resources are not the limiting factor for greater profit. Each individual will achieve according to his managerial ability and his desire to meet the challenge of progress.

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Influence of Soil Compaction on Emergence and First-Year Growth of Seeded Grasses

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Highlight

Adequate soil preparation will eliminate any compacted layers formed under cultivation and aid in securing a vigorous stand of grass on land converted from cash crop to pasture. Seedling emergence is not affected, but a compacted soil layer depresses the vigor of young grass plants by limiting root penetration and the volume of soil from which moisture for growth can be extracted. The curtailment of forage production is more pronounced with time.

Farmers and ranchers changing from a cash crop to perennial grass often have difficulty in establishing a satisfactory stand of grass. Minimizing the risk of establishing a stand of grass adequate for livestock forage and soil protection will benefit many segments of agriculture, especially livestock producers. Cooperative work was undertaken at the Big Spring Field Station between the Texas Agricultural Experiment Station and the Soil and Water Conservation Research Division, Agricultural Research Service, to determine some of the causes for the limited success in establishing grass on cultivated land.

Compacted soil zones or pans occur widely in cultivated soils. These soil pans usually are formed immediately below normal tillage depth in sandy as well as in fine-textured soils. The pans are very persistent in loam, fine sandy loam, and loamy fine sand soils of the Southern Great Plains.

Compacted soil zones and pans have been shown to restrict the yields of many crop plants. Cotton and grain sorghum (Taylor et al., 1964), corn (Phillips and Kirkham, 1962), tomatoes (Flocker et al., 1959), sugarcane (Trouse and Humbert, 1961), and sudangrass and soybeans (Zimmerman and Kardos, 1961) have shown depressed yields when grown on soils with compacted layers. Roots of sudangrass penetrated compacted cores more readily than did soybean roots under laboratory conditions.

The restrictive influence of compacted soil layers on production of many field crops is well documented, but very little is known concerning the reaction of forage plants to similar soil conditions. Few roots of native grasses growing in a prairie sod were present in the dense subsoil found at a shallow depth (Fox, Weaver, and Lipps, 1953). A compacted soil layer was shown to be associated with a depression of livestock production after 20 years of relatively heavy grazing use (Rhoades et al., 1964). In view of these findings, it seemed reasonable that a compacted soil pan would influence the establishment of seeded grasses.

Procedure

An Amarillo sandy clay loam, which had been cultivated for a number of years, and on which sorghum had been grown the previous season, was selected for this study. Sorghum stubble was still present when the following soil treatments were established:

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(1) disc-plow to 10 inches deep; (2) sweep tillage to a 4-inch depth on soil at normal field density; (3) sweep tillage to a 4-inch depth on soil compacted with wheeled tractor traffic; and (4) sweep tillage to a 4-inch depth on soil that was compacted with a 10-ton roadroller. The compaction treatments were applied while the soil was at field capacity and were followed by the appropriate tillage.

On May 28, giant or big cenchrus, *Cenchrus myosuroides* H.B.K.; green sprangletop, *Leptochloa dubia* (H.B.K.) Nees; and sideoats grama, *Bouteloua curtipendula* (Michx.) Torr., were planted on the various compaction treatments in 4-row blocks. All plantings were made using a 2-row tractor-mounted grass seeder equipped with double-disc furrow openers and press wheels. A rain of 0.80 inch fell immediately after planting, and 1.47 inches of precipitation fell within the next two weeks. To maintain growth, sprinkler irrigation was applied as needed until the emergent plants were well established.

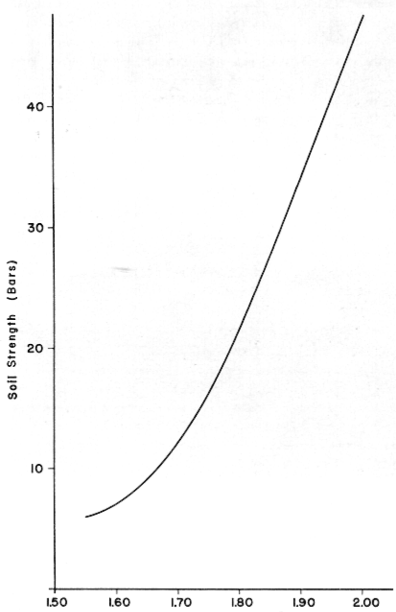

Fig. 1. Relationship of soil strength and bulk density in Amarillo sandy clay loam measured at ⅓-bar soil moisture tension.

Fig. 2. Stands of giant cenchrus 70 days after planting on Amarillo sandy clay loam soil having a compacted layer 4 inches below the surface (above) and tilled to a depth of 10 inches just before planting (below).

Measurements of plant response during the first season after planting included a count and height measurement of seedlings, average height of leafage extended vertically, number and average height of heads exserted, and yield of caryopses and forage at the end of the growing season.

In November, bulk density was determined with a clod method (Johnston, 1945) on 10 clods from the highest strength zone within the upper 6 inches of soil. These bulk density data were combined with data from Taylor et al. (1964) to provide estimates of soil strength at field capacity as measured with a force gauge penetrometer (Fig. 1).

The experiment was organized in a split-plot design. The main plots consisted of the various compaction treatments, and the grass species planted were considered as subplots. Since considerable variation in soil strength occurred between plots given the same compaction treatment, the data were analyzed using the least squares method.

Results and Discussion

Giant cenchrus came up to good stands. Initial stands of the other two species were spotty, but this spottiness did not appear to be related to the experimental treatments. Consequently, sideoats grama and green sprangletop were replanted, and satisfactory stands were obtained using a combination of hay mulch and sprinkler irrigation. Only the relationships established for giant cenchrus will be reported in this paper, although the other two grasses responded similarly to the imposed soil compaction treatments.

The magnitude of each plant response measured, except number of seedlings per unit length of row, was inversely proportional to soil compaction; i. e., as the degree of compaction increased the plant yield declined (Fig. 2). The number of live seedlings 35 days after planting was independent of the compaction treatment imposed, but the influence of the compacted zone was noted in measurements of seedling height made at the same time as the stand counts. Seedlings growing in soils that were either deep tilled or utilized at field density were taller than those growing on soils having a compacted layer. Yields of both seed (Fig. 3) and forage (Fig. 4) at the end of the growing season show a curvilinear relation between soil compaction and the various measured plant responses.

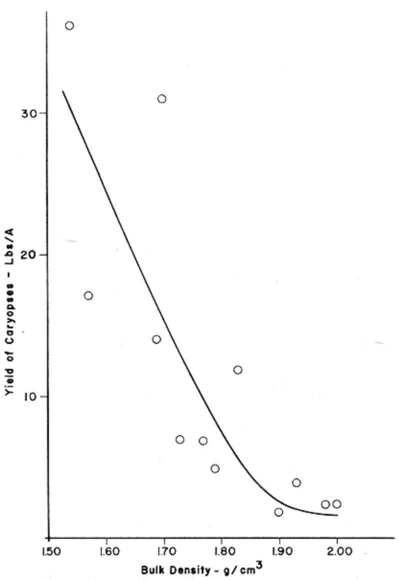

FIG. 3. Yield of seed (caryopses) of giant cenchrus grown on an Amarillo sandy clay loam soil subjected to several degrees of compaction.

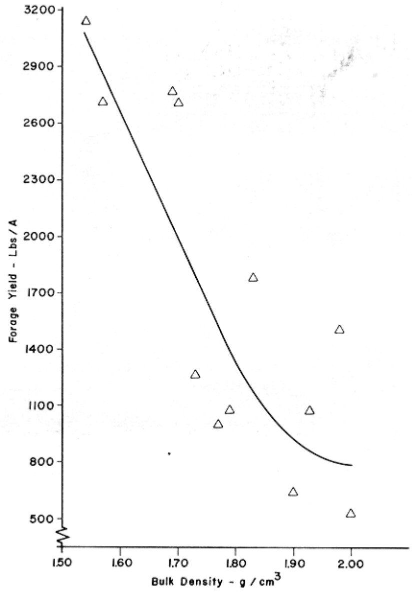

FIG. 4. Yield of forage from giant cenchrus at the end of the first growing season after planting in Amarillo sandy clay loam subjected to varying degrees of compaction.

Dryland cotton grown nearby during the same season showed curvilinear trends between soil compaction and growth rates and between soil compaction and lint cotton yield. In that experiment, Taylor et al. (1964) found that soil compaction increased soil strength to such an extent that cotton roots could not penetrate the high bulk density layers.

Periodic observations during the growing season showed that the grass roots were similarly stopped by the high strength layers (Fig. 5). Whenever Amarillo sandy clay loam soil bulk density exceeded 1.82 g/cm^3, few grass roots were able to penetrate the soil pan even when it was at field capacity. This corresponds to a soil strength of approximately 25 bars (Fig. 1). Experiments with cotton (Taylor and Gardner, 1963) have shown that a greater proportion of plant roots can penetrate soils at field capacity than at lower moisture contents.

The reduction in the growth rate of grass and, consequently, the yield reflects the limited moisture and nutrients available when plants are grown on high-strength pans. Most of the water and nutrients in and under pans are unavailable because roots do not grow through the pans. Observations during the growing season often showed available moisture in the second foot of soil while the grass plants grown on the compacted pans were suffering severely from moisture stress.

Thus, soil compaction alters the plant-soil-water relationships, and the vigor of the desirable plants is lessened. In this study, the measured responses of giant cenchrus and the observed responses of sideoats grama and green sprangletop were similar to those recorded for cotton (Taylor, Locke and Box, 1964). Under the conditions of this study, a soil pan approximately

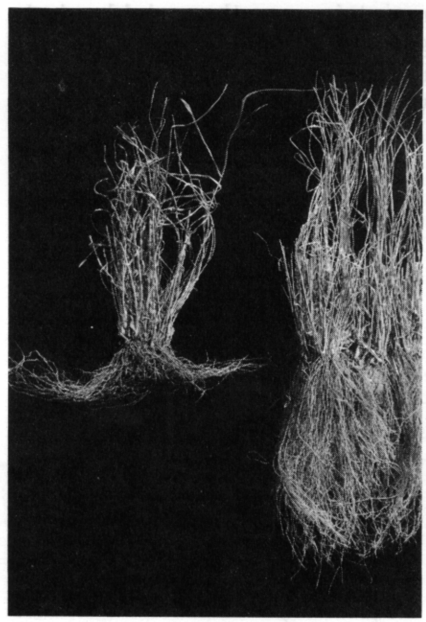

FIG. 5. Roots of giant cenchrus growing in soil with a compacted layer (left) were restricted to the 3-inch layer of soil above the pan. The greater vigor of giant cenchrus plants growing on soils without this compacted layer (right) is a reflection of the greater amount of moisture and nutrients available in this larger soil reservoir.

4 inches below the soil surface did not affect the number of emergent seedlings. However, the height of these young plants was associated with the imposed soil compaction, and the plant response to the restricted soil volume available for root growth became more pronounced with time.

The benefits from tillage to eliminate compacted soil pans are vividly demonstrated by this experiment. The compacted soil layers not only increase the risk of establishing an acceptable stand of seeded grass, but they reduce the vigor of the surviving plants.

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Competition in a Blue Grama-Broom Snakeweed-Actinea Community and Responses to Selective Herbicides

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Highlight

In a blue grama-broom snakeweed-Cooper actinea community, the presence of half-shrubs suppressed the growth of blue grama. Blue grama and forbs were increased when the half-shrubs were reduced by selective phenoxy sprays.

The portions of the juniper-pinyon woodland in Arizona and western New Mexico with highest rainfall and greatest potential for forage production are also particularly susceptible to weed infestations, and undesirable half-shrubs and forbs often outproduce desirable grasses. Typically, these areas fall along the Mogollon escarpment, and on other areas of rough topography. The study reported here shows the interrelations among some of the important species of these areas. These interrelations were studied by modifying the amounts of the different species with selective herbicides.

Methods

The study area was located at an elevation of 6,400 ft on the Beaver Creek Watershed, Coconino National Forest, 40 miles south of Flagstaff, Arizona. Precipitation, about equally divided between a winter and summer season, totals about 20 inches annually. The study was located in a natural opening among the alligator juniper trees *(Juniperus deppeana.)*[2] In addition, trees near the plot were removed to eliminate their competition with the herbaceous plants. Soils in the area, silty clays and clay loams, have developed from basalt.

At the time the study began, the area had been closed to grazing for 3 years. Blue grama *(Bouteloua gracilis)*, bottlebrush squirreltail *(Sitanion hystrix)*, broom snakeweed *(Gutierrezia sarothrae)*, Cooper actinea *(Hymenoxis cooperi)*, and a number of forbs comprised the vegetation. In aspect, half-shrubs were most conspicuous.

A series of 96 plots was laid out in the study enclosure. These plots were 9 x 9 ft, separated by 2-ft-wide walkways. All measurements were made on the 5- x 5-ft center of each study plot except production of squirreltail, which was determined on 8- x 8-ft areas. Weed competition was varied by spraying some of the plots with selective phenoxy compounds[3] (2,4-D and 2,4,5-T). Spray treatments were (1) None (Check), (2) sprayed in 1958, (3) sprayed in 1960, and (4) sprayed in both 1958 and 1960. In 1958, plots were sprayed in the spring with a mixture of 2,4-D and 2,4,5-T, and in the fall with 2,4-D. In 1960, 2,4-D was used alone

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[1] *In cooperation with Northern Arizona University; central headquarters maintained at Fort Collins in cooperation with Colorado State University.*

[2] *Latin nomenclature follows Kearney and Peebles, 1960.*

[3] *Thomas N. Johnsen, Jr., of the Agricultural Research Service, U. S. Department of Agriculture, provided and applied the chemical sprays.*

in the spring. Herbicide applications were similar to the higher rates tested by Johnsen (1962) on Colorado rubberweed *(Hymenoxis richardsoni)*. Treatments were applied to 24 replications.

Grasses were sampled each year from 1958 through 1961 by weight estimates. Estimated values of fresh weight were converted to ovendry weight values by a regression equation of dry weight on estimated fresh weight developed from clipped plots outside the enclosure. Grass seedlings were counted each year. In 1961 half-shrubs and forbs were clipped and their dry weight determined.

Responses to Herbicides

The first year of the study, grass seedlings were most commonly found in the shade of half-shrubs and taller forbs; this resulted in more seedlings on unsprayed plots than on sprayed plots (Table 1). In 1960, however, plots sprayed in 1958 had far more seedlings than plots left unsprayed in 1958. In 1959 there were very few seedlings found in the study plots, and none were found in 1961. Very few of the seedlings survived during any year of the study. In general, the number of seedlings had little relationship to later production of grasses.

Spraying generally resulted in an increase in grass production (Table 2). The plots sprayed in 1958 had increased grass weights in 1959; plots sprayed in 1960 had increased production in 1961. In 1961 there were statistically significant differences among the treatment means for both squirreltail and blue grama. The differences for squirreltail, however, were erratic and not clearly related to the various treatments except that all sprayed plots produced more than unsprayed plots. There were also some production changes on the check plots not related to treatments. Blue grama decreased slightly on unsprayed plots the second and third year of the study. During the course of the study, squirreltail increased on check plots from 9 to 35 lb/acre.

After grass weights were determined in 1961, half-shrubs and forbs were clipped, dried, and weighed from the 5- x 5-ft center of each plot. The half-shrubs, broom snakeweed and Cooper actinea, produced less on sprayed plots (Table 3). The differences in the amounts of half-shrubs on plots sprayed at different times were minor and not statistically significant.

Some herbaceous forbs were most important on plots sprayed in 1960. These included common purslane *(Portulaca oleracea)* and sawatch knotweed *(Polygonum sawatchense)*. Western ragweed *(Ambrosia psilostachya)*, on the other hand, produced most on plots sprayed in 1958. Annual goldeneye *(Vigueria annua)* produced about the same on plots sprayed once in 1960 and plots sprayed once in 1958, but produced less on plots sprayed twice. All forbs produced as much or more on sprayed plots as on unsprayed plots.

Production of all plants on sprayed plots averaged 560 lb/acre compared to 735 lbs on unsprayed plots. Herbaceous plants increased an average of 158 lb/acre as a result of treatment while half-shrubs decreased 333 lb. This indicates that each pound of half-shrubs killed by the sprays was replaced by less than 0.5 lb of herbaceous plants.

The gain in herbaceous plant production as a result of spray

Table 1. Grass seedlings per 1,000 ft^2 on untreated plots and on plots sprayed with phenoxy compounds in 1958 and 1960.

		Year of spray		
Year of count	Not sprayed	1960	1958	1958 and 1960
1958	927	877	270	333
1959	68	80	28	68
1960	593	412	1,750	1,818
1961	0	0	0	0

Table 2. Major grasses produced (lb/acre) on untreated plots and on plots sprayed with phenoxy compounds in 1958 and 1960.

		Year of spray		
Year of herbage sample	Not sprayed	1960	1958	1958 and 1960
Blue grama				
1958	323	259	309	337
1959	247	214	369	400
1960	206	194	256	270
1961	272	309	335	376
Bottlebrush squirreltail				
1958	9	8	8	9
1959	15	18	24	26
1960	20	30	31	34
1961	35	106	70	91

Table 3. Plants produced (lb/acre) in 1961 on untreated plots and on plots sprayed with phenoxy compounds in 1958 and 1960.

		Year of spray		
Species	Not sprayed	1960	1958	1958 and 1960
Grasses				
Blue grama	272	309	335	376
Bottlebrush squirreltail	35	106	70	91
Other grasses	2	0	5	0
Total grasses	309	415	410	467
Half-shrubs				
Broom snakeweed	285	32	44	8
Cooper actinea	125	62	54	30
Total half-shrubs	410	94	98	38
Forbs				
Western ragweed	9	12	53	7
Knotweed	1	10	1	4
Purslane	4	20	10	10
Annual goldeneye	0	7	6	2
Other forbs	2	8	5	3
Total forbs	16	57	75	26

treatments would apply to areas with a similar composition of plants prior to treatment. It is reasonable to assume that if more half-shrubs had been present, responses of herbaceous plants due to treatment would have been greater. Covariance analysis was used to show how much of the treatment response of blue grama was related to changes in half-shrubs. Blue grama was taken as the dependent variable, and the two species of half-shrubs as the independent variables. This is probably valid since other work has shown that the half-shrubs do not respond to changes in the amount of blue grama present (Arnold et al., 1964).

The covariance analysis showed that the difference between treatment means of blue grama was not significant when the effect of the half-shrubs was accounted for. Thus it can be concluded that increases in blue grama on the treated plots were a result of reductions in half-shrubs.

Interspecific Relations

In this study, partial correlation coefficients were used to express the relationship of each species to the others. Full descriptions of the meaning of these coefficients and methods of analyses can be found in most statistics texts.

Species may competitively exclude each other, compete to a lesser degree than total exclusion, passively coexist, or cooperate (Patten, 1961). In terms of correlation analysis, correlation coefficients would be expected to range from −1 for competitive exclusion to some value between 0 and +1 with interspecific cooperation.

Previous studies have indicated that broom snakeweed competes little with blue grama (Stewart and Keller, 1936) and black grama (Campbell and Bomberger, 1934). In these reports, other species present were not mentioned in the interpretation of results. Dwyer (1958) found that 12.5 g/plot of broom snakeweed reduced big bluestem *(Andropogon gerardi)* 2.1 g. The presence of 16.2 g of western ragweed, on the other hand, reduced big bluestem 14.2 g. Dwyer's results were taken from plots with only two species per plot.

In this study, the five species that made up most of the herbage weight were considered separately in the analysis (Table 4). The remaining species were included as a group so that all herbage would be considered. The partial correlation coefficients indicate that the most interesting and important relationships were between the grasses and other categories of plants. Interspecific relationships among the forbs and half-shrubs were much less important. Blue grama was significantly and negatively related to both the half-shrubs and to forbs other than western ragweed. Squirreltail, on the other hand, was not related to half-shrubs. This indicates that half-shrubs and squirreltail are not competitive, and that reducing the amount of half-shrubs on an area would not be expected to increase the amount of squirreltail.

The relationships between squirreltail and blue grama, and between squirreltail and forbs were positive and highly significant. Since squirreltail makes most of its growth in spring while blue grama and the forbs make most of their growth in summer, a negative correlation between squirreltail and the other herbaceous plants would not be expected. The highly significant positive coefficients indicate more than a lack of competition, however. Two hypotheses are apparent: (1) squirreltail is adapted to the same microsites as blue grama and the forbs, and since squirreltail grows at a different season both classes of plants can increase simultaneously on the better microsites, or (2) squirreltail either benefits or is benefited by the presence of blue grama or forbs.

Observations on the study plot indicate that there are probably some microsite effects involved in the squirreltail-blue grama-forb relationship. A plot-by-plot and species-by-species study of the data showed that the positive relationship between squirreltail and the forbs was perhaps strongest in the case of purslane. Purslane was largely confined to microsites with slightly less soil structure and a slightly darker soil color than the average for the study area, and on these plots production of squirreltail was higher than average. Other species of forbs, however, which did not appear to be more abundant on one microsite than on another, also contributed to the positive relationship with squirreltail. In addition, blue grama and the forbs may have provided some protection to new seedlings

Table 4. Matrix of partial correlation coefficients of weights of major species in the study plots.

Species	Bottlebrush squirreltail	Broom snakeweed	Cooper actinea	Western ragweed	Other forbs
Blue grama	+.401**	−.445**	−.434**	−.152	−.502**
Bottlebrush squirreltail		−.032	−.032	+.038	+.406**
Broom snakeweed			−.137	−.205*	−.115
Cooper actinea				−.099	−.214*
Western ragweed					+.121

* Indicates significance at the 5 per cent level.
** Indicates significance at the 1 per cent level.

of squirreltail, which could possibly result in a positive relationship.

Summary

Selective phenoxy sprays applied to broom snakeweed and Cooper actinea reduced the weight of these half-shrubs on study plots about 90 and 60%, respectively. As a result of reductions in half-shrubs, blue grama on the treated plots increased 14 to 38% over the untreated check plots. Bottlebrush squirreltail and forbs also increased on the sprayed plots. Squirreltail production was positively related to production of blue grama and forbs, but not directly related to the amount of half-shrubs. Blue grama production was inversely related to the amount of half-shrubs and forbs.

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Crude Protein in Rumen Contents and in Forage[1]

DWIGHT R. CABLE AND R. PHIL SHUMWAY[2]

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Highlight

Rumen-fistulated steers consistently selected a diet higher in crude protein than hand-clipped samples of the major available perennial grasses. The excess of rumen protein over grass protein depended on the availability of higher-protein shrubs and annual forbs that supplemented the perennial grasses, and on selection of high-protein parts of the grasses. Since the abundance of these high-protein forages varied greatly with time, the protein content of grass clippings did not reliably indicate the protein level in the steer's diet.

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[1] *Conducted in cooperation with Western Regional Research Project W-34, Range Livestock Nutrition. Approved as Ariz. Agr. Exp. Sta. J. Article No. 1033.*

[2] *Research accomplished while author was on sabbatical leave with the Animal Science Department, University of Arizona, Tucson.*

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

The chemical and botanical composition of the grazing animal's diet are difficult to determine. Hand-clipped samples, taken as the observer watches the animal graze, do not reliably match the composition of the animal's forage intake (Hardison et al., 1954; Anon., 1962; Lesperance et al., 1960). Now, with rumen and esophageal fistula techniques, the animal itself does the collecting (Torell, 1954; Cook et al., 1958). This paper deals mainly with comparisons between crude protein values for rumen fistula samples and for hand-clipped samples of Arizona cottontop (*Trichachne californica* [Benth.] Chase) and Lehmann lovegrass (*Eragrostis lehmanniana* Nees). Some protein values for certain common non-grasses are also included. Initial results of this study were reported by Shumway et al. (1963) and Shumway and Hubbert (1963).

Materials and Methods

The study area.—The study was conducted in a 150-acre pasture at an elevation of about 4,000 feet on the Santa Rita Experimental Range, south of Tucson, Arizona. Annual precipitation averages nearly 16 inches in two distinct rainy seasons: about 60% falls from late June through September, with most of the remainder during the winter-spring period of December through April.

The vegetation cover consisted of a shrubby overstory of velvet mesquite (*Prosopis juliflora* var. *velutina* [Woot.] Sarg.) and catclaw acacia (*Acacia greggii* A. Gray), with an understory of perennial grasses and low-growing shrubs. The dominant perennial grasses were Lehmann lovegrass, a reseeded introduction, and Arizona cottontop. The most common low shrubs were false-mesquite (*Calliandra eriophylla* Benth.) and velvet pod mimosa (*Mimosa dysocarpa* Benth.). In addition, several species of annual grasses and forbs were common during the winter-spring and summer growing seasons, when moisture conditions were favorable.

The perennial grasses are primarily summer growers, although all of them produce some herbage during the spring. All except one of the shrubs mentioned are deciduous and produce most of their leaf and stem growth in the March to May period. In general, growth begins in the spring when soil and air temperatures meet species requirements, and growth in the summer begins with the beginning of effective summer rains.

Procedure. — Three rumen-fistulated yearling Hereford steers were used in this study the first year, May 1961 till April 1962, and a second set of three steers from November 1962 till September 1963. Rumen samples were taken at approximately monthly intervals, with more frequent collections during some periods of rapid vegetation growth. The night before a collection was to be made, the steers were penned off feed and water. The next morning the rumen contents were removed and stored in clean garbage cans, while the steers were returned to the study pasture to graze for about 45 minutes. The freshly grazed material was then removed from the rumen for later analysis and possible identification, and the original rumen contents were replaced. While the steers were grazing, they were observed with binoculars to see what they were taking. Perennial grass forage was abundant at all seasons of the year.

Samples of the two dominant perennial grasses, Arizona cottontop and Lehmann lovegrass, were clipped on each day that rumen samples were collected, and also midway between monthly rumen collections. No attempt was made to simulate the steers' grazing in the clippings. Depending on availability, samples of common forbs and shrubs were also collected. Observations of the stage of growth of the important vegetation species were recorded for each clipping date.

Crude protein content of the rumen samples and of the clipped vegetation samples were determined in the laboratory by standard A.O.A.C. (1955) methods. Subsequent references to protein will mean crude protein. Data were also obtained for green-material-only, in addition to that for the whole-plant clippings, for three clipping dates in March and April 1961.

Results

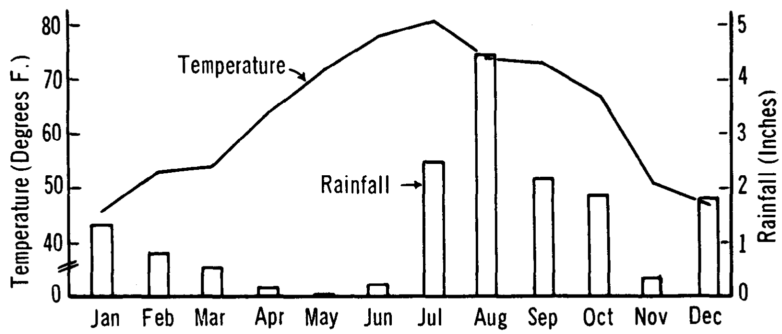
Growth patterns of grasses and shrubs. — Lehmann lovegrass completed two growth cycles each year in response to the two rainy seasons; a minor one in the spring, and a major one in the summer. New leaf growth began in January, heads began emerging from the boot in March, and the foliage was dried up by June (Fig. 1). For the main growing season, new leaf growth started in late June, seed stalks developed rapidly, and flowers were in bloom in August. Foliage was dried up by December.

Arizona cottontop started growing a little later in the winter-spring period, but also completed two growth cycles, although total leaf growth was much shorter and flower stalks much less numerous in the spring than during the main summer growing season.

The three shrubs on which records were kept remained dormant until March, when leaf buds began bursting. The main stem elongation period for mesquite and catclaw acacia was from March until June, with a second shorter period in August. False-mesquite had a comparatively short period of stem elongation in the spring (April), followed by a longer period in July and August.

Protein content of clipped

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lovegrass	A	B	B–D	B–F	E–G	H–A	B–C	C–E	E–F	E–F	G	H
Cottontop	H	A	A–B	B–H	B–H	H–A	B–C	C–E	E–F	F–G	H	H
Mesquite	E	E	E–A	A–C	C	C–D	D	C	D	D	D	D
Catclaw acacia	E	E	E–A	A–C	C	C–D	D	C–D	D	D	D	E
False mesquite	E	E	E–A	A–C	D–E	D–E	A–B	B–C	D	D	E	E



Grass Stages

A Green growth appears
B Leaves or stems 4" long
C Flower stalks evident
D Heads emerging from boot
E Flowers in bloom
F Seed ripe
G Seeds disseminating
H Foliage dried up

Shrub Stages

A Leaf buds bursting
B Stems elongating
C New stem growth 6" long
D Stem elongation stops
E Leaves dried up

FIGURE 1. Growth and development of grasses and shrubs in relation to monthly rainfall and temperatures, March 1961 to October 1964 (rainfall and temperature data interpolated from nearby stations).

grasses.—The protein content of whole-plant grass clippings was highest in young, succulent growth and decreased rapidly as plants matured. Thus, a significant increase in crude protein was recorded for lovegrass, but not for cottontop, in the spring, but the major high was in August during the main growing season. The low points were recorded when plants were dormant in winter, November to January, and during the late spring drought in May and June (Fig. 2).

The two grasses exhibited about the same pattern of change in protein content during the year; monthly averages seldom differed by more than one percentage point. Lowest protein content was 3.6% for cottontop in January, and the highest was 12.8% for cottontop in August, with an overall average of 6.3% (Table 1).

Percent protein in lovegrass green-material-only in mid-March 1961 was over 2½ times as high as that of the whole-plant clippings, but declined to about 1⅔ times as high by mid-April, as shown in the following tabulation:

Date	Whole plant	Green only
3-15-61	3.56	9.52
4- 3-61	4.25	9.31
4-12-61	4.50	7.52

This overall change in the relationship between whole plant and green-material-only, between March 15 and April 12, was the net effect of two contrasting trends: average protein content of the green-material-only was declining as it matured, especially during the latter part of the period, and average protein content of the whole plant was increasing as green material made up an increasing percentage of the whole plant, especially during the first part of the period.

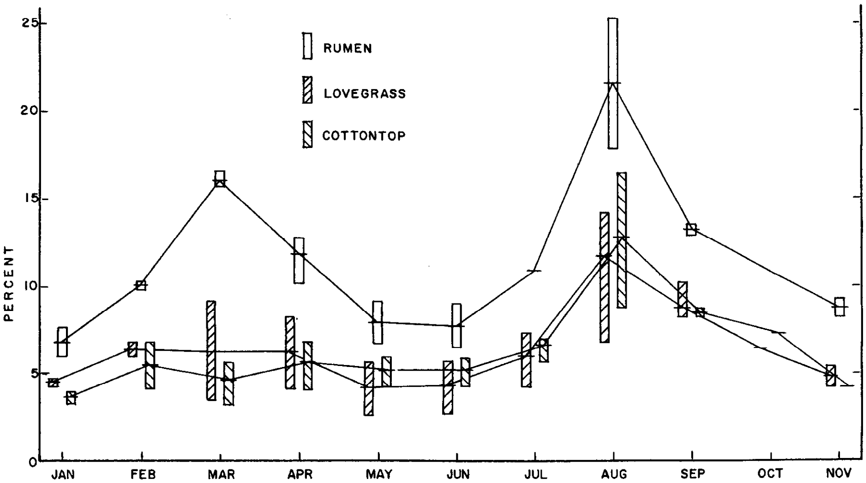


FIGURE 2. Changes in crude protein of clipped grasses and of rumen contents; range and averages of monthly determinations.

Table 1. Crude protein percent in dry matter; monthly averages, May 1961 to September 1963.

Month	Rumen	Lovegrass	Cottontop	Annual Forbs	Cacti	Mesquite Foliage	Other Shrubs
Jan.	6.80	4.54	3.58		7.18		10.98
Feb.	10.10	6.42	5.54		5.69		13.88
Mar.	16.06	6.38	4.64	20.45	9.50		15.31
Apr.	11.88	6.28	5.68	17.34	6.99	25.58	16.13
May	7.94	4.24	5.22		6.01	20.62	18.16
June	7.78	4.34	5.12		7.28	18.12	
July	10.90	6.00	6.68			15.56	
Aug.	21.60	11.64	12.76	21.91	15.04		
Sept.	13.24	8.76	8.50		9.99		
Oct.		6.44	7.28				
Nov.	8.76	4.84	4.19		6.69	15.81	11.36

Protein content of forbs and shrubs.—Protein content of these plants, too, was highest when growth was young and succulent, but periods of growth differed somewhat among species, and protein did not reach a peak in all species at the same time (Table 1). Mesquite leaves were very high in protein in April when first developing (25.6%), and decreased steadily until August (15.6). Mesquite beans were high when green (25.5% in June), but dropped to 12 to 13% when dry.

Other shrubs, catclaw acacia, false-mesquite, and desert zinnia (*Zinnia pumila* Gray) increased from a low of 11% in January to an average of 18.2% in May (catclaw acacia was 23.9% in April).

Protein content of cacti (jumping cholla [*Opuntia fulgida* Engel.] and pricklypear [*O. engelmannii* Salm-Dyck]) generally followed the clipped-grass pattern; they varied from a low of 5.7% in February to a high of 15.0% in August.

Annual forbs were present in useful amounts only in the spring and summer growing periods. Important genera included

Sisymbrium, Eschscholtzia, Amaranthus, and *Tribulis.* When available, these plants were always high in protein (13.5 to 26.5%).

Crude protein content of rumen samples.—Rumen protein content followed about the same pattern of change as the clipped grasses: a peak in March (16.1%), a higher peak in August (21.6%), and lows in May and June (7.8%), and from November till January (6.8%) (Fig. 2). For all months, rumen protein content averaged 11.5%.

Although three animals constitutes a rather small sample, variability among animals was not considered excessive. Coefficients of variation for 18 dates, with 3 animals each, varied from 0.11% to 18.82%, with an overall average of 7.81%. On only two dates did CV exceed 15%, and it was less than 5% on seven dates.

Discussion

Protein content of the rumen samples consistently exceeded that of the grass clippings but, in general, followed the same pattern of change (Fig. 2). Two possible sources of the higher rumen protein content were: 1) contamination of the grazed material between the time it was grazed and the time it was removed from the rumen, or 2) selective grazing of other higher protein plants in addition to the two grasses, or of certain parts of the grass plants which were higher in protein than the whole plant.

The possibilities of protein content increasing appreciably by saliva contamination or bacterial action in the rumen are remote. Separate tests with alfalfa and cottonseed hulls indicated non-significant or only slight average increases in nitrogen due to saliva contamination (Shumway et al., 1963). And, since essentially all the rumen bacteria were removed with the rumen contents prior to each test grazing, contamination from this source was not likely. Also, the rumen samples showed no evidence of fermentation. Thus, the higher rumen protein content appears to be due to selective grazing.

Direct observation of the animals as they grazed, and preliminary examination of the rumen samples, showed that plants other than grasses were eaten. Unfortunately, loss of the frozen rumen samples due to refrigeration failure prevented us from determining botanical composition. At times the steers grazed almost exclusively on annual forbs or on mesquite leaves, even though perennial grasses were available. They even occasionally ate such apparently unpalatable plants as cholla and barrel-cactus. The influence of other-than-grass plants was especially marked in March, when annual forbs comprised a high percentage of the rumen content.

Protein content of the rumen averaged 1.82 times that of the whole-plant clippings of the two grasses for the 10 calendar months in which rumen samples were collected, but varied considerably between months because of differences in the availability of high-protein forbs and shrubs. In September, a month with few high-protein forbs, rumen protein was only 1.53 times the grass protein; but in March, a month with many high-protein forbs, rumen protein was 2.91 times that of the grasses. For the other months, rumen protein varied from 1.67 to 1.99 times that of the grasses. The results for the summer months are similar to those of Van Dyne and Heady (1965) in California, who found 1.5 to 2 times as much crude protein in esophageal fistula samples of sheep and cattle as in clipped herbage collected in July, August, and September; but these results are somewhat higher than reported for esophageal-fistulated sheep on native range in California by Weir and Torell (1959). And, Edlefson et al. (1960) found no significant differences in protein between hand plucked and esophageal fistula samples from winter grazing by sheep on Utah desert range.

These ratios between grass and rumen protein are a measure of the relative opportunity for the steers to improve their diet by selective grazing. This relative opportunity for diet improvement was highest in March and August, when the grass protein was at its peak and other forages were also at their peaks. The excess of rumen protein over grass protein at this time was about 10 percentage points. By contrast, in winter when grasses were dormant, annual forbs absent, and deciduous browse was defoliated due to low temperature and sometimes low moisture, the relative opportunity for diet improvement was low. High temperatures and lack of rainfall bring about similar vegetation conditions in May and June. During these periods the excess of rumen over grass protein averaged only 3 to 4 percentage points (Fig. 2 and Table 1).

As suggested above, protein content in the rumen was strongly correlated with that in the grass clippings. However, this relation is believed to have little value for extrapolation to other areas and other times because the presence and abundance of high-protein forbs and shrubs, on which the relation depends, vary markedly from year-to-year and place-to-place.

Based on National Research Council recommendations of 7.5% crude protein for wintering 600-lb steers, as quoted by Savage and Heller (1947), the two grasses were deficient in all months except August and September (Table 1), although protein content of lovegrass green-material-only was adequate in March and April. The rumen samples contained more than

7.5% in every month except January, however, which was about 10% low. Apparently the deficiencies in protein in the grasses were made up by higher content in the forbs and shrubs grazed by the steers.

Summary and Conclusions

A comparison of the crude protein contents of rumen samples from fistulated steers with those of hand-clipped vegetation samples shows that the steers invariably selected a diet higher in protein than whole-plant clipped samples of the major available perennial grasses. Data obtained over a period of 2½ years show that rumen protein varied from 1.53 to 2.91 times that of the clipped grass samples, and suggest that the higher protein content in the rumen was due to selective grazing by the steers of green parts of grasses rather than the whole plant, and of high-protein shrubs and annual forbs when they were available.

Although protein content of the rumen was highly correlated with that of the clipped grasses, clipped grass samples will not give reliable estimates of rumen protein in other years or other places because of large variability from year-to-year and place-to-place in the abundance of the high-protein forb and shrub forage which supplements the perennial grasses.

The data presented and reviewed indicate that non-grass plants contribute significantly to the protein intake of grazing animals, even when perennial grasses are abundant. This becomes of immediate practical importance when considering the need for feeding protein supplements. If the perennial grasses have some green shoots around the base, or if palatable annual forbs or browse are available, protein supplements probably are not needed even though the average protein level in grasses is below the recommended level.

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American Society of Range Management Trust

TRUSTEES ANNUAL MEETING

January 31, 1966, Jung Hotel, New Orleans, La.

The meeting was called to order by Chairman Wasser at 4:30 P.M. Trustees present: Don Cox, Don Cornelius, Wm. Hurst, Alex Johnston, Wayne Kessler, Melvin S. Morris, and John Clouston, Secretary-Treasurer.

The Secretary-Treasurer read a resolution required by banks for deposit of funds of a trust, stating that the adoption was necessary before the bank would accept the deposit. Cox moved the adoption of the resolution, seconded by Morris. Carried. Resolution stated "That the officers of the American Society of Range Management, Inc., were appointed to serve as Trustees of the American Society of Range Management Trust with C. H. Wasser as Chairman of the Trustees and John G. Clouston as Secretary-Treasurer."

Chairman Wasser asked for ideas on how to publicize the Trust in order to receive funds. He suggested a page in the Journal describing the Trust with reprints to be used for publicity. There was no other suggestion made, but the Journal article had general approval.

There being no further business the meeting was adjourned.

John G. Clouston
Secretary-Treasurer

Seed Physical Characteristics And Germination of Hardinggrass (*Phalaris tuberosa* var *stenoptera* (Hack.) Hitch.)[1]

R. DERWYN B. WHALLEY, CYRUS M. MCKELL, AND LISLE R. GREEN

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Highlight

Commercial samples of hardinggrass contained an appreciable number of immature seeds. These seeds were light green in color, generally lighter in weight, and after storage for some time had low viability. When care was taken to harvest only mature seed there was little relationship between seed weight and viability. Seeds from the lower portions of the panicles matured last and had a lower seed weight than those from the top.

Hardinggrass (*Phalaris tuberosa* var *stenoptera* (Hack.) Hitch.) is an important perennial range species in areas with a Mediterranean climate such as California. An important application of this species is in the conversion of chaparral to grassland. However, hardinggrass is noted for low seedling vigor, and difficulty is often experienced in obtaining satisfactory stands. Part of the difficulties in establishment could result from low seed viability. Accordingly, a study was carried out to examine the physical characteristics of individual seeds in different samples of hardinggrass and their relationship, if any, to germination.

Materials and Methods

A number of hardinggrass seed lots were kindly supplied by the Crop Improvement Association, Agronomy Department, University of California at Davis. Some of these were from samples which had been submitted by commercial growers for germination and purity tests and some were from seed grown on the station.

An additional lot of hardinggrass seed was collected by hand from an established stand at Tule Springs Range, Alpine, California (McKell et al., 1965). Only mature seed was collected for comparison with machine-harvested seed lots. The identification numbers used by the suppliers were used throughout.

Two hundred seeds were selected at random from several of these hardinggrass seed lots and the color of each seed determined according to the Munsell system of color notation (Munsell Book of Color, 1958). This is a three dimensional notation, involving hue (yellow, blue, etc.); value, indicating the degree of lightness or darkness; and chroma or degree of saturation of the color. Thus, any color may be denoted in numerical terms by comparison with a set of standard color chips, and results may be statistically analyzed. The seeds were then weighed individually, and frequency distribution histograms of the seed weights constructed. Correlation coefficients were also calculated for the three components of color and seed weight. Approximately 3 g samples from several seed lots were divided into three or four sub-samples of differing mean seed weight, using a South Dakota seed blower and 50 seeds weighed individually from each subsample. Frequency distribution histograms were then constructed to show the degree of separation achieved.

Germination tests were carried out on the sub-samples on moist blotters on top of "Kimpak" in petri dishes in an alternating temperature incubator, to determine the effects of seed weight on germination. Temperatures used were 20 C for 16 hours and 30 C for 8 hours. Tests were carried out in the dark but trays were usually examined twice per day under a fluorescent light. Total exposure to diffuse daylight and this lamp was approximately 0.5 hour each day. An arcsin transformation was applied to the germination percentages followed by an analysis of variance.

To obtain further information about the seed color differences noted in machine-harvested hardinggrass seed, a stand of this species at Tule Springs Range, San Diego County, was studied during the ripening period in 1963. Seed was collected by hand from individual plants and from different parts of the panicles from a number of plants. Mean seed weights were obtained for the seed from the sectioned panicles.

Single seeds were harvested from one plant growing at Riverside over a period of about a week in 1964. The color and moisture percentage of each seed was determined individually. Correlation coefficients were then calculated for the three components of color and seed moisture percentage.

Results

Frequency distribution histograms revealed wide differences

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[1] *Part of a project conducted under a cooperative agreement, Supplement No. 83 to Contract No. A5FS-16565, between the Agronomy Department, University of California, Riverside and the U. S. Forest Service, Pacific Southwest Forest & Range Experiment Station, USDA, Riverside. This study is a portion of a thesis submitted by the senior author in partial fulfillment of the requirements for the Ph.D. degree in Plant Science. Paper No. 1650, Citrus Research Center and Agricultural Experiment Station, Riverside, California.*

in the distribution of different weight classes within lots of similar mean seed weight (Fig. 1). Correlation coefficients showed inverse relationship between hue, value, and chroma and seed weight for all lots, but not all r values were significant for each lot (Table 1).

With lot SCS 35-32, all seeds were of one hue. This was a relatively old sample and probably any new seeds which originally were green in color had been bleached to a straw color.

Germination tests showed a significant increase in germination percentage with increasing seed weight (Table 2) in machine-harvested lots of seed. With the hand-harvested lot from Tule Springs where care was taken to only collect mature seed, there was no significant change in germination percentage. Germination of the lighter fractions could not be improved by using KNO_3. The degree of overlapping in seed weight between the sub-samples is shown in Fig. 2.

When fully mature seed was harvested from individual plants the color and shape of seed from each plant was remarkably constant (Fig. 3). However, there were large variations in seed size and shape from plant to plant. There was little variation in hue or chroma from plant to plant but there were large variations in value. That is, seeds were all more or less the same brownish-grey, but they varied in degree of darkness. These plant to plant variations were probably the result of genetic differences. Variation in seed size from the same plant was also variable. When harvested at maturity, seed from the top third of the panicles weighed more than seed from the bottom third (Table 3).

When seeds were harvested with moisture contents ranging from 45% to 9%, significant correlations were found between moisture content and hue, mois-

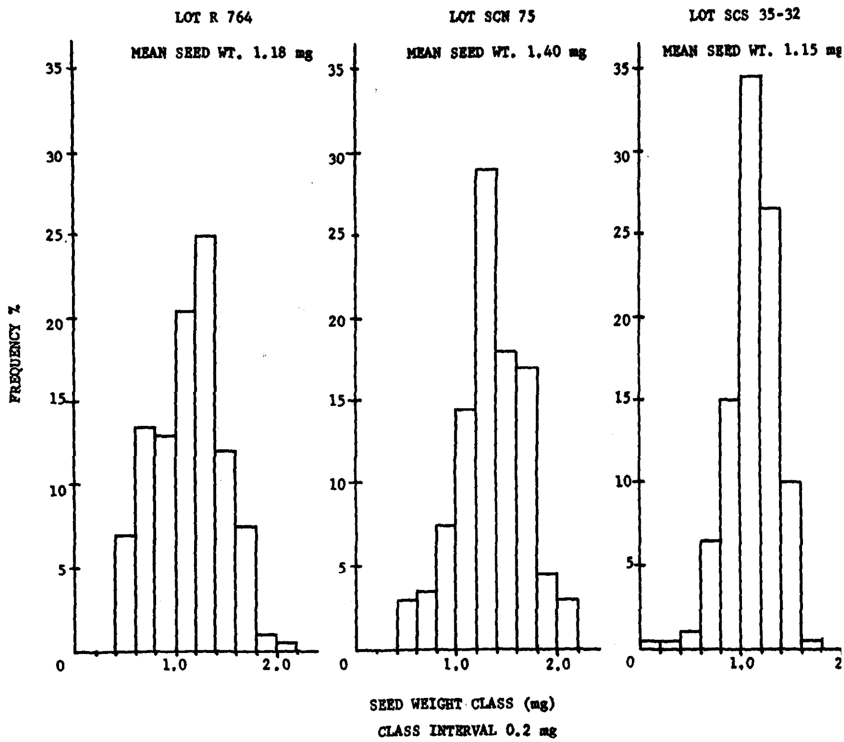

FIGURE 1. Frequency distribution histograms for individual seed weights of three sampl of hardinggrass.

Table 1. Correlation coefficients among the three components of color ar seed weight or seed moisture percentage of hardinggrass seed.

Munsell notation	Corr. coeff. between seed weight and color			Corr. coeff betwee color and moist. o seed from one plar
Sample No	R764	SCN75	SCS 35-32 all seeds	
Hue	−0.383*	−0.361*	one hue	0.693*
Value	−0.715*	−0.615*	−0.613*	0.365
Chroma	−0.087	−0.277*	+0.025	0.911*

* Significant at 1%.

Table 2. Mean seed weight (mg) and germination percentage of sub-sampl separated from five hardinggrass seed lots with a South Dakota see blower.[1]

	R 764		SCN 75		SCS 35-32		0067		Tule Springs 1963	
Sub-sample	Seed wt	Germ %	Seed wt	Germ %	Seed wt	Germ %	Seed wt	Germ %	Seed wt	Germ %
1	0.65	0_a	0.91	25_d	0.64	2_f	0.81	20_h	1.19	72_k
2	1.29	42_b	1.51	78_e	1.21	38_g	1.35	68_i	1.32	77_k
3	1.63	62_c	1.69	78_e	1.76	34_g	1.67	88_j	1.46	71_k

[1] Values differing significantly at the 5% level are indicated by differer letters (Duncan 1955).

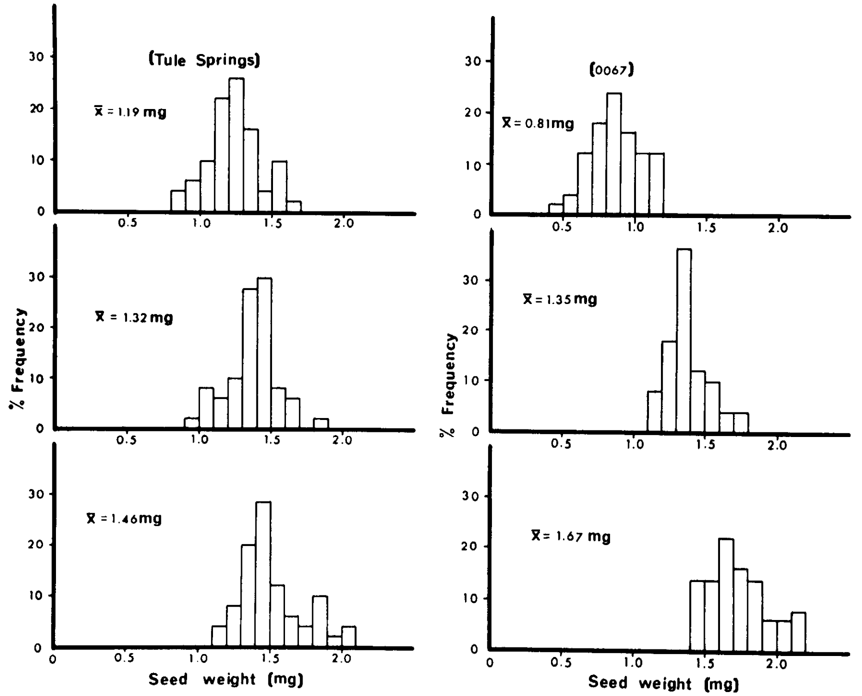

FIGURE 2. Frequency distribution histograms of individual seed weights of hardinggrass from two seed lots separated into three sub-samples with a South Dakota seed blower. The Tule Springs lot was hand-harvested at maturity and the 0067 lot was machine harvested according to usual procedures.

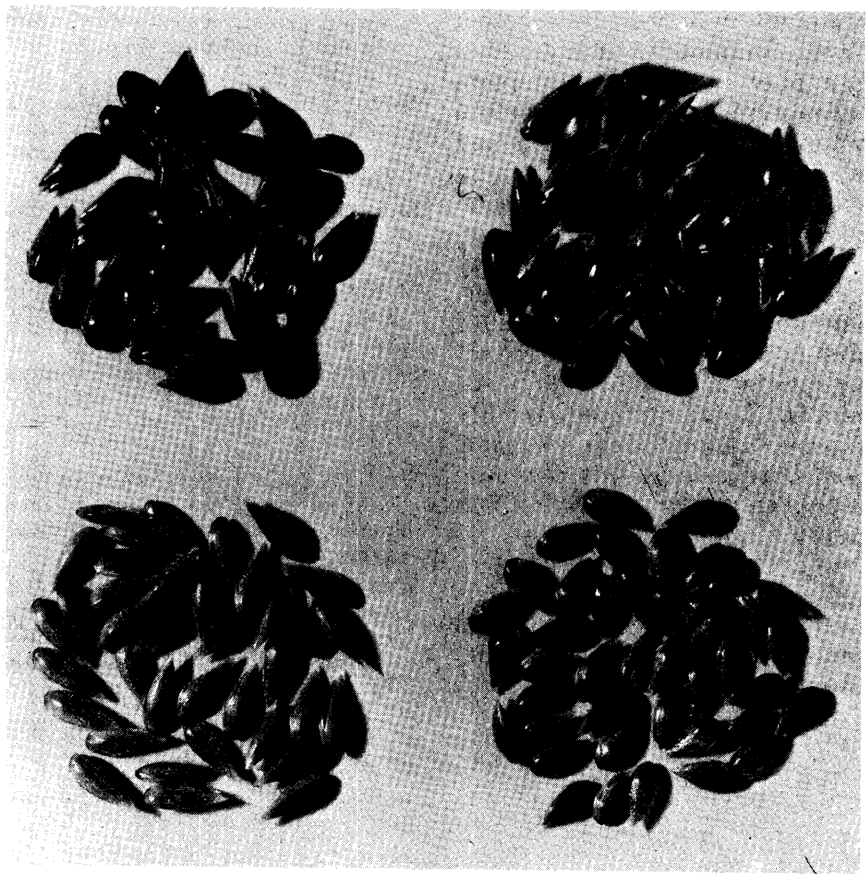

FIGURE 3. Randomly selected seeds harvested from four individual hardinggrass plants.

Table 3. Mean seed weight (mg) of hardinggrass from different parts of the panicle.[1]

Portion of panicle	Weight of seeds
Top third	1.45_{a}
Middle third	1.44_{a}
Lower third	1.38_{b}

[1] Values differing significantly at the 5% level are indicated by different letters (Duncan 1955).

ture content and chroma, but not moisture content and value (Table 1).

Examination of an established stand at Tule Springs during the ripening period revealed that the seed of hardinggrass is borne in a contracted spike-like panicle and ripening commences about two-thirds of the way up the head. Ripening then proceeds both up and down, and seed at the base is the last to mature. At maturity, the rachilla disarticulates above the glumes, with the caryopses tightly enclosed within the lemma and palea. So long as the head remains upright, the caryopses remain inside the glumes, but any shaking, such as from a strong wind, tends to dislodge them.

Discussion

The inverse correlations between hue and seed weight and between value and seed weight (Table 1) indicate that the seeds which were lighter in weight were less mature and lighter in color. The positive correlations between moisture content at harvest and hue and chroma (Table 1) indicated that as the individual seeds matured, their color changed from green to a brownish-grey color and from more saturated to less saturated colors. Thus, the light weight fractions contained a high proportion of immature seeds which could be identified by their green color. These green-colored seeds had a low viability and accounted for the minimum germination of the sub-samples which were least in mean seed weight (Table 2). Since the Tule Springs seed lot contained only mature seed, there were no differences in viability among sub-samples. When the seed lots were fractionated using the seed blower the differences in color among the sub-samples were quite striking.

Although there was an inverse correlation between value and seed weight in commercial samples, the correlation between value and seed moisture content of singly-harvested seeds was not significant. This would suggest that whether the seed is light or dark in color is genetically determined and is not related to maturity at harvest (see Fig. 3). However, there may be some genetic association between large seeds and dark seed color.

Except for the hand-harvested lot from Tule Springs, all the seed lots tested were two or more years old. Myers (1963) stated that the green colored seeds of hardinggrass could be induced to germinate with KNO_3 but with the older seed used in the present study, the germination of the light weight sub-samples was not improved. McAlister (1943) has also referred to the short storage life of seed harvested before full maturity.

Myers (1963) also pointed out the usefulness of seed color for identifying immature seeds in hardinggrass seed lots, but Stoddart (1964) was suspicious of the value of this approach for perennial ryegrass, cocksfoot and timothy. He reasoned that the green color could fade following harvest, depending on the conditions of storage. Nevertheless, the presence of an appreciable number of green colored seeds in a lot is a sure indication that the seed was harvested before maturity.

In several of the lots examined, a high proportion of the seed population weighed less than 1.0 mg (Fig. 1). In later studies (Whalley et al., 1966), where individual seeds were weighed and germinated, very few hardinggrass seeds of less than 1.0 mg germinated.

When seed is harvested before full maturity, knowing that the seed at the bottom of the panicles matures last, the differences in seed weight between the top and bottom of the panicles would be accentuated. The light weight seeds recorded in some lots probably come from the lower parts of green panicles.

Sumner (1963) recommended that, for the highest yield per acre, hardinggrass seed should be harvested when 11% of the heads are mature. Excessive losses by shattering will then be avoided. This recommendation is generally applied as shown by the presence of seeds harvested before maturity in all commercial seed lots examined. However, a high proportion of the seeds will then be low in weight, light green in color, and with low viability after storage for some time. There is a distinct need for strains with a high degree of seed retention which may be harvested when the seed is fully mature without loss of seed. Some progress in this direction has been made by McWilliam (1963).

Summary

Commercial samples of hardinggrass seed were found to contain an appreciable number of immature seeds. These seeds were light green in color, low in weight, and after storage for some time had low viability. The immature seeds result from the practice of harvesting seed before all seed heads are fully mature to avoid seed losses by shattering.

When care was taken to only harvest mature seed there was little relationship between seed weight and viability. Seeds from the lower portions of the panicles matured last and had a lower seed weight than those from the top, even when harvested at full maturity.

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An Introduction to Range Management

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In 1963, the Range Management Education Council began a project to standardize university coursework in range management. The Council, composed of representatives from every American university granting a degree in range management, felt a need for unification of names and content in range coursework. The objectives were: 1) to facilitate analysis of curricula and student transcripts among universities, 2) to help schools and professors in developing new courses in range management, and 3) to aid Civil Service and employing agencies in determining what coursework a student has completed.

The first such course approved by the Council was a beginning course in range management. This outline is designed to serve for both a terminal course for students not majoring in range and a first-course for range majors. Emphasis given various phases might differ depending upon which group of students is involved.

Since this course covers the entire subject, the outline has the interesting additional value of constituting a sort of definition of range management which will be of interest to members of the Society as well as to students who may contemplate a career in range management.

Students taking the course will preferably have had coursework in native plant identification and in the science of plant ecology. The course, outlined below, should be accompanied by laboratory work in the field.

Beginning Range Management

I. Introduction
   A. Definitions and terms
   B. Economic importance of ranges and range products
   C. Application of the science of range management
      1. Public land administration and management
      2. Game management
      3. Ranching
   D. Professional opportunities in range management

II. The range resource and its use
   A. Major grazing lands of the world
      1. Physical nature of the range resource
      2. History of grazing
      3. Present use and management
   B. American grazing lands
      1. Physical nature of the range resource
         a. Climate
         b. Soil
         c. Vegetation
      2. History of grazing
         a. Wild animals
         b. Livestock introduction
         c. Development of land use and ownership patterns
         d. Land laws and policies
         e. Present public land administration and use
      3. Present livestock grazing patterns and practices

III. Plant physiology in relation to grazing
   A. Requirements for plant growth and reproduction
   B. Details of plant food synthesis and storage
   C. Effect of intensity and season of grazing upon:
      1. Herbage production and regrowth
      2. Root development
      3. Seed quantity and quality
      4. Asexual reproduction

IV. Grazing as an ecological factor
   A. Plant—animal—soil relationships in the natural ecosystem
      1. Grazing as a factor determining climax flora
      2. Change in animal species and animal numbers — its effect on succession and nature of the flora
   B. Details of grazing successions
   C. Use of plant indicators in range management

V. Range inventory and appraisal
   A. Vegetation mapping
   B. Vegetation sampling
      1. Methods available
      2. Statistical reliability of samples
      3. Plot size and shape
   C. Forage utilization
      1. Factors affecting
         a. Topography
         b. Forage preferences of animals
      2. The use factor
      3. Methods of measuring utilization
      4. Key species and key area concept
   D. Range condition and trend
   E. Range capability classification
   F. Grazing capacity estimation
      1. Problems relating to annual fluctuation in forage production
      2. Effects of animal distribution and other management factors

VI. Increasing range production
   A. Artificial seeding
      1. Seeding methods
      2. Season to seed
      3. Adapted species

4. Need for protection
5. Economics

B. Controlling undesirable species
1. Burning
2. Mechanical methods
3. Chemical methods

C. Fertilizing

D. Water spreading and terracing

E. Range rodent control

VII. Range improvements

A. Water development
1. Amount required
2. Methods available and comparable costs
3. Storage facilities
4. Hauling water

B. Fencing
1. Function in management
2. Types available and comparable costs

C. Trail and driveway construction

VIII. Livestock and grazing management

A. Kinds and breeds—their adaptations
1. Livestock quality
2. Exchange ratios
3. Common-use grazing

B. Livestock breeding

C. Factors affecting calf and lamb crop

D. Calving and lambing

E. Supplemental feeding, including salt
1. Kinds available
2. Ways to supply on the range
3. Effects of kind of vegetation on nutrition
4. Effects of season of year on vegetation quality

F. Effect of intensity of grazing on livestock production

G. Livestock marketing

H. Animal Disease and insect problems

I. Predator problems

J. Management to avoid poisoning

K. Securing proper distribution of livestock
1. Grazing systems
2. Use of water, salt, trails, fences, and herding

L. Ranch management planning

IX. Multiple use relationships on range land

A. Big game
1. Forage habits and adaptations
2. Conflicts with domestic stock

B. Timber production and livestock grazing

C. Watershed management
1. Water as a land product
2. Hydrological cycle
3. Soil erosion control

Fertilization of Mixed Cheatgrass-Bluebunch Wheatgrass Stands[1]

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Highlight

On both dense and sparse bluebunch wheatgrass stands, cheatgrass became dominant with increasing applications of ammonium sulfate. High and repeated fertilizer applications (80 lb N/A in 4 successive years) depressed bluebunch wheatgrass yield 50%.

Annual and perennial grasses growing in competition often respond differently to nitrogen fertilization. In Colorado, ammonium nitrate at 40 lb N/A increased sixweeks fescue *(Festuca octoflora* Walt.) yield 146%, but increased blue grama *(Bouteloua gracilis* (H.B.K.) Lag. ex Steud.) yield only 18% (Hyder and Bement, 1964). In California, ammonium sulfate at 60 lb N/A increased yield of annual grasses 91%, but did not increase yield of hardinggrass *(Phalaris tuberosa* (Hack.) Hitchc.) (Martin et al., 1964). Only at high nitrogen rates (240 lb N/A) was growth of hardinggrass appreciably stimulated. In northeastern California, ammonium sulfate at 60 lb N/A increased percent ground cover of cheatgrass *(Bromus tectorum* L.) but decreased ground cover of intermediate wheatgrass *(Agropyron intermedium* (Host) Beauv.) (Kay and Evans, 1965). In southeastern Washington, nitrogen fertilizer greatly increased the yield of cheatgrass (Patterson and Youngman, 1960). Although nitrogen at 20 or 40 lb/A applied for 3 and 4 years had little effect on bluebunch wheatgrass *(Agropyron spicatum* (Pursh) Scribn. and Smith), 60 or 80 lb N/A applied for the same period reduced bluebunch wheatgrass yield.

In southeastern Washington, cheatgrass is palatable and nutritious during 6 to 8 weeks in the spring, but is less desirable as forage than bluebunch wheatgrass throughout the remainder of the year. Consequently, fer-

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[1] *Cooperative study of Crops Research Division, Agricultural Research Service, U.S.D.A., and College of Agriculture, Washington State Univ. Scientific paper 2635, Coll. of Agric., W.S.U. Michael Maynard and Richard Page assisted with 1961 and 1962 measurements.*

[2] *Formerly Range Conservationist, Crops Research Division, Agricultural Research Service, U.S.D.A.*

tilization resulting in dominance of cheatgrass and suppression of bluebunch wheatgrass is contrary to management objectives on most of these ranges.

This paper reports changes in mixed cheatgrass-bluebunch wheatgrass stands induced by nitrogen-containing fertilizers.

Procedure

Two experiments, separated by about 20 miles, were located within the *Agropyron spicatum-Poa secunda* habitat type described by Daubenmire (1942). The first site was located 8 miles southwest of Lacrosse, Washington, on a moderately deep (20 to 36 inches) Benge silt loam soil. The second site was located 8 miles northwest of Dodge, Washington, on a deep (more than 60 inches) Ritzville silt loam soil. Both sites had an elevation of 1,400 feet and a slope of approximately 10% in a northeasterly direction. During the study, 1961-1964, average October to June precipitation reported by the Lacrosse and Pomeroy stations was 13.8, 11.2, 10.1 and 10.4 inches. This was slightly lower than the 13.2-inch average during the preceding 10 years.

At each location, studies were conducted on adjacent good and poor condition sites (dense and sparse bluebunch wheatgrass stands) which were the result of past management on different sides of an old fenceline (Fig. 1). Five replications were established at each site with a randomized complete block design. Ammonium sulfate was applied every year or every second year in October or March at rates of 0, 20, 40, and 80 lb N/A. In the fall of 1960 the sites were fenced to exclude cattle. Little evidence of grazing by game animals or rodents was observed.

Yields were measured in subplots (0.5 x 2.0 meters) within each major plot. Subplots were clipped in a new location each year. Time of clipping was determined by the phenological development of bluebunch wheatgrass. When this species reached the soft-dough stage, plants were clipped to the ground level, separated by species, oven-dried, and weighed. In August each year, after all species were dormant, the entire area was clipped at 4 inches above ground level and the herbage removed from the plots.

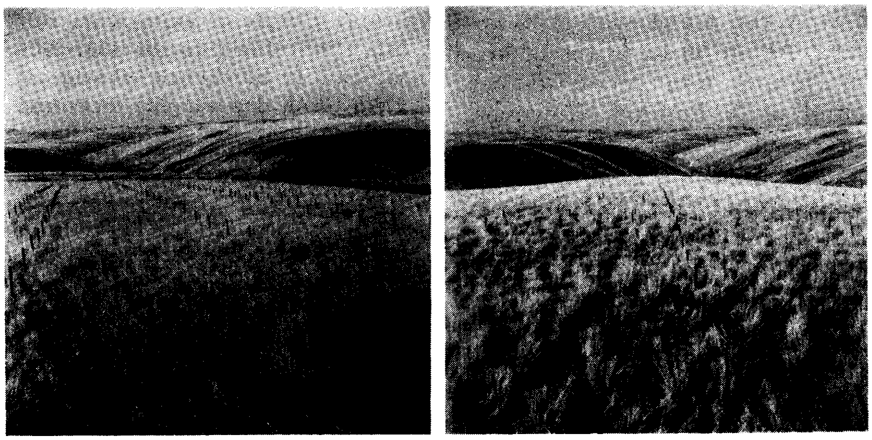

FIGURE 1. Experimental sites near Lacrosse, Washington in fall of 1960: dense cheatgrass and sparse bluebunch wheatgrass (left), dense bluebunch wheatgrass and sparse cheatgrass (right).

Results

Yields of cheatgrass and bluebunch wheatgrass were measured in 1961 and 1962. Because response at the two locations (Lacrosse and Dodge) and for the two application dates (October and March) was not significantly different, yield data were combined.

Average yields of unfertilized bluebunch wheatgrass were about 2.5 times higher on good than on poor condition sites (Fig. 2). The reverse was true of unfertilized cheatgrass yields; poor condition sites yielded slightly more than twice as much cheatgrass as good condition sites. This was expected because good sites were selected to have more bluebunch wheatgrass and less cheatgrass.

In the growing season immediately following either fall or spring application, cheatgrass yields increased with increasing rates of ammonium sulfate. At 80

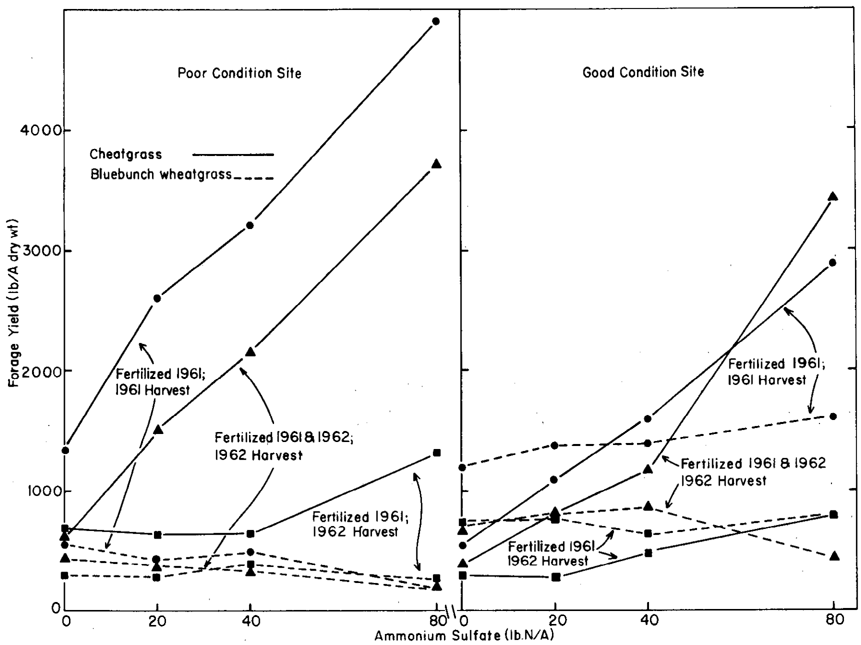

FIGURE 2. On poor and good condition sites, cheatgrass became dominant when increasing amounts of ammonium sulfate were applied.

lb N/A the trend was still upward. About 30 to 40 lbs of air-dry forage was produced per pound of N applied. However, 1962 yields from plots fertilized in 1961 but not in 1962, and 1962 yields from plots fertilized in both 1961 and 1962 showed little carry-over of fertilizer.

Bluebunch wheatgrass yields failed to increase significantly with increasing rates of ammonium sulfate, except in one instance. This was during the first year of fertilization on good condition sites where cheatgrass competition was at a minimum. Bluebunch wheatgrass yields were increased one-third above similar unfertilized plots by the application of 80 lb N/A.

The high rate of ammonium sulfate applied to poor condition sites in the first year or applied to both good and poor condition sites in two successive years slightly decreased bluebunch wheatgrass yields. Fertilizer treatments were, therefore, continued in 1963 and 1964 to determine the long-term effects of fertilization on yield of bluebunch wheatgrass.

Eighty lb N/A applied to the same plots in 4 consecutive years depressed bluebunch wheatgrass yields approximately 50% on both good and poor condition sites (Table 1). The lower rates of ammonium sulfate had no obvious effect on the bluebunch wheatgrass stand.

Annual application of 80 lb N/A to the same plot for 4 consecutive years quadrupled the number of cheatgrass plants (Table 2). In fertilized plots, cheatgrass was often growing in bluebunch wheatgrass clumps.

In 1963, new plots were treated to separate the influence of cheatgrass competition from the influence of fertilizer application on the yields of bluebunch wheatgrass. Competing species were removed from selected plots on the good condition site at Lacrosse by hand-hoeing.

Table 1. Effects of ammonium sulfate applications, in the 1961-1964 seasons, on bluebunch wheatgrass yield (lb/A dry weight) measured in June 1964.

Ammonium sulfate (lb N/A)	Yield[1] Good site	Poor site
0	520	370
80	270	160

[1] LSD at 5% level for differences between yields is 100 lb/A on both good and poor condition sites.

Table 2. Effects of ammonium sulfate, applied in fall or spring, on number of cheatgrass plants per square foot in June 1964.

Ammonium sulfate (lb N/A)	Cheatgrass plants[1] Fall	Spring
0	150[a]	120[a]
80[2]	320[b]	310[b]
80[3]	580[c]	620[c]

[1] Values having the same letter in the superscript do not differ significantly at the 5% level (Duncan, 1955).

[2] Applied in 1961 and 1964.

[3] Applied in 1961, 1962, 1963, and 1964.

Treatments were continued on the same plots for two consecutive years.

In 1963 and 1964, removing competing vegetation doubled bluebunch wheatgrass yield (Table 3). Applying 80 lb N/A to plots without competing vegetation increased yields an additional 30%. Fertilizer applied to plots having competing species increased bluebunch wheatgrass yields about 70% the first year, but only 35% the second year. This indicates the intensified competition with other species resulting from consecutive years of fertilizer application.

In a 1963 experiment at Lacrosse, ammonium nitrate and calcium sulfate were applied, separately and in combination, to determine whether the stimulated growth of cheatgrass was due to nitrogen, sulfur, or a combination. When applied separately, neither ammonium nitrate nor calcium sulfate greatly influenced cheatgrass yield (Table 4). However, when they were applied in a combination that was equivalent to 80 lb N/A using ammonium sulfate, cheatgrass yield increased sixfold.

Discussion

In southeastern Washington, ammonium sulfate fertilizer applied to mixed cheatgrass-bluebunch wheatgrass stands resulted in ecological regression rather than improvement of condition. This was especially true where applications were made in 2 or

Table 3. Effects of ammonium sulfate applications, in two consecutive years, on yield of bluebunch wheatgrass (lb/A dry weight) in plots with and without competing species.

Ammonium sulfate	Yield[1] With competition	Without competition
0 lb N/A		
1963	560	1260
1964	450	890
Average	510[a]	1080[c]
80 lb N/A		
1963	970	1620
1964	580	1250
Average	780[b]	1440[d]

[1] Yield averages having the same letter in the superscript do not differ significantly at 5% level (Duncan, 1955).

Table 4. Cheatgrass yield (lb/A dry weight) in response to nitrogen, sulfur, or nitrogen and sulfur.

Fertilizer treatment[1]	Cheatgrass yield[2]
Unfertilized	290[a]
90 lb S/A	210[a]
80 lb N/A	440[a]
90 lb S & 80 lb N/A	1900[b]

[1] Fertilizer applied in March 1963. Yield measured in June 1963.

[2] Values having the same letter in the superscript do not differ significantly at the 5% level (Duncan, 1955).

more consecutive years at the highest level tested. In the first year of application and on good condition sites where wheatgrass yields exceeded cheatgrass yields more than 2:1, the application of 80 lb N/A reversed the yield to favor cheatgrass 2:1.

Wheatgrass bunches were invaded by cheatgrass on plots receiving heavy and repeated annual fertilization. Cheatgrass seedlings crowded wheatgrass plants by growing closely around and within established bunches. These bunches became progressively smaller under the pressure of competition.

Important in this competitive relationship is the ability of cheatgrass to grow and reproduce under the extreme habitat variations found in eastern Washington. When moisture and nutrients are limiting, cheatgrass may mature as a single stem 3 to 4 inches tall and produce only one spikelet containing one or two viable seeds. On the other hand, when growing conditions are favorable, cheatgrass plants may develop 10 to 15 tillers 2 to 3 feet tall, each producing 50 or more viable seeds.

When fertilizer was applied in successive years, the density of cheatgrass increased. New bluebunch wheatgrass seedlings were not observed in either fertilized or unfertilized plots. Therefore, scattered wheatgrass bunches would not be as effective as dense cheatgrass in utilizing surface-applied fertilizer.

Periodicity in growth also favors cheatgrass in its competition with bluebunch wheatgrass. Because it reaches maximum growth earlier than bluebunch wheatgrass (Hull, 1949), cheatgrass often completes its life cycle before soil moisture is depleted. But bluebunch wheatgrass, normally green until mid-July, is damaged when heavily fertilized cheatgrass depletes moisture by early June.

Removal of cheatgrass competition is much more effective than fertilization in stimulating bluebunch wheatgrass growth. Preliminary trials, using selective herbicides which remove cheatgrass without obvious harm to wheatgrass, show promise in providing a practical means of increasing vigor of established bluebunch wheatgrass plants.

Under normal conditions, during the short period when cheatgrass is green and grazable, a surplus of forage exists. Fertilizing to provide more forage at this time may be wasteful, except in special cases. Examples where the use of fertilizers on cheatgrass may be economically feasible include: (1) fertilization of drop range near lambing sheds or (2) fertilization of a small area of annual spring range to shorten the winter livestock feeding period and allow later turn-out on perennial grass range. Grazable cheatgrass was produced 2 to 3 weeks earlier on fall fertilized plots than on unfertilized plots. In considering fertilizer applications, however, the cost and returns of fertilizing must be weighed against the cost of alternative sources of forage. Any plan for fertilizing in this region should include preliminary trials to determine whether sulfur is required in addition to nitrogen.

In general, fertilization of semi-arid ranges in southeastern Washington appears undesirable. Even excellent condition sites have a small population of cheatgrass plants which have the potential to increase and take over a site as a result of fertilization. In most situations, there are adequate amounts of cheatgrass to fill the needs for forage of this species without fertilization. Generally, management objectives on these ranges should include increasing the amount and vigor of bluebunch wheatgrass.

Summary

Range sites having dense bluebunch wheatgrass and sparse cheatgrass or sparse bluebunch wheatgrass and dense cheatgrass were fertilized with increasing amounts of ammonium sulfate. Rather than improving range, heavy fertilization (80 lb N/A in 4 consecutive years) produced a retrogression in range condition: bluebunch wheatgrass yields decreased 50%, cheatgrass yields increased 400 to 600%. This retrogression occurred regardless of the initial density of bluebunch wheatgrass.

In the absence of competing vegetation, bluebunch wheatgrass was not responsive to fertilization. On plots with competing vegetation removed and fertilized with 80 lb N/A, bluebunch wheatgrass yielded only 30% more than on similar unfertilized plots.

Neither ammonium nitrate nor calcium sulfate greatly influenced cheatgrass yield; but in a combination, equivalent to 80 lb N/A using ammonium sulfate, they increased cheatgrass yield sixfold.

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TECHNICAL NOTES

Effect of a Wildfire on Idaho Fescue and Bluebunch Wheatgrass[1]

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Highlight

The accidental burn of a research site in sagebrush-grass vegetation created an opportunity to investigate some factors which affect the susceptibility of Idaho fescue and bluebunch wheatgrass to damage by fire. The former was more susceptible than the latter. Factors associated with relief increased and those associated with grazing prior to the burn decreased the detrimental effects of fire.

Fire! Both a friend and enemy of the range man. Shortly after completion of field work on what was to have been a long-term study of range condition and trend, a hot wildfire raced across our study area in northeastern Oregon. The fire occurred in July, 1960; by then, the plants had produced seed and had dried.

Two of the important plant associations in the study area were *Artemisia tridentata/Festuca idahoensis* (big sagebrush/Idaho fescue) and *Artemisia tridentata/Agropyron spicatum* (big sagebrush/bluebunch wheatgrass. A partial characterization of these associations, as they were before the fire, is shown in Table 1. Knowledge of these associations and availability of an 80-acre livestock exclosure in the study area led us to feel that information should be obtained to improve our understanding of the susceptibility of the two dominant grasses to fire damage.

The livestock exclosure was established in 1940 and most all livestock have been excluded since that time. The long protection from grazing had resulted in marked range improvement with considerable accumulation of old growth and consequently of fuel supply. Grazing outside may, in addition, have produced some differences in vigor of the plants at the time of the burn. The opportunity, thus, existed to consider the net influence of protection and grazing on the effects of a wildfire. Relief variation was such that comparable directions of slope could also be considered both inside and outside of the exclosure.

Blaisdell (1953) and Pechanec, Stewart, and Blaisdell (1954) have reported on work in southeastern Idaho which shows that Idaho fescue was severely damaged by fire with a strong carryover of the detrimental effect. Bluebunch wheatgrass, on the other hand, was only slightly damaged and in three years had exceeded its preburn production.

Table 1. Foliar-cover and soil-surface features (in percent) for the plant communities prior to burning.

Item	Plant Community Artr/Feid	Artr/Agsp
Big sagebrush	9	1
Idaho fescue	46	4
Bluebunch wheatgrass	6	42
Cheatgrass	10	30
Stone & Gravel	20	27
Bare soil	10	8

Methods

In August, after the wildfire, and before any rain had fallen on the area, groups of 25 plants each of Idaho fescue and bluebunch wheatgrass were staked and measured on different aspects both within and outside the exclosure. All Idaho fescue groups were marked in the sagebrush/fescue association and all bluebunch wheatgrass in the sagebrush/wheatgrass association. Separate Idaho fescue groups were marked on north, northwest, northeast, and ridgetop aspects. The north aspect was grazed and the other three were both grazed and ungrazed. Bluebunch wheatgrass plants were marked on southeast and ridgetop exposures with grazed and ungrazed conditions possible only for the southeast exposure. In each case, the plants were selected by walking along a line through the center of the relief condition being sampled. In each association, the sample plant was determined by taking the nearest member of the selected species at every fifth step. Each plant was marked with a wooden stake.

To avoid additional injury when the plants were selected, tentative identification was made in August, 1960. Because of the distinctive morphological characteristics of these two species, identification of the burned material was reasonably good; but some errors were made. Upon re-examination the following year, identification of all marked plants was checked on living material where possible. For plants killed by the fire, identification was verified by root characteristics. Bluebunch wheatgrass is the only grass in these associations that produces rhizomes and Idaho fescue has much

[1] *Technical Paper No. 2051, Oregon Agricultural Experiment Station. These data were taken in conjunction with research contributing to Western Regional Project, W-25, "The Ecology and Improvement of Brush-Infested Ranges."*

[2] *Formerly Range Conservationist, Oregon Agricultural Experiment Station.*

darker roots than the other grasses. Our final sample included 20 to 25 bluebunch wheatgrass plants and 16 to 25 Idaho fescue plants per group. Data were summarized on the basis of the number of correctly identified plants.

Unfortunately, data were not available on the basal area or diameter of the individual plants prior to the burn so two measurements of the basal diameter of each plant were made at the time they were marked. This was taken as an estimate of the pre-burn diameter. In the case of all low-intensity classes of burn, these measurements gave essentially the pre-burn diameters.

We measured the distance to the nearest shrub if it was 6 ft or less. We felt this distance may have influenced the effect of the fire on the grasses. Identification of the shrub species was not attempted, but nearly all were big sagebrush. The only other possibilities would have been a rare occurrence of antelope bitterbrush *(Purshia tridentata)* or of rabbitbrush *(Chrysothamnus* spp.) plants. In many cases, the intensity (heat) of the fire was so great that the stems of shrubs were burned into the ground.

The intensity of burn was rated for each grass plant according to the following scale:

1. Plants unburned, but may be scorched.
2. Plants partially burned, but not within two inches of the root crown.
3. Plants severely burned, but with some unburned stubble less than two inches.
4. Plants extremely burned, all unburned stubble less than two inches and mostly confined to an outer ring.
5. Plants completely burned, no unburned material above the root crown.

The authors wish to acknowledge the contributions of the U. S. Bureau of Land Management to this study. The exclosure, where the work was done, was built by the Civilian Conservation Corps and has been maintained by the Bureau. It was made available to Oregon State University to use in grazing succession studies.

Results

In August, 1960, after the burn, the area appeared completely desolate. Eleven months later, June, 1961, there was considerable green growth but islands of dense cheatgrass brome *(Bromus tectorum)* were obvious. Most of these islands could be traced to areas that were barren of bluebunch wheatgrass before the fire. As a result, cheatgrass was dominant and remained so after the fire.

As evidence of the heat of the fire, iron pipes used for staking plots on an earlier study had turned to the bluish cast characteristic of overheated metal. In the few unburned patches, leaves on some sagebrush plants were curled, were brittle, and fell at the slightest touch. Some of these plants were not alive in June, 1961.

Based on the above burn-intensity classes, the average burn-intensity index was 3.2 on 150 staked Idaho fescue plants, with the majority of plants in classes 3 and 2. Item 4 in Table 2 shows the average burn intensity by aspect and grazing history. The fire originated northwest of the exclosure and apparently was driven by wind from that direction. The Idaho fescue plants that received the least intense burn were on the north and northwest slopes and those most intensely burned were on the ridgetop and northeast slope. The burn intensity on Idaho fescue also tended to be higher on the ungrazed than on the grazed, northerly aspects. Survival of the Idaho fescue plants (Table 2, Item 5) followed a somewhat different pattern from that of burn intensity. The ridgetop was the only area where survival of fescue dropped below 65%, but survival did not exceed 82% in any location. Survival on the ridgetop was poorer on the ungrazed area even though burn intensity was lower than on the grazed area. This apparent inconsistency caused us to look back at the field data. We found all of the dead plants on the grazed ridgetop

Table 2. Some effects of slope and grazing on the severity of a wildfire on Idaho fescue and bluebunch wheatgrass. Fire occurred July, 1960, in northeastern Oregon.

Item	Idaho fescue								Bluebunch wheatgrass			
1. Slope direction[1]	N	NW	NW	NE	NE	RT	RT	ALL	SE	SE	RT	ALL
2. Grazing history[2]	G	G	U	G	U	G	U	....	G	U	U	....
3. Number of plants	24	22	21	21	25	21	16	150	20	25	22	67
4. Average burn intensity	2.70	2.50	3.00	3.40	3.70	3.70	3.30	3.20	3.40	3.30	3.60	3.40
5. Percent of plants alive 11 months after burn	79	82	71	71	80	62	56	73	95	100	100	99
6. Estimated preburn basal diameter of living plant material (ft)	0.17	0.15	0.19	0.15	0.22	0.19	0.15	0.18	0.68	0.66	0.51	0.62
7. Percent of preburn basal diameter living 11 months after burn, excluding dead plants	80	67	63	86	62	67	53	71	94	58	45	71

[1] Slope direction: N = north>50% slope, NW = northwest>40%, NE = northeast>40%, RT = ridgetop<5%, SE = southeast>40%.

[2] G = grazed moderately in recent years; U = ungrazed, protected for about 19 years by a livestock exclosure.

were in burn intensity classes 4 and 5. In contrast, some plants in each of classes 2, 3, 4 and 5 on the ungrazed ridgetop died. In these latter instances, the fire may have smoldered in the plant crowns because of accumulated debris. This "slow" burn may have been more damaging than the average burn intensity for the ungrazed ridgetop would indicate.

The average burn intensity on 67 bluebunch wheatgrass plants was 3.4 (Table 2, Item 4). Burn intensity on this species was less variable than on Idaho fescue. Compared with the intensity on the grazed, southeast slope, it was a little higher on the ungrazed ridgetop and lower on the ungrazed, southeast slope. Bluebunch wheatgrass plants in these comparisons almost all survived the burn (Table 2, Item 5).

Change of basal diameter in the first year after the fire was used as an index of vigor. Item 7 in Table 2 shows the effect of the fire on living basal diameter. Only the plants that were still living in June were used to calculate change in basal diameter.

The most severe reduction in basal diameter of Idaho fescue occurred on the ridgetop. Diameter reduction of plants on comparable slopes was decidedly less under grazed conditions, 27%, than under ungrazed conditions, 40%. Thus, here are two important effects of fire on Idaho fescue—(1) reduction of plant numbers and (2) reduction of plant size—and these were influenced by grazing and slope.

Bluebunch wheatgrass plants lost almost half of their basal diameter, 52%, in the ungrazed areas of the burn. On the southeast slopes that were both ungrazed and grazed, the loss of diameter was 6% against 42%, respectively. Thus, the primary effect of fire on bluebunch wheatgrass is reduction of plant size, not plant density. This effect was influenced by grazing and possibly by slope.

Some of the data were rearranged according to burn intensity (Table 3). These data indicate strong relationships between the burn-intensity index and both percent of plants killed and reduction of basal diameter. Idaho fescue is much more easily killed than bluebunch wheatgrass and is particularly sensitive to intensity of burn on individual plants (Table 3, Item 3)—especially when the above-ground material is extremely to completely burned. The same conclusions are supported by the basal diameter data (Table 3, Item 4).

The effect of fire on the relative vigor of these two species is indicated by the change in basal diameter (Table 3, Items 4 and 5). The values given in Item 4 include all plants whether they lived or died. If the plant died, its diameter was zero. Since the dead plants were eliminated in the calculation of values in Item 5, these percentages index the relative impact of burning on living material of each species, or on plant vigor. If there were no effect of burn intensity on plant vigor, the values in Item 5 should all be the same. This is essentially true for bluebunch wheatgrass, but the vigor of living Idaho fescue plants is apparently reduced by the extreme and complete burn intensities.

Some loss may also have occurred soon after the fire due to broken summer dormancy of plants of both species. Some plants had sprouted and sent up weak, green growth which died within a month after the fire even though there had been no rain. This phenomenon may have affected plant diameter more than to have been the cause of complete death of the plant.

The measurements of distance to nearest shrub showed no relationship to severity of burn or impact on the plants. This may have resulted from at least two things: (1) the low cover of big sagebrush in each of the communities (Table 1), and (2) the way our data were taken. In retrospect, we believe that the distance from each staked plant to the single, nearest shrub provides insufficient data to show a relationship between shrub density and the effect of fire. A truer index of the density of shrubs surrounding each staked plant may have enabled detection of possible relationships between amount of woody material and the effects of fire on individual staked plants. A better index of density could have been obtained by measuring the distance from each staked grass to all shubs within a six-foot radius.

Conclusions

The following conclusions are suggested by the results of our examination of Idaho fescue and bluebunch wheatgrass plants following the wildfire.

1. Idaho fescue is more critically affected by fire than is bluebunch wheatgrass. The adverse effect on Idaho fescue is both in complete mortality and reduction of basal diameter of plants left alive. The effect on bluebunch wheatgrass is primarily limited to a reduction of basal diameter.

A basic difference exists between these two species in northeastern Oregon, which may explain the greater death loss of Idaho fescue. Idaho fescue is characterized by a compact root crown area where the budding zone is confined to a rela-

Table 3. Some effects of burn intensity on the severity of a wildfire on Idaho fescue and bluebunch wheatgrass.

	Idaho fescue						Bluebunch wheatgrass					
	Burn intensity classes					All	Burn intensity classes					All
Item	1	2	3	4	5	Classes	1	2	3	4	5	Classes
1. Number of plants	1	54	38	29	28	150	0	8	26	28	5	67
2. Percent of total plants	1	36	25	19	19	100	0	12	39	42	7	100
3. Percent of plants alive 11 months after burn	100	96	92	52	21	73	0	100	96	100	100	99
4. Percent of preburn basal diameter living 11 months after burn—including zero for dead plants	100	73	65	33	4	50	..	73	75	64	78	71
5. Same as item 4 except dead plants excluded	100	80	74	59	18	71	..	73	76	64	78	71

tively small area as compared to bluebunch wheatgrass. In addition, the budding areas of Idaho fescue plants are at or above the surface of the ground. On the other hand, bluebunch wheatgrass has short rhizomes that produce buds below the ground surface. This results in the heat of the fire being more directly on living material of Idaho fescue than of bluebunch wheatgrass.

2. Grazing Idaho fescue and bluebunch wheatgrass before a fire may reduce loss of individual plants.

This conclusion is particularly supported by the effects on plant diameter. Where particular slope aspects were grazed, the loss of plant diameter was lower than where comparable slopes were ungrazed. If this conclusion is correct, one would expect moderate to heavy grazing on the year before burning to benefit the plants. If the plants were grazed, however, some rest in at least the second year before grazing would be needed to let the plants become as vigorous as possible.

3. The intensity of a burn tends to be greater on ridgetops and northeasterly slopes, but the impact on the plants is consistently greatest only on the ridgetops.

As evidence for this conclusion, the burn-intensity index was highest on the ridgetops and next highest on the northeasterly facing slopes. In addition, the greatest loss of Idaho fescue and the greatest reduction of basal diameter of bluebunch wheatgrass occurred on the ridgetops.

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Cattle Grazing Time is Related to Temperature and Humidity

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Highlight

Temperature and humidity are recognized to affect the physiology of animals and thus influence their activities including grazing. The temperature-humidity index (T.H.I.) discussed here is an accurate expression for relating these climatic factors to grazing time of beef cattle.

Investigators have known for some time that cattle, like people, restrict their activities on uncomfortably hot days. But attempts to predict how much time cattle will spend grazing on hot days have been few and none has taken humidity into account. In a recent study we used a formula that accurately predicts beef-cattle grazing time. It depends on a temperature-humidity index (T.H.I.) that was devised to measure human comfort.

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[1]*Formerly with the Central States Forest Exp. Sta.*

Methods

In the spring of 1962, twelve 500-lb. heifers were selected for uniformity in size and weight from a herd grazing an area of glade prairies, old fields, and woods on the Mark Twain National Forest in the Missouri Ozarks. Large letters were painted on the sides of the study animals with a cattle-marking dye. The cows were then allowed to disperse over the area with the rest of the herd. At 2-week intervals throughout the 6-month grazing season one of the marked animals, selected at random, was followed and observed for 24 hours. Temperature, humidity, and wind direction and velocity were recorded hourly.

Results

In general, the higher the average daytime temperature (5:00 AM to 8:00 PM) the less time the animals spent grazing. The formula we used to express this relation is similar to Dwyer's (1961) used in Oklahoma.

But, like Dwyer, we observed that humidity as well as temperature affected grazing time. For example, one day when the temperature was 75 F the cattle grazed 8.8 hours while another day when the temperature was 85 F they grazed 8.9 hours. According to our regression equation, using temperature and grazing time, they should have grazed less on the hot day. Both days were calm and aside from temperature the only apparent difference between the two days was the relative humidity. On the cooler day the average relative humidity was 76% while on the warmer day it was only 57%.

In our attempt to define the relation between grazing time and weather more accurately, we used a system similar to the one used by Johnson et al. (1962) for dairy cattle. That is, when we found that we could not correlate grazing time and humidity alone, we used a T.H.I.—the one developed by the American Society of Heating and Air-Conditioning Engineers (Anon. 1957) and used by the U.S. Weather Bureau to express relative human comfort. This index is obtained by the equation:

$$\text{T.H.I.} = 0.4\,[T_d + T_w] + 15$$

where T.H.I. = Temperature-humidity index
T_d = dry-bulb temperature
T_w = wet-bulb temperature

This expression is more closely related to time spent grazing than air temperature alone. A nonlinear regression equation gave a highly significant multiple correlation of 0.968 between the T.H.I. and time spent grazing (Fig. 1). This curvilinear regression is significantly different from and more logical than a linear regression.

The T.H.I. reported here is similar to the one Johnson et al. (1962) used to study animal comfort by measuring physiological reactions of dairy cattle in controlled-environment chambers. They found that body functions changed little with slight changes in either temperature or

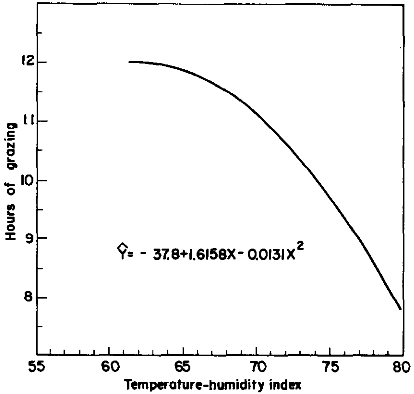

FIGURE 1. Grazing time per cow-day versus average temperature-humidity index (calculated from average 5:00 a.m. to 8:00 p.m. temperature and humidity). (Correlation coefficient ($R = 0.968$) is significant at the 0.01 level.)

humidity in a range of T.H.I. from 60 to 70. However, relatively large changes in body functions occurred with slight changes in temperature or humidity in a T.H.I. range from 73 to 80. Assuming grazing time is related to animal comfort, our curve of time spent grazing and T.H.I. is in general agreement with their work. An increase in T.H.I. from 65 to 67 would result in about 0.25 hours less grazing while a change in T.H.I. from 73 to 75 would result in a change of about 0.84 hours grazing.

We also found, as expected, that grazing time increased when windspeed increased on hot, humid days. For example, one afternoon when the T.H.I. was 82, cattle that had been resting in the shade began grazing when a 7-mile-per-hour breeze occurred. The increase in windspeed must have made it possible for the animals to transfer more body heat, by conduction and skin vaporization of moisture, to the air. Since deep body tissues rapidly lose efficiency and express discomfort when their temperature rises only slightly, small changes in air conditions can be significant. The guide for heating, ventilating, and air-conditioning engineers takes wind as well as wet- and dry-bulb temperatures into account. So on the particular day in question the increase in windspeed lowered the T.H.I.

This engineering index was prepared for humans and because of differences in body structures the relation between atmospheric conditions and comfort may not be exactly the same for cattle. Still, the index was more closely related to the time beef cattle spend grazing than any of the indices prepared specifically for cattle.

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A Low Cost Apparatus for Taking Undisturbed Soil Cores[1]

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Highlight

A low cost apparatus for sampling near surface structural properties of soil can be constructed from aluminum irrigation pipe and shop equipment. The device is suitable for taking cores in soils from fine sands to clays.

It is often desirable in grazing studies to measure the structural properties of the soil. The most common technique for measuring bulk density, pore space, and other physical properties involves the use of cores of undisturbed soil. A sampler with a brass or stainless steel cylinder inside a machined, tempered-steel casing similar to those described by Lutz (1947) and Baver (1956) is the most widely used device for obtaining the cores. The steel head is often expensive and requires the services of an experienced machinist to build.

A simple, inexpensive core sampler has been built from aluminum irrigation pipe and used in soil structural studies on the Welder Wildlife Foundation (Fig. 1). The sampler was made from the standard female coupling on 3 inch aluminum irrigation pipe and the extracting cylinders were made from sections of the pipe. The procedure is as follows.

The cast aluminum female coupling is removed from the pipe. The inside surface of the coupling is smoothed with sandpaper until the coupling slips easily over the pipe. A drainage spade handle is equipped with a steel yoke and bolted onto the coupling to complete the sampling device.

The sampling cylinders are made by cutting the irrigation pipe into 3 inch segments with a power hack saw equipped with a guide to insure a square end cut. The cylinder ends are smoothed with sandpaper.

In the original model, aluminum pipe cost 38¢/ft. Sawing the pipe

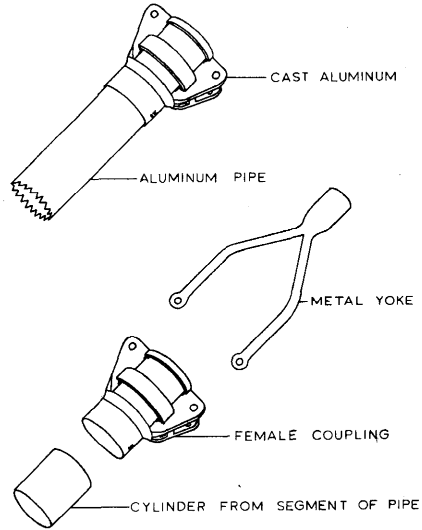

FIGURE 1. Sketch showing construction of sampling apparatus and cores from aluminum irrigation pipes.

[1] *This paper is contribution No. 98, Welder Wildlife Foundation, Sinton, Texas.*

added an additional 4¢/cut, making each cylinder cost 13.5¢. The female coupling cost $1.20, the handle, $1.50, and the yoke, including welding, $2.50. The entire cost of the sampling apparatus and 100 cores was only $18.70. A machine shop estimate for a steel head alone was $150.00 at the time the device was made. No estimate was obtained on the cylinders.

Sampling procedure for using the apparatus consists of removing the vegetation and litter and smoothing the soil. The aluminum cylinder is placed in the device and the cylinder forced into the soil until the upper edge of the cylinder is flush with the soil surface by placing a foot on top of the sampler as one would use a spade. The lower edge of the cylinder acts as its own cutting edge. The sampling apparatus is lifted from the core, leaving the metal cylinder, imbedded in the soil. The entire core is removed with a drainage spade. The soil is smoothed flush with the bottom of the cylinder by cutting with a knife. The core is placed in a paraffined, pint-sized ice cream container and sealed with masking tape. The entire process takes about one minute per core in most soils.

The sampling apparatus works well in soils with no large woody roots or stones. It has been used successfully on soils of a wide textural range: Victoria clay, Orelia clay loam, Medio fine sandy loam, Zavala loamy fine sand, and Nueces sand. Bulk densities of soils sampled varied from 1.15 to 1.53 g/cc. (Box 1961). The sandy soils must be sampled while they are moist for the soil to remain in the core.

In extremely hard soils, the yoke and handle may be removed and the cylinder and sampler driven into the soil with a sledge hammer. A board should be placed across the sampler to absorb the shock. Forcing of the aluminum cylinders into the soils sometimes damages the lower edge. However, the low cost of the cylinders allows damaged cores to be discarded and replaced.

There are several advantages to the apparatus described here over the standard steel core sampler with removable cylinders. First, the difference in cost is obvious. The low cost of sampler and cylinders allows for many more cores to be taken on a limited budget. Second, there is less compression of the soil since the cylinder itself is forced into the soil instead of a thick steel casing plus a cylinder. Third, various length cylinders may be used in sampling the surface foot of soil. Machined steel samplers must be made for a given length core. Cores of up to one foot length may be forced into the fine sands and fine sandy loams with this sampler. Fourth, the sampler can be made by most technicians from material available at good hardware stores.

The soft metal is a disadvantage. Many cores cannot be used after a dozen or so samples are taken with them in hard soil. Likewise, each core must be dug from the soil with a spade and the apparatus is useful only in studying near surface soil characteristics. However, the low cost and ease of construction makes the equipment attractive for structural studies of surface soils.

The simple construction of the core sampler and the tension table described by Leamer and Shaw (1941) make soil structural studies within the limits of even the most meager budget. The equipment needed for sampling and testing for pore space can usually be made in one day for less than $20.00.

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Direct Processing of Field Data

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Ecological, agricultural, and range data frequently traverse a processing route which subjects the data to an unacceptable risk pattern of erroneous modification. When the processing of such data becomes routine and involves the utilization of a computer facility, most of the detectable errors arise in the phase of the processing route which lies between the actual initial data recording and its submission to the computer for data reduction. This includes re-transcription of the data and subsequent key-punching with verification.

In an operation of small to moderate scope and involving a normal turn-over of support personnel, the frequency of errors arising from re-recording of data can be expected to be moderately high. These errors may be both difficult and expensive to detect and to correct. The experiences of the authors have shown that such errors are primarily the result of either random mistakes or misunderstandings of instructions. While both types of errors are costly, the latter becomes extremely so when large volumes of data are involved.

In addition to the errors arising from data handling there exists the inconvenience that the usual elapsed time from the initial recording of data in the field to the storing of it in a suitable punched card format runs from a minimum time of one week up to several weeks. This means that visual scanning of new data in a meaningful and useful display is delayed for at least an equivalent period of time. In turn, then, the feasibility of in-the-field verification of doubtful results is significantly reduced; whereas, with a rapid data-display return the opposite could be true.

While there may be several ways of overcoming most of these objectionable characteristics of this route of data acquisition, there exists one which may prove to be superior to others from both the practical and economical points of view. This procedure involves the use of special data acquisition forms for use with an optical reader attached on-line to a small computer. The actual facility utilized by the authors for this purpose is located in the Statistical Laboratory of Colorado State University; it includes an IBM 1231 Optical Mark Page Reader attached on-line to an IBM 1401 computer with card, tape and printer input-output devices.

The 1231 is a sensing device capable of detecting and translating markings from an 8½ x 11 inch sheet of paper into records in the memory of the computer. The interpretation and manipulation of the records can be accomplished through programs in such a fashion that the data from the 1231 sheets are simultaneously punched on cards, stored on tape and listed on a print out.

Fig. 1 shows the form we are using in an ecological study of alpine vegetation. Area identification is marked with a black felt pen marker by the observer directly on these sheets; the presence of a species in a given sample plot is then indicated by similar marks in the tracks following the code number of that species. These data sheets are processed without additional error providing the investigator with a data listing and a deck of punched cards. Such processing of data sheets can be performed at the rate of 1,500 to 2,000 per hour, thus providing the investigator with an immediate display

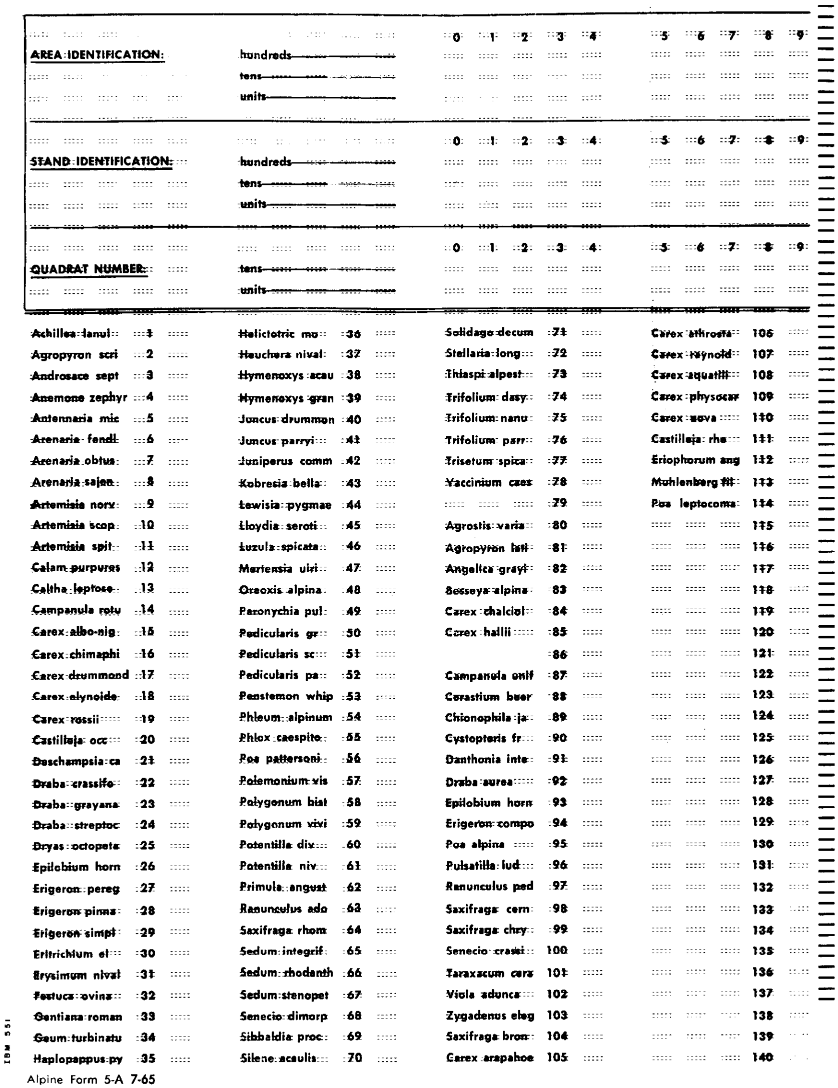

FIGURE 1. Data acquisition form for in-the-field use in conjunction with an ecological study.

of recently acquired data. Utilizing the described computing facilities we find that the processing cost per document exclusive of card cost is about 2¢ each; utilizing the equivalent facilities of the same institution in the manner described at the beginning of this report, the processing cost per document is about 6¢ each.

Briefly, then, utilizing this type of data acquisition, significant increases in efficiency are obtained with regard to;

1. Accuracy of data procurement.
2. Processing time.
3. Direct costs of data acquisition.

Sample forms will be sent to readers upon request.

Germination Requirements of Scarlet Globemallow[1]

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Highlight

Seed germination percentages of scarlet globemallow can be increased by acid and mechanical scarification. However, the highest germination rate was produced with diethyl dioxide. All treatments interacted with temperature conditions. Alternating temperatures, particularly 12 hour periods at 15 and 22 C, were most favorable in attaining relatively high germination percentages.

Scarlet globemallow *(Sphaeralcea grossulariaefolia* (H. & A.) Rydb.) is an important perennial forb component of Shadscale Zone vegetation in the Great Basin (Billings, 1951). Few other species of comparable life form have persisted as well under the heavy grazing characteristic of this region. A major reason for this persistence is delayed dissemination of seed until favorable conditions for germination occur (Kearney, 1935). The indehiscent part of the carpel is known to hold the seed until the reticulate wall has disintegrated. Literature lacks any information, however, on how environmental factors influence germination once the seed is disseminated. The following research was conducted since such information is necessary if this species is to be used in revegetation programs.

Materials and Methods

Native seed collected near the campus of Utah State University, Logan, was stored for 10 weeks at 5 C. All fruits were reduced to individual carpels by rubbing them between two sheets of ribbed rubber. For each experiment, seeds were randomly divided into lots and uniformly spread over sterile filter paper in petri dishes.

Plexiglass germinators with individually time-clock controlled heat sources were operated in a walk-in controlled-temperature room.

Seeds were considered to have germinated when the radicle had elongated 0.5 cm. Responses were recorded for 19 days; a period found adequate by pilot experimentation.

Percentage germination was computed directly and by subtracting the number of hard coated and empty seeds from those initially treated. The number germinated was then divided by this new denominator. This procedure was necessary, in most tests, because of large numbers of seeds with empty carpels or heavy seed coats. Otherwise values of positive responses were depressed too much for optimum data analysis. Values quoted are on this latter basis.

Since preliminary tests indicated that no germination occurred when the filter paper of the plates was merely moistened with distilled water, the effects upon the seed coat of mechanical scarification, acid scarification and diethyl dioxide were first investigated.

Mechanical Scarification: Four replications of 100 seeds were scarified by high speed rotation in a sandpaper lined container for 5, 15 or 25 seconds. The seed was then placed in germinators with alternating 12-hour periods at 15 and 22 C.

Acid Scarification: The possibility of embryo damage from mechanical scarification may be obviated by the immersion of seeds in sulfuric acid. Effects of concentrated sulfuric acid were tested by placing four 100 seed units each in the acid for periods of 15, 25 or 35 minutes. One set was germinated on filter paper disks saturated with distilled water, an identical set of treated seeds was germinated with tap water as the medium.

Diethyl Dioxide (Dioxan) Treatment: Seeds of some species do not germinate because the seed coats prevent water penetration. To test whether or not a non-wetting substance was contained in the seed coats of scarlet globemallow, 3 replications of 100 seeds each were immersed in dioxan for 1, 2, 3, or 4 hours. Dioxan is a paraffin solvent which mixes easily with water and substitutes readily for the water in plant tissues without causing plasmolysis (Sass, 1940). After treatment all seed lots were placed in germinators with alternating 12-hour periods at 15 and 22 C.

Potassium Nitrate: The use of KNO_3 as a germination stimulant is well known (Toole et al. 1955). Three 100 unit replications of seeds were scarified for 25 min. with concentrated sulfuric acid at room temperature and then allowed to imbibe water for 24 hours. Then a 0.2% solution of KNO_3 was substituted as the germinating medium.

Temperature Effects: There are minimum levels, as well as maximum temperatures, at which germination is inhibited in various species. The following set of germination temperature regimes were tested with four 100 seed replications of acid-scarified seed: constant 8, 15, or 22 C, and alternating 12-hour periods at 15 and 22, 15 and 27, or 15 and 32 C.

Light Effects: Continuous light can inhibit seed germination of arid-zone species, and germination may increase as the dark period is lengthened (Koller, 1957). We tested the effect of alternating light as compared to total darkness. The 400 seeds per treatment used in this test were acid-scarified at room temperatures for 25 min., washed in distilled water and then placed on water-saturated filter paper at 4 C for 24 hours.

After the pretreatment period, those petri dishes containing seed to germinate in total darkness were placed in a black-walled can, containing a petri dish full of water to maintain a saturated atmosphere. The cans were not opened until the end of the germination period.

The dark treatment cans plus those petri dishes to be exposed to alternating light and darkness were placed in three germinators set at constant temperatures of 8, 15 and 22 C. A 150-watt clear-glass incandescent lamp approximately 5 ft above the germinators furnished light.

Viability Tests: A random sample of 250 seeds was allowed to imbibe distilled water for 12 hrs, and placed in the dark on filter paper saturated

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[1] *Published with the approval of the Director of the Utah Agricultural Experiment Station as Journal Paper No. 502.*

with 2, 3, 5-triphenyl tetrazolium chloride. (Porter et al., 1947).

Results and Discussion

Mechanical Scarification: As scarification time increased, germination percentage decreased. Average germination was 47.4% for the 5 sec. treatment, 10.5% for 15 sec. and 8.0% for 25 sec. This trend may have been caused by increasing damage to embryonic tissue or weakened seed coats which permitted abnormal appearance of cotyledons before the radicle.

Acid Scarification: Germination percentage for these treatments was very erratic in all instances, showing few definitive trends. Germination ranged from approximately 30 to 40% for all treatment combinations. Germination increased with time of immersion when tap water was used. Germination was significantly higher with distilled water. Immersion in the acid up to 35 min. did not decrease germination rates.

Diethyl Dioxide (Dioxan) Treatment: Average germination for the four treatments was 36.7, 51.5, 48.2, and 67.1% for the 1, 2, 3, and 4 hour treatments, respectively. This progressive increase seems to indicate that a non-wettable agent is a primary factor responsible for cases of reduced germination in this species. Results of this treatment compared with those of the previous two experiments showed that: (1) germination was quicker and more uniform, (2) percent germination was higher than for the mechanically or acid-scarified seed lots, and (3) no abnormal germination occurred.

Potassium Nitrate: KNO_3 treatment increased average germination by 9% over that of the controls treated only with tap water. As used in these experiments in combination with acid scarification, the germination was below that obtained when dioxan was used alone.

Temperature Effects: Germination percentages of acid-scarified seed increased as constant temperatures were increased at intervals of 8, 15 or 22 C. Average percentages were 4, 10, and 12% respectively. Fluctuating temperature regimes were generally more conducive to germination than constant temperatures. The most favorable thermoperiodic treatment was alternating 12-hour periods at 15 and 22 C. Such treatment gave an average germination of 34.3% for the four 100 seed replications, whereas the 15 and 27 C treatment yielded 22.5% and the 15 and 32 C regime 18.6% germination. Thus, germination percentages decreased as the maximum temperature of the alternating regime increased.

Light Effects: Germination percentages were low (2 to 12%) in this test, probably due in part to the constant temperature regimes imposed. No significant differences in germination response were attributable to the light treatments imposed.

Viability Tests: An average of 85.7% of seed (hard-coated and empty seeds not subtracted) tested imbibed red color, allowing interpretation of that percentage viability. Of this sample, 58.0% of the seeds possessed hard seed coats and 13.6% were empty. The tetrazolium test showed 95.2% of the hard seeds to be viable. That seed in none of the other tests approached the apparently potential level of germinability is probably due to the high proportion of seeds with either a hard or heavily impregnated seed coat.

Summary and Conclusions

Our results show that germination percentages of scarlet globemallow can be enhanced, particularly by treatments with diethyl dioxide. Sulfuric acid and mechanical scarification also increased germination, but, in both of these methods more care must be exercised to prevent injury to the seed. Potassium nitrate had only negligible effect as a germination stimulant.

All treatments interacted with temperature conditions. Alternating temperatures, particularly 12-hour periods at 15 and 22 C, were found to favor relatively high germination percentages.

Contrary to the general rule of continuous light inhibition of seed germination of arid zone species, scarlet globemallow showed no differential response in exposure of seeds to light or total darkness.

The generally low level of germinability of scarlet globemallow seeds is believed to be due to the hard seed coats that are heavily impregnated with a non-wettable substance.

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MANAGEMENT NOTES

Controlling Blowouts for Forage Production

A. C. Everson, B. E. Dahl, and A. H. Denham

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Highlight

Blowouts on sandy soils in the Great Plains can be controlled by leveling hummocks and shaping sharp banks, developing sorghum stubble and seeding warm-season grasses into the stubble. This practice will provide grazeable forage and reduce damage to adjacent areas by wind-blown soil.

Removal of the protective cover of native vegetation by heavy grazing or cultivation has resulted in blowouts on sandy soils throughout the Great Plains. These blowouts vary in size from small pockets to several acres and represent two areas of disturbance—the area from which soil is removed and the areas upon which wind blown soil is deposited. The result is two sources of economic loss—reduced forage and livestock production on the blowout and damage from deposition on adjacent lands and installations.

Research on blowout reclamation was initiated at the Eastern Colorado Range Station in 1954. Annual precipitation at the station is 14.8 inches with about 75% occurring from May through July. In 1954 and 1955 treatments were applied to an 18 acre blowout in strips 750 feet long and varying in width from 20 to 80 feet. The blowout was first bulldozed to remove sharp banks so that seeding equipment could be used and to reduce further wind

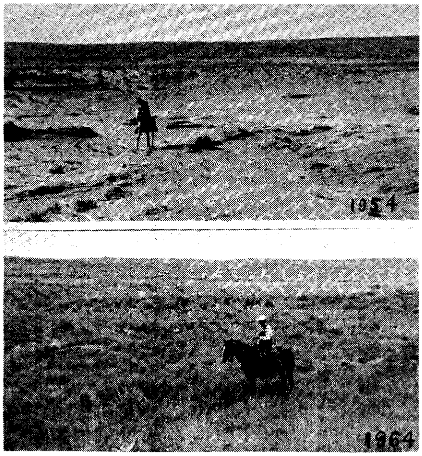

Figure 1. *Top,* Original blowout in 1954 before treatment; *bottom,* blowout in 1964 after treatment and vegetation establishment.

scouring. Then the following treatments were applied:

1. Seeding, application of 7 to 8 tons/acre of manure and cultipacking.
2. Fertilizing with 100 lb of 33% ammonium nitrate, or 210 lb of 43% phosphorous pentoxide, or a combination of nitrogen and phosphorus at equivalent rates per acre; seeding; application of 1 to 1.5 tons/acre of grain straw and cultipacking.
3. Planting sorghum in 12-inch rows. Fertilizing with nitrogen phosphorus, or nitrogen and phosphorus and seeding into the sorghum stubble the next year.

In 1954 a mixture of cool-season grasses including 5 lb of tall wheatgrass *(Agropyron elongatum* (Host.) Beauv.), 5 lb intermediate wheatgrass *(A. intermedium* (Host.) Beauv.) and 3 lb yellow sweet clover *(Melilotus officinalis* (L.) Lam.) was planted in the manure and straw treatment strips. A warm-season grass mixture including 2 lb each of sideoats grama *(Bouteloua curtipendula* (Michx.) Torr.), switchgrass *(Panicum virgatum* L.), indiangrass *(Sorghastrum nutans* L.), bluestem mixture *(Andropogon)* and yellow sweetclover was also planted in these strips.

Nitrogen and/or phosphorus fertilizers, as outlined in basic treatment number 2, were applied to one fourth of each straw treatment strip prior to seeding and covering with straw. Sorghum, at the rate of 20 lb/acre in 12-inch rows, was planted in strips to establish a stubble in which to plant grass the following year.

The manure and the straw treatments were repeated in 1955. The sorghum stubble strips were fertilized with nitrogen and/or phosphorus as indicated for straw treatment strips and then were seeded with the appropriate grass mixture. The cool-season mixture in 1955 was made up of 3 lb each of tall wheatgrass, intermediate wheatgrass, desert wheatgrass, also called crested wheatgrass *(Agropyron desertorum* (Fisch.) Schult). The warm-season mixture was the same as that used in 1954, except the bluestem mixture was omitted.

The stand of grass developed slowly under the extreme habitat conditions and grazing was deferred until 1961. It has been grazed for about 2 months each summer since then. The stocking rate was 2.5 acres/cow month in 1961 and 1.5 acres in 1964. This indicates the stand of grass has continued to become more productive. The stocking rate compares favorably with 1.6 acres/cow month under moderate grazing on native range.

In August 1964 two hundred systematically-located point-plots were recorded by species in each of the 28 strips. There were no differences in improving stand establishment among seedbed preparation methods nor did commercial fertilizers or manure improve establishment. During the 10-year period, 1954 to 1964, the cool and warm-season grasses had interseeded across treatment strips and the original strips almost lost their identity. The kinds of plants and cover indicated in Table 1

Table 1. Plants that were most numerous in the reseeded blowout on the basis of 5600 plots.

Species	Number of plants	Percent of all plots
Switchgrass	853	15.2
Sand dropseed (*Sporobolus cryptandrus* (Torr.) A. Gray)	566	10.1
Sideoats grama	492	8.8
Sand lovegrass	461	8.2
Slimflower scurfpea (*Psoralea tenuiflora* Pursh)	410	7.3
Crested wheatgrass	378	6.8
Yellow sweetclover	247	4.4
Other species	606	10.8
Blank spaces	1587	28.4
	5600	100.0

are adequate to control wind erosion and to permit controlled grazing.

The approximate cost of the three seedbed cover treatments for the seed and the cover material was $29 to $35 for the manure treatment, $25 to $35 for the straw treatment, and $6.75 to $12.25 for the sorghum treatment. Bulldozing, planting and fertilizing were additional costs. Nitrogen cost $4.60/acre; phosphorus, $8.60, and nitrogen plus phosphorus, $13.20.

These costs were based on experimental procedures in order to compare a number of species, fertilizer combinations, and ground covers. The cost of planting the sorghum and grass seed would have been considerably less if the fertilizer had not been added.

Summary

The most economical and satisfactory method to stabilize and reclaim sandy blowout areas in eastern Colorado is to level hummocks and shape sharp banks, plant sorghum to establish a ground cover, and plant forage species into the sorghum stubble the following year.

The recommended rates and species to plant are 2 pounds of switchgrass, 2 pounds of sideoats grama, and 1 pound of sand lovegrass per acre. Commercial fertilizers have not been effective in improving stand establishment.

Prior to planting a blowout, uneven places and sharp banks must be shaped and smoothed. This is necessary in order to permit the use of seeding equipment, mulch spreaders and cultipackers. It also minimizes further wind action which could cover the seeds too deeply or possibly blow them away.

The best time to level and smooth out the blowout is in early spring just prior to planting. The blowout should be fenced to protect the plants from grazing during the years required for establishment.

When grazing is permitted, stocking rates must be closely controlled to prevent overgrazing and the formation of another blowout.

Mesquite Control on the Coronado National Forest

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Highlight

Mesquite is one of the most tenacious invaders of rangeland in the Southwest, and control efforts have resulted in only partial success. Aerial spraying was the most effective and inexpensive of six control methods tried on the Coronado National Forest in Arizona.

On the Coronado National Forest, velvet mesquite *(Prosopis juliflora* var. *velutina)* is a problem on approximately 40% of the grazing allotments. Usually, mesquite is thickest on the most productive and the most accessible range sites (Fig. 1). Where mesquite is thick enough to

FIGURE 1. Mesquite covered bottomland. Site produces little forage.

completely occupy the site, sheet and gully erosion are often a serious problem. On such sites the mesquite must be controlled before any appreciable benefits can be expected from improved grazing management. In lighter stands, the beneficial effects of better management will be nullified in time by the spreading and thickening of the mesquite. The purpose of this article is to present briefly the experience of the Coronado National Forest in controlling mesquite on its grazing lands.

Several control methods for mesquite are available but none is completely satisfactory. Several methods are described by Reynolds and Tschirley (1963). We have used all of the popular methods. Although the work has not been on a particularly large scale, some of these pilot tests do give a fair idea of the relative cost and effectiveness of the different methods under practical conditions (Table 1).

Basal Stem Treated With Diesel Oil.—The basal stem diesel-oil treatment was tried on about 1,000 acres over the past several years. This method involves applying a low-grade diesel fuel around the base of the tree. A backpack pressure tank is used with a pipe nozzle about 4 ft long curved at the end. The long nozzle is necessary to reach under the canopy to the base of the stems of low-branching trees. Enough oil must be applied so that it effectively soaks down and envelops the bud zone to prevent sprouting. This method resulted in approximately an 85% kill on upland sites where the bud zone was close to the surface. On bottomland sites sometimes the buildup of soil is so great that the bud zone is buried beyond the reach of the diesel oil. Projects involving this type of mesquite netted approximately a 35% kill. One gallon of diesel oil will treat 6 to 8 trees. An active worker should treat 30 to 40 trees/hr. Our cost for the hand treatment operation averaged 10¢/tree.

Table 1. Summary of Mesquite Control Projects on Coronado National Forest.

Method	Acres Treated	Average Cost Per Tree	Average Cost Per Acre	Remarks
Basal Stem Diesel Oil	1032	10¢		Practical and successful on stands of 50 trees per acre and under
Fenuron Poisoning	21		$12.00	Not successful
Pushing	578	10 to 12¢		Fairly successful, although resprouting
Chaining	1510		$4.00	Prolific resprouting
Root Plowing	862		$12.00[1]	Successful, some resprouting
Aerial Spray[2]	2000		$2.50	Good success, 40% total kill

[1] $4.00 additional for seeding.
[2] Two applications necessary.

Fenuron Pellets.—Our use of fenuron pellets was very limited and not too successful. Three different rates of application on plots of 7 acres each were used. The area treated had been chained two years previously and, at the time of treatment, had a tree density of 145 live trees/acre. The following dose rates were of fenuron pellets used on the three plots:

Tree Ht. feet	Dose rate in teaspoons Plot A	Plot B	Plot C
0 - 3	1	2	0.5
3 - 6	2	4	1.0
6 - 12	3	6	1.5

The largest kill of 26% and 28% respectively was obtained in Plots B and C on the 0 - 3 and 3 - 6 ft trees. For some unexplainable reason Plot A showed only a 10% mortality in these classes.

No effect at all was observed on the 6 - 12 ft class even by the heaviest application.

Costs were eight cents per tree or $12.00/acre for the fenuron alone.

FIGURE 2A. Bottomland site immediately after mesquite was removed by pushing with dozer.

FIGURE 2B. Two growing seasons later—site is highly productive once mesquite is removed.

The use of fenuron is not in the least encouraging.

Pushing with Dozer.—We have pushed 600 acres of mesquite with a dozer, and this method was fairly effective. More trees were missed with the dozer than was true of hand treatment; this was particularly true of small trees. These are difficult for the bulldozer operator to see, and the larger trees that are pushed out tend to cover up the smaller ones.

Bulldozing creates considerable ground disturbance which has proven to be an asset (Fig. 2A). On areas where there was a remnant sod of perennial grasses, the response of more vigorous growth was much more rapid than where it was not disturbed (Fig. 2B). Where there was very little native grass remaining, the disturbed areas provided a good seedbed for reseeding.

Nearly all of our pushing projects were done with a D-7 Hula Dozer. Costs averaged between 10 to 12¢ per tree. After 5 years some of these projects show considerable resprouting. We have found that unless a tree is completely severed from the roots of the bud zone, it will not die. If the tree breaks off above the bud zone, it resprouts from the stump.

Chaining—has been the least successful method on the Coronado for removing mesquite. Because of the sprouting ability of the mesquite, about all that was accomplished was to trade large trees for small ones. However, about 6 to 8 years of time was gained by reducing the competition. The sprouts on 6-year old chaining projects are now becoming large enough to reduce forage production.

All of our chaining was done by contract. Two D-7 Caterpillar tractors or equivalent were used, pulling 300 feet of anchor chain between them. The cost was $4.00/acre. Chaining and the dragging of the brush left considerable soil disturbance and a reasonably good seedbed. The treated area was then planted to Lehmans Lovegrass.

Root Plowing.—A rear-mounted Fleco plow on a D-8 tractor and a front-mounted plow on a D-7 were used for root plowing. Our two projects with root plows total 862 acres. There was no apparent difference in results between the rear-mounted and front-mounted plows. All vegetation was severed from the root systems to a depth of about 12 to 16 inches.

It is essential to reseed after root plowing. One area was seeded to Lehmans lovegrass from an exhaust seeder behind the Dozer. After three years this project can be considered a success. The other area was seeded to Lehmans lovegrass from a fixed-wing aircraft. After three years the seeding is a failure and will have to be redone. We draw no conclusion from this failure that aerial seeding is not satisfactory.

On areas where the mesquite has a density of 150 trees/acre or more and where there is little perennial grass remaining, root plowing was found to be the most effective method. At a cost of $16.00/acre it is possible to convert non-productive forage land to good grazing land.

Aerial Spraying.—We sprayed about 2,000 acres of mesquite with 2,4,5-T, using fixed-wing aircraft. The rate of application was ⅓ lb of 2,4,5-T iso-octyl Ester in a 1:7 mixture of diesel oil and water. Two applications are necessary. It is dedirable to skip a year between applications to give the sprouts a chance to grow out enough so that the second application is effective. Aerial spraying is the only method where timing is critical. Spraying must be done in the late spring when the leaves are full-sized but have not yet become waxy. Usually the plant is still blooming at this stage and small beans up to an inch long can be found on some trees. This stage of development usually occurs during the latter part of May or the early part of June. The projects treated have been relatively level areas or those with a fairly even gradient. In the future we expect to do some work with helicopters. The helicopter may be particularly advantageous in more undulating country where small isolated patches are hard to reach effectively with fixed-wing aircraft.

Our costs for aerial control of mesquite were about $2.50/acre per application, or a total of $5.00/acre for the full treatment. Examination of treated areas shows a total kill of about 40%. When 40% of the trees are killed outright, competition has been reduced by 85 to 90% on the area. Aerial spraying was the most effective as well as the cheapest method we tried. As a result, our recent work has been almost entirely limited to aerial spraying.

Summary

Mesquite encroachment is a problem on about 40% of the highly productive range on the Coronado Forest. Methods tried on a pilot basis include basal oiling with diesel oil, individual tree poisoning with fenuron, pushing with a bulldozer, chaining, root plowing, and aerial spraying. The basal diesel oil method is good for small areas where the density does not exceed 50 trees/acre. Aerial spraying appears to be the most practical method available for extensive areas.

None of the control methods are completely effective in removing the mesquite permanently. All treated area will need periodic maintenance treatment.

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Grazing Cattle on Sub-irrigated Meadows[1]

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Highlight

Until recently it was thought that sub-irrigated meadow sites should not be grazed by livestock during the growing season but reserved for hay production. Only the very early spring growth or aftermath was grazed. Grazing cattle on sandhill meadows is a sound practice under proper management. The increased cost of making hay and the inflated values of land in the Sandhills suggest that ranchers should take a look at alternative land uses when planning their grazing-forage program.

The weight gains of cow-calf pairs grazing meadow pasture were compared with comparable cow-calf pairs grazing adjacent hill pastures four different years on the 47 Ranch[2] near Brownlee, Nebraska. (Fig. 1 and 2). In each trial cow-calf pairs were divided into two groups equal in cow age, calf age, and calf sex. The cows and calves were individually weighed before going on the pastures in May and again when coming off the pastures in the fall. They were sorted into the two groups coming off the scales in the spring and the two groups were reassembled the day before the fall weights were taken. This procedure equalized shrink conditions between the two groups.

The meadows were pastured one year and harvested for hay two years in a three year rotation. Thus, the meadow pastured in 1960 was also grazed in 1963 (Table 1). In 1961 two meadows were pastured using a rotation-within-season procedure. One of these meadows was grazed again in 1964.

By the end of the 2nd year of the study it was obvious that watering places were located so that one end of the hill pasture received most of the grazing pressure. Before the 1963 grazing season a cross fence was constructed and two watering places developed. The part of the pasture that received light use during 1960 and 1961 (about 418 acres) was used in the 1963 and 1964 trials. All hill pastures were grazed continuously through the season except in 1961, when livestock were moved to a fresh pasture in August.

The meadow used in 1960 and 1963 was about 25% sub-irrigated and wetland, 60% dry valley and 15% sand range sites. The combination of the two meadows used in 1961 was about 53% sub-irrigated and wetland, 18% dry valley and 29% sand range sites. The meadow used in 1964 was about 65% sub-irrigated and wetland and 35% dry valley. The hill pastures were on choppy and gently rolling sand range sites with some dry valley range site in the pastures grazed in 1960 and 1961. The hill pastures were in good to excellent range condition.

Forage Use

The sub-irrigated range site of the meadow pastures showed close and non-uniform use. Grazing patterns were often patchy. There are two reasons for this. One is the early establishment of grazing patterns that result from livestock preference for regrowth of grazed plants — the other is a development of grazing patterns from manure and urine contamination of forage. The wetland portion of the meadow was virtually unused. Vegetation of this area consisted mostly of sedges and rushes. This area was mowed late in the season to remove excess forage. The upland portion of the meadow pastures showed moderate to full use of forage.

[1] *Contribution of the Nebraska Agricultural Experiment Station. Published with the approval of the Director as Paper No. 1831, Journal Series, Nebraska Agri. Exp. Sta.*

[2] *Acknowledgement is made to Forrest Lee and Jerry Garner of the 47 Ranch for their cooperation in making this research possible.*

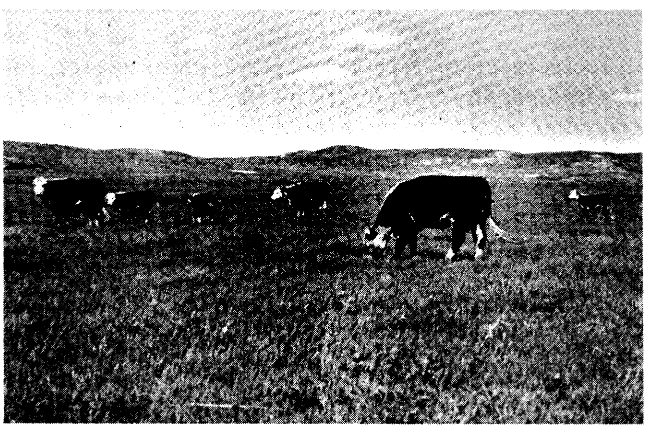

FIGURE 1. Cows and calves produce well when grazed on sub-irrigated meadow pasture.

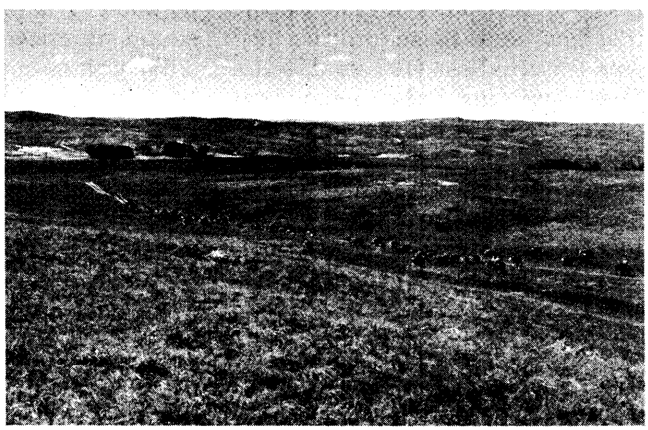

FIGURE 2. The meadow pasture can be seen in the background between the trees. The hill pasture is in the foreground.

Apparently correct use of meadow pastures was obtained with a stocking rate of 3 acres per cow-calf pair for 5 months. In 1963 when 3.6 acres were grazed by a cow-calf pair for 5 months, 50 tons of hay were harvested in addition to the forage removed by grazing. In 1964, at a stocking rate of 2 acres per pair, the experiment had to be ended by the first of September. Had it been continued until October, over-grazing would have occurred. Sub-normal precipitation also reduced the amount of forage available for grazing in 1964.

Lack of uniform grazing was obvious on the hill pastures. The closely grazed portions were in areas surrounding the watering places. The portions farthest from the watering places showed slight to light use. It appears that 7 to 8 acres per cow-calf pair is an optimum stocking rate for summer grazing hill pastures in good to excellent condition in the 19 to 20-inch rainfall area of the Sandhills. In 1960 under a stocking rate of 12 acres per cow-calf pair, 150 animal-unit-months of grazing were obtained from the hill pasture after the experiment was terminated.

Table 1. Average gains of livestock when grazed on sub-irrigated meadows and sandhill pastures.

	1960		1961		1963		1964	
	Mead.	Hill	Mead.	Hill	Mead.	Hill	Mead.	Hill
Days grazing	148		168		158		100	
Pasture size, acres	186	720	299	840	186	418	103	418
Cow-calf pairs	62	60	107	120	50	51	51	51
Stocking rates								
Acres/A.U.[a]	3.0	12.0	2.8	7.0	3.7	8.2	2.0	8.2
Acres/A.U.M.[a]	0.62	2.47	0.51	1.27	0.71	1.58	0.61	2.51
A.U.M./acre	1.61	0.40	1.96	0.79	1.41	0.63	1.64	0.40
A.U.M. of grazing	299	288	586	664	262	263	169	167
A.U.M. grazing left	......	150	......	......	100	......	......	......
Ave: gains, lb								
Total								
Cows	191	151	187	174	215	163	154	131
Calves	272	266	257	261	295	278	201	194
Daily								
Cows	1.29	1.02	1.11	1.04	1.36	1.03	1.54	1.31
Calves	1.84	1.80	1.53	1.55	1.87	1.76	2.01	1.94
Per acre	154	35[b]	159	62	138[b]	54	178	40

[a] A.U. in this data is one cow-calf pair. A.U.M. in this data is one cow-calf pair for one month.

[b] This figure underestimates the gains per acre because of forage left after the grazing season.

Cattle Performance

Cows grazing the meadow gained more weight than those grazing the hills each year (Table 1). In 1961 the difference between the gains of cows on the meadow and those on the hill was the smallest (187 vs. 174 lb). This was also the year that calves from the hill pasture were heavier than those grazing the meadows. The cows and calves on the hill pasture were moved to a fresh pasture in August 1961. The fresh pasture probably prevented the decline in weight gains generally experienced by cattle grazing continuously on hill pasture. It suggests there may be an advantage to using a deferred-rotation grazing system for obtaining optimum livestock gains.

Discussion

The vegetation of the meadows was closely checked during the study. No deterioration of range condition or productivity occurred under the system of management used during the study. Considering this, together with the favorable livestock response, meadow grazing is considered a sound practice.

By grazing meadows every third year and producing hay the other two years, a rancher could graze as much as one-third of his present hay land each year. The grazing of meadows in any two consecutive years is not recommended.

Yearling cattle to be marketed in the fall would be the best class of livestock to graze meadows. Cows that normally would be fed hay from the meadows can graze during early winter on the pastures that would have been summer-grazed by the yearlings. It may mean the cows would need somewhat more protein or concentrate supplement. Because the cow's nutrient requirements through most of the winter are essentially for maintenance, they can do well with a minimum of hay if adequate forage for winter grazing is available.

Management of sub-irrigated meadows for grazing as well as hay production includes the introduction of red and alsike clover when they are not present in the stand. It also requires application of 20 to 25 lb of elemental phosphorus every fourth year to insure satisfactory growth of legumes.

Cowboy on the Coconino

Kel M. Fox

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Figure 1. Cattle on north Arizona mountain ranch, fall, 1965.

The Coconino National Forest, located in north-central Arizona, has some of the best year-round grazing on the North American continent. It is also a fine example of multiple use land management. Its ponderosa pine forests provide an annual allowable cut of 54,000,000 board feet of choice timber and 16,250 cords of pulp wood. It is a primary source of water for three-quarters of a million people living in Phoenix and the Salt River Valley. It is also a recreational paradise, supporting large herds of deer, elk and antelope.

My family came to the Coconino in 1926, in the days of open range. There was only one drift fence on the Forest, running roughly east and west, dividing the range between the Little Colorado drainage on the north and the Verde on the south. Our ranch was on the Verde side.

Our country was divided into several units, each of which operated wagons during the spring and fall working seasons. We belonged to the Oak Creek wagon, named for the famous canyon that now attracts over a million tourists a year.

Our cattle were driven to points on the Santa Fe railroad, and frequently sold by the head rather than by the pound, as we do now. I missed most of the drives because I was away at school, but I do remember making one to Flagstaff, where we found the railroad pens full of cattle, making it necessary for us to night herd our bunch in 10 below zero weather.

Calf crops in those days were often below 50%. Death losses were high. Bulls were mostly "natives". Salting was casual. Some did. Many didn't bother. Wild horses, wild cattle and wild burros were plentiful, available to any wild cowboy who had the guts to run 'em—and there were plenty who did, and some who made a fair living at it.

Our ranges were terribly overstocked, and I never heard the term "range management" until many years later.

The cattle were small and lean, and it was a good thing because they had to walk a long way to water. For many years we had just one dependable source of water on our summer country, a dam my father built at the headquarter place.

The Forest Service began fencing the open range into individual allotments in the late 1920's, and by the time the Great Depression rolled around most of the Coconino was fenced. Our allotment was called "Foxboro".

The Depression brought about a lot more changes. The banks soon found themselves in the cow business in a big way and by the mid-thirties many of the old outfits had new owners—with new ideas.

Our own little outfit came close to going under. We had to strip it of every cow we could find to pay off what we thought was a small mortgage, and then had to borrow money at an exorbitant rate of interest to keep going.

By this time my father had concluded the cow business was a sorry way to make a dollar. When a neighbor offered him cold cash for our range rights he was all for selling out.

I was graduating from college about this time, and I begged him for a chance to try my hand at running the outfit. That was in June, 1935.

I spent that summer and the following fall and winter gathering the remnants, 14 head in all. Six of the 14 were bulls, which I sold to a butcher for 1.5¢/lb (an average of $18.00 per animal). A few shelly, half-wild cows brought 2.5¢. I was glad to get 5¢ for the calves.

Fortunately, it didn't cost much to live in those days. Beans and spuds were a couple of dollars a hundred. Flour was cheap, and I never threw away a biscuit. My home was a primitive one-room shack, with only pieces of corrugated iron between me and the elements. How I got through the winter I'll never know, but when you are young, you don't ask silly questions.

Things picked up the following fall. During the winter I had renewed acquaintances with an old friend who had lost his ranch but had managed to salvage some money from the sale. He had cash, but no range. I had range, but no cash, so we decided to throw in together.

Scouting around for some cattle, we heard about a bunch of old cows for sale at $27 per head in the stockyards at Clarkdale. We went to see them, but wound up buying 100 head of young cows instead at $30 per head. They were sure worth the extra $3.00.

It took two days to drive the cattle home, and I got bucked off my horse when a big tumble weed came roaring under his belly, but it was worth the pain and indignity. They were a fine bunch of cows and a good nucleus for the herd we were trying to build up.

We picked up other cattle in

smaller lots. I remember one bunch in particular. There were supposed to be five head, three cows and two yearlings. The owner wasn't exactly sure; he hadn't seen the cattle for a couple of years. If we could find them—and catch them—they were ours at $20 for the cows and $10 for the yearlings. We spent all winter looking for these cattle, but could never find a trace. We were beginning to think they existed only in the owner's imagination when one evening a man rode in from a neighboring outfit to tell us his crew had found the cattle and had them tied up in a juniper thicket about five miles away. We got them the following morning, and, although one of the cows later got away and was gone two more years, we eventually sold them all at a good profit.

That second winter I "graduated" from the shack to a tent—my winter home for the next five years. It had a wood floor and a pot-bellied stove, and, all things considered, was a great improvement over the shack. We spent most of that winter and the following spring and summer building dirt tanks. My partner brought six good saddle horses with him, plus a number of unbroke horses. He also had two big, gentle work horses. We built many a tank with a four-horse team, using the two gentle horses in the middle, with a bronc on each end. We found this was a pretty good way to break the broncs.

On one of these tank-building expeditions, we broke an axle on the wagon, luckily within sight of the place where we planned to make camp. We decided to work on the tank all week, then take the axle out and drag it to a point where we could load it on a pickup. On Saturday morning I was given a choice: I could ride the one work horse gentle enough to ride and drag the axle or I could ride one of the broncs. I chose the gentle horse, but that was an awful mistake. We had gone only a few hundred yards when the rope got under his tail and he bucked me off. I decided riding the bronc might be safer, and it was. We got to the ranch without further incident and in time to clean up for a dance that night at the community school house.

We were not only building tanks and improving our water situation, we were also taking the first, faltering steps towards more intensive management of our cattle.

Purebred bulls were introduced into the herd. Old cows were carefully culled. Our calf crop was now averaging well above 50% and the calves were heavier and of better quality.

Bob-tail trucks were coming into use, and this made another big change in our lives. Now we could haul calves to the railroad instead of making the long drives. It was a lot easier on all concerned, the cows, calves and the cowboys. And more profitable too.

Even bigger changes began coming after World War Two. And they can be summed up in one term—range management. All the outfits on our part of the Coconino run cattle in the summer in the high country on top of the Mogollon Rim and winter in the Verde Valley. June 1 is the usual date for going from the winter to the summer country.

This created a problem for me. My cattle would drift from their winter range into a narrow canyon connecting the two ranges and hang up along the fence waiting for me to let them through. I spent many a hot, disagreeable day driving cattle from this fence back to water, only to see them return a day or so later. One spring I didn't catch them soon enough and lost eight head.

About this time I had an opportunity to buy some 20 sections of summer range adjacent to our old range. Included in the deal was some 400 acres of private land.

This purchase provided a chance to suggest a bold experiment. I proposed relocating the summer headquarters on the newly-acquired private land, where there was a fine spring and some wet-meadow pasture. The Forest Service was requested to build a fence from this point to the Rim. I would build a fence across the mouth of the dry canyon. These two fences would create a new unit, a range that could and should be used in the spring and fall. In effect, the ranch would now be divided into three main units: a winter range (House Mountain), a spring-fall range (Jack's Canyon-Jack's Point), and a summer range. See Fig. 1 of the following article by Ranger Perry. The cattle would spend roughly 4½ months each on the winter and summer ranges, the other 3 months on the spring-fall range. Cattle could enter the new unit around April 15, gradually moving, on their own, through the canyon to the higher country. In the fall the process would be reversed.

The Forest Service was enthusiastic, and the plan was soon put in operation. Later I added a well and a branding corral at the mouth of the canyon and built a bull pasture.

The plan has proved to be very effective. The cattle now pretty much move themselves. Death loss has been cut to about 1%. My calf crop is never less than 90% and has been as high as 97%, with most of the calves coming in February, March and April. Calf weights at shipping time have jumped from around 395 lb to 480 lb (Fig. 1). Instead of branding at three different points on the winter range, we now brand virtually all the calves as they enter the spring-fall unit and, because we brand early, we rarely have a case of worms.

About the same time I was putting this new management plan into action I was converting the old-worn out and abandoned farm lands I had acquired into good holding pastures, using various types of wheatgrasses, the best of which was the Amuir strain of intermediate wheatgrass.

I make it a point to sell about 20 head of cows each year, replacing them with carefully-selected heifers. Heifer calves are taken off the cows at the summer headquarters, trucked to the lower ranch, then put on high-protein feed for three months. This gets the heifers off to a good start. They breed as yearlings and get to be big cows. I rarely ship a cow weighing less than 1,000 lb and not infrequently a shipment will average over 1,200 lb. And, since the calves are fed in a corral at the winter headquarters, they develop no fear of people. I now work all my cattle afoot in the corrals, which saves a lot of time.

No cow outfit is, of course, without its problems, and mine is no exception. After 30 years of building tanks and drilling wells, I still find portions of the range that need more water. Juniper is a problem on some 5,000 acres. In my own lifetime I have seen lots of good grass land eliminated by the spread of pine thickets. A noxious plant, pingue, is a problem on perhaps 2,500 acres. My winter and spring-fall ranges get a rest during the summer growing season, but the summer range doesn't. It would be nice if we could work out a rotation system to accomplish this.

Perhaps the greatest problem of all, and one faced by all range cattle people, is the rising cost of production. I feel confident all these problems can be licked eventually, and I look forward to running cattle many more years on my favorite National Forest—the Coconino.

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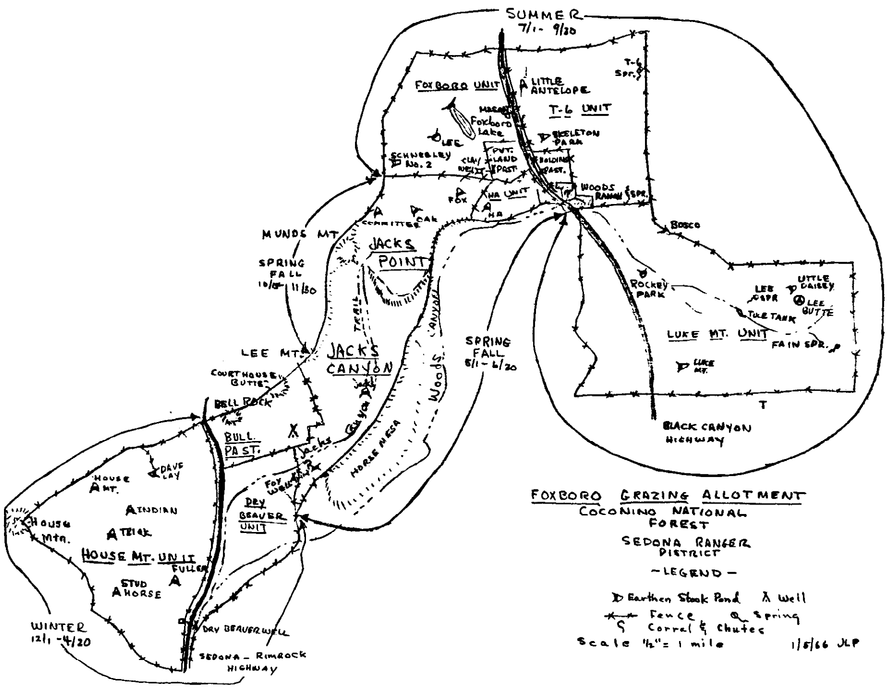


FIGURE 1. Sketch map of Foxboro Allotment, Coconino National Forest, Arizona.

Foxboro Allotment

JAMES L. PERRY
District Ranger, Coconino National Forest, Forest Service, U. S. D. A., Sedona, Arizona.

The Foxboro Allotment lends itself very well to yearlong grazing. The summer units are located in the Mogollon Rim area at elevations running from 6300-7300 ft. (Fig. 1). The higher terrain is characterized by the pine-bunch grass association. Principal grass species are Arizona fescue *(Festuca arizonica)*, pine dropseed *(Blepharoneuron tricholepsis)*, bottlebrush squirreltail *(Sitanion hystrix)* and Kentucky bluegrass *(Poa pratensis)*. These grasses occur in open parks and under an overstory of mature and blackjack pine. In the lower portion of the summer range, junegrass *(Koeleria cristata)*, blue grama *(Bouteloua gracilis)* and pine dropseed are associated with fringe-type pine and mixed-juniper overstory.

The summer ranges are very productive, but need rest and deferment in order to realize full production. Plans are prepared and are contingent on watershed analyses in progress by the Beaver Creek Watershed evaluation team. Repeated growing season use has reduced the full productive capabilities of the summer ranges.

A long area of varied elevational makeup is the spring-fall range that we call the Jacks Point-Jacks Canyon Unit. This area really has two major portions as the name suggests. The Jacks Point area is characterized by fringe pine and juniper overstory with a northern woodland grass association, including blue grama, black dropseed *(Sporobolus interruptus)*, bottlebrush squirreltail and spike muhly *(Muhlenbergia wrightii)*. Early spring and late fall use in this unit allow the warm weather plants to rest during the growing season, thereby helping to maintain a vigorous stand of grass. Further down in the Jacks Canyon area the same growing season rest effects are realized by the warm weather growing species. This area falls within the southern woodland grass association. The overstory is characterized by small juniper, shrub live oak *(Quercus turbinella)* and mesquite and other scattered bushes. Principal grasses are sideoats grama *(Bouteloua curtipendula)*, tobosa *(Hilaria mutica)*, buckwheat brush *(Eriogonum wrightii)*, and curly-mesquite *(Hilaria belangeri)*.

There are two winter units, the Dry Beaver and House Mountain. The Dry Beaver receives light use at the beginning and end of the winter season. It is in the lower reaches of the southern Woodland type. Grasses present not mentioned in the Jacks Canyon unit are sand dropseed *(Sporobolus cryptandrus)* and black grama *(Bouteloua eriopoda)*. There are fewer brush species in this unit.

The main winter unit is the House Mountain. This area provides a wide range of elevational relief from 4000 to 5000 ft. This unit is grazed from December until April and provides a wide range of variety for the cattle. The higher elevations support fairly heavy stands of juniper. Some work at controlled burning of individual trees has been done on this area. Winter use allows for growing season rest.

In addition to the two winter units for general grazing, a bull pasture is maintained for winter use. It is located in the same type country as the Dry Beaver unit.

In addition to being beneficial to the grasses this allotment allows for natural movement through the spring-fall unit. The cattle are branded and put into the Jacks Canyon unit in the spring and move up country with the weather. They are concentrated in the Jacks Point unit before being distributed in the summer units.

The cattle are gathered off the summer units and shipped from the summer ranch headquarters. The mother herd and bulls then are released into the spring-fall range where they move down to the winter range with the weather. The bulls are cut out in Jacks Canyon and the cattle put on Dry Beaver unit, then over to House Mountain for the winter.

Here is where the cycle began.

BOOK REVIEWS

History of Wyoming. By T. A. Larson. *University of Nebraska Press, Lincoln. 619 p. 1965. $6.95.*

To the natives, there is no better place on earth than Wyoming. To tourists, Wyoming is Yellowstone National Park, the Grand Tetons, and the Cheyenne Frontier Days. To many others Wyoming is only a long stretch of bleak windy aridity that connects Nebraska with Idaho.

Really worthwhile histories are objective and are developed from original sources. This book is the result of thorough, objective scholarship. The author has lived in Wyoming for many years and probably considers himself a loyal "native son," but his work does not reflect any of the partisan chamber-of-commerce myopia so common in state and local histories.

Professor Larson's *History of Wyoming* is an interesting, well-written, book about all of Wyoming from the building of the Union Pacific Railroad to the mid 1960's. He has concentrated on writing the history that others have not written. Thus the early Indians, the mountain men, and the early travelers of the old wagon trails are discussed only enough to provide a background for the events of 1867-1965.

The author's approach is basically chronological, but some chapters are devoted to important topics that span more than one time period. Also, the author has done a good job of tying together related subjects discussed as part of different eras. His treatment is thorough, well-documented, but also concise and interesting.

There is something here for Society members who are interested in public land policy, the history of early range use, development of the western range livestock industry, history of the "old west," economic development, modern American politics, and development of tourism. Material on range, livestock, and public lands is found in almost every one of the 18 chapters. Much of it is concentrated in the chapters, "Boom and Bust in Cattle," "Years of Struggle 1890-97," "Huggermugger on the Range 1898-1914," and "Depression Years 1920-1939."

Professor Larson tells what life in the "old west" was really like, and this is interesting reading. He points out that movies and T.V. have overdramatized violence and over-glamorized the "cowboy". He notes though that "one cannot go so far, however, as to assert that there was not more violence then than now, for in proportion to population there was at least ten times as much—long after the turbulent hell-on-wheels era was gone. One who reads the Wyoming newspaper files of 1870 to 1890 finds more shootings, knifings, and general brutality than among the far greater population of the 1960's. Nevertheless, territorial people were, for the most part, civilized. The rough stuff usually happened in saloons or houses of ill fame or near them. People who remained sober and avoided these places usually avoided trouble as well."

The unusual events, of course, always attract attention, and Professor Larson's book has much raw material for many a wild West story or movie. For example, there was the Great Diamond Hoax in the Rocky Springs area in the 1870's, the Pattee Lottery Swindle, scattered cases of vigilante action, the 1885 massacre of 28 Chinese workers at Rock Springs, and the long standing friction between big cattlemen and small cattlemen that led to the "Johnson County War" in 1892.—*Russell D. Lloyd,* Rocky Mountain Forest & Range Experiment Station, Fort Collins, Colorado.

The Changing Mile: An Ecological Study of Vegetation Change With Time in the Lower Mile of An Arid and Semiarid Region. By James Rodney Hastings and Raymond M. Turner. *University of Arizona Press, Tucson. 317 p. 1965. $12.50.*

The main theme of this interesting, well-documented and well-written book is the recent changes in the vegetation, below 5000 ft elevation, of the desert region of southern Arizona and northwestern Sonora, Mexico. Historical records of climatologists and geographers have been used to recreate the climate and vegetation of the past. The story portrayed by repeat photography is depicted by some 194 photographs and illustrates very well that "A thousand words cannot describe a picture". The clarity and detail shown in photographs taken 1890 to 1900 is remarkable. But even more amazing is having a photograph taken from the same point in 1962 on the facing page for comparison. Each photograph is well described giving location, vegetation, altitude and other pertinent information. The authors have done well in interpreting the changes illustrated in each set of contrasting photographs.

The book contains nine chapters. The first three: "The Desert Habitat"; "The Influence of Man: Indians, Spaniards, Mexicans"; and "The influence of Man: The Anglo-Americans" describe the environment of the desert and the factors responsible for changes in vegetation and soil. These chapters prepare the reader for the photographic treatment of vegetation types which follows. Chapter 4 presents "The Oak Woodland"; chapter 5, "The Desert Grassland"; and chapter 6, "The Desert". I think the authors are to be commended for providing in the next three chapters an acute analysis of what has been shown in the photographs. Chapter 7 discusses "The Patterns of Change"; chapter 8, "Some Hypotheses of Vegetation

Change"; and chapter 9, "Change and Cause".

The "Notes" section which appears at the end of the book could more effectively be used on the page where the footnote reference appears. The notes are quite pertinent in many instances but are difficult to refer to because of their unhandy location.

A complete list of scientific and common names appears in Appendices A and B. Appendix C gives location, elevation and photographic credits for all photographs in the book.

This book should find a place in the libraries of all who have an interest in ecology. It will provide a useful reference for university classes in range management and ecology. The authors have emphasized in this volume the importance and value photographs can have in recording history in 1/25th second at f 21.—*Don D. Dwyer,* New Mexico State University, University Park.

Soil Fertility and Fertilizers. By S. L. Tisdale and W. L. Nelson. *The MacMillan Company, New York City. 2nd ed. 1966. $12.50.*

Although primarily a text book, the comprehensive treatment of the relationship of soils and fertility to plant growth and production will be of value to agricultural workers in many disciplines. Especially noteworthy is the historical review of the development of soil fertility concepts from earlier beginnings to modern times.

Each of the seventeen chapters is followed by a summary and a list of questions on the material covered. The bibliographies are complete and useful. Even though many of the concepts are presented in technical terms, the material is understandable and practical. This book will be valuable as a reference in the field of soil fertility.—*Arthur L. Bell,* Agronomy Field Specialist, Soil Conservation Service, USDA, Temple, Texas.

NEW PUBLICATIONS

DESERT CHALLENGE: An Interpretation of Nevada—is a paperback edition of the 1942 book by Richard G. Lillard. This Bison Book by the University of Nebraska Press sells for $1.60 and is attractively printed in large readable type. It is well illustrated, with some 45 pages of photos of every Nevada activity from sheepherding to skiing—taxes and gambling are not overlooked. Chapters are: One of the Forty-Eight, Blueprints of Creation, Horizon Seekers, Chasing a Dollar to Hell, and Wild West in Neon.

TALL TIMBERS FIRE ECOLOGY CONFERENCE.—Proceedings of the Fourth such conference held March 18-19, 1965 in Tallahassee, Florida and sponsored by the Tall Timbers Research Station. This is 279 pages of papers presented by experts from many parts of the USA, with one outstanding paper by John Phillips on fire in Trans-Saharan Africa. It seems that Edwin Komarek and Herbert Stoddard are putting together a more comprehensive fire ecology conference each year.

MAJOR CRITICAL PROBLEM IN THE AMERICAN UNIVERSITY: Quality Teaching in the Freshman and Sophomore Years.—This article in the February 1966 issue of Bio-Science (16:98-101) is by W. T. Lippincott of the Ohio State University. He concludes that the American University, while doing a good job over the years, appears to have lost its first love, i.e.: quality teaching. He thinks it is time we returned to it.

PASTURE AND RANGE FENCES, new fencing bulletin tailored to range conditions in the West, is available to ranchers in 10 western states. Such variables as proper pasture size, topography, soil, vegetation, class of livestock and the variety of posts and wire available, are all carefully considered in the new bulletin. Authors are Michael A. McNamee, University of Wyoming extension agricultural engineer, and Edwin A. Kinne of Denver, United States Steel fencing specialist.

Ten land grant colleges in the West cooperated in printing the 36-page publication and copies are available to ranchers at no cost from the agricultural departments of these schools. They are Oregon State University, Corvallis; University of Wyoming at Laramie; Utah State University, Logan; Montana State University, Bozeman; University of Idaho, Moscow; Colorado State University, Fort Collins; University of Nevada, Reno; University of Arizona, Tuscon; New Mexico State University, University Park; and State University of North Dakota, Fargo.

Complete with pictures and drawings, the bulletin gives detailed recommendations for fence construction on rangeland according to use, class of livestock and type of range.

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

Ross Natural History Reservation

Kansas State Teachers College of Emporia, boasts a 1,040-acre reservation for the study of natural history. The land was leased to the school in 1958 to aid the teaching of biological sciences, to provide an area for research and field study, and to preserve a segment of the Flint Hills-Bluestem grassland in its natural condition.

The lessors, Mr. and Mrs. F. B. Ross, wanted to add the principles of a great out-of-doors laboratory to the education of Kansas teachers. In addition to use by the faculty and biology students at the college, the Rosses hope that teachers in Kansas schools will be able to use the Reservation's facilities in their teaching programs.

C. F. Gladfelter, professor of biology at Kansas State Teachers College for 35 years and a firm believer in natural resource conservation, started teaching a conservation course in 1951. His dream of an outdoor laboratory is now a reality.

"This reservation is a tremendous contribution to conservation education and a delightful source of study and inspiration for future Kansas teachers," says Gladfelter.

Kansas State Teachers College graduates 560 teachers each year, so the conservation education which they receive will have a huge impact on all future Kansans.

In 1961, Ross and his wife gave 200 acres of the original lease to the college outright. The next year, Kansas State Teachers College fenced the 200 acres to separate it from the leased land being grazed. Administrators applied to the Lyon County Soil Conservation District for help in developing a conservation plan. In early 1963, R. P. Felkner, Work Unit Conservationist, and P. N. Jensen, Range Conservationist, of the U.S. Soil Conservation Service, helped Gladfelter develop the plan.

Dale Greiner, graduate student at Kansas State Teachers College observes brush invasion study on rangeland relict area on Ross Natural History Reservation.

The primary objective is to maintain adequate cover for encouragement of wildlife in the area. Specifications are simple—no burning and no domestic grazing.

Many projects, some temporary and some permanent, are fulfilling the objectives of the Reservation. They are student studies or departmental research continuing beyond the time of any one student. All the projects are directly or indirectly related to natural resource conservation. Some major conservation projects involve studies of: (1) revegetation, (2) natural plant succession, (3) grass and forb growth, (4) ecology of range vegetation, (5) shrub invasion in prairie relict areas, (6) wildlife ponds, (7) gully control, (8) plantings for winter protection of wildlife, and (9) shelterbelt plantings. Conservation education programs are also held for grade and high school groups.

In 1963, a 40 x 80-foot steel building was erected. It is being completed for use as two classrooms, five research laboratories, a garage, and a storeroom. It is equipped for year-round use, complete with heating, air-conditioning, and restrooms. First classes were held in it in the summer of 1965.—*Glen P. Snell*, Range Conservationist, Soil Conservation Service, USDA; and *Clarence F. Gladfelter*, Professor of Biology, Kansas State Teachers College, Emporia.

American Institute of Biological Sciences, in cooperation with the National Science Foundation, maintains the National Register of Scientific and Technical Personnel for the biological community.

From the National Register, data are available on numbers of biologists, their experience, academic training, and qualifications. These data are utilized by Government organizations and requests from educational institutions vary from salary to information to assist them in evaluating curricula. Professional societies use Register data in analyzing their programs.

Individual questionnaires are confidential; data are released only on a statistical basis. Questionnaires are distributed every two years—those for 1966 were mailed by the AIBS, on March 15, 1966, to about 75,000 known biologists in the United States. If you do not receive a questionnaire and wish to participate in the National Register, write to Miss Mary G. Donner, Register Supervisor, AIBS, 3900 Wisconsin Avenue, NW, Washington, D. C. 20016.

Grasshoppers may be more of a problem on western and midwestern rangelands in 1966 than they were last year, according to USDA. Over 16.6 million acres of rangeland were found infested with economically significant numbers of grasshoppers in 13 States among those where a survey was conducted last fall by USDA's Agricultural Research Service and cooperating States. This is almost twice the 8.7 million acres found infested in these States the previous fall. An infestation is considered serious when as many as 8 grasshoppers/yd^2 are found. Montana had the largest infested area with 9,080,000 acres, followed by Wyoming with 2,342,000 acres, and Arizona with 1,811,200 acres.

Runoff water from Arizona highways is stored for stockwater where feasible, according to American National Cattlemen's Association "Cow Business." On 0.25 mi. of 2-lane highway, 8 inches of rain amounts to more than 100,000 gal of water.

1965 calf crop for U.S. was 43,140,000 head compared with 43,103,000 for 1964, according to USDA. This small increase made 7th consecutive year in which number of calves born was larger than preceding year. Increase in 1965 was result of more cows and heifers on farms early in year than in 1964. There were 50,376,000 cows and heifers 2 years old and older on Jan. 1, 1965 compared with 49,899,000 on farms Jan. 1, 1964.

1965 lamb crop totaled 17,557,000 head, 2% decline from 1964 crop of 17,905,000 head. 13 Western sheep States produced 1% fewer lambs than in 1964 and 12% less than average. In Texas, which annually produces approximately 15% of the Nation's lambs, lamb crop was 9% greater than 1964, but 8% below average.

World wool prices moved sharply upward in most of 2nd half of 1965, making up part of loss sustained in general downward movement from early 1964 to mid-1965.

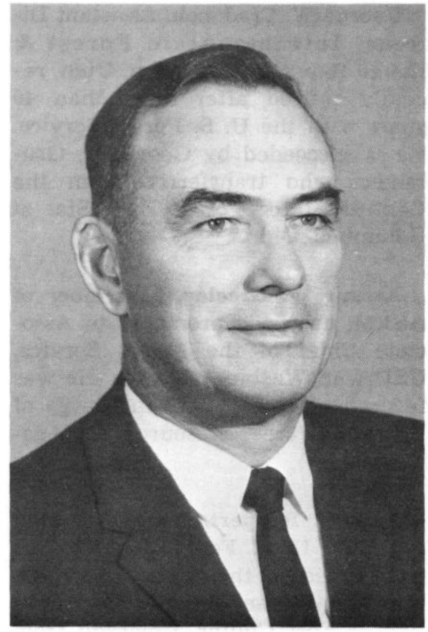
International Symposium on Selenium in Biomedicine, September 6-8, 1966, is being sponsored by Nutrition Research Institute, Oregon State University. Topics of: 1) Distribution of Selenium in Soils, Plants, and Animals; 2) Analytical Methods for Determining its presence in Relatively Gross (Toxic) Amounts and Micro (Essential) Amounts; 3) Toxicity; 4) Nutritional Requirements; 5) Therapeutic Response; 6) Pathological Aspects in Toxicity and Deficiency; and 7) Biochemical Relationships to Enhancing and Antagonizing Substances; will be considered.

For particulars write: O. H. Muth, D.V.M., Symposium Chairman, Dryden Hall, Oregon State University, Corvallis, Oregon 97331.

Caterpillar Tractor Co. expects demand for its products to remain strong in 1966, according to Annual Report. A substantial increase in sales cannot be expected, however, because the level of output in 1965 was close to practical capacity for most products and substantial additional capacity will not become available until late 1967. Caterpillar is a regular Journal advertiser.

Harold F. Heady, of the University of California School of Forestry, will spend most of 1966 in Australia. He has been awarded a Fulbright Foundation grant to finance the trip. Dr. Heady, who teaches and conducts research in range management, will spend nine months of a sabbatical leave at the University of Queensland, in Brisbane. He has been asked to work with university administrators there on development of a new teaching program in range management and to give instruction to both graduate and undergraduate students. Working also with the Department of Primary Industries of Queensland, Heady will visit pasture lands of the state and speak at regional meetings of the department's agricultural staff. He is accompanied by Mrs. Heady and their son.

William D. "Bill" Hurst recently was promoted to Regional Forester for the Southwest Region of the Forest Service with headquarters at Albuquerque, New Mexico. Hurst was Deputy Regional Forester for the Intermountain Region with headquarters at Ogden, Utah. He replaces Regional Forester Fred Kennedy, who retired December 31, 1965.



William D. Hurst, new Regional Forester at Albuquerque, New Mexico.

Bill's Forest Service career started in 1937 when he was employed as a seasonol aide on the Wasatch National Forest at Grantsville, Utah. He later worked on range survey, wildlife management, and as District Ranger, Assistant Forest Supervisor, Forest Supervisor, in the Division of Range Management, Washington, D. C., Assistant Regional Forester for the Intermountain Region in charge of Range Management, and in 1962 was promoted to the position of Deputy Regional Forester.

Bill has been active in conservation circles locally and nationally. He recently completed a term, 1963-1965, on the Board of Directors for the American Society of Range Management. He has served as chairman of the Range Management Section of the Society of American Foresters. In 1962 he received the Silver Beaver Award for his contribution to scouting. In the same year he was also recognized by Utah State University when he was given the annual Jim Bridger Award for conservation and achievement.

George W. Craddock, Assistant Director, Intermountain Forest & Range Exp. Sta., at Ogden, Utah, recently retired after more than 40 years with the U. S. Forest Service. He is succeeded by George F. Gruschow, who transferred from the Central States Forest Exp. Sta. at Columbus, Ohio.

Arthur W. Greeley, a member of ASRM, has been promoted to Associate Chief of the Forest Service, USDA, in Washington, D.C. He was formerly Deputy Chief in charge of National Forest Resource Management.

Jack N. Reppert, Range Scientist with the U. S. Forest Service, has transferred to the Rocky Mountain Forest and Range Experiment Station at Fort Collins, Colorado from the Pacific Southwest Station at Berkeley, California. He will work on a range inventory and evaluation project for the western United States.

George M. Jemison has been appointed U.S. Forest Service Deputy Chief in charge of Research. He succeeds Verne L. Harper who has retired after 38 years with USDA.

Fred Solace

Fred Solace, a forest administrator in Ely, Nevada for the past four years, died September 20, 1965, following an apparent heart attack suffered on the trail below Stella Lake on Mt. Wheeler. He was 32 years old.

Solace, and four other Humboldt National Forest personnel, had been on a one-day trip to get Bristlecone Pine slabs at 10,000 ft elevation and were on their way out when Solace felt pains in his chest. He died about an hour later, according to Donald E. Cox, Forest Ranger. The men were accustomed to working in high elevations.

Three of his companions, LeRoy Goodwin of Ely, Paul Russell, on summer assignment from Utah State University, and John Eldridge of Baker, took turns applying mouth-to-mouth resuscitation and chest heart massage for about two hours. Solace was dead and his companions were carrying him out of the high country when the doctor and officials met them. He is survived by his widow, Marie, infant son, Michael, and by his parents who reside in Craig, Colorado.

Walt Lowell, of Ft. Bidwell, California, died in early February from injuries he received in a plane crash. He had been hiring out to fly predator control (coyote hunting) with John Espil, a sheep rancher in Surprise Valley. Apparently the plane stalled out at a low altitude and crashed in a remote area of northwestern Nevada. Espil was only slightly injured but Walt could not survive the long trip back to civilization and died in the ambulance. Walt had attended the Chihuahua summer meeting of ASRM in 1964, and skippered one of the parties on the rancho air tour. He was a third-generation member of his family to operate a mercantile store and joined ASRM because he appreciated the range and livestock problems of the area.

Reed W. Bailey, Director of the U.S. Forest Service's Intermountain Forest and Range Experiment Station from 1935 until his retirement in June 1962, drowned in Pineview Reservoir near Ogden, Utah, the evening of January 24, 1966. His car slid off the slippery road that skirts the reservoir and down the embankment to the surface of the water. Tracks in the snow showed that Dr. Bailey had walked some distance across ice on the reservoir, when he fell into open water near the dam spillway. A strong ground blizzard was blowing at the time and the temperature was below zero. His body was recovered the following morning.

Reed W. Bailey

Reed was born at Nephi, Utah, January 29, 1896, attended Utah State Agricultural College, and received the B.S. degree in geology from the University of Chicago in 1924 and the M.S. in 1927. He did further graduate study at the University of Missouri. He taught geology at Utah State Agricultural College between 1924 and 1935 and advanced to the rank of full professor.

Bailey's understanding of the forces and factors relating to soil erosion was outstanding. He pioneered development and use of contour trenches to control floods from damaged mountainous and forest rangelands in Utah.

Dr. Bailey received extensive public recognition for his scientific studies. He was chairman of technical sessions on land management at the United Nations Conference in New York City. In 1950, the Secretary of Agriculture presented him a Superior Service award. In 1957, the School of Humanities at Utah State University gave him its Distinguished Service Award, and in 1960 the University granted him an honorary Doctor of Science degree. He was appointed to the Board of Trustees of Utah State University in 1965.

Reed was a Charter Member of ASRM and was influential in development of the Society during and following the first meeting in Salt Lake City in 1948.

INTERNATIONAL NEWS

Australian Arid Zone Research Conference

The second Australian Arid Zone Conference was held at Alice Springs September 12 to 17, 1965. A 4-day pre-conference tour visited the Ayres Rock-Mt. Olga area, a round trip of about 700 miles with stops to observe various plant communities.

About 125 delegates registered. The various subjects were covered by a review speaker who presented both published and unpublished materials, and a discussion leader who summarized the contributed papers. One-third to half the allotted time was usually allowed for discussion. A copy of the condensed papers had been mailed to each delegate 3 or 4 weeks beforehand to permit time for preparation of questions and discussion. The following were subjects covered with some of the points of interest to the author.

Arid zone animals — adaptive mechanisms — native animals. The individual problems of existence center around environmental requirements such as nutrition, cover, toleration of heat, and prolonged water shortages. Animals generally adapt behaviorally or physiologically. For example, there are as many species of frogs in arid areas of Western Australia as in more humid areas. They have survived 5 years of severe drought. They are adapted to arid areas behaviorally (they have deeper burrows) and physiologically (they can rehydrate more rapidly). When the nitrogen content of the diet is low, the euro (a kangaroo) recycles urea instead of excreting it.

Arid zone animals — adaptive mechanisms — introduced animals. During summer, the hair of camels, horses, donkeys, and most breeds of cattle is short from the photoperiodic spring shedding and there is reflection of solar energy from the shiny surface. However, the hair and skin of dark-colored animals in the sun is hotter by 3 to 5 C than that of lighter colored animals. When deprived of water, sheep and cattle continue to pass relatively large amounts of urine for 2 or 3 days, whereas camels promptly reduce urine flow. Sheep and camels conserve intestinal water, and so fecal water may be reduced to 45% of total weight. Water content of cattle feces is rarely less than 60%; *Bos indicus* reduces water loss in this way more than *Bos taurus.* At Rockhampton, Queensland, English breeds of cattle perform better in summer than Brahmans, but this is reversed in winter when feed is of low quality.

Arid zone plants—adaptive mechanisms. Several shrub species effectively increase soil water recharge around their bases by channelling a substantial proportion of the incident rainfall down their stems. The soil near the base of these plants often has a higher infiltration rate than soils away from shrubs. During drought periods, leaf water potentials as low as 140 bars have been measured in hard spinifex *(Tridens basedowii)* and mulga *(Acacia aneura).*

Utilization of local water resources. In arid areas, the catchment area for surface runoff should be at least 30 times as large as that in a temperate zone. A possibility for suppressing surface evaporation from open storage would be to use the South African technique of constructing sand-filled storages.

Range management. Arid zones have been defined by Meigs as "areas in which rainfall is not adequate for crop production." In Australia it is that area bounded by the 10-inch isohyet in the south, the 15-inch isohyet in the southeast, the 20-inch isohyet in the east, and the 25-inch isohyet in the north. Thus, 1,800,000 mi^2 of the total 2,900,000 mi^2 in Australia are in the arid zone. This area supports 2,000,000 cattle and 27,000,000 sheep. The mitchellgrass areas in Queensland support about half the cattle and sheep in the arid zone. The use of American methods of evaluating range condition and trend were reported to be of limited use in Australia for the following reasons: (1) Australian ranges, and the stock industries, are much less productive per unit area of land than American ranges, thus, the methods may be too expensive in relation to income; (2) Australian ranges are grazed year-long, whereas many American ranges are used for seasonal grazing and condition is determined prior to the grazing season; (3) with few exceptions, American methods are concerned with perennial plants whereas on Australian ranges much of the production is from annual plants; and (4) American range managers can draw considerable background knowledge of individual sites and plant species which is not available for Australian ranges.

Twenty-six papers were discussed in the range management session. In the Alice Springs District of the Northern Territory (144,000 mi^2), 69% is non-grazing land because of poor quality vegetation. The 88 properties in the area occupy 95,000 mi^2 and include 92% of the grazing land. To include such a high proportion of the grazing land, large areas of non-grazing lands are included in the properties. On the average, only 44% of the leased land is grazing land; 68% of the grazing land is within 5 miles of water; and 40% is within 3 miles. Because of severe drought since 1956, the cattle numbers in 1965 were down to about 50% of the high.

In Western Australia, burning soft spinifex *(Tridens pungens)* in late spring and deferring grazing for two growing seasons resulted in the growth of useful grasses. Since soft spinifex reinvades those areas, they must be burned every 6 to 8 years. Woody plants are likely to increase at the expense of grasslands. An alternative to long-term grazing management studies would involve computer simulation, based on analytical studies of the various processes.

Economic aspects of the pastoral industry—problems of adaptation of pastoral businesses to the arid zone. No one knows positively whether an economically viable cattle industry, as constituted at present, is compatible with the maintenance of the range resource. Some of the features of the arid zone that make decision-making processes more complex than those in more humid zones are: (1) rainfall is extremely variable; (2) the production period in the cattle enterprise is long; (3) some ranches are poorly organized; (4) fixed costs are high relative to variable costs; (5) the existence of only a single enterprise limits the scope of drought-evading tactics; and (6) space is a big factor in many managerial issues. The strategies which may be adopted by ranchers in the arid zone in an attempt to reduce the effect of climatic hazards on their businesses include: (1) adoption of flexible livestock systems; (2) moving livestock to take advantage of local rain storms; (3) feed reserves, particularly in situ; (4) use of areas reserved exclusively for drought periods; and (5) accumulation of financial reserves. History suggests that the greatest obstacle to the adjustment of a people to its particular physical environment is probably a lack of understanding of that environment.

Animal production. A 10-year study in Queensland, including 6,500 breeding ewes, revealed that one-third failed to lamb, and one-third of all lambs born alive died before attaining marking age. There are indications that reproduction can be influenced by selection against skin wrinkle and for certain hemoglobin types. Since 1910, the sheep population in arid Australia has fluctuated with seasonal conditions and has shown no long-term trend toward increase. In northwest Western Australia, flocks are now unable to maintain themselves. Grazing has probably reduced the diversity of the main plant communities which support sheep. This has resulted in the following changes: (1) increasing dominance of plant species that can withstand stocking; (2) reduced fertility in soil; and (3) reductions in the vigor of grazed plants. In some areas annual species formerly occurred between the tussocks of *Tridens* and *Plectrachne*. Injudicious grazing has denuded extensive areas of these annuals, thereby creating a habitat favorable for the euro; the area is virtually worthless for livestock. Many of the native plants in arid zones produce sparse amounts of forage for each unit of water used. From 60 to 180 tons of precipitation may be required for sheep to produce 1 lb. of greasy wool.

In northwest Western Australia, where summer maximum temperatures are commonly between 105 and 110 F, a comparison between rams imported from the southern part of the state and locally bred rams showed the following: (1) all rams were producing viable sperm during the winter months; (2) one-third of the first generation locally bred rams, and two-thirds of the imported rams were virtually useless from January to April; and (3) all rams initially showing a good semen sample were useless after 15 days of work (local rams recovered after several weeks of rest, but most imported rams did not recover until cooler weather).

Animals in arid areas must survive, produce, and reproduce. In adapted livestock, the feces has a lower moisture content, and the urine is more concentrated. Work at Rockhampton indicates that zebu and zebu crosses have a higher nitrogen conversion rate than English breeds of cattle.

Human adaptation. In most animals, physiological adaptation (acclimatization) is associated with behavioral adaptation. It is important to realize that the extent of physiological adaptation is limited, and that it is incumbent on men living in desert conditions to adapt their behavior to the maximum practical extent, including utilization of all available protective devices. The acute and chronic effects of skin exposure to the ultra-violet portion of the spectrum can result in sunburn or skin cancer. The Australian tropical zone is characterized by having probably the highest incidence of skin cancer in the world. The risk of any individual developing skin cancer is determined by the same factors as for sunburn, and as skin pigmentation is genetically determined, it seems that the specially susceptible light-complected, blue-eyed individuals are unsuited for life in the hot, arid regions.

When exposed to cold on winter nights, aborigines of central Australia had a reduction in blood flow to their skin, thus increasing their body insulation, and consequently reducing their heat loss. Caucasians reacted to the same situation by increasing their metabolism. When measured in terms of food intake the superiority of the aboriginal response is obvious; as an adaptation, it could well have survival value.

The combined demands of sweating and vasodilation mean that in the heat, the burden of temperature regulation is on the cardiovascular system. Acclimatization to heat results in a reduction of this burden. In hot-room experiments, acclimatization to heat is typically accompanied by an increase in sweat secretion. But in some recent experiments, aboriginals with a heat tolerance at least equal to the fully acclimatized Caucasians living in the same area secreted far less. Economy in water turnover would seem to be the desirable response. Sweat secretion involves the loss of sodium chloride from the body, and acclimatization to heat is always accompanied by a decrease in the concentration of salt in the sweat. Therefore, salt tablets are not needed. On the other hand, water intake cannot be restricted without loss of efficiency, or, in the extreme case, danger to life. Thirst is a poor guide to water requirements; many people in the outback probably spend their lives in a state of low-grade, chronic dehydration. Humans working in arid areas may need 4 to 5 gallons of water daily. There is a higher incidence of kidney stones in people living in hot, arid areas. Apparently there is no difference among the human races as to tolerance to heat.

Tourism in the Australian Center is increasing. One of the main factors impeding development of the Australian arid zone is the tremendous isolation (particularly difficult for women) and the lack both of available schooling and good transportation facilities.

A half-day mid-conference tour visited the Amoonguna Aboriginal Settlement and the Animal Industry Research Institute farm.—*Carlton H. Herbel*, Research Range Scientist, Jornada Experimental Range, Crops Research Div., Agric. Res. Serv., USDA, Las Cruces, New Mexico.

WITH THE SECTIONS

NEBRASKA

Section Council Meeting in January made plans for this year and next. The 1966 Nebraska Range Camp at Halsey will be August 7-13, and hopes are to increase the number of boys attending, perhaps up to 50 or more. Section Annual Meeting will be held at North Platte, with headquarters in Pawnee Hotel, September 15-16. The Nebraska Centennial Year Section Annual Meeting is planned for Ainsworth in 1967.

NEVADA

The winter meeting was held in Ely on January 12 and 13, 1966. Approximately 100 members and guests attended.

Wednesday, January 12 was devoted to the business meeting. Agency reports were presented for the Soil Conservation Service, Forest Service, Bureau of Land Management and Agricultural Research Service.

A report on membership indicates there are now 151 members with an additional 6 members joining during the meeting making a total of 157.

Thursday January 13 was devoted to many interesting discussions by: Eric Cronkhite, Planning coordinator for the Nevada State Park System; Jim Crowell, Nevada Division of Forestry; J. B. Wyckoff, Chairman, Agriculture Economy and Education, University of Nevada; A. Perry Plummer, Range Scientist, U.S.F.S., Ephraim, Utah; Paul T. Tueller, Donald H. Heinze, Fred Gifford, Thomas Townsend and H. Richard Holbo, of the University of Nevada; and J. A. Young, Agricultural Research Service.

During the evening banquet, Charles Westover, the 1965 summer range camp's outstanding boy gave his impressions of the camp.

Mr. Wayne Gonder, a rancher, gave a talk on "Selected Events of Range Livestock Development".

Mike Kilpatrick was presented the range man-of-the year award. Kilpatrick has been a member of the ASRM since 1948 and affiliated with the Nevada Section in October 1955. He served as chairman of the Youth Committee since 1956 and was a zone councilman before being appointed Secretary-Treasurer of the Section in 1959 to the present time. He has been the Range Camp Director for the first 5 annual range camps.

The summer range tour is planned during June in Cedarville, California.

NEW MEXICO

The Section faced a difficult situation in February when incoming Section President A. D. Brownfield, Jr., found it necessary to resign. The Council promptly moved President-Elect Richard J. Johnson up to President and called for an election to name the new President-Elect—the man who will be Section President when the Section hosts the Annual Meeting of ASRM in Albuquerque in 1968.

Section Annual Meeting was held in Albuquerque March 18. Theme was "Look to the Future", under program chairman Frank Smith. Speakers included Jon Norris, Les Davis, Bill Currier, H. L. Jacobson, Bill Bates, Eugene Bates, and Jim Anderson.

SOUTH DAKOTA

Tentative range tours for 1966 are: June, John Glaus ranch, Chamberlain; July, Martin Relict Area and Medicine Butte; and September, Henry Frawley Ranch, Spearfish.

SOUTHERN

February Section Newsletter indicates the group has recovered from the Annual Meeting of ASRM in New Orleans. Annual meeting of Section is scheduled for Alexandria, Louisiana in October.

TEXAS

January-February Newsletter lists the complete organization of officers and committees—with a paragraph on the purpose and specific duties of each committee—a good idea for other sections to consider. Section Annual Meeting is scheduled for College Station December 2-3.

UTAH

Initial activity will be associated with the 1966 Conservation Week at Utah State University. On Friday, April 15, 1966, the Utah Section will meet jointly with the Utah State College of Forestry Alumni Association, Intermountain Association of the Society of American Foresters and Utah Section of the Soil Conservation Society of America. All of us are looking forward to the program which will again be a highlight of Conservation Week activities. Deane Harrison is representing the Utah Section of ASRM in planning the program. The program chairman is Ben Heywood who is representing the Soil Conservation Society; Ben is also active on the program committee of the Utah Section of ASRM.

A second activity planned is an all day field tour on the Manti Mountain area on Saturday, June 11. Jim Butler of the Manti-LaSal National Forest will be chairman.

One of the biggest activities of the year will be the annual summer meeting of ASRM at Logan, Utah, July 27-30, 1966. The Utah Section will be host. Ben Heywood is ably planning an interesting program, field tours, and evening entertainment.

The concluding feature of this year's schedule will be the Annual Meeting of the Section on Saturday, December 10, 1966, at the Hotel Newhouse in Salt Lake City. Warren Miller of BLM is chairman.

WYOMING

The Range Management Section of the University of Wyoming has just initiated a series of talks for high school students. These talks are designed to provide students with an understanding of basic range principles and career opportunities in the field. Seniors, biology, general science and FFA students will be the primary audiences. The meeting schedules are set up so that whenever someone from the range section is traveling in the state on other business, they can plan to meet with one or more schools that have indicated their interest in the program.

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Wesley Keller, Plant Industry Station, USDA, Beltsville, Md. 20705

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Crop Science Society of America

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Soil Conservation Society of America

Hurlon Ray, P. O. Box 206, Springfield, Virginia 22150

Soil Science Society

Don Burzlaff, College of Agriculture, University of Nebraska, Lincoln, Neb. 68503

American Grassland Council

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National Watershed Congress

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Ecological Society of America

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American Society of Animal Science

G. M. Van Dyne, Oak Ridge National Laboratory, Box X, Oak Ridge, Tennessee 37831

American Institute of Biological Sciences

C. L. Leinweber, Texas A & M University, College Station, Texas 77843

National Wildlife Federation Conference on Conservation

L. M. Berner, Bureau of Sport Fisheries and Wildlife, USDI, Washington, D. C. 20250

American Association for the Advancement of Science

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Meetings

Summer (July 27-29, 1966) Logan, Utah

B. B. Heywood, Chairmon, 141 W. 2nd N., Logan, Utah 84321

Annual (Feb. 14-17, 1967) Seattle, Washington

Local Arrangements: Wallace Hoffman, Chairman, Dept. of Natural Resources, Box 168, Olympia, Washington 95801
E. Reade Brown
Avon Denham
Claude Dillon
Grant Harris
Robert Hostetter
Norman Knott
Ray Knudson

W. C. Pendray
William Smith
Program: Dillard Gates, Chairman, Oregon State University, Corvallis, Oregon 97331
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A. D. Smith
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Joe J. Alessi
John Gibson
Fred C. Hall
W. A. Hubbard
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Mark Stevens
Harry Wegeleben
Range Plant Contest: Ervin Schmutz, Watershed Management Dept., University of Arizona, Tucson, Arizona 85721
A. M. Davis
Don Dwyer
John Launchbaugh
Jess Lowe
Jack Reppert
Forest Sneva
Interview Service: John Ehrenreich, Chairman, Watershed Management Dept., University of Arizona, Tucson, Arizona 85721
Martin Buzan
J. D. Dodd
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Preliminary Arrangements, Albuquerque 1968: Claude Martin, Chairman, South Star Route, Box 196, Corrales, New Mex. 87048
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S. H. Fuchs
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John Cross
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L. K. Halls
J. F. Vallentine

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Herbert Fisser
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Paul Howard
Wayne Kessler

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Wilson Gutzman
E. H. McIlvain
Laurence E. Riordan
John Schwendiman
George Weaver
Warren C. Whitman

1966 Annual Meeting

The Annual Meeting in New Orleans February 1 to 4 was not the largest, but many participants agreed that it was one of the best in several years. Certainly the ladies must have anticipated it because more than ¼ of the registered delegates were ladies. There were 63 students and total registration of 470. It was reported that at least 100 more had planned to attend, but were cancelled out at the last minute by Government restrictions on travel, including some of those who were to deliver papers. For the first time, some technical sessions were split into three concurrent meetings, a regular three-ring circus. This allowed the acceptance of more good papers, but with the limited attendance in New Orleans did result in rather slim audiences for some sessions. As in the meeting last year, most evenings were left free, and members did enjoy the food and music of Old New Orleans. The seafood was grand. The Social Hour and Banquet on Thursday evening were delightful, with Robert Murphey's droll stories—followed by fine Dixieland Jazz and dancing.

Official actions of the Board of Directors and the Sections Advisory Council will be carried in the Journal. Special mention should be made of the fine field tours provided by the Local Arrangements Committee; one southwest of New Orleans featured fresh marsh rangeland, pastures, and general attractions of the Bayou country. The second tour was across Lake Pontchartrain north of New Orleans and featured marsh ecology, woodland grazing, and wildlife. Both tours were well attended. Ladies had a full schedule with coffee and rolls each morning in the Pavillion Room. Tuesday there was a talk about the Vieux Carre by Fred Wohlford, Director of the Commission, followed by an enjoyable tour arranged by Miss Lillian Redon. Wednesday was Breakfast at Brennans, followed by a boat tour up the river for many. A full schedule, well prepared and handled by the Ladies Committee headed by Ivan Porter, with lots of help from Mesdames Stephenson, Zillgitt, Cloward, Campbell, and many others.

C. W. Zumwalt, left, receives first place grand prize in photo contest from Walter Bunch.

Committees who have planned and staged annual meetings know the work involved — there was unanimous expression of appreciation to the Southern Section and to all the committees on arrangements and program for another fine Annual Meeting.

The accompanying photos of the Annual Meeting are courtesy of the U.S. Forest Service, which provided press service for the meeting under the leadership of Bill Huber of the Southern Regional Office in Atlanta, Ga.; see inside back cover.

Outgoing President Clint Wasser, left, inducts incoming President Mel Morris into his new office.

1966 Range Plant Contest

Eleven schools and 41 students took part in the Intercollegiate Range Plant Identification Contest at New Orleans. Winning schools and coaches were:

1. Texas Tech, Joe Schuster
2. Utah State Univ., Jim Grumbles
3. Colorado State Univ., Roy Miller

Other schools participating were Univ. of Wyoming, Brigham Young Univ., South Dakota State Univ., Oklahoma State Univ., Univ. of Arizona, New Mexico State Univ., and Fort Hays Kansas State College.

Individual high scores were won by:

1. Jimmy Brown, Texas Tech
2. Joe Fraser, Texas A&M
3. Alma Winward, Utah State.

1966 Photos and Displays Contest

Color Slides

RANGE PLANTS
1. Bill Berg, Berea, Kentucky
2. Bob Ragsdale, College Sta., Texas
3. Hugh E. Cosby, Minot, North Dakota

RANGE ANIMALS
1. Richard Hafenfeld, Costa Mesa, Calif.
2. William Laycock, Logan, Utah
3. Keith Severson, Laramie Wyoming

RANGE CONDITION
1. J. T. Nichols, Brookings, So. Dakota
2. William Laycock
3. Dan Merkel, Santa Fe, New Mexico

RANGE IMPROVEMENT
1. Bob Ragsdale
2. J. T. Nichols
3. C. W. Zumwalt, San Francisco, Calif.

RANGE & RANCH SCENE
1. Tom Shiflet, Alexandria, Louisiana
2. Dan Merkel
3. C. W. Zumwalt

RANGE VEGETATION TREND
1. Hugh E. Cosby
2. William Laycock

Black & White Photos

RANGE PLANTS
1. Bob Gibbons, Berkeley, California
2. George Wolstad, Missoula, Montana
3. Richard Rodgers, Edmonds, No. Dakota

RANGE ANIMALS
1. George Wolstad
2. Richard Rodgers
3. Bob Ross, Bozeman, Montana

RANGE CONDITION
1. J. L. Gardner, Tucson, Arizona
2. George Wolstad
3. Carl Goebel, La Grand, Oregon

RANGE IMPROVEMENT
1. C. W. Zumwalt
2. George Wolstad
3. Tom Shiflet

RANGE & RANCH SCENE
1. C. W. Zumwalt
2. George Wolstad
3. Vinson Duval, Alexandria, Louisiana

RANGE VEGETATION TREND
1. William Laycock

GRAND CHAMPION (All photos-Color & Black & White) $15.00
C. W. Zumwalt, San Francisco, Calif.

PICTURE STORY
1. C. E. Conrad and C. A. Graham, Berkeley, California
2. Bob Ross, Bozeman, Montana
3. Tom Shiflet, Alexandria, Louisiana

DISPLAYS
1. Colorado Section
2. Kansas-Oklahoma Section
3. California Section

From The Executive Secretary

Several important actions were taken by your Board of Directors at their two meetings in New Orleans in February.

It was decided to refer to the membership by letter ballot the proposal to require 75 signatures on a petition for nomination and also to require that signers be paid-up members, and must represent at least two Sections. This will be done this year.

The Board adopted a policy of granting an annual certificate and citation to one or more persons who have made truly outstanding contributions to the Science and Art of Range Management.

The Society was presented a beautiful silk Mexican flag as a gift from the Chihuahua Livestock Union by Sr. Quevado, President the Union.

Approval was voted to present a membership certificate to all new members and to old ones who want one.

Action was taken to improve, expand, and implement a broader public relations program for the Society.

Certain steps toward an expanded central office of the Society were taken. It was decided that eventually the permanent headquarters of the Society should be in the Denver, Colorado area. As a first step it was decided to employ a managing editor to work in the office of the Executive Secretary this year. This person will take part of the load from the Editor and part from the Secretary's office.

The Glossary of Terms used in Range Management will be translated into Spanish for sale in the Spanish speaking countries. The Editorial Board was instructed to consider charges for papers printed in the Journal which exceed four pages in length and to make a recommendation to the Board in July on the kind of cumulative index to be printed at the end of the twentieth or twenty-fifth volumes.

A resolution presented by the Range Management Education Council, an organization of representatives of colleges and universities teaching Range Management, was adopted by the Board. The resolution published in this issue of the Journal, specified minimum educational requirements for qualification for Civil Service examination for Range Conservationist.

Albuquerque, New Mexico was chosen as the site of the 1968 convention.

The possible publication of a report on libraries having range management material is to be reviewed by a committee selected by the Editor and recommendation made at the meeting of the Board in July.

On January 31 the Board temporarily recessed its meeting and sat as the Officers and Trustees of the Amercian Society of Range Management Trust. The suggestion was made that the existence of the Trust be publicized in the Journal and reprints be made for publicity purposes and to encourage donations thereto. See bottom page 128.

Big news from the Secretary's Office is the move to new quarters on April 8th. This involves only a move of two blocks to 4023 N.E. Tillamook Street. We'll be out of the basement, on the ground floor and have separate office rooms. Our mailing address continues to be P. O. Box 5041.

RESOLUTIONS ADOPTED BY ASRM
Board of Directors at New Orleans, February 3, 1966

Range Research

The American Society of Range Management recognizes the importance and need for establishing and maintaining an aggressive research program relating to the improvement, use and management of grazing land resources.

The Society also recognizes that range research needs are being inadequately supported in relation to the importance of these range-land resources for livestock, wildlife, watershed and recreation uses. Increased costs of operating has seriously reduced the previous combined capacity of the research agencies to meet these needs. As a result, research positions have been closed out and work discontinued in order to keep some semblance of a program operative. A continually growing body of research is just as essential to proper land management as research is to commerce and industry. The facilities and manpower dedicated to solution of natural resource problems must not be reduced. New or expanded facilities to more adequately meet range research needs are behind schedule.

The elimination of some stations has been or is being proposed. For instance, abandonment of beef cattle research and disposal of property at the Fort Robinson, Nebraska Research Station is currently being considered. Elimination of a station represents a critical loss to society. The locations of these stations have been carefully selected to serve the regional conditions which they represent. Furthermore, these stations and their test results become more valuable with time.

We urge all appropriate federal and state agencies to give very serious consideration to retention, strengthening or broadening of aggressive and adequate research programs on range-land problems. We further urge that these programs be developed to meet modern multiple use needs of the resource considering livestock, game and related uses.

Minimum Professional Standards for Range Managers and Conservationists

The American Society of Range Management is an international organization of nearly 5,000 members, representing a broad spectrum of interests. As such, we have special concern for the proper management of this country's land resources.

Management of these resources requires the use of scientific principles, techniques, and arts development by a complement of courses essential and unique to the range management profession. It is therefore important that the men employed to manage federal lands, and to advise users of private range lands, have specific knowledge and abilities. For this reason, the American Society of Range Management adopts the following minimum educational requirements for professional Range Conservationists, and Range Managers and urges the U. S. Civil Service Commission and personnel officers of Federal agencies to establish the following as minimum qualifications for the Range Conservationist Federal civil-service examination:

Completion of a bachelor of science degree from an accredited college or university with major course work in Range Management or in a closely allied natural resources field with minimum course work in essential subject matter areas as follows:

One course each in Plant Taxonomy, Plant Physiology, and Plant Ecology.

One course in Soils.

Animal Science or Husbandry—one course in either Nutrition or Feeds and Feeding.

Range Management — 16 semester credits which must include work in each of the following areas:

1. *Range Plants:* identification and ecology of individual plants and plant communities, including agrostology,
2. *Range Methods and Techniques:* vegetation sampling, inventory, utilization, condition and trend,
3. *Range Management Principles:* grazing management, improvements and developments, economics and planning, and multiple-use inter-relationships.

Inclusion of these courses in a professional curriculum allows ample flexibility for additional academic training in such related areas as economics, speech, sociology, public-land administration, business administration, personnel management, game management, watershed management, forestry, and recreation.

This resolution was passed by the Board of Directors of the American Society of Range Management in session at New Orleans, Louisiana, February 3, 1966.

Melvin S. Morris
President, American Society of Range Management

Range Seeding Equipment Committee Meets

The Range Seeding Equipment Committee, chaired by John Forsman of the U.S. Forest Service, held its twentieth annual meeting at the Jung Hotel, New Orleans, 30 & 31 January 1966. Twenty-one subcommittees presented project accomplishments for the past year and developed a program for 1966.

A brief history of the Committee and its objectives should be of interest. In the early 1940's, western regions of the Forest Service recognized the shortcomings of commercially-available equipment used in rangeland management and improvement programs. Commercial equipment, in the main, was designed for agricultural purposes. Consequently, use of such equipment under rigorous wildland conditions met with failure or, at best, presented many operational problems. Accordingly, representatives of 6 western FS regions met in Portland, Oregon in 1946 to ". . . . Consider, evaluate and assign priorities to the equipment problems suggested by the various Regions". A program of work for the FS Equipment Laboratory was to be developed each year. In 1949, the Committee's purpose and objectives were described in more detail as follows: (1) Evaluate the potential use of available equipment for range seeding and brush control programs. If unsatisfactory, design, construct and test suitable equipment under Committee guidance, (2) Prescribe specifications and standards for purchase, maintenance and use of equipment and materials, (3) Function as a clearing house for interchange of seeding equipment information between Regions and Stations, and (4) Act in an advisory capacity to various FS units on range seeding and undesirable plant control policies, techniques and methodology.

The Committee's existence and purpose became known to other Federal agencies. Agricultural Research Service (Bureau of Plant Industry), Bureau of Land Management and Soil Conservation Service were represented at the 1949 meeting. Also in attendance were 15 individuals designated by the Chief, USFS., representing his office, six western Regions and four western Experiment Stations. It was readily apparent that broader representation of agencies, organizations and individuals with similar needs would maximize the Committee's contribution.

Accordingly a subcommittee was designated in 1954 to explore the Committee's future. Its report at the 1955 meeting in San Jose was approved as follows: Retain the name "Range Seeding Equipment Committee" and maintain an informal organization, unrestricted as to membership or participation by interested agencies, groups or individuals.

Broad aims of the Committee as stated then were: (1) to keep abreast of commercially-developed equipment and modify as required for wildland use, and (2) to develop equipment, if not commercially-available, with priority determined by urgency of needs. The Committee's initial activities were mainly concerned with range seeding equipment development and testing and seeding techniques. Since, however, equipment needs for allied fields such as plant control, pitting, contour furrowing and water spreading have been included.

Responsibility for modification of commercial equipment and/or design and prototype fabrication of specialized equipment is assigned to the FS Equipment Development and Testing Center located at San Dimas, California. Program financing is jointly borne by the Bureau of Land Management, Bureau of Indian Affairs and Forest Service at present. The Soil Conservation Service has provided funds in the past.

Interest, participation and membership have increased steadily. Peak attendance occurred at the Fifteenth Annual Meeting in Salt Lake City with 150 individuals representing 24 varied interests (State and Federal agencies, educational institutions, equipment firms, ranchers, International Cooperative Administration, and foreign countries).

Development of suitable equipment to satisfactorily accomplish objectives of wildland management programs (as well as those less demanding) has been an outstandingly successful accomplishment of the Committee. Several of the main equipment items developed include the Rangeland Drill, Brushland Plow, Baby Brushland Plow, Rockland Tiller, Contour Furrower, tractor-mounted sprayers (small and large track-layers), brush cutters, alpine equipment, pitting equipment, precision grade indicator, and terracing-dike building equipment. These and others have made it possible to improve watershed cover and forage supplies under conditions that would not have been possible otherwise and commonly at a reduced cost.

Specialized equipment developed by the Committee must necessarily be custom-fabricated. The relatively limited demand precludes normal stocking by commercial firms. Participating Federal agencies, the main users of this equipment, arranged to center purchasing responsibility with the California Region, Forest Service. This includes bid preparation and award, inspection and other related matters. Annually, purchase orders from respective field units of participating agencies are consolidated into one contract.

The California Region has authorization to process only Federal purchases. However, non-Federal parties have also purchased some specialized equipment. Upon award of a contract, the name of the contracting firm is provided interested parties. They, in turn, negotiate their own purchase with the firm; usually for or approximating the contract price. Several rangeland drill purchases have been made in this manner by ranchers, industry, educational institutions, foreign countries and others.

Perhaps, the most unique and outstanding contribution of the Range Seeding Equipment Committee has been the unselfish cooperation it has fostered. All individuals, regardless of allegiance, have cooperated unstintedly to get the job done. Little consideration has been given to individual or organization credit.

Various publications by the Committee have filled an urgent need. These include an updated revision of a Range Seeding Equipment Handbook itemizing equipment suitability for various rangeland treatments, Chemical Control of Range Weeds Handbook, Equipment Operating Hints, Grazing of Seeded Species, Rangeland Drill and Brushland Plow Parts & Service Manuals, and other reports related to specific types of equipment and phases of seeding.

Most of the 1965 projects are of a continuing nature. In addition, several new projects were proposed at this year's meeting. Incorporation into the 1966 program will be dependent upon available financing.

The Range Seeding Equipment Committee plays an important role in the field of rangeland improvement and management. Much of its accomplishment is applicable to other fields of resource management. The Committee is especially effective as a clearing house and coordinating body for free exchange of thinking as related to equipment suitability and needs. Greatest good will continue to result from the active participation of a large and varied group of individuals devoted to development and management of rangeland. —*A. B. Evanko,* Division of Range and Wildlife, Forest Service, USDA, San Francisco, California.

Second Call for Papers
20th Annual Meeting, American Society Of Range Management

February 14-17, 1967
Olympic Hotel,
Seattle, Washington
Theme: "The Next Twenty Years"

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

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

Deadline: Titles, preliminary abstract, and supporting statements must be in the hands of the Program Chairman by June 1, 1966. For details see p. 108-109, March 1966, issue of the Journal.

File four copies of requested material by June 1, 1966, with:

Dr. Dillard H. Gates, Program Chairman
1967 Annual Meeting, American Society of Range Management
Withycombe Hall 208
Oregon State University
Corvallis, Oregon 97331

ASRM 1966 Summer Meeting in Logan, Utah

The 1966 ASRM summer meeting will be in Logan, Utah July 28-29-30. Utah Section will host this gathering in scenic and historic Cache Valley. Registration will begin in the evening July 27, Room 112 Forestry and Biological Sciences Building, Utah State University. There will be a lecture on natural resources of Logan Canyon.

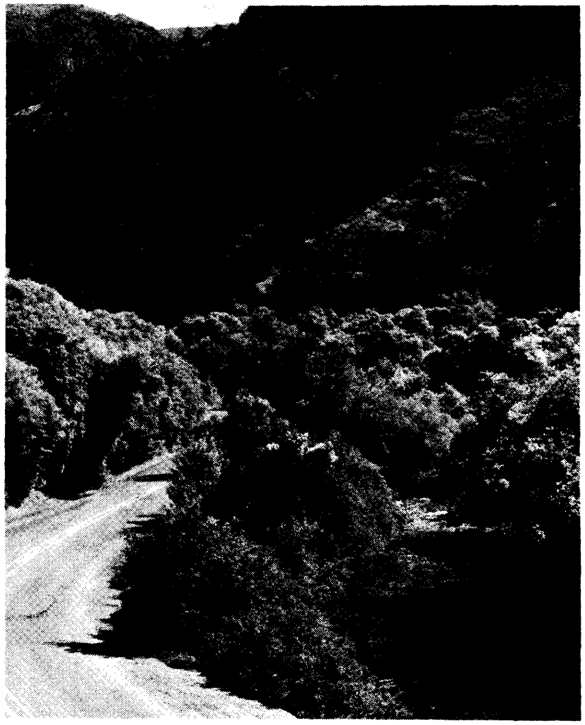
On July 28, the program on range and livestock subjects will begin at 2:30 PM with Prof. L. A. Stoddart, Attorney Edward Clyde, Livestockman Dan Freed, and Public Officials Jay Bingham and Hugh Colton. At 6:30 PM there will be a smorgasbord dinner and entertainment, followed by Prof. Leonard Arrington speaking on Early History of Utah Ranching.

On July 29 a tour to Bear Lake and Monte Cristo will be conducted, at $4.00 per person for bus fare and box lunch. Evening activity features a steak barbecue in Logan Canyon.

On July 30 there will be a choice of four tours: (1) Research in Logan Canyon; (2) Davis County Watershed; (3) Management of Private Ranches in Cache Valley; and (4) Wildlife Management, Fish and Game.

The 1966 Youth Range Fact Forum will be synchronized with other sessions as follows: July 27, PM only, Forum Committee assignments and Range Management as a Profession; July 28, Section reports on youth activities, papers, range tour; July 29, range and ranch tour; July 30, AM, Committee reports.

Special activities are planned for ladies and children, with a luncheon on July 28 at $1.75 per person. Additional recreation includes swimming, bowling, golf and tennis.



Logan has many motels; list with prices can be furnished on request. Housing will be available in University dormitories at $12.00 per person for the three nights. Some three-bedroom apartments with kitchens are available near campus. Accommodations for Youth Forum delegates and chaperones have been arranged courtesy ASRM. Forest Service campgrounds are available in near-by Logan Canyon under National Land and Water Conservation Permit or a small daily charge. Logan is accessible by major highways, Greyhound bus, and air taxi service from Salt Lake City and Ogden. The nearest rail station is Ogden. For further information, write to: D. S. Winn, Room 201 Professional Building, 52 North First East, Logan, Utah 84321.

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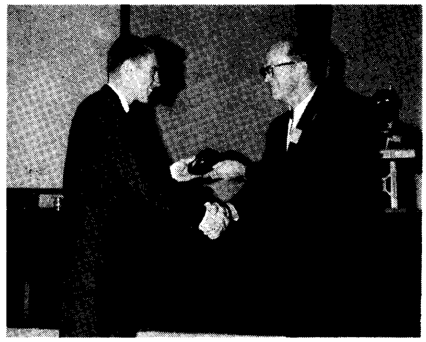
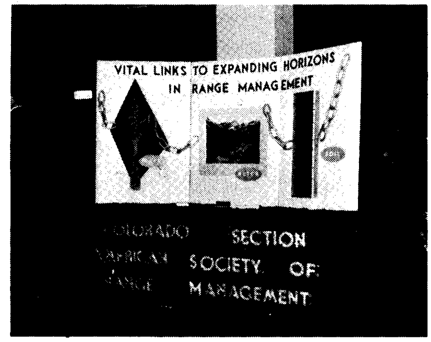
Photos from the 1966 Annual Meeting

(Courtesy U.S. Forest Service)

Close scrutiny in the plant identification contest.



Jimmy Brown, left, of Texas Tech receives first place individual award in plant identification contest from Dr. Ervin Schmutz.



First prize winning display from Colorado Section.

At the Annual Banquet.

Our dancers loved the music of this New Orleans Dixieland Jazz Band after the Banquet.

Ladies tea in Pavillion Room: Left to right, Mesdames Dahl, Reid, Wasser, and Klemmedson.

Officers and Board of Directors of ASRM for 1966. Back row, l. to r., Alex Johnston, Donald R. Cornelius, Charles E. Poulton, Morton May, Martin H. Gonzalez. Front row, Editor R. S. Campbell, President Elect C. Wayne Cook, President Melvin S. Morris, and Executive Secretary John G. Clouston. Missing: Board member William J. Hoffman and Past President C. H. Wasser.

Winning team in range plant identification contest, Texas Tech: l. to r., coach J. L. Schuster, George Mitchell, Darrell Ueckert, Jack Prichard, and Jimmy Brown.