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New Developments in Chemical Brush Control in Arkansas

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Eradication and control of noxious brush on rangelands, pasturelands, and woodlands offer excellent opportunities for improved forage and timber production in Arkansas. The fight against low grade trees and brush has been going on here for many years. Farmers, timber companies, chemical companies and Federal and State agencies are now working side by side in the battle. The progress in the last six years is most encouraging.

With the advent of chemicals made especially for control of broadleaf plants, many large scale aerial applications have been made on Soil Conservation District cooperators' farms in Arkansas. To date, over 68,000 acres have been aerial sprayed on these farms and many more thousands of acres have received ground applications.

These applications follow field trial plots established in the years 1950 to 1956. Technicians of the chemical industry provided most effective cooperation in setting up the trial plots. This paper gives some of the important techniques learned from applications on these farms. These applications included treatment on pasture lands, rangeland, and removing hardwoods in woodlands.

General Information on the Herbicides Used

Both the high-volatile and low-volatile esters of 2,4-D and 2,4,5-T have been used. The high-volatile esters used were methyl, ethyl, propyl, butyl and pentyl. The low-volatile esters used were isooctyl, butoxy ethyl, tetrahydrofurfuryl, butoxy propyl, butoxy ethoxy propyl, ethoxy ithoxy propyl, and propylene glycol, butyl ether ester.

Work is now underway using urea herbicides. The mode of action of these herbicides provides a new and fundamentally different approach to the control of woody plants. Urea herbicides are applied to the soil surface and subsequently are absorbed by the roots of the plants and translocated to the aerial parts of the plant, where toxicity is expressed. The symptoms of urea herbicide toxicity are typically a chlorosis of the foliage, which is followed by necrosis of leaf parts and finally by leaf abscission and defoliation of the plant. These changes take place slowly, and are progressive throughout the growing season. Several seasons usually are required to kill most woody plants of any size.

Of considerable interest in the field of brush control with chemicals is the current work underway with herbicides in pellet form. The pellets are applied to the surface soil, and the chemical is moved to the root zone by rainfall. This type of application has great possibilities in Arkansas. Ammate emulsions are being evaluated by various field trials to determine the

FIGURE 1. Aerial application of chemicals for brush control in Arkansas. Chemicals are being applied by a Stearman airplane flying 75 mph. on 26 ft. swaths and as low as possible.

effectiveness of standard sprays with ammate solution.

Application

Most of the large scale chemical brush control work on the farms of Soil Conservation District cooperators in Arkansas has been with 2,4-D, 2,4,5-T and propionic acids. The application has employed many types of equipment. The foliage application has been done with modified Stearman airplanes, Super Cubs, helicopters, ground equipment, and hand sprayers.

The method used most extensively on farms in Arkansas has been aerial application of the chemical with the Stearman airplane, using a 220-horsepower engine. Approximately 55,000 acres of brush have been sprayed on farms in Arkansas with the Stearman airplane since 1950. Most of the Stearmans used have an improved hydraulic-driven pump unit operating a boom equipped with 12 nozzles, delivering 5 gallons of spray solution per acre in swaths of 26 feet, flying 75 miles per hour. These planes have a capacity of 100 gallons.

A high percentage of the brush work has been done with Super Cubs, using an engine having 150 horsepower. Best results have been obtained with a pressure of 30 pounds, using a boom with 16 nozzles with a Number 6 spray jet. The Super Cubs have a capacity of 110-120 gallons and deliver 5 gallons of spray solution per acre in swaths of 30 feet, operating at 80 miles per hour.

There is an increasing interest by landowners in Arkansas in the use of helicopters. They are more expensive than the Stearman and Super Cubs, but they do have an advantage in that they can take off and land straight up and down without a runway. Most of the helicopter work has been done using a pressure of 30 pounds on a boom with 12 nozzles. The rate of speed is usually 45 miles per hour, using a swath of 35 feet when applying 5 gallons of mixture per acre.

Table 1. Recommended treatments using foliage application.

Airplane Spraying

Type of Brush	Herbicide	Pounds Acid Per Acre	Volume Spray Per Acre*	Remarks
Mixed oaks and associated hardwoods	2,4,5-T	2	5	Re-treat the second year with 1 to 2 lbs. per acre
Oaks	Propionic Acid	2	5	Re-treat the second year with 1 to 2 lbs. per acre
Willow, cottonwood, locust	2,4-D 2,4,5-T (50/50)	2½	5	Re-treat the second year with 1 to 2 lbs. per acre
Persimmon, sassafras, sumac	2,4-D 2,4,5-T (50/50)	1½	7½**	Re-treat the second year with 1 lb. per acre
Release of coniferous trees	2,4,5-T	2	5	Spray after June 25

* Use 1 gallon diesel oil in 3½ gallons of water
** Use 1 gallon diesel oil in 6 gallons of water

Ground Spraying

Type of Brush	Herbicide	Pounds Acid Per 100 Gal. Water	Remarks
Mixed oak and associated species	2,4,5-T	4	Mix 4 lbs. of chemical with 5 gal. diesel oil before mixing with water.
Persimmon, sassafras, willow, cottonwood, locust	2,4-D 2,4,5-T (50/50)	3	Re-treat the second year with 2 lbs. of same material per 100 gal. water. Apply as wetting spray. Volume per acre depends on density and size of brush

With all types of aerial application on farms, best results have been obtained when the equipment has some type of pressure pump. The pressure behind the spray seems to give an even, controlled flow and good atomization. The orifice outlet faces rearward to give a coarse droplet.

Behind every good aerial spray job is planning, which includes flagging. Permanent and swath flagging is difficult in some areas in Arkansas because of the terrain, height of trees, and type of brush. Adequate flagging has been one of the most important factors. Many types of flagging have been used including: balloons, smoke pots, flags in trees, radios, and so forth. At the present, the best flagging is done by placing the flags in tree tops fastened to 20-30 foot cane poles, the permanent flags being spaced every ten swaths, or 260 feet. With this type of permanent flagging, it is best to use the colors of white, yellow and orchid. Experienced swath flagmen are essential. They must get to their next station before the pilot is ready to line up for his next pass. Most flagmen use three-foot squares of white cloth atop cane poles, which are mounted on aluminum tubing.

In addition to insuring good coverage, proper flagging will enable the pilot to make quick checks on the volume of material per acre that is being applied.

Airplane application appears to be the only feasible method for applying spray rapidly and economically on large areas of moderate to heavy brush. Also, airplanes can operate when it is too wet for ground sprayers. Aerial application of chemicals for brush control is a very sensitive operation. Good

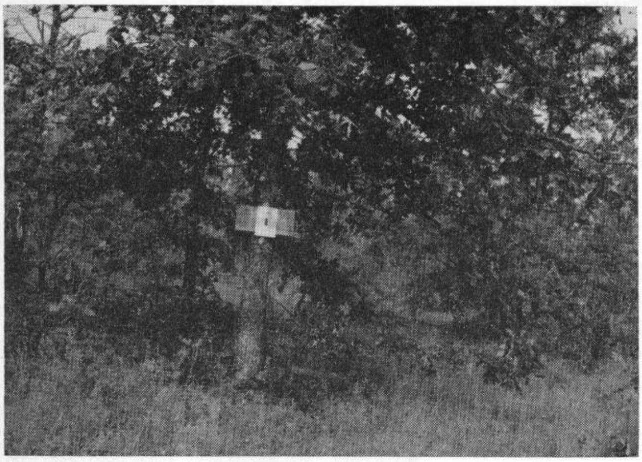

FIGURE 2. *Left*: Portion of brush covered area before aerial spraying with 2,4,5-T on May 22, 1955. *Right*: Same area on June 1, 1956. Rate of application was 2 pounds of acid of 2,4,5-T with one gallon of diesel oil and 3½ gallons of water per acre.

results are obtained only when all phases of the operation are carried out correctly. The important factors in a proper aerial application include the following:

1. Study of the area to be sprayed
    a. Soil types
    b. Types of woody plants
    c. Purpose of spraying—such as timber stand improvement, or brush control on range or pasture land
2. Time of day—early morning, late evening
3. Time of year — May, June, early July
4. Temperature—65°-80° F.
5. Wind—less than 5 miles per hour
6. Humidity—high
7. Soil moisture—favorable for plant growth at time of application and for several weeks following application
8. Proper spray system on aerial equipment
9. Pilot trained in aerial application of herbicides
10. Area properly flagged with permanent flags
11. Trained flagging crew
12. Reliable chemicals and carrier, mixed correctly
13. Correct flying of airplane

Number 2 diesel oil is the principal oil used as a carrier for the ester formulations. Oil-water emulsions prepared with emulsifying agents also give effective and economical carrier solutions. Some work is now underway using nontoxic oils as a carrier. A formulation containing a new emulsifier is now being used that permits mixtures in straight oil without the difficulties of the emulsifiers and other settling to the bottom of the spray mixture. This new emulsifier has been designated as O S (oil stable) formulation.

Ground Equipment

Spray solutions may be applied to the foliage of brush with many types of ground equipment. The character, density, and type of woody plants will determine the type of equipment to use. Hand sprayers are good for small areas of brush, fence rows, and seedlings. With any equipment, it is necessary to completely wet the foliage. Best results have been obtained with a mixture of one gallon 2,4,5-T, five gallons diesel oil and 94 gallons of water. However, some species, such as willow, persimmon, sassafras and cottonwood, can be controlled better with half 2,4-D and half 2,4,5-T.

Power equipment such as tractor, truck, or jeep drawn vehicles is becoming popular for many types of brush control work in Arkansas. The spray solutions applied by ground power equipment are the same as hand equipment. Good results have been obtained with power equipment on a foliage application as late as August. However, best results have been obtained when the brush was sprayed in May, June, and July.

Several kinds of power sprayers are on the market. Some are driven by tractor, power take-off or belt, some are trailer mounted and driven by small gasoline motors, and others are mounted on jeeps, tractors and trucks. Good results usually have been obtained when the following procedures and precaution have been observed:

1. Use nozzles that give a fine fan-shaped spray.
2. Mixture: one gallon 2,4,5-T (4 lbs. acid) with 5 gallons diesel oil mixed with 94 gallons water.
3. Wet foliage thoroughly.
4. If a boom is used, it must be well braced.
5. Use a by-pass valve to insure uniform pressure from 20 to 100 lbs.
6. Use a pressure gauge to assure constant pressure.
7. Use screens or filters to keep nozzles from clogging.
8. Use a detergent, such as "Tide", to add a sticking characteristic to the mixture.

The spray equipment for control of woody plants must be of sturdier construction and capable of delivering a larger volume of liquid than those used in weed control. The equipment should be as compact as possible.

Observations made over a 6-year period indicate that control of broadleaf plants with foliage

Table 2. Recommended treatments using basal application

Method of Application	Herbicide	Pounds of Acid	Remarks
Hand sprayer	2,4,5-T	4 lbs. per 25 gal. diesel oil; ½ to 1 pint per 3 gal. diesel oil	Lower dilution may be used on stems up to 3 inches in diameter.
Hand sprayer	Propionic acid	Same	Same
Tree Injector	2,4,5-T	2 lb. per 4½ gal. diesel oil	One injector will hold enough chemical for approx. 400 injections. Use from Sept. to March
Tree Injector	Propionic acid	Same	Same
Frill and spray	2,4,5-T	Use 1% solution	Apply solution in a frill
Stump Treatment	2,4,5-T	4 lbs. per 25 gals. diesel oil; ½ to 1 pint per 3 gal. diesel oil	Spray entire stump. Adequate wetting necessary for best results.
Stump Treatment	Propionic acid	Same	Same
Power sprayer	2,4,5-T	16 lbs. acid per 100 gal. diesel oil	Spray lower 12-15 inches of stem until wet. For small brush wet whole plant.
Power sprayer	Propionic acid	Same	Same
Tree Girdling	2,4,5-T	½ lb. per 5 gal. motor oil	Apply to lower part of groove with brush
Ground Application	Monuron (unsubstituted urea)	⅛ to ¼ lb. per one gal. water	Apply a four inch band around, and a foot away from tree

sprays has been much better on some soils than on others. Greater success has been obtained on such soils as Muskingum, Hector, Pottsville, and Fayetteville fine sandy loam, than on Cleburne fine sandy loam, Waynesboro fine sandy loam, Newtonia loam, Pulaski, and Centerton.

Basal Treatment

This refers to a chemical spray application by hand or ground equipment to the lower stem, cut stump, actual injection of chemical into the trunk, application of chemical into frills made with an axe, or application of chemical into a groove made by a girdling machine.

Basal application of chemicals is the most common method used for controlling unwanted trees in desired stands. This application has been highly effective for control of most of the broadleaf type plants.

Spraying the stems of trees less than five inches in diameter is a common method that has proved successful. This treatment consists of spraying the lower 12 inches with a mixture of one gallon 2,4,5-T (4 lbs. acid) mixed with 25 gallons diesel oil. For effective control encircle the stem to the point of runoff. Best results have been when the spraying was done from October to March.

Another basal treatment that has proven successful, especially in removing unwanted hardwoods in pine stands, is frilling the tree and applying a one percent solution of 2,4,5-T in the frill. The frills are made by making a single hack girdle at chopping height. This treatment is good for trees 6 to 10 inches in diameter.

A new method of controlling worthless trees with chemicals is proving successful in Arkansas. An injector is used to shoot the chemical—2,4,5-T—into the inner part of the tree. The injector is driven through the outer bark into the inner bark of the tree. Better results are obtained when the injector is literally thrown at a

FIGURE 3. Portion of an area having shortleaf pine mixed with oaks and other hardwoods one year after spraying with 2 pounds of propionic acid in one gallon of diesel oil and 3½ gallons of water per acre. Note good kill of hardwoods and no damage to the pines. Area sprayed May 19, 1955.

downward angle into the tree. When done properly, a cup is formed and the chemical is released through the injector bit. The chemical remains in the cut and is absorbed into the inner bark. It is necessary to hit some trees harder than others, depending on the type of bark. The important thing is to see that the bit goes into the inner bark and a pocket is formed to hold the chemical. With some practice, a rhythm can be developed so that each injection can be made in one or two seconds. Injections are made every 2 to 4 inches around the tree.

Best results have been obtained using a mixture of one-half gallon of 2,4,5-T in 4½ gallons of diesel oil.

The tree girdling machine commonly known as the "Little Beaver" is being used extensively with an application of chemicals applied with a paint brush on the lower side of the groove. This application is proving very successful in pine stands to remove unwanted hardwoods. The mixture used with this method is one pint of 2,4,5-T mixed with 5 gallons of used motor oil. The application of chemical should be done immediately following the girdling.

Conclusion

Brush is the number one agricultural problem in Arkansas, and the annual loss in dollars due to brush invasion would be impossible to measure. For the past hundred years the loss due to the invasion of brush has increased yearly due to burning and overgrazing.

The method of brush control used most extensively in Arkansas has been the applying of chemicals by airplane. Many thousands of acres of brushland have been airplane-sprayed since 1950. Complete eradication of all brush is seldom accomplished by a single aerial spraying, although present indications are that over 90 percent or more of the scrub hardwood brush can be eliminated with one spraying. When complete eradication is desired, it may be necessary to make a repeat spraying to control undergrowth that was not affected with the first application. Also, seedlings will come up from acorns and nuts in the ground after the first spraying.

Experience in Arkansas shows that in achieving successful control *the efficiency of application is fully as important as the chemicals used.* In aerial applications it is necessary that the applicators be experienced in brush control work and that the area to be sprayed be plainly marked and flagged.

Certain general conclusions can be drawn from the various data presented:

1. Air temperature affects the activity of the herbicide and the effectiveness decreases when the temperature is above 85° F.
2. Soil moisture affects the activity of the herbicide. Better controls are obtained when soil moisture is favorable for plant growth.
3. The type of soil affects the percent of control.
4. Time of year and time of day are important factors in a good spray operation. The most favorable time of year is May and early June, while the most favorable times of day are early morning and late afternoon.
5. Some esters appear to affect the terminal buds of pine less than other esters.
6. July and August sprays appear to affect terminal buds of pine less than May and June sprays.

Foliage sprays applied with ground equipment have also given good results in Arkansas. Basal applications of herbicidal chemicals have been used successfully to remove unwanted species from stands of desired trees.

Screw-worm Eradication Tests Begun in Florida

Pilot-type field tests to evaluate and improve procedures and equipment for screw-worm eradication by using sterile male screw-worm flies have been started in the 2,000-square-mile area southeast of Orlando, Florida. The State of Florida and USDA are cooperating in these tests. Screw-worms are the larvae, or maggots, of the fly, *Callitroga hominovorax,* which develops from eggs laid on open wounds on animals. They cause heavy losses to livestock producers in Florida and Texas.

Eradication of the screw-worm by this method is based on the fact that when normal females of the species mate with sterile males, the eggs produced will not hatch. If enough sterile male flies can be introduced into a screw-worm infested area at proper intervals, they will cause a progressive reduction in the laying of fertile eggs, and the fly population will eventually be wiped out.

The flies used in the tests will be rendered sterile by radio-active treatment. The program calls for the release of about 2,000,000 laboratory-reared flies per week for a period of four months. The program is expected to yield information essential for the planning and operation of an all-out eradication effort.

Nitrogen Fertilization of Northern Great Plains Rangelands[1]

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Research studies as well as the experience of individual ranch operators have shown that range land has a great potential for increased production. It is known that reseeding, weed and brush control, and proper management can do much to improve the range and increase the return per acre of land. A few recent studies on the use of fertilizers on native grasslands have indicated that here also may be a method of range improvement and of increasing the return per acre.

Unfortunately there is very little research information available on fertilization of native grass, especially in the Northern Great Plains region. Most of the studies have been with seeded grasses and results have been obtained only in terms of herbage yields. Results of these studies have shown, in general, that the response of seeded cool-season grasses to nitrogen in particular, even under low rainfall conditions, makes the use of this fertilizer economically feasible in many cases.

One of the few reports from the Great Plains region on the effect of nitrogen fertilizer on gains was made by McIlvain and Savage (1950). Their work at the U. S. Southern Great Plains Field Station, Woodward, Oklahoma, showed that ammonium nitrate applied to weeping lovegrass at 30 pounds of nitrogen per acre in 1947 and 53 pounds in 1948, increased grazing capacity 33 percent and gain of yearling steers per acre by 37 pounds.

Another experiment with fertilizers on native range in the Great Plains is being conducted in western South Dakota at the Range Field Station near Cottonwood. A progress report by Westin, Buntley and Brage (1955) for the 1952-54 period showed that good responses in forage yields were obtained from the application of 20, 40, and 80 pound rates of nitrogen per acre on pastures that had been grazed at heavy, moderate and light intensities. The greatest response was obtained on the heavily grazed pasture, where 80 pounds of nitrogen were applied per acre annually. This treatment produced 3,165 pounds more hay per acre over the 3-year period than the check plots. Their studies also showed that 80 pounds of nitrogen per acre applied once in three years produced more hay per unit of nitrogen than 80 pounds applied every year for three years. All rates of nitrogen produced residual effects for a period of three years. Marked increases were obtained in the percentage of protein from the higher rates of nitrogen.

Williams (1953) conducted a fertilizer experiment on upland prairie near Lincoln, Nebraska. He found the application of 60 pounds of nitrogen per acre raised the crude protein and phosphorus levels in most grasses, especially at the earlier stages of growth. Nitrogen-treated cool-season grasses were higher in crude protein at growth stages up to jointing time than were nitrogen-treated warm-season grasses at corresponding growth stages. The application of nitrogen fertilizer also resulted in greatly increased dry matter yields.

Climate, Soil and Vegetation

The climate of the area where the present study is located does not differ greatly from that of other sections of the Northern Great Plains. Temperatures reach extremes in both winter and summer, rainfall is limited, strong drying winds are common, and there are frequent drought periods.

Normally about half of the annual rainfall comes in May, June, and July, and the seasonal precipitation from April 1 to September 30 is about three-fourths of the annual. The annual rainfall, as shown in Table 1, averaged 17.91 inches during the period of the study. This compares with a 42-year average of 16.01 inches. During the period of study, 1952 was the only year when the lack of precipitation sharply limited plant growth. The most favorable year for growth was 1953.

The soil of the plots is classified as Williams silt loam. It is developed over calcareous glacial till and has a dark grayish-brown surface soil. Tests made prior to the initiation of the experiment showed the total nitrogen content of the soil in both a heavily and moderately grazed pasture, where the experiment was conducted, to be relatively high, being .257 and .250 percent in the surface six inches for the heavily and moderately grazed pasture, respectively.

Table 1. Annual and seasonal precipitation for the 1951-56 period at the Northern Great Plains Field Station, Mandan, North Dakota

	Precipitation	
Year	Annual total	Seasonal total (Apr.-Sept.)
	in.	in.
1951	20.31	16.65
1952	10.25	7.46
1953	21.76	16.56
1954	20.17	18.10
1955	18.33	16.24
1956	16.64	14.94
Average (1951-56)	17.91	14.99
Average (1915-56)	16.01	12.50

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

Under moderate grazing the vegetation in the area is quite typical of much of the Northern Great Plains. It is mixed prairie type. The dominant warm-season grass is blue grama (*Bouteloua gracilis*) and the dominant cool-season grass is western wheatgrass (*Agropyron smithii*). Needle-and-thread (*Stipa comata*) is another important cool-season species along with threadleaf sedge (*Carex filifolia*), a grass-like plant. A number of forbs are normally present in the vegetative cover.

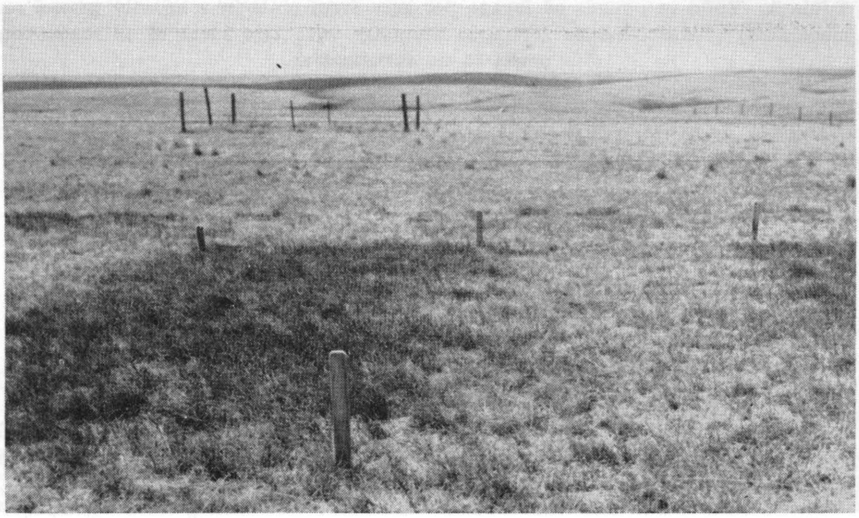

FIGURE 1. Fertilized and unfertilized plots of native grass in a moderately grazed pasture. The plot on the left shows the early growth and increase in amount of western wheatgrass on May 15, 1956, after six years of annual fertilization with 90 pounds of nitrogen per acre. The check plot on the right received no fertilizer.

Experimental Methods

The experiment was conducted on areas fenced off from grazing in 1951 in each of two pastures. One pasture had been heavily grazed for a period of 35 years immediately prior to the start of the experiment, and the other pasture moderately grazed for the same period. Nine plots, 6 by 20 feet in size, were established randomly in each of the enclosed areas. Three treatments with three replications were used. Plots in one treatment received no fertilizer and were used as checks. In another treatment, 30 pounds per acre of nitrogen were applied in the form of ammonium nitrate in the early spring the first year but in the late fall each year thereafter. The other treatment was a 90 pound per acre treatment applied in the same manner as the 30 pound treatment.

Observational notes were taken during the course of each season, and the forage harvested at one inch in height about the middle of August after the cessation of growth. Yields were calculated on the basis of 12 percent moisture in the forage. Separations were made of the forage from plots in the heavily grazed pasture to determine the amount contributed by various species. In addition to the fertilized plots in the heavily grazed pasture, an area was fenced off from grazing each year without further treatment, except annual harvest, in order to determine the natural recovery of the vegetation from an overgrazed condition. Soil moisture samples were taken to a depth of six feet by 1-foot increments in non-fertilized plots in both pastures and in the fertilized plots in the heavily grazed pasture in the spring and fall of each year. Crude protein determinations of the forage from the various treatments were made each year by the standard Kjeldahl method.

Results

At the initiation of the experiment in 1951, response to nitrogen by western wheatgrass and other cool-season species in the native mixture was almost immediate, as reflected in darker color and increased growth. This marked early response was evident every year thereafter (Fig. 1). Observational notes indicated that on the average there was sufficient growth on the fertilized plots to support grazing 10 days earlier than on the check plots.

Yields obtained during the course of the experiment are shown in Table 2. It is interesting to note that in the heavily grazed pasture, where the vegetation had changed from a typical mid-grass type to almost pure blue grama due to heavy grazing, yields were extremely low the first year for the check plots. The blue grama was also reduced in vigor due to close grazing. The application of 30 pounds of nitrogen per acre approximately doubled the yield the first year. Ninety pounds more than tripled it. Remnant western wheatgrass plants made a rapid recovery and accounted for most of the yield increase. In the moderately grazed pasture, where the vegetation was in excellent condition at the start of the experiment with a high percentage of western wheatgrass, the yields of the check plots were considerably higher. The percentage increase due to nitrogen application was not as high as in the heavily grazed pasture, but the total yields were greater. Since the vegetation was in a more vigorous condition at that time, yields naturally were more.

In 1952, when rainfall was much below normal, yields were extremely low in the moderately grazed pasture. Moisture shortage, as shown by moisture samples, was more pronounced because of the previous extraction of soil moisture by a deeper rooted, more vigorous grass cover. Soil moisture was actually higher at the deeper depths in the heavily grazed pasture, where a reduced root system had extracted less moisture previ-

Table 2. Yield in pounds of forage per acre from plots in a heavily grazed and moderately grazed pasture fertilized annually with two rates of nitrogen compared to no fertilization.

	Heavily grazed pasture			Moderately grazed pasture		
	Pounds nitrogen per acre			Pounds nitrogen per acre		
Year	0	30	90	0	30	90
1951	259	504	875	703	941	1218
1952	321	612	1158	243	345	544
1953	1247	2595	5062	944	2217	4341
1954	1172	1593	2334	674	1724	2086
1955	751	1350	2285	841	1414	2101
1956	739	1302	1915	533	1242	1754
Average	748	1326	2271	656	1314	2007

L.S.D. between treatment means for heavily grazed pasture:
at 5% level—381 pounds
at 1% level—630 pounds

L.S.D. between treatment means for moderately grazed pasture:
at 5% level—210 pounds
at 1% level—348 pounds

ous to the dry weather than that in the moderately grazed pasture. With the application of nitrogen, a more extensive root system developed which could tap the soil moisture at the deeper depths. Natural increase in vigor of the grass in the heavily grazed pasture resulted in increased yields over the previous year in spite of the extreme shortage of rainfall.

Precipitation was much above normal in 1953 and yields were extremely high in both pastures. The importance of moisture in relation to yield is shown by the fact that the check plots in the heavily grazed pasture yielded more than fertilized plots in previous years. Over a 4-fold increase in yield above the check plots was produced by the plots receiving 90 pounds of nitrogen. The extremely high yield was probably due partially to a residual effect of nitrogen from the preceding year, when growth was limited due to drought. Response to nitrogen continued to be marked from 1954 through 1956. The 6-year average shows that in both pastures, yields were approximately doubled by the annual application of 30 pounds of nitrogen per acre. Ninety pounds approximately tripled the yields.

The increases in pounds of hay per pound of nitrogen applied are shown in Table 3. On the basis of hay production, the data indicate a higher return per unit of nitrogen from the 30 pound rate of application than from the 90 pound rate. For hay production only, nitrogen fertilizer would be on the border line of being economical at present-day prices, since it would take an approximate increase of 20 pounds of hay per acre for each pound of nitrogen applied. Other factors which may be of greater economic importance than hay production must be considered in the determination of the possibilities for profitable use of nitrogen fertilizer on native range. Some of these factors will be considered in this paper.

One of the evident advantages of the use of nitrogen was the beneficial effect it had on the vegetation in the heavily grazed pasture. Yields in this pasture from plots isolated from grazing and harvested for hay every year but receiving no fertilizer are given in Table 4. There was a natural recovery in vigor and an increase in western wheatgrass, which was an indication of an improved range condition. Even so, two years of fertilization with 90 pounds of nitrogen each year did more to improve the range condition and to increase yields than six years of complete isolation from grazing.

Most of the increase in yield was due to the increased amount of western wheatgrass. In 1956, 83.5 percent of the herbage from the plots receiving 90 pounds of nitrogen in the heavily grazed pasture consisted of western wheatgrass, while only 57.5 percent of the herbage from plots protected from grazing six years without fertilization was western wheat. The herbage from plots protected from grazing only in 1956 contained just 9.4 percent western wheat. It should be pointed out that under the system of harvesting used, the basal cover or density was greatly reduced in the heavily fertilized plots. Blue grama, which is a short growing, high density species, was thinned out because of the shading effect and competition of the taller western wheatgrass. In this experiment, as in many others, there was a definite need for grazing trials to measure the total effects of fertilization. The removal of top growth of western wheatgrass throughout the season by grazing animals would have greatly altered the effects of shading and competition.

In addition to response to nitrogen in increased yields, protein

Table 3. Increase in pounds of hay per acre for each pound of nitrogen applied, from plots fertilized at two rates of nitrogen in a heavily grazed and moderately grazed pasture.

	Heavily grazed pasture		Moderately grazed pasture	
	Pounds of nitrogen per acre		Pounds of nitrogen per acre	
Year	30	90	30	90
1951	8.1	6.8	7.9	5.7
1952	9.7	9.3	3.4	3.3
1953	44.9	42.4	42.4	37.7
1954	14.0	12.9	35.0	15.7
1955	20.0	17.0	19.1	14.0
1956	18.8	13.1	21.5	13.6
Average	19.3	16.9	21.6	15.0

Table 4. Yield in pounds of hay per acre from plots isolated from grazing each year in a heavily grazed pasture.

Year	Number of years isolated from grazing					
	One	Two	Three	Four	Five	Six
1956	256	528	603	528	679	739
1955	248	690	524	677	751	—
1954	398	489	733	1172	—	—
1953	344	659	1243	—	—	—
1952	180	321	—	—	—	—
1951	259	—	—	—	—	—

content of the herbage was considerably higher for those plots receiving the high rates of application. Here again grazing tests were needed to determine whether increased protein in the herbage would have increased gains beyond those based strictly on amount of dry matter produced. Table 5 shows the percentage crude protein each year from 1952 through 1956 for the plots in both the heavily grazed and moderately grazed pastures. In some years the 30 pound application of nitrogen tended to decrease the percentage protein of the herbage below that from the check plots. This was probably the result of growth stimulation in the plants without sufficient nitrogen accumulation beyond the actual needs of the plants for growth. There evidently was a dilution effect on the nitrogen in the plants resulting in a lower percentage of protein.

Discussion and Conclusions

Many of the research studies that have been carried on indicate that range fertilization has a greater chance of successful application in the Northern Great Plains than in more southern regions of the Plains, or in many other areas in the west. The reason for this is that native grass in the northern Plains consists of a mixture of both cool- and warm-season grasses. The cool-season grasses show a marked early spring response to the application of nitrogen fertilizer, even on soils high in total nitrogen, because of the lack of available nitrogen from nitrification under the low soil temperatures that exist. Later on in the season, warm-season grasses will provide much of the forage needed for livestock use. Even though moisture is limited in the northern Plains, there is generally sufficient moisture in the early spring for plants to be able to take advantage of nitrogen that is applied artificially. Studies at Mandan have shown that, even after 32 years of heavy grazing, the total soil nitrogen under native grass has not been reduced below that in non-grazed areas or in moderately grazed pastures. Production, especially in the early part of the growing season, appears to be influenced primarily by available nitrogen and available soil moisture.

It has been demonstrated that the use of fertilizers can be economically profitable in the west on mountain meadows, sub-irrigated meadows, on irrigated pastures, and on seeded pastures of cool-season grasses. Full scale research would now seem justified on the problem of increased production of native range land. The meager information available is not overwhelming evidence in favor of the use of fertilizer, but it does indicate great possibilities. If the fertility level can be balanced with the supply of soil moisture, the efficiency of use of both moisture and fertilizer would be increased.

Nitrogen fertilizer can be used along with other range management methods as an effective tool in range improvement. Many of the present-day management methods have been designed to maintain the production of range land. Fertilizer use points up the possibilities of increased production. Because of the vast size of the Northern Plains, even a small increase in production per unit of area would amount to great economic value to the area as a whole. Many other advantages could well accrue from the use of commercial nitrogen, including a longer grazing period, better distribution of livestock over the range, and the maintenance of a better ecological complex of species.

Results of this study indicate a great potential for more efficient range production and increased returns per acre by the proper use of range fertilization in the Northern Great Plains, where the major portion of the land is in grass.

Summary

The effects on native range production from the annual application of two rates of nitrogen compared to no nitrogen on a heavily and moderately grazed pasture were studied for a period of six years at the U. S. Northern Great Plains Field Station.

On the heavily grazed pasture, 90 pounds of nitrogen per acre applied annually produced an

Table 5. Percentage crude protein of the herbage harvested from plots in a heavily grazed and moderately grazed pasture fertilized annually with two rates of nitrogen compared to no fertilization.

	Heavily grazed pasture			Moderately grazed pasture		
	Pounds nitrogen per acre			Pounds nitrogen per acre		
Year	0	30	90	0	30	90
1952	7.56	7.56	9.31	7.38	7.44	9.44
1953	6.25	6.31	7.19	6.50	6.44	9.06
1954	7.88	7.38	8.25	7.38	6.63	8.44
1955	7.44	6.75	9.19	7.00	6.56	8.06
1956	7.56	7.75	10.00	7.38	6.75	9.69
Average	7.34	7.15	8.79	7.13	6.76	8.94

average of 2271 pounds of dry forage per acre compared to 1326 and 748 pounds, respectively, for 30 pound and no nitrogen treatments. On the moderately grazed pasture, 90 pounds of nitrogen, 30 pounds of nitrogen, and no nitrogen produced 2007, 1314, and 656 pounds per acre, respectively.

The increase in yield resulting from nitrogen fertilization was due primarily to the increase in western wheatgrass. This grass showed a marked response because of the readily available nitrogen in the early spring, when low soil temperatures did not permit a rapid rate of natural nitrification, and because of its cool-season growth habits.

A greater return in pounds of hay produced per pound of nitrogen applied was obtained from the 30 pound rate than from the 90 pound rate.

Two years of fertilization of a heavily grazed pasture at the 90 pound rate of nitrogen did more to improve range condition and production than six years of complete isolation from grazing.

The crude protein level in the herbage was higher every year from the plots receiving 90 pounds of nitrogen than from the check plots but was lower in some years in the plots receiving 30 pounds of nitrogen because of a dilution effect.

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Problems of Population Pressure Upon the Desert Range

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You are not alone in the desert most anywhere in the Arab world. It appears to be devoid of human or animal life of any kind. You stop to eat lunch or to change a tire, or perhaps only to study a closely-browsed shrub. After a few moments your eye is attracted by a moving object. You glance up. A man has materialized from somewhere and is approaching. It happens every time! And soon you begin to realize how crowded the desert is—considering its meager resources for sustaining human life. You begin to appreciate how direct is the ratio of human misery to animal starvation, and you come to grips with the *Number One Problem*—How can you undertake a range management program, which invariably requires relief from grazing pressure, under conditions like these?

Problems are Manifold

But this is not all of the problem. You find that a fuel-wood supply must also be drawn from this overgrazed range, not only for the desert-dwellers, but usually for the nearby towns and villages as well. The trees and taller shrubs have likely long since disappeared in this quest for fuel. So, within walking distance of villages or desert camping places you find the women and girls obtaining fuel by pulling up small shrubs or weeds, or even digging out the roots of perennial grasses and shrubs, as that is the last remaining source. Thus humans are competing directly with camels, sheep, and goats in utilizing the dwindling cover of shrubs and brush.

There is yet another problem. The desert-dweller, having practically no cash income,. must raise his own cereals somewhere out on the desert range. The wadis (drainage bottoms) are the best place, naturally, but there are not enough of these to go around to all. So the marginal and sub-marginal soil types are plowed and put into grain, with the bad results that we all know so well. A national range authority in one of the neighboring countries to Libya said that he was sure that over the long haul, cereal production in the deserts of his country was a losing business—both to the people and to the soil.

What effect has all this on the soil-erosion problem? Any good conservationist reading these lines has already formed a picture in his mind of the destructive erosion that is inevitably going on. At first I consoled my own mind as best I could with the thought that erosion must have reached its maximum rate a long time ago, and at least couldn't increase much faster. I was wrong. In Libya erosion has definitely accelerated over the past 25 years. We have proof of it. It's due to population pressure on the range resource. I've traveled enough in some of the neighboring countries to know that the same thing is true there too.

Can the Problem be Solved?

To summarize our problem: In the face of increasing population pressure we must sustain forage production, fuelwood production, and cereal production and yet improve ranges that likely have been declining in productivity for ages and are still doing so. Is the problem insuperable? Yes, if left to the range specialist alone. No, if all agricultural and industrial specialists of a country join with the range specialists to turn the tide.

Where do the industrial specialists come into the picture? They must create jobs in new industries and train workmen so that industry can absorb some of the overpopulation on the range.

Foresters Can Help

For a solution to the fuelwood production part of our range problem we must turn to our old coworkers, the foresters. No doubt in their own programs they can take over the job of providing from improved forest reserves major fuelwood supplies for the larger towns and villages. However, it may take a bit of urging on the part of the range specialists to get the foresters to come down into the desert scrub country and help set up community-group fuelwood production areas. Rural society anywhere is always much better organized than meets the eye. The rural organizations of the desert will likely be found adequate to manage fuelwood production areas with help from the central government. There are tree species, such as the acacias, that grow surprisingly fast in arid climates.

Agricultural Programs

Land classification is needed to locate the suitable dryland cereal production areas. Agricultural programs must then be geared towards the goal of full productivity from such areas.

Long ago the Romans proved that sites can be artificially made suitable for cereal production by surface water conservation methods. The remains of their old rockdike waterspreading systems and the rock houses that sheltered the people are still common sights along many a desert wadi that now supports only a few migratory Bedouins. It is amazing how widespread was this system of agriculture and how completely it has been forgotten! Reintroduction of this technic is proving a great boon to desert peoples.

New irrigation developments from ground water supplies and perennial streams is one of the main hopes for taking animal and human pressure off the grazing lands. Arid and semi-arid areas also need irrigation projects to carry the breeding herds through the inevitable periods of drought. In some countries where no such reserves are available, when drought disaster strikes, death losses among livestock may reach as high as 80 percent in the worst affected areas. Droughts are frequent.

The livestock specialists play a vital role in helping to breed up better animals and in improving disease and insect control programs, so as to keep the animals in better health. I am reminded, however, that General Omar Draz, formerly chief veterinarian of the Egyptian Army, reported that he quickly discovered that the best preventive of sickness and insect infestation among the army camels was plenty of forage to eat.

The Bedouins follow the rain clouds with their herds, traveling hundreds of miles in the great free-grazing, give-and-take of the Arab world. Even national boundary lines are ignored in this search for grass. Effective range management is impossible under such a system because controls cannot be set up.

This whole pattern of uncontrolled grazing in the countries of the Middle East and North Africa should be altered, but it is deeply intrenched, and can be changed only gradually. Land ownership titles, usually vague and often indefinite, will have to be put on a firmer basis. These problems call for assistance from the legislators and political leaders.

Teamwork Needed

All of the foregoing leads up to my main and concluding point—that in the Middle East and North Africa range management is difficult and requires the close teamwork of many types of specialists. It may possibly be one of the very last agricultural programs to achieve success, because in so many cases it cannot be undertaken until the other programs relieve the pressure on the range.

In the meantime the range specialists must exercise astute judgment and unflagging patience. They must "spar around for an opening" here and there to get small and large range management demonstration areas successfully launched as a necessary preliminary to the main event. And they must push along with the range extension program—particularly with local agricultural leaders. The goal of attainment, though difficult to reach, is well worth the effort, for in most of the countries mentioned the grazing resource will likely be called upon to sustain in perpetuity a goodly portion of the human population.

National Committee Notes

Dr. R. T. Clark, Denver, has replaced Mr. A. L. Baker on the Range Research Methods Committee. C. Wayne Cook, Utah State, is chairman of the committee.

Pat McIlvain, Woodward, Okla., is working on the program for the 12th Annual Meeting of the Society, which will be held at Tulsa, Okla., in January 1959.

Nutritive Value of Some Browse Plants in Winter

ARTHUR D. SMITH

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The general reduction of browse forage upon game ranges in recent years due to high concentrations of game animals has impaired the carrying capacity of many winter ranges. Game herd reductions, especially if accompanied by mild winters, may be sufficient to restore many of these impaired ranges to a satisfactory state of productivity. In other cases more direct measures may be required. Artificial re-establishment of desirable species will doubtless be necessary to renovate the more seriously damaged areas.

The preferences of game animals for different forage species do not provide an adequate basis for the selection of plants to be used in revegetation. Knowledge of the nutritive values of browse plants will aid in selecting superior winter forage, provided that the more nutritious plants are equally well suited to revegetation procedures. These considerations led to digestion studies of native forages. Some results were reported earlier (Smith, 1952). These data complete the digestion studies thus far conducted.

Procedures

The deer were confined to specially designed digestion cages (Smith, 1950a and 1952). The forage offered was collected from the range and brought to the feeding site where, by means of hand clippers, the buds and current twig growth were removed. This procedure, though laborious, permitted more accurate determinations of forage consumption and aided in securing representative samples for chemical analyses.

The chemical determinations were made by chemists in the nutrition laboratory at Utah State Agricultural college. Methods of feed fractionation and analysis common to digestion trials were employed.

Plants tested were birchleaf mahogany (*Cercocarpus montanus*), cliffrose (*Cowania stansburiana*), chokecherry (*Prunus virginia* var. *melanocarpa*), and oak (*Quercus gambelii*). Two additional tests were made on Utah juniper (*Juniperus utahensis*). An attempt was made to conduct trials using sumac (*Rhus glabra*) but the deer refused to eat it. No explanation could be found for this behavior for it is observed to be eaten by deer in the wild.

The animals used varied in age from fawns to mature animals and exhibited various degrees of domesticity. Some had been raised as pets and were fairly tractable under handling. Others had been caught in the wild and had been kept in the pens for varying periods prior to being used. In general, the wilder animals, although being more troublesome to put into and remove from the cages, behaved better under confinement provided the cages were darkened. If it was possible for them to see through openings in the cage walls they became disturbed during the process of feeding and collection of the excreta. By contrast, animals that were raised as pets, on the approach of anyone, kept up a continual bleating and pacing within the confines of the cage and, in general, accepted the poorer forage species less readily. In no case was an animal trapped from the wild and immediately placed in a cage.

Results

The average composition and digestion values secured are shown in Table 1. The digestibility coefficients are lower than comparable figures for most ordinary stock feeds, and lower than those found in the case of sagebrush (*Artemisia*

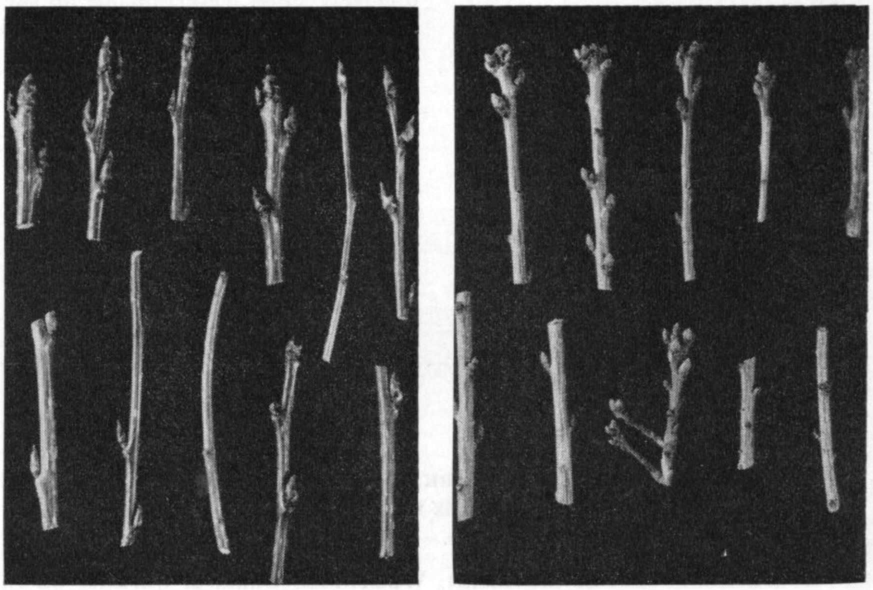

FIGURE 1. Material of chokecherry, *left*, and oak, *right*, as it appeared ready to be offered to the animals.

Table 1. Average percent composition and digestibility of some native browse plants during winter.

	No. of tests	Composition: Protein	Composition: Ether extract	Composition: Crude fiber	Composition: Nitrogen-free extract	Digestion Coefficients: Protein	Digestion Coefficients: Ether extract	Digestion Coefficients: Crude fiber	Digestion Coefficients: Nitrogen-free extract
		%	%	%					
Juniper*	4	6.2	14.1	24.9	50.3	16.8	58.9	33.7	70.4
Birchleaf mahogany	4	7.2	4.5	34.7	52.1	48.5	37.6	31.8	60.0
Cliffrose	5	8.4	10.8	23.0	52.6	39.8	47.7	4.4	59.4
Chokecherry	4	9.9	2.4	29.1	53.6	48.4	23.3	8.8	56.1
Gambel oak	5	5.4	3.2	34.0	51.0	10.7	38.4	16.6	53.6

*Includes data from two tests reported earlier (Smith 1952).

tridentata) and curlleaf mahogany (*Cercocarpus ledifolius*). Especially low digestion values were secured for protein in juniper and oak, and for crude fiber in cliffrose and chokecherry.

Table 2 shows the digestible nutrients present in all the browse plants tested in these and earlier trials. Some common livestock feeds were selected from Morrison (1943) and their nutritive values included in order to provide a basis for comparison with the forages tested. It is not possible in all cases to find livestock feeds which have closely similar values. It would appear from these comparisons that the browse plants tested are but fair to poor roughages. The best of them might be considered to be acceptable maintenance rations. The poorer ones are perhaps not adequate maintenance forages.

Only sagebrush and curlleaf mahogany appear to be reasonably nutritious forages. Juniper and oak have especially low nutritive values in the case of protein. Chokecherry provided few digestible nutrients from the ether-extract or the crude-fiber fractions. Even fewer nutrients were provided by the crude fiber in cliffrose.

Admittedly, there may be a source of error in the data secured. Many of the plants are high in ether extract, part of which is probably composed of volatile oils. These oils disappear from the plant residues during the process of digestion but may not be assimilated by the animal. Ordinary digestion calculations make feeds appear to be more valuable than they actually are when unutilized materials are present in the ether extract fraction. Were it possible to correct for the materials not utilized by the animal nor appearing in the collected waste products, the balance between protein and other fractions would be improved. The wide nutrient ratios shown here may not in actuality exist. Juniper and sagebrush especially might prove to be much lower in total nutrients than these data indicate. Some idea of the magnitude of this error can be secured in the case of juniper. Previous tests have shown that the volatile oil content of Utah juniper averaged 2.10 percent (Smith, 1950). This amounts to 15 percent of the ether extract fraction or approximately 4 percent of the total nutrients. Disregarding this portion under the assumption that it contributes nothing to the animal would reduce the total digestible nutrients to 60.8 rather than 63.5 as here calculated.

No attempt was made to obviate this source of error in the earlier tests. In some of the last tests

Table 2. Digestible nutrients in pounds per hundred pounds (oven dry) of browse plants compared with nutrients in some common livestock feeds.

	Protein	Ether extract	Ether extract x 2.25	Crude fiber	Nitrogen-free extract	Total digestible nutrients	Nutritive ratio
Sagebrush	7.3	8.8	19.8	10.0	41.0	78.1	1: 9.7
Common millet hay	8.2					68.9	1: 7.4
Curlleaf mahogany**	6.0	4.0	9.0	6.9	43.6	65.5	1: 9.9
Timothy hay (before bloom)	6.3					56.6	1: 8.0
Juniper	1.0	8.3	18.7	8.4	35.4	63.5	1:62.5
Milo stover	1.2					53.6	1:43.4
Birchleaf mahogany	3.5	1.7	3.8	11.0	31.3	49.6	1:13.2
Field pea straw	3.5					57.4	1:15.2
Cliffrose	3.3	5.2	11.7	1.0	31.2	47.2	1:13.3
Sudangrass straw	3.6					49.3	1:12.5
Bitterbrush**	2.7	3.0	6.8	5.8	29.6	44.9	1:15.6
Bunchgrass hay	2.9					53.1	1:17.0
Chokecherry	4.8	0.6	1.4	2.6	30.1	38.9	1: 7.1
Alfalfa straw	4.9					46.0	1: 8.4
Oak	0.6	1.2	2.7	5.6	27.3	36.2	1:59.3
Corn husks	0.5					45.7	1:86.3

* Nutrient data on common feeds from Morrison (1943).

** The values reported for curlleaf mahogany and bitterbrush differ slightly from those reported earlier (Smith, 1952) since they were first reported on an air dry basis.

energy determinations of the forages were made, but due to misunderstanding between the persons making the collections and the chemists, it was possible to complete calculations on only five tests. Two sets of data for oak showed 1.14 and 0.83 Calories of metabolizable energy per gram of food material consumed. In two tests cliffrose gave values of 1.64 and 1.06 Calories per gram, and in a single test chokecherry gave a value of 1.14 Calories per gram. These values compare with metabolizable energy values of 1.64 and 1.26 Calories per gram for timothy hay and wheat straw respectively.

Attempts to use specific gravity values of the urine from these tests, to calculate metabolizable energy values for the digestion tests of the same species made earlier, yielded results so variable that they were regarded as valueless. These results were not unexpected, for it had been observed that the urine output and its apparent density varied tremendously among individual animals while on the same feed. The meager data secured do not, however, indicate that the comparative nutritive ratings of these three species secured from digestion trials is unfair. Moreover, the basis for determining any measure of energy production involves the assumption that the loss of energy through gaseous discharge is the same as it is with domestic animals on common livestock feeds. It is doubtful, therefore, that greater precision results from attempts to determine energy values of such forages as were tested so long as no respiration chamber data exist for plant materials of similar kinds.

It must further be recognized that feed values other than digestible nutrients are not here considered. Vitamin contents, for example, of living plant materials are very likely superior to the dried forages to which comparisons are made.

Two of the plants reported, bitterbrush and sagebrush, have been used in digestion trials in California (Bissell, *et al.,* 1955). The results secured there gave lower TDN values in the case of sagebrush and higher values for bitterbrush than have been found by us. No clear reasons for the differences found appear, although it may be noted that the level of intake of sagebrush achieved by us was more than twice that secured by Bissell —1.32 lbs. per hundred weight as compared to 0.6. Moreover, our own figures are supported by digestion values secured from sheep (Smith, Turner, and Harris, 1956). By contrast, less bitterbrush was consumed in our trials than in the California trials, a fact which may have influenced the values secured.

Summary

Birchleaf mahogany, cliffrose, chokecherry, and oak were used as feeds in conducting digestion trials with mule deer. The digestion coefficients secured were somewhat lower than those found for sagebrush and curlleaf mahogany in earlier tests.

Calculations of the total digestible nutrients reveal that the nutritive levels of the range plants tested are from fair to poor during the winter months, when the tests were made. However, the apparent nutritive contents of these plants may differ from their actual values due to the volatile oil contents of the plants tested. The oil contents are known to be high in juniper and may possibly be so in other species. Digestion calculations have the characteristic of attributing values to the volatile oil fractions which are probably not utilized.

An attempt was made to avoid the error involved from this source by making energy determinations of the materials tested. Through misunderstanding, only five sets of energy data were secured involving but three of the species tested. The data thus secured, though meager, do not indicate that energy determinations of the feeds and by-products provide a more critical measure of nutrient value than total digestible nutrients based, as they are, upon the use of average values secured from quite dissimilar feeds and with domestic animals.

Two of the plants tested have been subjected to similar tests in California. In the case of sagebrush our values are higher, and with bitterbrush, lower, than were secured by the investigators there.

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Encroachment of Big Sagebrush on Seeded Range in Northeastern Nevada

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Possibilities for increasing forage production on depleted range lands overgrown with big sagebrush (*Artemisia tridentata*) have been successfully demonstrated in many places. The proved formula includes brush removal and seeding adapted grasses. The introduced, dought-tolerant wheatgrasses (crested wheatgrass, *Agropyron desertorum,* formerly known commonly as the "Standard variety" and now sometimes called desert wheatgrass, and crested wheatgrass, *A. cristatum,* formerly known commonly as "Fairway strain") have been used more than native grasses for this purpose. They are generally better seed producers, easier to establish, and will tolerate as much or more grazing than native bunchgrasses found in the sagebrush zone. The native bunchgrasses have disappeared, wholly or in part, over extensive acres as a result of past heavy grazing, thereby allowing increase of brush. The question arises as to how long crested wheatgrass will persist under grazing, and to what extent it can prevent sagebrush and other undesirable species from reinvading. This paper provides information on these important points from an 825-acre planting in typical sagebrush land in Ruby Valley, Nevada.

Prior to treatment of the experimental plots in 1944, big sagebrush averaged 20 plants, 18 to 48 inches in height, plus 60 seedlings, per 100 square feet of area. Other vegetation in order of abundance included Sandberg bluegrass (*Poa secunda*), Douglas rabbitbrush (*Chrysothamnus viscidiflorus*), squirreltail (*Sitanion hystrix*), tailcup lupine (*Lupinus caudatus*), hoary phlox (*Phlox hoodii canescens*), little larkspur (*Delphinium andersoni*), Indian ricegrass (*Oryzopsis hymenoides*), arrowleaf balsamroot (*Balsamorhiza sagittata*), Great Basin wildrye (*Elymus cinereus*), and trace amounts of a few other species. Grasses occupied only 1 of every 220 square feet of area, or less than one-half of 1 percent of the ground surface.

Considering big sagebrush to be 10 percent palatable, the annual grazing capacity was judged to be 40 to 50 animal months for the 825 acres, but one experienced range man voiced his opinion that "one cow would starve on the entire area." One stockman would not risk grazing the area because of larkspur.

The area was made available for experimental seeding and demonstrations in 1944 by cooperative agreements between the Intermountain Forest and Range Experiment Station, private ranchers, Bureau of Land Management, and Humboldt National Forest. A major point of interest was to demonstrate on a large scale the feasibility of removing sagebrush and seeding rangeland to provide suitable spring forage for cattle, and thereby relieve early grazing use on certain nearby allotments of the Humboldt Forest. An average annual precipitation of approximately 12 inches and a sandy clay loam soil of average fertility, at an elevation of 5,800 feet, favored success.

Treatments and Early Responses

Four main brush-removal and seeding treatments were applied to the area: (1) 500 acres of big sagebrush were wheatland-plowed in July and August and drilled in October, 1944, at the rate of 7.8 pounds per acre; (2) 60 acres of large, brittle brush were double-railed in July and drilled similarly in October, for comparison with plowing; (3) 210 acres were plowed and broadcast-seeded simultaneously, in October and early November, at the rate of 12 pounds per acre; and (4) 55 acres, untreated in 1944, were plowed and broadcast-seeded in May, 1945.

Commercial crested wheatgrass, including both *A. desertorum* and *A. cristatum,* was seeded over most of the area. Crested wheatgrass was seeded also, with smooth brome (*Bromus inermis*) and western wheatgrass (*Agropyron smithii*), on 28 acres of poorly drained land that supported a dense stand of rubber rabbitbrush (*Chrysothamnus nauseosus*) and greasewood (*Sarcobatus vermiculatus*), with some saltgrass (*Distichlis stricta*), prior to treatment. Four other species, beardless bluebunch wheatgrass (*A. inerme*), Nevada bluegrass (*Poa nevadensis*), big bluegrass (*P. ampla*), and blue wildrye (*Elymus glaucus*), were seeded singly on small plots of one-half to one acre, and a mixture of the latter three was planted on a 4-acre plot. A year following plowing, western wheatgrass, intermediate wheatgrass (*A. intermedium*), and Russian wildrye (*E. junceus*) were drilled separately on a narrow 4-acre strip that missed being seeded.

Favorable growing conditions in the spring and summer of 1945 resulted in an excellent stand of grass seedlings. An abundance of new sagebrush seedlings occurred also, along with some old, surviving plants. Young grass and brush grew undisturbed by livestock for the first year and up to the fall of the second growing season, when light grazing by cattle was permitted. At that time, in 1947, an average yield of 1,100 pounds of air-dry crested wheatgrass forage per acre was recorded, along with an average of one old surviving sagebrush plant per 37 square feet and one sagebrush seedling per 13 square feet (Hurd, 1949).

Grazing Use

Regular spring grazing began in 1947 after the seeded area, which was about 2½ miles long by one-half mile wide, had been divided into three pastures of 245, 400, and 180 acres from north to south, respectively. It was intended to graze the north pasture heaviest, but due to water shortages in the north and sometimes middle pastures, gates were left open, and this was achieved only in 1947, when utilization there averaged 55 percent, compared to 35 percent in the middle and 30 percent in the south pastures. Such light grazing left many ungrazed plants in all pastures, some of which went ungrazed in succeeding years, developing into "wolf" plants having an accumulation of old stalks. Ungrazed plants were reduced materially in the summer of 1948, when unauthorized use following the regular grazing season increased utilization to an average of 85 percent in all pastures. Again in 1949 utilization was heavy in the south and middle pastures, averaging 86 and 82 percent, respectively, compared to a more moderate 65 percent in the north pasture. Since then estimated average utilization has varied between 50 and 85 percent, but it has been consistently heaviest in the south pasture, with the north pasture being grazed least.

Approximately 400 head of cows with calves have grazed this area for about 3 weeks each spring—the equivalent of 272 animal months annually. Cattle entered on the date they would otherwise have entered the Humboldt National Forest, usually around May 20, which provided relief on the early-season mountain range.

Crested wheatgrass was usually approaching heading by May 20, with sufficient forage to carry the large herd of cattle for the period indicated. Although other studies (Williams and Post, 1945; Barnes and Nelson, 1950; Frischknecht, *et al.*, 1953; Bleak and Plummer, 1954) have shown that highest animal gains on crested wheatgrass can be expected when grazing begins early, the cattle appeared to do well on these pastures.

Brush-Grass Status in 1954

In 1954 three transects, of 94 plots each, were run lengthwise through the area so as to cross all pastures: one near the east end, farthest from water, where use was lightest; one near the west end, closest to water, where use was heaviest; and one through the center, intermediate in use and distance from water. Plots were spaced 150 feet apart along the transects. These were supplemented with additional plots where further information was desired, so that all the major preparatory treatment areas were sampled. Brush data were obtained from 100-square-foot plots, with grass data being taken on the center one-tenth for more refined measurement. An adaptation of the square-foot density method (Stewart and Hutchings, 1937) was employed in obtaining grass basal area, and yield was obtained by the weight-estimate technique of Frischknecht and Plummer (1949).

After considerable practice in cutting sagebrush plants of different sizes and counting annual rings, it was fairly easy to divide them into age classes by inspection, as follows: (1) plants less than 3 years old, referred to as "seedlings"; (2) plants 3 to 7 years old that had invaded between 1947 and 1952; (3) plants 8 to 10 years old that would have been classified as seedlings in the 1947 survey (most plants in this class were in their tenth growing season in 1954, showing that they originated in 1945 following brush removal); and (4) old plants that survived treatment. If the age of any plant was questioned, the plant was cut and the annual rings counted.

Numbers of sagebrush plants by age classes are shown in Table 1, along with corresponding grass data. Grass data from many of the same plots are included in more than one brush class, where sagebrush plants of different age classes occurred on the same plot. Averages, however, show relations between certain characteristics of the grass and brush invasion.

The average basal area of crested wheatgrass encompassed 13.2 percent of the ground surface, but only 10.4 percent was occupied by live basal area; dead plant centers over 1½ inches in diameter made up the difference. An average of 181 crested wheatgrass plants per 100 square feet accounted for this average basal area. Grass wolf plants averaged 8.4 plants per 100 square feet, and small plants having less than a 1-inch crown diameter averaged 1.2 plants per 100 square feet.

Brush plants that invaded after the grass became established are

Table 1. Numbers of big sagebrush plants by age classes and their relation to crested wheatgrass on 282 plots in 1954.

	Age class of brush (years)			
	Less than 3	3 to 7	8 to 10	Old
Big sagebrush				
Total brush plants in class	447	24	1,228	379
Crested wheatgrass				
Number of grass wolf plants per 100 square feet	3.0	8.5	8.9	10.6
Basal-area encompassed by grass (Percent ground cover)	11.2	9.9	13.3	13.6
Live basal-area of grass (Percent ground cover)	7.8	7.6	10.4	10.8
Yield of crested wheatgrass (Pounds per acre, air-dry)	248	296	308	321

represented in the two younger age classes. These account for a little more than one-fifth of all sagebrush plants tallied. However, plants under 3 years of age were about 20 times more numerous than plants 3 to 7 years of age, showing that brush invasion has recently accelerated. Both age classes were localized on plots where the average basal area encompassed by grass was considerably less than the all-plot average of 13.2 percent. Notably, plots with brush seedlings had the highest percentage of dead basal area of grass, the lowest grass yield, and the fewer wolf plants, suggesting that recent rapid sagebrush invasion is related to heavy use of crested wheatgrass. It is significant also that these seedling plants occurred on only 15.6 percent of the plots, principally on the west transect, and more particularly in the south and middle pastures, where use had been heaviest.

Evidences of decreased use from the south to north pastures and from west to east were a decrease in the proportions of grass plants having dead centers, and an increase in the number of grass wolf plants. Thus, in the south, middle, and north pastures, plants having dead centers over 1½ inches in diameter amounted to 35, 29, and 23 percent of the total plants examined, and there were 4.2, 7.9, and 12.8 wolf plants per 100 square feet, respectively. Similarly, 41, 24, and 21 percent of the plants in the west, middle, and east transects had dead centers, and there were 4.5, 9.7, and 11.5 wolf plants per 100 square feet, respectively. It was reported in Utah that wolf plants increased greatly under 50 percent utilization, decreased slightly under 65 percent utilization, and almost disappeared under 80 percent utilization of crested wheatgrass over a 4-year period (Frischknecht, *et al.*, 1953).

The low precipitation from January 1 through May, 1954, which was barely one-half of average, accounts partly for the relatively low yields of crested wheatgrass in 1954. It is recognized, too, that grass yields tend to decline to levels somewhat lower that the high peaks reached in the first few years following seeding; general declines in yields of crested wheatgrass with age were noted by Barnes and Nelson (1950) and Bleak and Plummer (1954).

Table 2. A comparison of sagebrush plants present in both 1947 and 1954 by age class and initial ground treatment.

Preparatory ground treatment	Size of area	Old plants surviving treatment 1947	1954	Plants invading with grass establishment 1947	1954
	Acres	No. plants per 100 sq. ft.		No. plants per 100 sq. ft.	
Railed summer 1944 (Drilled Oct.)	60	4.9	2.5	8.6	4.9
Plowed summer 1944 (Drilled Oct.)	500	4.1	1.2	3.9	3.5
Plowed fall 1944 (Broadcast same time)	180	3.1	1.1	6.9	4.5
Plowed late fall 1944 (Broadcast same time)	30	4.4	2.1	12.3	8.4
Plowed spring 1945 (Broadcast same time)	55	3.1	1.7	3.5	4.2

Only 24 of the total 2,078 brush plants were tallied in the 3- to 7-year age class, and they occurred on 4.6 percent of the plots. It would be difficult, if not impossible, to ascertain grass conditions during the period when these brush plants became established, but it is doubtful whether effects of heavy grazing had yet become pronounced. Apparently, crested wheatgrass largely excluded sagebrush established during this period, except where openings between grass plants were larger than usual. Observations elsewhere in the Intermountain region indicate that sagebrush seedlings can usually be found in the spring, wherever a seed source is present, but their chances for survival are much less in a full, vigorous stand of grass than where the stand is thin at the outset (Blaisdell, 1949), or weakened by too heavy use (Frischknecht and Plummer, 1955).

Approximately three-fifths of the sagebrush plants tallied on the plots were in the 8- to 10-year class, having become established simultaneously with grass. They were found on 87 percent of the plots, well distributed over the area. Plowing had prepared a good seedbed for young brush as well as young grass, and the two developed together. As would be expected for this large representation of plots, numbers of wolf plants, basal area, and yield of crested wheatgrass approximated averages for the area as a whole .

Old, surviving sagebrush accounted for nearly another fifth of the total sagebrush plants in 1954. These, too, were well distributed over the area, occurring on 61 percent of the plots. These old survivors are probably the parents of many brush plants in the other classes. There were a few more crested wheatgrass wolf plants than average on these plots, and grass basal area and yield were a little higher than averages for the area as a whole.

Sagebrush plants in the latter two age classes were the only plants present in both 1947 and 1954. Table 2, relating numbers of sagebrush in both years to preparatory treatment, shows that reductions occurred in plant numbers of both age classes over the 7-year period. The one exception was the spring-plowed area, where more 8- to 10-year-old brush plants occurred in 1954 than had been seedlings in 1947, an increase that could be due to sampling error. The

FIGURE 1. *Left*: An excellent stand of blue wildrye and big bluegrass with a small amount of Nevada bluegrass was present on this area in 1947. *Right*: By 1954 the seeded grasses had almost disappeared and big sagebrush was again taking over. The large sagebrush plants were seedlings in 1947; the smaller plants have invaded since 1947.

main point is that plant numbers did not decrease here as on the other areas. That there were only 70 percent as many crested wheatgrass plants per acre on this area as on the others may have been a contributing factor. It appeared that sagebrush plants of the 8- to 10-year class tended to stabilize at a constant number, between 4 and 5 plants per 100 square feet.

Aside from this exception, areas having the most brush plants in 1947 had the most brush plants in 1954. It is noteworthy that more brush plants were found on the railed area than on the comparable plowed area as late as 10 years after treatment. This was true both for plants that survived treatment and those that invaded shortly after treatment. It is noteworthy, also, that the area plowed in the fall, and especially the area plowed in late fall, contained more brush plants that invaded shortly after treatment than the area plowed the previous summer or the area plowed the following spring. These findings are in agreement with those of Bleak and Miller (1955) who found that late fall plowing resulted in more sagebrush seedlings the following spring than plowing done earlier before brush seed approached maturity. Another possible seed source for some of the many brush plants on the late-fall treated area was the adjacent, 55-acre tract that was not treated until the spring of 1945.

Performances of Other Seeded Grasses

Performances of the other seeded grasses demonstrate the outstanding superiority of crested wheatgrass on the area. The mixture of blue wildrye, big bluegrass, and Nevada bluegrass produced an excellent stand at the outset (Fig. 1. *Left*). However, numbers of plants as well as yields of these species have been decreasing since 1947, both under grazing and where protected. Few plants of these species remained in 1954, and sagebrush is reoccupying the area (Fig. 1. *Right*).

Bluebunch wheatgrass, drilled on a ½-acre plot, has received heavier use than nearby crested wheatgrass. This is in contrast to some observations elsewhere in the Intermountain region. It probably results from the late spring grazing, since palatability of crested wheatgrass declines greatly as it approaches maturity. Even where bluebunch wheatgrass had maintained a good stand, plant vigor was poor and forage production less than that of crested wheatgrass in 1954. Big sagebrush has encroached more on both grazed and protected plots of bluebunch wheatgrass than on adjoining plots of crested wheatgrass.

Drillings of intermediate wheatgrass, western wheatgrass, and Russian wildrye into a dense stand of annuals in the fall of 1945 produced poor stands. The adverse initial factors from planting a year after plowing make this an unfair test, but even if good initial stands had been obtained, it is doubtful whether these species would have surpassed crested wheatgrass on this site over the 10-year period.

Rubber rabbitbrush, greasewood, and saltgrass again dominate the areas of heavier soil which had been planted to a mixture of crested wheatgrass, western wheatgrass, and smooth brome. The latter two species have almost disappeared and crested wheatgrass plants are small, occurring mainly where protected by rabbitbrush. Experience elsewhere indicates that Russian wildrye and possibly tall wheatgrass (*A. elongatum*) would have been better suited to this particular area of heavy soil having a high water table part of the year.

Other Native Species in 1954

Douglas rabbitbrush, the second most abundant brush species, averaged 4.5 plants per 100 square feet over the area in 1954. The comparative number prior to treatment is unknown, but it is doubtful whether this species has decreased in abundance because of treatment, and possibly it has increased, judging from the numbers of relatively small plants.

Sandberg bluegrass was the most abundant native herbaceous species in 1954, as it was prior to treatment. Much of this grass was undoubtedly killed by plowing, but new plants came from seed on the ground in the favorable spring of 1945 or have increased since.

All other species previously listed as being present prior to treatment were present in 1954, most of them being somewhat less common. Larkspur appeared to be markedly less abundant in 1954. In contrast, hoary phlox appeared to have increased considerably since the area was plowed and seeded. This species was found generally over the area in 1954; either it was not killed by plowing or it has reinvaded.

The introduced poisonous weed, *Halogeton glomeratus*, was first observed inside the area in 1951 and was thick on disturbed and barren spots in the west ends of the south and middle pastures by 1954 (Fig. 2). It was confined to ridgetops, along roads, near gates, salt grounds, and on rodent diggings where crested wheatgrass stands were thin and most heavily grazed. Halogeton was not found where crested wheatgrass was thrifty and formed a full stand.

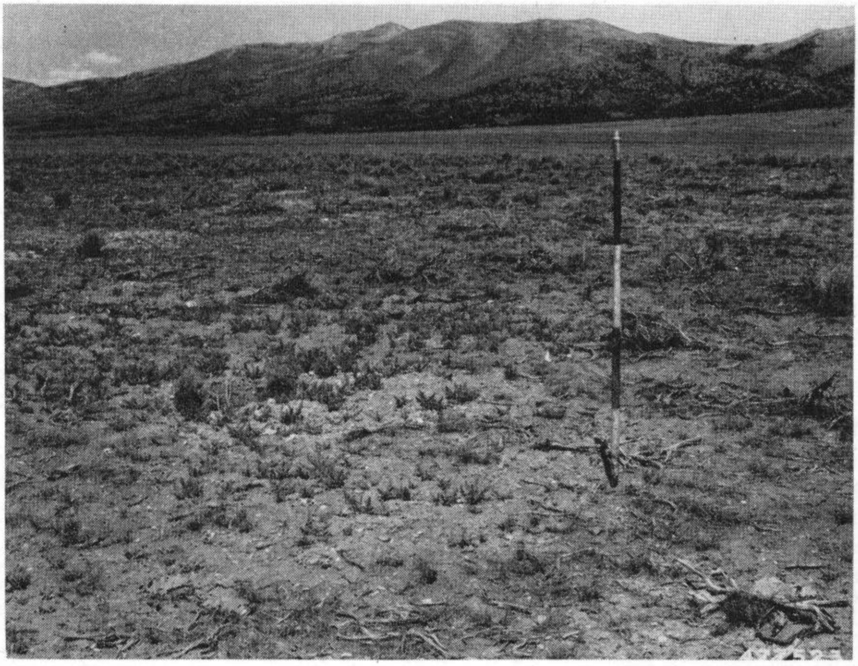

FIGURE 2. Halogeton is growing vigorously on the disturbed area to left of staff but is not found in crested wheatgrass to right of staff.

Summary

Survey of an 825-acre grazed crested wheatgrass planting in Ruby Valley, Nevada, 10 years after treatment showed that slightly more than one-fifth of the present total big sagebrush plants invaded after the grass became established. Of these, plants less than 3 years of age were about 20 times as numerous as plants 3 to 7 years of age, indicating that brush invasion has accelerated. These youngest plants were localized on 15.6 percent of the plots where grazing use had been consistently heavy.

The very few brush plants in the 3- to 7-year age class were confined to 4.6 percent of the plots with thinner than average stands of crested wheatgrass; apparently elsewhere, grass tended to exclude sagebrush between the third and seventh years following seeding.

Sagebrush plants that had become established with the seeded grass (8 to 10 years old in 1954) were the most numerous and widespread of any class. These accounted for three-fifths of the total plants and occurred on 85 percent of the plots.

Old sagebrush plants that survived treatment accounted for a little less than one-fifth of the total plants and occurred on 61 percent of the plots. These plants were probably the seed source for many sagebrush plants in the other age classes.

Plants in the latter two age classes decreased considerably in numbers from 1947 to 1954, except for 8- to 10-year-old plants on a 55-acre tract treated in the spring of 1945. The failure of young sagebrush to decrease under this treatment as under the others may reflect the establishment of fewer than average crested wheatgrass plants on this area. A fall-treated area, and especially a tract treated in late fall, contained more sagebrush plants that invaded shortly after treatment than areas similarly treated earlier, before brush seed maturity. A railed area contained more sagebrush plants than a comparable wheatland-plowed area, both in numbers of old survivors and plants that invaded soon after treatment.

Blue wildrye, big bluegrass, Nevada bluegrass, and bluebunch wheatgrass were inferior to crested wheatgrass on this site. Tests with intermediate wheatgrass, Russian wildrye, and western wheatgrass were inconclusive, but it is doubtful whether any would have surpassed crested wheatgrass. Rubber rabbitbrush, greasewood, and saltgrass have again dominated a 28-acre area having heavy, alkali soil which was planted to a mixture of crested wheatgrass, western wheatgrass, and smooth brome.

Most native species, present prior to treatment, were present also in

1954, though generally less common. Larkspur appeared to have been greatly reduced, whereas hoary phlox and Douglas rabbitbrush appeared to have increased.

Halogeton increased rapidly during the 4 years it has been on the area, but only in heavily grazed and barren spots; it was not found in full, vigorous stands of crested wheatgrass.

ACKNOWLEDGMENT

The authors gratefully acknowledge the work of Dr. Joseph H. Robertson, Dr. George Stewart, Richard M. Hurd, and John M. Fenley, all former employees of the Intermountain Forest and Range Experiment Station, who actively participated in this project. Thanks are due the cooperators: the Humboldt National Forest, particularly Ranger T. E. Brierley for keeping records of stocking, the Bureau of Land Management, and the stockmen cooperators of Ruby Valley, Nevada.

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Range Management Education
VI. A Rancher's View

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From time immemorial, livestock producers have governed their operations on the presumptions that only the livestock can be managed by man and that the utilization of the grass should be governed only by the condition of the livestock, *i.e.*, cattle should be shifted from one pasture to another when the feed is gone. Fortunately, this concept is being modified by many practicing ranchers as a result of education derived from their own observations and from the work of specialists in range management. In spite of this trend, however, ignorance of basic information concerning range and pasture plants still abounds throughout the livestock industry. Consequently the question has been raised, are the students of animal husbandry, who are going to be ranchers, adequately impressed with the importance of grass management as a part of their training in the management of livestock?

This article was originally presented as part of a panel discussion on range management education at the Ninth Annual Meeting of the Society at Denver, Colorado, in January, 1956. Articles I through V have appeared in previous issues of the Journal. The remaining articles in the same series will be published in subsequent issues of the Journal.

It is generally recognized that a rancher's real wealth lies in the forage produced on his land because, most assuredly, he cannot maintain highest meat production from his land unless the production and quality of the forage is maintained. Furthermore, certain basic knowledge of forage plants increases the rancher's ability to maintain or to increase the forage production on his lands.

With this concept as a basis, it should be recognized that the student majoring in animal husbandry is first of all a student of agriculture, but that the adequacy of his knowledge will be evidenced by the wisdom of his use of the land. Furthermore, knowledge of any or all types of livestock is without proper foundation and is incomplete in scope without an associated knowledge of the proper use of land for the production of livestock feed.

Plant Information Important

The information that I wish I had obtained in college concerning plants is: (1) a knowledge of how plants make and use their food for growth and reproduction; (2) the ability to readily identify the parts of a plant; (3) the ability to identify the different grasses and other forage plants; (4) knowledge about the relationships that exist between plants and their environment; and (5) how plants can be expected to respond to management. This, with a knowledge of the nutritional value of plants, would have provided me with the information necessary for most efficiently managing our cattle for the maintenance and improvement of our forage production and concomitantly our beef production. The fact that I did not obtain this information at college, and do not now possess it, is not to say that the information was not available. A review of the curricula of the major colleges shows that the information indicated above is available to any student of animal husbandry who wishes to study the particular subjects involved. Therefore, a pertinent question would be, are the animal husbandry students availing themselves of this information, and if not, why not? I believe they are not. Why? Because the animal husbandry students are neither required, nor often seriously advised, to study plant science.

I can recognize that it is unwise to require all animal husbandry students to study plant morphology, agrostology, plant physiology, and ecology, when many of them may devote their lives to an intensive study of only the animals. For them, a knowledge of grass and other range plants would be no more appropriate than a detailed knowledge of the production of grain or other livestock feed. Consequently, I do not consider it desirable to make the above subjects required study for all animal husbandry majors.

Student Guidance Needed

A better solution appears through proper advisement and instruction. The student should be impressed with a necessity for a fundamental knowledge of plants as a prerequisite to an adequate understanding of their use by animals. This should be done in an introductory agriculture course. If one general, introductory course in agriculture were offered instead of Introduction to Animal Husbandry, Poultry Husbandry, Dairy Husbandry, Horticulture, *etc.*, as is presently required of all agricultural students in some colleges, it would be easier to build this appreciation of the related sciences. This introductory course, in conjunction with far-sighted guidance by the student's faculty advisor, should insure a proper start. In fact, proper guidance alone should be sufficient in most instances.

Providing proper guidance is not easily accomplished. Most professors are specialists in their respective fields, and frequently they are not aware of the scope and magnitude of the questions confronting the rancher, except as they relate to their particular specialties. For example, even as I here promote the thought that animal husbandry students do not adequately avail themselves of the opportunity to learn about plants, others interested in range management suggest that students majoring in range management are lacking information pertaining to animal husbandry. In both instances the failure and the solution are related: the failure—exceeding concentration in a limited field condoned by the faculty advisor, who is and should be a specialist, when a broader and perhaps less intensive knowledge will be required of the student after graduation; and the solution—encouragement by the faculty advisor to acquire a broader but related knowedge.

To summarize, I believe that information concerning the growth and reproduction of plants and their respective forage values, coupled with an ability to accurately identify them, would be valuable information for any rancher. A student who is majoring in animal husbandry, with the intention of being a ranch livestock producer, should be seriously advised and encouraged to study those subjects that will provide him with such information. It is preferable to attain this by advisement rather than by altering the subjects now listed as "required."

Great Plains Program and Public Law 1021

The conservation program provided for under Public Law 1021 will be in support of the total Great Plains Program as outlined in President Eisenhower's message of January 11, 1956. PL 1021 authorizes the Secretary of Agriculture to enter into long-term, cost-sharing, contracts with farmers and ranchers for the purpose of establishing conservation plans and needed changes in land use and cropping systems in designated counties in the Great Plains region.

The program is scheduled to go into operation in July 1957, and the contracts are to be for periods not longer than 10 years. The program emphasizes the long-range aspects of planning for the complete conservation needs of the farm or ranch. It is not designed as an income supplement measure, and no new agencies have been set up to carry out the program. Neither is it to be considered a substitution for any other existing program.

Technical help in planning and installing needed conservation measures and land use changes will be provided by agencies of USDA, wtih the Soil Conservation Service taking administrative leadership.

Meadow Grazing—1: A Comparison of Gains of Calves and Yearlings When Summering on Native Flood Meadows and Sagebrush-Bunchgrass Range[1]

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The number of cattle that a ranch operation may support is dependent upon the forage resources in the immediate area. In the sagebrush-bunchgrass country of eastern Oregon cattle are normally summered on the federal range which is administered by the Bureau of Land Management. During the winter the cattle are fed hay cut from native flood meadows. There are about 350,000 acres of native flood meadows in Oregon which are mostly privately owned. These meadows are continuously irrigated by wild flooding with early spring runoff from surrounding watersheds for periods ranging from six to twelve weeks. The forage produced upon them is predominantly composed of rushes (*Juncus spp.*) and sedges (*Carex spp.*).

During the past years the number of cattle permitted to run on federal range has been generally decreased in an effort by range managers to obtain more proper utilization of the forage and thereby preventing further range deterioration. A ranch operator faced with a reduction in the use allowed on federal range must either decrease the size of his operation or look for an alternative forage resource. The grazing of native flood meadows seems to offer such an alternative resource, particularly in view of the reported increase in production from these areas with nitrogen fertilizer (Cooper, 1955). A number of ranchers are considering the possibility of fertilizing part of their meadows to provide necessary hay supplies and grazing the remainder.

Information is presented in this paper on gains of calves for four years and gains of yearling steers for one year while grazing flood meadows, with a comparison of gains of calves and yearlings on sagebrush-bunchgrass range.

Management and Experimental Procedure

The data presented on calf gains on the meadow were taken during 1952-1955, inclusive, from calves of a small breeding herd, consisting of about thirty cows, carried on the meadow unit of the Squaw Butte Station. Calf weights for comparative purposes were taken from a like number of calves summering on the range unit of the Station. The two sets of calves were paired as closely as possible by birth date and sex.

In 1954 two groups of ten yearling steers were randomly selected. One group was grazed on the meadow and the other with the herd on the range.

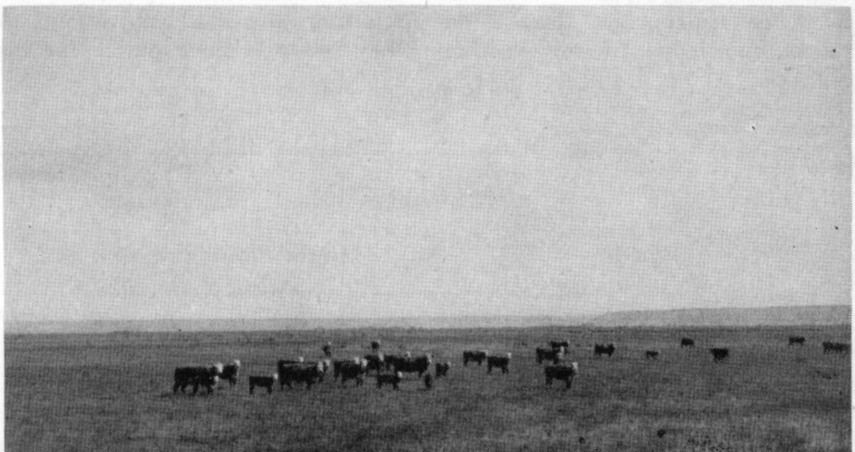

FIGURE 1. Cattle summering on a native flood meadow in eastern Oregon. Meadows such as these are irrigated by natural flooding with early spring runoff from surrounding watersheds. The vegetation on these meadows is composed of sedges and rushes.

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[1]*A contribution from the Squaw Butte-Harney Range and Livestock Experiment Station, Burns, Oregon, which is jointly operated by the Agricultural Research Service, United States Department of Agriculture and Oregon Agricultural Experiment Station. (Formerly jointly operated and financed by the Bureau of Land Management, USDI, and Oregon Agricultural Experiment Station). This report is published as Technical Paper No. 1002, Oregon Agricultural Experiment Station.*

Animals on meadow pasture grazed freely until about August 1 each year. From August 1 to September 15 they consumed bunched hay cut from the pasture and meadow aftermath. Animals on the range were removed to the meadow on September 15 and grazed on meadow aftermath. Cows and calves on range were supplemented from July 20 to September 15 in 1954 and 1955 with a cottonseed meal-salt mix to provide an intake of approximately two pounds of cottonseed meal per cow per day.

Cows and calves were individually weighed at approximately monthly intervals from the beginning of the grazing season to weaning. Steers were also weighed individually at monthly intervals, but weighing was terminated on September 15. All weights were taken after the animals had been without feed and water overnight (approximately 12 hours). During the shrinking period calves remained with the cows. Only calf and steer weight data are considered in this report. These data were subjected to statistical analyses.

Table 1. Average daily gains of calves on meadow or range by periods during each of four years.

	Pasture	May 1 to July 1	July 1 to Sept. 15	Sept. 15 to Nov. 15	Birth to Weaning
		lb.	lb.	lb.	lb.
1952					
	Meadow	1.73	1.76	.69	1.44
	Range	1.30	1.07	.35	.92
	Diff.	.43	.69	.34	.52
1953					
	Meadow	2.04	1.96	.82	1.70
	Range	1.85	1.59	.97	1.50
	Diff.	.19	.37	–.15	.20
1954					
	Meadow	1.96	1.96	.87	1.51
	Range	1.75	1.53	.86	1.34
	Diff.	.21	.43	.01	.17
1955					
	Meadow	1.95	1.77	.93	1.61
	Range	1.81	1.51	.56	1.36
	Diff.	.14	.26	.37	.25
4 Yr. Avg.					
	Meadow	1.92	1.86	.83	1.56
	Range	1.68	1.42	.68	1.28
	Diff.	.24	.44	.15	.28

Results and Discussion

Calf weight gains

The average daily gains of calves from birth to weaning were computed for three periods, which were approximately May 1 to July 1, July 1 to September 15, and September 15 to November 15 (Table 1). The first period corresponds to the period of green grass on range, the second to the period of dry mature grass, and the third to the period in which both groups grazed dry meadow aftermath.

In all years calves on meadow gained more than calves on range.

The better performance during the first period is likely due to greater milk production of the dams resulting from the greater availability of forage on meadows. During the second period, July 1 to September 15, range herbage loses much of its green color and rapidly loses protein. The crude protein content of range grass declines to a level of about 4 percent by August 1, and continues to decline[2]. In contrast, meadow herbage contains about six percent crude protein on August 1, and when pasture is cut and the forage bunched, no further decline in crude protein content occurs[2]. However, as calves on meadow continued to outgain calves on range in 1954 and 1955, when the latter and their dams were supplemented, it appears that most of the differences may be attributed to a greater quantity of readily available forage on meadows. The main limiting factor affecting gains of range calves in late summer, therefore, appears to be energy and its effect on milk production of dams.

During the third period in 1952 and 1955, when cows and calves from both groups grazed meadow aftermath in common, calves which had been summered on meadow continued to gain more than those summered on range. The difference is most likely due to a more sustained milk flow of dams. The reason why a like response was not obtained in the other years is not known.

The weaning weights of both groups followed the same pattern during the four years and were highest in 1954, lowest in 1952, and intermediate in 1953 and 1955 (Table 2). The difference in weaning weight of calves in 1952 was much larger than in the other three years. Several factors serve to explain this difference. Calves grazed on meadow in 1952 weighed an average of twelve pounds more at birth than those grazed on range, whereas in the other three years birth weights were quite comparable. It has been shown that each additional pound of birth weight of a calf is associated with about two additional pounds of weight at weaning (Sawyer, *et al.*, 1949). On this basis calves on meadow could be expected to weigh 25

[2]*Unpublished data, Squaw Butte-Harney Experiment Station, Burns, Oregon.*

Table 2. Weaning weights of calves summering on meadow or range in each of four years.

Summer Pasture	1952	1953	1954	1955	Avg.
	lb.	lb.	lb.	lb.	lb.
Meadow	388	452	465	418	430
Range	267	406	412	369	364
Difference	121	46	53	49	66

pounds more at weaning as a result of higher birth weights. As all cows were treated alike during fall and winter, the difference in birth weight in 1952 appears to be a reflection of the summer nutrition pattern the preceding year (1951) in which the range was extremely dry. Meadows depend upon spring runoff for moisture supply and are not as readily affected by a prolonged drought during the growing season. Apparently the poor growing season of 1951 adversely affected calf birth weights of range cows in 1952.

The differences between groups in 1954 and 1955, when cows and calves on range were supplemented, was considerably less than in 1952 but is comparable to 1953. The difference in 1952 is higher than should normally be expected due to smaller calves of the range group, and the difference in 1953 is less than should be expected due to an extremely wet growing season on range.

Yearling gains

The average daily gains of yearlings in 1954 are presented for two periods—April 20 to July 10, and July 10 to September 10 (Table 3). Yearlings on range gained slightly more than those on meadow prior to July 10; however, the difference was not statistically significant. After July 10 steers on meadow gained 1.2 pounds per day more than steers on range. The better performance of steers on meadow during the last part of the grazing season is due to a greater quantity of forage of a higher quality.

Total average gains for the entire grazing season were 244 pounds for steers on meadow as compared to 180 pounds for steers on range.

Discussion

The data presented show that cows and calves, and yearlings may be successfully grazed on native flood meadows and better performance is obtained than on range.

In making a decision on whether or not one should graze meadows a number of factors may be considered.

It is estimated that an acre of good meadow will carry a yearling, or that two acres will carry a cow and calf through a five months grazing period. On this basis each acre produced 244 pounds of yearling beef, or, at 17 cents a pound, grossed a return of $41.00 per acre. On a hay yield basis each acre would produce approximately one ton of hay or a gross return of about $25.00 an acre. Clearly, utilizing the meadow by grazing is profitable at current hay and fertilizer prices.

Table 3. Average daily gains of yearling steers on meadow or range by periods in 1954.

Pasture	April 20 to July 10	July 10 to Sept 10
	lb.	lb.
Meadow	1.62	1.84
Range	1.76	.65
Difference	–.14	1.19

It is not known whether nitrogen fertilizer will increase grazing capacity in the same ratio as it does hay yields. Controlled experiments are being initiated to obtain this information. It is known that 80 pounds of nitrogen will increase hay yields approximately one ton per acre (Cooper, 1955). The opportunity therefore exists to release meadow acres from hay production to grazing. If an operator producing 400 tons of hay on 400 acres, fertilized 200 acres with 80 pounds of nitrogen, he could expect to produce 400 tons on 200 acres. This would release 200 acres for pasture. The cost of fertilizer per acre would be about $13.50, including application costs. If each of the released acres produced 244 pounds of beef valued at $41.00, the net return from the use of fertilizer is $27.50 per acre on 200 acres.

The practice of grazing meadows is dependent upon limited range forage resources. With present charges of 15 cents per AUM for grazing federal range, one could not expect to graze meadows on a competitive basis. However, when the range forage resource is limited, meadows offer a good alternative forage resource.

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Effect of Cages on Yield and Composition in the California Annual Type[1]

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Techniques which employ cages or other types of small exclosures are used extensively in range research to determine total plant production on grazed areas. Differences between weights of forage on paired plots, one enclosed and one not, are used to measure forage removal by livestock. Usually data of these kinds are given without reference to the effect of the cage or exclosure upon the microenvironment within the exclosure and, hence, upon the plants themselves. In other words, any differences in forage weight between the closed and unclosed areas that may be due to the exclosure itself are usually ignored.

Daubenmire (1940) described several cases in which the material of which permanent enclosures were made acted as a barrier to wind movement, insolation, and precipitation. Reduced wind resulted in deposition of snow in winter, dust in summer, and most certainly altered humidity and temperature. The enclosure itself catches wind transported materials and intercepts rainfall which further change the environment within.

In England cage techniques have been used for many years and criticized on the basis that growth was greater within the cage than outside (Cowlishaw, 1951). Williams (1951) established that cages reduced wind velocity and light and increased relative humidity. Temperatures within a cage were lower, the same as, or higher than the temperature outside. Apparently less wind and less loss of latent heat in evaporation caused temperatures to increase, while the shading effect of the cage acted in the opposite direction. The relative importance of these opposite effects may be different at various times of the day and with various combinations of weather. They suggest that less heat is lost at night, and, therefore, less dew and frost occurs under the cage than outside.

Cage techniques to measure herbage yield have been used in the California annual type (Bentley and Talbot, 1951). The vegetation is well adapted to the use of square foot plots and cages because it is a thick mixture of many low growing species. However, one question concerning their use is unanswered: Does the cage have a significant effect on the enclosed vegetation?

During the growing season of 1955-1956 (November to June), 110 cages that were being used in conjunction with grazing trials on the Hopland Field Station were also situated to show the effect of cage. This location is in the coast ranges of California about 100 miles north of San Francisco and 40 miles from the coast. The study was entirely concerned with the herbaceous cover in the California annual-grass type. Many of the plots were in openings in the grass-woodland type; others were actually under a thin and scattered canopy of the woodland trees.

In November, 1955, before the beginning of fall rains, cages were located in a grid system in four pastures. At each cage location two areas within approximately 20 feet of each other were selected for uniformity of vegetation in terms of kinds of plants, density, and height of the previous season's growth. A coin was flipped to determine which of the two similar areas was caged.

The cages varied somewhat in size and shape, but in general they

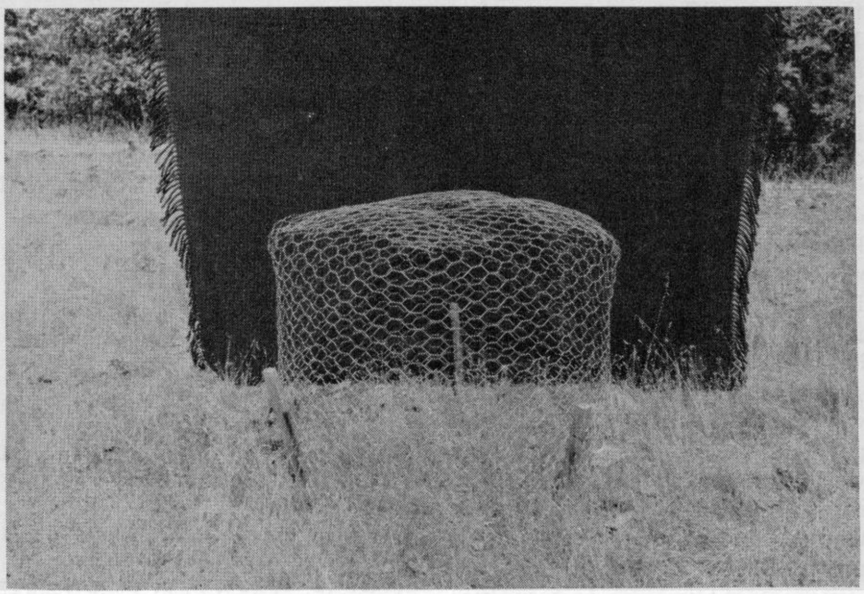

FIGURE 1. A cage of the type used in the study. It is constructed of 1½-inch mesh stucco netting and is approximately 3½ feet in diameter.

[1]*The data in this paper were collected as a part of Project 1501 in the California Agricultural Experiment Station.*

[2]*Appreciation is expressed to Lynn Rader and Thomas Bedell for aid in reading the field plots and in making some of the calculations.*

were made of 1½-inch mesh stucco netting with 17 gauge wire. They were approximately 3½ feet in diameter and 2½ feet high (Fig. 1). The wire was folded so that the top of the cage was closed or nearly so.

There was no grazing by domestic animals during the period the cages were in place. Deer were present in one pasture (first two rows of Table 1) and absent from the others.

Measurements of the vegetation were with the pointplot system and square-foot plots clipped both inside and outside of each cage. These field measurements were summarized according to percentage botanical composition, height of the first hit, condition of the soil surface, and weight of material, oven-dry. In one set the clippings were separated according to new growth and mulch from previous years. The clippings were made at ground level.

Effects of Cages on Weight of New Growth

In March the amount of new plant materials was obviously greater inside the cage than outside. The "T" tests of the mean differences were highly significant for two groups of cages in one pasture and significant at the 5 percent level in another pasture. These three mean differences amounted to 108 pounds per acre with a Confidence Interval of 64 pounds, 50 pounds per acre with a CI of 31 pounds, and 110 pounds with a CI of 92 pounds. These data clearly indicate that the cages had an effect on the vegetation. Williams (1951) has shown the reasons to be amelioration of the micro-climate; therefore, repetition of the environmental measurements was not deemed necessary in this study. Of special note is that these results were obtained during the winter period when the mean temperature was 42.5 degrees F. and when freezing temperatures were recorded on 62 percent of the days. Plant growth was slow, and the small increases in amount due to cages was a 16-48 percentage increase.

Grazing by deer probably contributed to the mean differences shown in the first two rows of data in Table 1. They were present at the approximate density of one per 6 acres and they are known to feed on herbaceous plants at that time of year (Longhurst, 1956). Both deer and sheep were absent from the other pastures during the dates shown in Table 1.

When the cages were in place from November to May, and from March to June, no significant mean difference was found between the yields of new growth inside and outside the cages. Both of these periods encompassed the major portion of the fast growing season.

These data are interpreted to mean that cages result in a small but significant increase in plant growth in the California annual type during the cool part of the growing season, but that any differences due to the cages soon disappear as spring temperatures become warm enough for fast growth.

The clippings from one set of cages sampled in March were separated into new and old growth. No real difference was found in the amount of old growth or mulch between the caged and uncaged samples. This indicates similar rates of decomposition under the two conditions during the winter, and that differences were in the amount of green material.

No Effects on Composition

Points were taken to determine the percentage botanical composition of the vegetation on a coverage basis. These were at the rate of 60 points per location, of which 30 were on the caged plants and 30 on the uncaged plants.

The most important plants found were soft chess (*Bromus mollis*), broadleaved-filaree (*Erodium botrys*), ripgut (*Bromus rigidus*), slender oat (*Avena barbata*), hairgrass (*Aira caryophyllea*), fescue (*Festuca dertonensis*), annual clovers (*Trifolium spp.*), nitgrass (*Gastridium ventricosum*), and about 35 other species of minor importance.

Table 1. Differences in oven-dry weights of herbage from paired plots, one caged and the other uncaged.

Period cages were on the ground	Number of pairs	Average weight in grams per sq. ft.		Mean difference in grams/sq. ft.	Confidence Interval	
		Caged	Uncaged		Grams	Lbs./acre
Open grass, Nov. 8, 1955 to March 3, 1956	38	3.46	2.33	1.13**	0.6645	64
Grass under thin tree canopy, Nov. 8, 1955 to March 3, 1956	25	2.38	1.88	0.50**	0.3234	31
New growth, Nov. 8, 1955 to March 3, 1956	15	8.16	7.02	1.14*	0.958	92
Mulch, Nov. 8, 1955 to March 3, 1956	15	3.42	3.26	0.16	—	—
Nov. 8, 1955 to May 8, 1956	16	19.72	19.72	0.00	—	—
March 8, 1956 to June 6, 1956	16	11.52	11.23	0.29	—	—

** Significant at the 0.01 level; confidence intervals at the same level.
* Significant at the 0.05 level; confidence intervals at the same level.

Considerable variation in botanical composition and plant height occurred between cage locations. On a pasture basis, or group of cages, as given in Table 1, very little difference existed between the caged and uncaged conditions and, therefore, the data are omitted. This was also true of the percentages of bare soil, moss, mulch, and rocks, measured at the soil surface. The conclusion is reached that the cages had little effect on the kinds of plants and the soil surface conditions. At some specific cages a few species appeared on an ocular estimate basis to be favored or disfavored by the cages, but the data did not bear this out for the whole of a set of cages treated alike.

Summary

This study was undertaken to determine the effect of cages on herbage yield when they are used to protect small plots of vegetation from livestock use. Studies by others indicate that the change in micro-climate under the cages results in an increase in plant growth. Results of this study are in agreement with the reported findings under conditions of slow growth in the winter period. With the onset of warm spring temperatures and rapid growth of the plants, the differences soon disappear, and by plant maturity any effects of the cage on amount of growth, percentage botanical composition, and foliage cover could not be detected in the conditions of this experiment.

The conclusion is reached that the cages, themselves, do not materially influence results of total yield studies and utilization in the area of the experiment. Yields taken in late winter with cage techniques will include a significant cage effect. These results should apply to most of the California annual-grass type, although the point has not been tested at other locations.

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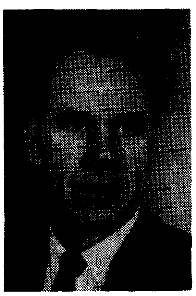
A Message from the President



By this time of year section field meetings and tours will be in full swing. It is encouraging to see what sizeable summer meetings many sections have worked up. This is surely one of the best ways of advancing the cause of range management, both among our own members and among land users in general.

John Clouston, our Executive Secretary, has new office space in Portland and is rapidly picking up the many facets of a big job. Many of you will see him this summer, for he is planning to attend a number of section meetings, as well as the summer meeting in Jackson.

The May issue of the Journal contains the list of National Committees for 1957. This list is worth your attention, as a group who do much of the work of our Society. Each committee has a definite job to do and each of them will welcome suggestions that any member may have—so don't hesitate to let them know if you have an inspiration!

The latest releases on membership from the Secretary and the Membership Committee show that our old problem of delinquent members is still with us. Bringing these people back into the group is a major job that each section must handle as it sees best. Experience indicates that a personal letter, or better still, direct contact by a section representative is most effective.

The arrangements for the summer meeting at Jackson, Wyoming look good. I hope many of you can be there.

PROTECTING RANGE FORAGE PLOTS FROM RODENTS

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Rodents frequently become a problem in rangeland seeding trials. Experimental plots, even up to 20 acres or more in size, often suffer considerable loss of seed or seedlings due to the depredations of rodents (Howard, 1950). Unless protection from rodents is supplied in these instances, it is difficult to evaluate the adaptability of the various forage species to a given site with respect to weather and soil conditions. Also, rodents can be of considerable annoyance when one wants to take yield measurements and they have caused large openings in the stands.

A successful attempt to protect a 20-acre seeding of wheatgrasses and other forage trials from rodents was made on the Flournoy Range Demonstration Project near Likely, Modoc County, California. Abandoned service station one-quart oil cans were used as bait stations. The cans were placed 50 to 100 feet apart (Fig. 1). More than 300 cans have now been used in various parts of the state.

The 1¼-inch opening made in the oil cans by the standard punch-type opener is just the right size to admit field rodents up to and including kangaroo rats (*Dipodomys*). Ground squirrels (*Citellus*) cannot enter the cans, but they are able to reach in and pull poison grain out. Other genera that we controlled with the cans included deermice (*Peromyscus*), pocket mice (*Perognathus*) and harvest mice (*Reithrodontomys*). This simple method of rodent control around plots should work just as well in other areas. It should provide protection for seeds and seedlings for at least one year.

Our first attempt at controlling the rodents on the 20-acre study area was to poison them by the conventional method of broadcasting poison grain. This was done on June 16, 1955, by Loring White, Modoc County Agricultural Commissioner, who cooperated in the study. We knew this method would not keep rodent numbers reduced for many months (Spencer, 1955), even if the area had been larger; and, as Commissioner White also predicted, the rodents quickly reinvaded the relatively small area following their control. This was borne out 1½ months later when 29 mice were trapped on the 20-acre poisoned area in 200 trap nights. In comparison, only six rodents were trapped during the same period with equal trapping on the undisturbed check area (Table 1). One reason for the higher population of certain species of rodents on the study area is that the habitat conditions present there were more favorable. Whenever man alters the natural environment, certain species of rodents may become sufficiently numerous to then be classed as a pest (Howard, 1953). The habitat was made more favorable for certain species of rodents as a result of disking under the sagebrush, which improved cover conditions, and seeding to wheatgrasses, which increased the variety and the quantity of the food supply.

The bait cans were placed 50 to 100 feet apart on the area on November 1, 1955. When the site was retrapped five months later, no ro-

FIGURE 1. Bait stations for use in controlling range rodents in the vicinity of field plots. They are made from discarded service station one-quart oil cans.

Table 1. Percent reduction of rodents on a 20-acre plot five months after poison-bait cans were put out. A trap night equals one trap set one night.

Date	No. Trap Nights Each Area	Species	20-Acre Study Plot	Bulldozed Check Area	Undisturbed Check Area
4/19/55	182	*Peromyscus maniculatus*	Not trapped	14	Not trapped
		Reithrodontomys megalotus		3	
				17	
6/16/55	—	—	Poisioned by broadcasting bait	—	—
7/26-27/55	200	*Peromyscus maniculatus*	19	8	3
		Dipodomys ordi	4	2	3
		Reithrodontomys megalotus	4	1	0
		Perognathus parvus	2	0	0
			29	11	6
11/1/55	—	—	Put out poison bait cans	—	—
3/27-28/56	200	*Peromyscus maniculatus*	0	20	6
		Dipodomys ordi	0	0	2
		Reithrodontomys megalotus	0	5	0
			0	25	8

dents were captured in 200 trap nights (Table 1). This is an unusually good control for such a long period of bait exposure. The bait was in good condition and had not mildewed as a result of the winter snow and rain. On smaller sites, with fewer bait cans, it is probably desirable to have the cans closer together and to replace poisoned bait every few months. Bait should always be replaced with fresh material. Some individual rodents will develop bait-shyness (Tevis, 1956), but to help overcome this, different poison-bait combinations can be used in separate cans. However, do not mix poisons in any one can. If success drops off, change the kind of bait and kind of poison.

Discarded one-quart oil cans are readily available at service stations or city dumps. Since the cans we picked up from a city dump had been burned, they were dipped in a dilute solution of black asphalt (varnish) to preserve them from rust, although this it not necessary, if the cans are going to be used for only a few years. Cans that we obtained from service stations were drained overnight to allow all the oil to drain out. Then a little soil was shaken around in them to absorb any oil that might have remained.

Poisons and baits used in different cans included oat groats with three ounces of 1080 poison per 100 pounds of bait, whole wheat with 8⅓ ounces of strychnine per 100 pounds of bait, and a small amount of two percent Endrin dust. Other poison baits, such as the safer anticoagulant materials, can also be used. The Endrin as a contact poison was not effective. Cotton was added to many of the cans, but it did not seem to be of any particular advantage. Occasionally mice died in the cans. We do not know if such cans were rendered ineffective while the carcass was present.

In some of the cans the strychnine-coated wheat was embedded in a solid pack of paraffin to preserve the grain for a longer period. All paraffin baits were utilized to some extent by mice. The paraffin may have been of some value, but at this time we can only recommend the use of grain baits without the addition of paraffin, as all grain baits held up well even without paraffin. In more recent trials we have poured a small amount of "office supply" rubber cement over

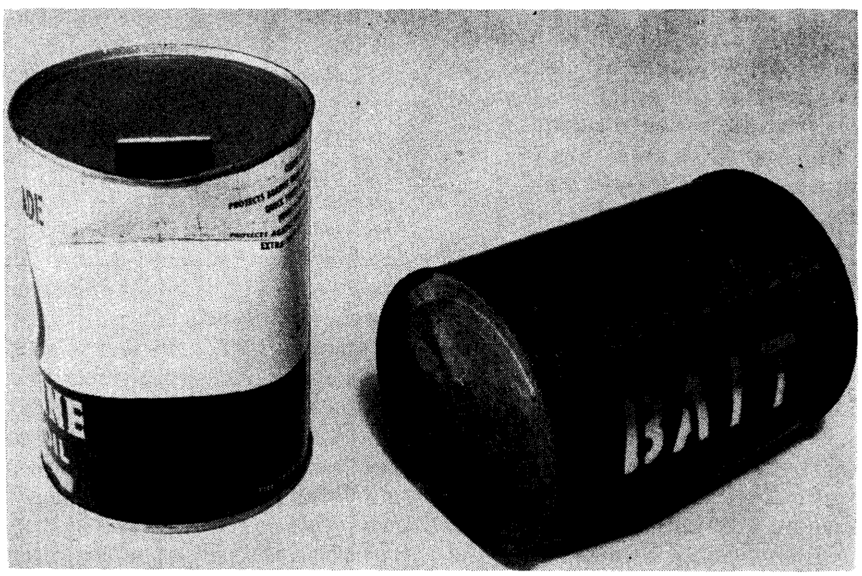

FIGURE 2. A crease is made on one side of the bait can just behind the 1¼-inch opening to help keep bait in and ground water out.

the kernels and then shaken the can to make sure that each kernel is coated. This adheres the kernels together so that there is no chance of livestock or game spilling the poison bait from the cans. We do not know whether this will reduce acceptance of the bait. Paraffin is not convenient when rebaiting cans in the field, and it melts when the sun shines on the cans in summer.

To keep ground water from entering the cans we dented them an inch or so below the opening (Fig. 2). This crease was made by rolling the can along the edge of a table or board. The ridges also prevented grain from spilling out of the cans.

In another study by Howard, *et al.*, (1956) to learn what propensity a kangaroo rat has for gathering broadcast seeds (hence to determine the need for rodent control at forage trial plots) 300 grams of rose clover seeds were scattered in a room with 500 square feet of concrete floor space. One kangaroo rat from the San Joaquin Experimental Range was released in the room. It ate on the average of between 12 and 13 grams (3400 to 3500 seeds) per day, and in one night cached an additional 59.4 grams (16,000 seeds). This means that on the night of peak activity the kangaroo rat must have picked up about 20,000 individual rose clover seeds (equal to one pound per week). Kangaroo rats gather seeds by picking them up individually, using both forefeet, and then tossing them into their external cheek pouches. It is not known how many pouches the 70 grams of seed represented.

Summary

Service station used quart oil cans show considerable promise as being effective bait stations for protecting rangeland seeding trials from rodents. They are readily available, light to transport, and effectively protect grain baits from snow and rain. The bait supply may have to be replenished every few months on small plots, but fresh bait twice a year should be adequate to protect areas of many acres in extent.

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RABBITS AS A TOOL IN PASTURE AND RANGE UTILIZATION RESEARCH

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Many workers have pointed out the disadvantage of simulating grazing by clipping. Perhaps the greatest objection to clipping as compared to animal grazing was reported by Crider (1955) who found parts of a bunchgrass plant to function independently so far as the effects of foliage removal on root growth were concerned. In his opinion, the habit of cattle grazing only part of a plant seems desirable.

However, there are two important problems in using large animals. The first is the fact that the grazing enclosure used needs to be large enough to supply forage for a minimum of two or more animals. The second is that with larger enclosures variability increases which in turn requires a larger area or more replication of pastures. In order to overcome both of these difficulties the experimenter must increase the cost of his studies. Whenever a treatment has been sufficiently well tested on a plot basis, naturally a large grazing experiment is desirable for final evaluation or demonstration. In the screening process, however, there is a need for techniques to be used in simulating effects of large animals on small uniform areas.

Rabbits were used at the Oregon Agricultural Experiment Station in 1955 in an attempt to test the effectiveness of spring-applied nitrogen fertilizer to increase forage production during the sheep breeding season in August. Fertilizer treatments consisted of a March application of 33 lbs. of nitrogen per acre to a mixed stand of Alta fescue (*Festuca arundinacea*), orchardgrass (*Dactylis glomerata*), and burnet (*Sanguisorba minor*). The fescue made up about 45 percent of the stand, orchardgrass 15, burnet 20, and other species 20 percent.

Since clipping experiments had been conducted over a two-year period to determine the best method of treating this type of pasture, it was thought that rabbits might be useful in making an animal evaluation. Forty weaner New Zealand rabbits, about six-weeks old and weighing approximately 1,200 grams each, were used on the fertilized and unfertilized plots. Each plot was six-hundredths of an acre in size. These two fertilizer treatments were applied in four replications making a total of eight plots in the experiment. Late in July the weaner rabbits were grazed in groups of twenty on each of the two treatments.

Groups were weighed four times weekly and moved to the corresponding treatment in the next replication at the end of each week. Fourteen separate weighings were made during the course of the experiment which lasted 28 days.

Utilization checks were made by clipping 30 randomly located square-foot quadrats in each plot immediately before and after grazing. Utilization figures varied from none the first week of the study when grazing by rabbits was balanced by forage growth to 50 percent in the unfertilized plots in the fourth replication. No significant differences in rabbit gains were observed among the treatment groups. It is believed that the intensity of rabbit grazing was too low to be reflected in their gains. In other words, in all treatments the rabbits were receiving sufficient forage to maintain a near-normal gain.

A range of use levels was obtained, however, on the four replicates in both the fertilized and unfertilized plots. These were correlated with early spring production in April of 1956, and a close inverse relationship was found to exist between the intensity of August grazing and early spring production the following year. These data are summarized in Table 1.

Unintentionally a range of use was obtained with rabbit grazing which confirmed a relationship demonstrated earlier by clipping studies. In addition to these indications obtained from rabbit use ranging from 0 to 50 percent, extreme use by sheep outside the experiment on an unfertilized area (90-100 percent utilization fall 1955) resulted in zero forage production on April 16 the following spring.

Table 1. Effect of intensity of rabbit grazing in August on early spring forage production the following year.

Percent Utilization (August 1955)	Production of Air-Dry Forage on April 16, 1956 — Unfertilized	Fertilized (30 lbs. N, March, 1955)
	lbs./acre	lbs./acre
0	240	380
10	220	
15		400
30	100	
30		340
40		290
50	110	
Means	170	350

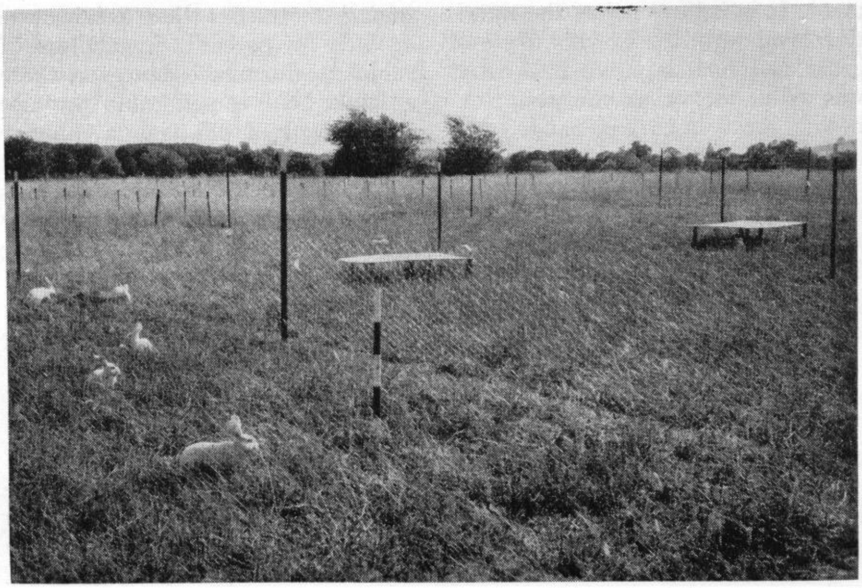

FIGURE 1. Rabbits grazing on experimental pasture plots. The shelters provide both shade and protection from predatory hawks.

These data suggest the value of rabbits in applying grazing treatments to small plots so that effects can be studied over a wider range of use than would be possible with large animals alone. Perhaps preliminary results from similar trials would become valuable in planning large experiments where, of necessity, the number of grazing intensities would be limited.

In Figure 1 the rabbits are shown grazing during the experiment reported. The outside of the experimental area was fenced with heavy six-foot woven wire used by turkey men for protection against dogs and foxes. Burrowing under the fence was prevented by plowing out a furrow slice around the area and burying 12-inch poultry netting with 1-inch mesh. Divisions between plots within the area were made with 2-inch mesh light-weight poultry netting 48 inches high. The bottom 12 inches of this division wire was turned into the plot and secured to the sod with 3-inch staples. This left the vertical segment 36 inches high which was sufficient to prevent rabbits from jumping between exclosures and still allowed free access by the attendant.

At the four corners of the main area, number one jump traps were placed on the top of 10-foot, 2 x 4-inch posts to guard against owls. To protect the rabbits from depredation by hawks and to supply necessary shade during the hot part of the day, 4 x 4-foot panels of ¼-inch plywood were supported in a horizontal position by five 1-foot x 2-inch surveyor's stakes. This kept the shelter about 10 inches above the ground and was sufficiently large for ten weaner rabbits. No losses occurred from predation and no difficulty was experienced from dietary deficiency. A constant supply of fresh water was provided in 10-quart poultry self-waterers. During the transition to pasture forage a small amount of supplement was provided in small galvanized troughs secured to the partition fence.

A total of four rabbits was lost during the study. Three died of acute bloat the first day on pasture and were replaced by excess animals from a pool kept for that purpose. This loss could have been avoided by providing them with green grass while the rabbits were still on dry feed. One rabbit became ill the last week on pasture from dysentery and was killed as the animals came off the experiment. It is believed that the nutritive level supplied by this dryland grass and forb mixture in August was about as low as one would expect in most pasture or range grazing experiments.

The rabbits gained an average of 300 to 400 grams in the four weeks. This was at a nearly linear rate of 75 to 100 grams per week. These gains should be large enough to measure significant differences among treatments when grazing use exceeds 50 percent. Regardless of rabbit performance, however, these animals hold considerable promise as a means of effecting a number of levels of utilization in grazing experiments. In addition, rabbits leave pastures in a more normally grazed condition than clipping does.

Although one may reasonably question the value of simulating trampling effects with rabbits, this problem is greater with clipping. In fact, on the dry pastures in this experiment there were noticeable trails and evidence of surface trampling wherever the rabbits congregated.

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A HISTORY OF SQUIRREL BURROW GULLY FORMATION IN RELATION TO GRAZING

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During April and May, 1940, in the course of gathering material for an M.A. thesis, the writer had occasion to photograph two sites in southwestern Napa County, California, where ground squirrel burrows had incited gully formation. The thesis, together with the photographs, was subsequently published (Longhurst, 1940) and the process of gully formation with the relation to grazing described. Fifteen years later, in April, 1955, these two sites were again photographed. Since contrasting changes have taken place on the two sites, a brief description of them and their grazing history appears worth while.

More recently other workers have added further observations of gully formation from rodent burrowing to the literature. Crouch (1942) illustrated pocket gopher gullying, while Gunderson and Decker (1942) found that this process also occurs in Iowa, particularly with woodchuck burrows. Howard (1953) made additional observations in California, where he considered pocket gophers to be the chief burrowing rodent.

The two sites under study, which for convenience are designated as A and B, are located on the headwaters of Huichica Creek about one-fourth mile apart. Elevation for both is slightly over 200 feet. Precipitation in the form of rain averaged 24.61 inches for the 15-year period, as measured at the town of Napa, some five miles to the east. Carpenter and Cosby (1938) place the soils as Butte Stoney Loam on Site A and Coombs Gravelly Loam on Site B. Storie and Weir (1953) describe these soils as follows:

Butte—Podzolic upland soil from coarse-textured acid igneous rocks; moderately deep and perme-

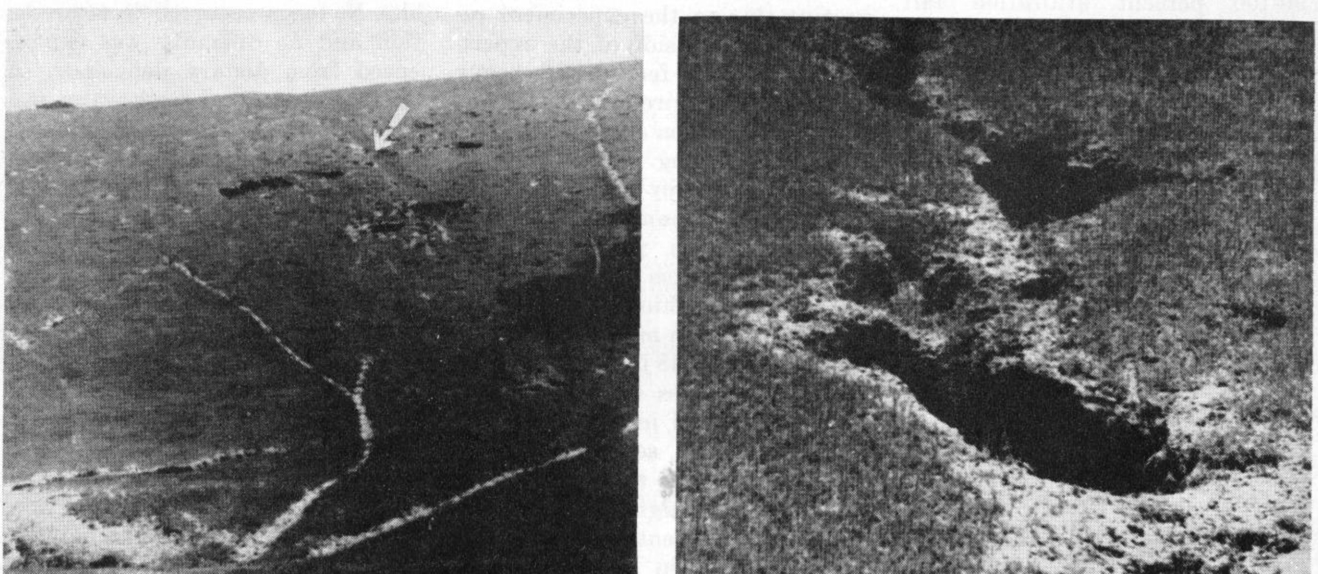

Figure 1. *Left:* General view of Site A photographed on April 21, 1940, with location of burrow gully area indicated by arrow. *Right:* Close-up of burrow gully area in Site A in April, 1940.

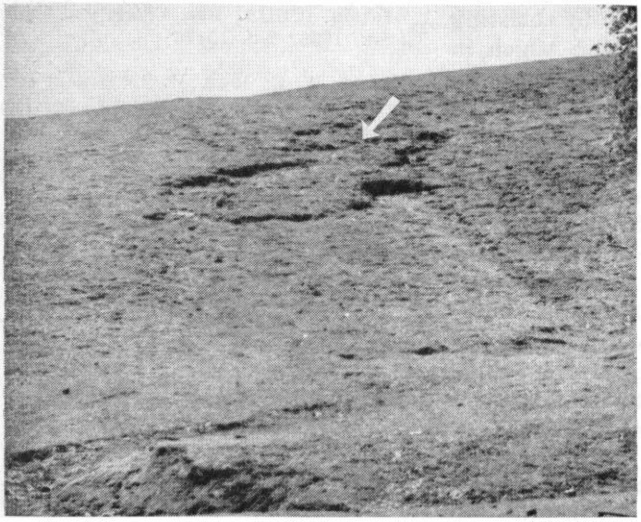
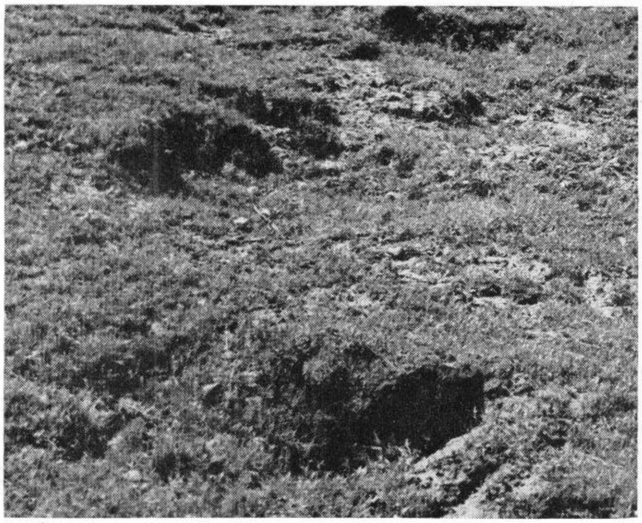

FIGURE 2. *Left:* General view of Site A on April 23, 1955, 15 years after the first photographs. *Right:* Close-up of burrow gully area in 1955. Compare with Figure 1.

able with a natural vegetation of woodland or timber.

Coombs—Noncalcic brown valley and terrace soil from basic igneous alluvium with good drainage; has a natural grass vegetation.

Cover on the two sites, which were in adjoining pastures, was predominantly annual grass and forbs with scattered oaks on the watersheds above. Both pastures were operated together from 1930 until 1939 with heavy seasonal sheep use. At that time the sheep were replaced with cattle, which also used the pasture seasonally during the winter and spring but at a more moderate stocking rate. In November, 1943, the pasture containing Site B was sold to a nearby dairy ranch, and, since then, has been exposed to extremely heavy yearlong cattle use by the dry stock from the dairy.

The important point is that during the fifteen year period between photos, Site A had moderate seasonal cattle use for the entire time, while Site B had 3½ years of moderate seasonal cattle use and 11½ years of very severe cattle use.

When first photographed in 1940, both sites were in approximately the same relative stage of erosion. Burrows of the Douglas ground squirrel (*Citellus beecheyi douglasii*) which ran with the slope had been enlarged to a diameter of two feet or more by subsurface waterflow during the rainy season. When the soil covering finally became too thin the tunnels collapsed, leaving the condition shown in Figure 1 and Figure 3 (*left*).

Figures 2 and 3 (*right*) show the two sites in 1955, 15 years later. On Site A, gullying had progressed to some extent, but the gullies were well grassed over and not actively enlarging. In contrast the gully at Site B had enlarged greatly both in depth and through headward erosion. (Note the eight-year-old boy standing in the hole.) As can be seen in Figure 3, in recent years the left hand channel has "pirated" the bulk of the overland flow and has been enlarging, while the original channel to the right has healed to some extent. The owner of the dairy had tried unsuccessfully to stem the erosion by piling old baling wire and brush in the gully.

The watershed behind Site B is slightly greater than behind Site A, but comparing the sites themselves, Site A had the steeper gradient. While these two sites were

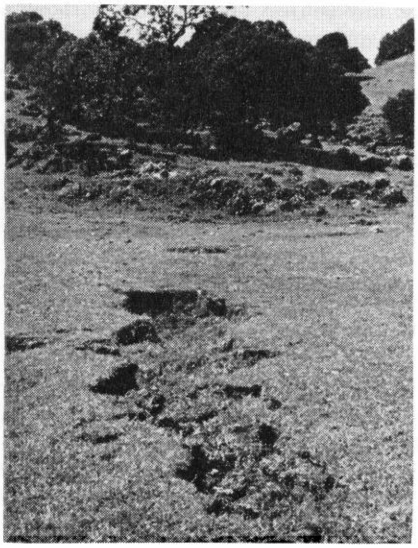
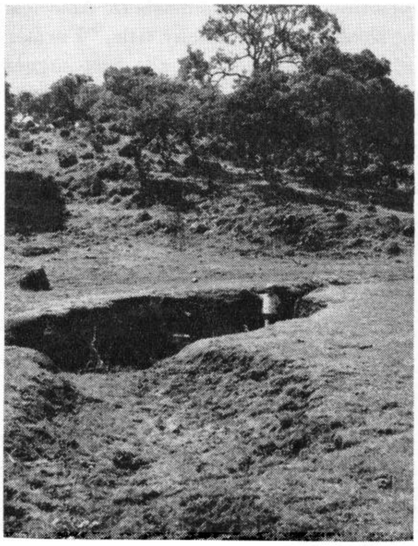

FIGURE 3. *Left:* General view of Site B on May 5, 1940. *Right:* Gully on Site B 15 years later. Photographed on April 23, 1955.

chosen for detailed comparison because of the photographic record available, a number of other gullies in the two pastures present the same general picture.

Although detailed records were not kept through the years, the impression gathered was that there were no major differences in squirrel numbers on the two areas. Apparently there was sufficient grazing on both areas to provide adequate squirrel habitat. The course of events suggests that rodent burrows are merely the precursors of gullies which are enlarged first by subsurface flow until they cave in, and secondarily by overland flow. It is primarily the overland water flow, as conditioned by existing ground cover and litter, which in turn are affected by grazing, that eventually determines the extent of erosion.

Since this process of water enlargement of rodent burrows, particularly those of the ground squirrel (*Citellus beecheyi*) and the pocket gopher (*Thomomys bottae*), is a widespread and common source of gully formation on the annual ranges of coastal California, there is added strength to the argument for moderate grazing.

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BOOK REVIEWS

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

Farmers at the Crossroads. By Ezra Taft Benson. *Devin-Adair Company, New York. 107 pages. 1956. $2.50.*

This is indeed a remarkable little book containing 102 pages of agricultural information and philosophy. It deals with the past history, present position, and future needs of American agriculture. The catchy title, "Farmers at the Crossroads", is the first suggestion that this book is not purely a statistical treatise.

The short biographical sketch of the author's life in the forepart of the book is very good, for it puts the reader in the right frame of mind to understand what is to follow. No one having read this sketch could help but know that the opinions of the author would be written with the utmost honesty and sincerity, backed by a thorough knowledge of agriculture.

The glossary in the back, like the biography in the front, should be read before starting the book because it contains a thorough explanation of each term.

There are eleven chapters in "Farmers at the Crossroads", and each chapter deals with some phase of the agricultural situation. Each chapter is subdivided into several topics. I like this method of presentation because it is readable and keeps the ideas well defined.

No writer could cover this subject, or any subject of this kind, without a certain amount of statistical information. However, the author has kept figures to a minimum and the statistics that are used are interspersed with other material. This method of presentation makes the figures more readable and keeps them from becoming burdensome.

There are seven graphs to explain points of interest, and each has a very thorough explanation.

Mr. Benson gives a full history of the agricultural picture, including the effects of war economy, price supports, acreage quotas, and agricultural legislation that have contributed to our present problems. He defends his present stand on flexible price supports; yet his Great Plains program shows the willingness of The Department to offer assistance in times of emergency.

It is my opinion that the author places too much emphasis on price supports and their effect on the agricultural situation. He recognizes the importance of research, education, expanded markets, and adequate long-term farm financing. I would like to have seen it made clearer that research, conservation, education, markets, and financial programs working properly would largely do away with the necessity of commodity supports of any kind.

Considerable mention is made of farmers losing their self reliance. We in agricultural circles know that this is just a trend and not an actuality. The thought has occurred to me that a person outside of agriculture reading this book (and it should be read by those kind of people) would picture the farmer as a dependent and unresourceful person.

Although "Farmers at the Crossroads" is a record of the hard facts that will influence this nation and the whole world, the reader will very likely remember it longer for the gems of shrewd philosophy that appear at intervals through the entire book. Following are a few of the many quotes that show what I mean:

"Never before have so few produced such an abundance for so many."

"No single diagnosis is correct and no single solution will work."

"Research is basic to our entire economy."

"Conservation means making soils yield abundantly year in and year out for an indefinite period."

"The soil, water, range, and forest resources of the United States are the foundation blocks of the structure in our national economy."

"To me this is not just another nation, it is a great and glorious society with a divine mission to perform for liberty-loving people everywhere."

"Freedom is a God-given, eternal principle vouchsafed for us under the constitution."—*R. A. Long*, Rancher, Fort Rock, Oregon.

Soil Conservation. By J. H. Stallings. *Prentice-Hall Inc. New York. 575 pages. 1956. $8.50.*

"Soil Conservation" is an admirable text, broadly and specifically encompassing the inter-related sciences that make up soil conservation. There are 575 pages and 25 chapters developed under four parts as follows: Part I—Introductory and Geographical Aspects; Part II—Fundamental Considerations of Soil Conservation; Part III—Conservation Practices; Part IV—Farm and Watershed Planning.

Stallings worked for 20 years for the Soil Conservation Service, both in the field and Washington office, and since 1953 has been associated with the Research Branch of Soil Conservation under the Agricultural Research Administration. For many years, the author had the task of reviewing and reporting on fundamental conservation work for field use; hence he is one of the world's best informed men on soil conservation literature.

Conservationists in all fields will find this to be a foundation text for their own specialties because each aspect of conservation sciences must be concerned with the conservation of soil, water, and vegetation. And all sound conservation must proceed with proper analyses of resources and problems before successful integration and action can be carried out.

The case against erosion is firmly established, and methods for control are plausible and well-oriented. Numerous excellent black and white photographs helpfully illustrate the text.

Readers with grazing interests will find two excellent chapters entitled "Grassland Farming" and "Protect the Soil and Improve the Range."

This new book is particularly well-suited as a text for high school and college students.—*B. W. Allred*, Soil Conservation Service, Washington, D.C.

The Future of Arid Lands. Papers and Recommendations from the International Arid Lands Meetings. Edited by Gilbert F. White. *American Association for the Advancement of Science, Washington, D. C. 453 pp. 1956. $5.75.*

The objective and general scope of this analysis of arid land problems is briefly stated in the first sentence of the preface: "This volume sets down the efforts of scientists from seventeen countries and from as many disciplines to assess the state of man's struggle to make productive and stable use of the world's arid lands." "Arid lands" as defined by Charles E. Kellogg in his chapter on the "The Role of Science in Man's Struggle on Arid Lands," includes specifically "those regions in which the normal soils, although perhaps productive of grass and browse, are usually too low in moisture for the dependable production of cultivated plants without irrigation."

The volume consists of a collection of the various papers presented at the International Arid Lands Meetings held in Albuquerque, New Mexico, April 26-May 4, 1955. The variety of topics included is indicated by selected contents of the text:

History and Problems of Arid Lands Development
The Role of Science in Man's Struggle on Arid Lands
The Challenge of Arid Lands Research and Development for the Benefit of Mankind
Climatology in Arid Zone Research
Water Resources in Arid Regions
Variability and Predictability of Water Supply
Fluctuations and Variability in Mexican Rainfall
Beneficial Use of Water in Arid Lands
Geochronology as an Aid to Study of Arid Lands
Grazing Resources
Geography's Contribution to the Better Use of Resources
Agricultural Use of Water under Saline Conditions
Consequences of Using Arid Lands beyond Their Capabilities
Possibilities of Increasing and Maintaining Production from Grass and Forest Lands without Accelerating Erosion
Land Reclamation and Soil Conservation in Indian America
Demineralization of Saline Waters
The Salinity Factor in the Reuse of Waste Waters
Induced Precipitation
Some Relationships of Experimental Meteorology to Arid Land Water Sources
The Economics of Water Sources
Adaptation of Plants and Animals
Animals and Arid Conditions: Physiological Aspects of Productivity and Management
The Locust and Grasshopper Problem in Relation to the Development of Arid Lands
Desert Agriculture: Problems and Results in Israel
Problems in the Development and Utilization of Arid Land Plants
Plants, Animals, and Humans in Arid Areas

Analyses of the sorts included in these titles, made in large part by men recognized as leaders in their respective fields, would be expected to contain much information not otherwise obtainable without extensive research. Such is the case. Similarly, in so comprehensive a compendium it would seem almost inevitable that no little commonplace knowledge should also be included. This also is the case.

Most of the chapters are written in easily understandable, essentially non-technical language. This makes the volume rather well suited to use by those who do not profess to be specialists in the various fields covered. Although 25 of the chapters include literature citations, the references are generally not exhaustive enough to be of particular value in detailed research on any of the topics. They do, however, provide beginnings and indicate some of the publication avenues available.

Today, more than at any time in the past, use is being made of lands formerly considered too arid for satisfactory human use. The symposium from which this volume emerged was particularly timely and focused attention not only on the general problem, but on already proven or potential solutions. As a general reference, it is highly deserving of a place on the shelves of all who are interested in arid lands and their future.—*R. R. Humphrey*, Arizona Agricultural Experiment Station, Tucson, Arizona.

CURRENT LITERATURE

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

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The History and Accomplishments of Our Range Society[1]

JOSEPH F. PECHANEC

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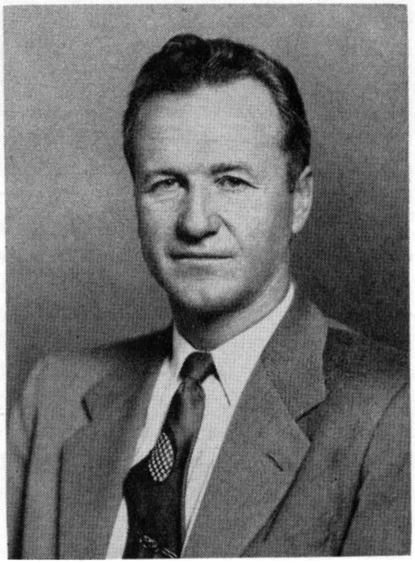
How many of you have read and thrilled at the objectives of our Society—To foster advancement in the science and art of grazing land management, to promote progress in the conservation and greatest sustained use of forage and soil resources, to stimulate discussion and understanding of scientific and practical range and pasture problems, to provide a medium for the exchange of ideas and facts among society members and with allied technologists, and to encourage professional improvement of its members?

How did we get a Society with these objectives? When was the beginning? Who was behind the formation of this Society? History is a dry subject to many. But at this—the 10th Annual Meeting of the American Society of Range Management—I think it well to review some of the highlights in the formation and growth of our Society. Many of our present members did not share in the experiences of the formative years.



JOSEPH F. PECHANEC

Early Developments

The concept of a society for range men goes back at least to 1931. Between 1931 and 1946, several different groups of range men seriously considered such an organization. Chiefly because there was a general feeling that numbers of range men were insufficient to support a strong society, none of these earlier considerations bore any tangible move toward formation of a society. The fact that the idea was kept alive, however, was a real accomplishment of the earlier workers.

The first tangible event which subsequently gave birth to the American Society of Range Management took place in Moscow, Idaho, on March 28-30, 1946. Here, at an Interagency Range Management Conference attended by representatives of five colleges and several state and federal agencies, one of the panel discussions was entitled "The Need for a Range Management Organization." Members of the panel included Charles A. Fite, Gene Payne, Vernon A. Young and myself, with Harold F. Heady as leader.

The needs for a common meeting ground for range men employed by the several agencies—a place where we could get together and thresh out our common problems—and for a journal

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[1] *For much of the material relating to early years of the Society acknowledgment is given to a report entitled "History of the American Society of Range Management, 1946-1949," which was prepared by the Historical Committee for the Society and presented to President D. A. Savage on January 1, 1951.*

to which we could turn and find current literature on range and grassland problems were clear from the discussion. There was no question regarding the need for some type of organization. But a spirited and somewhat heated discussion took place between panel members and from the floor, with the group pretty sharply divided on the issue of whether the needs of range men could be taken care of by affiliating with an existing society, or whether a separate organization was needed.

At the close of the meeting a motion was passed instructing Vernon A. Young, chairman of the conference, to appoint a committee to inquire further into interest by range men in a range organization and the type of organization desired. Tom Lommasson, Liter F. Spence, W. T. White, Harold Heady and myself were appointed to that committee, with the last two named as co-chairmen.

During the spring and summer of 1946 committee members inquired further into the desires of range men. Need for a more thorough canvass became evident, and on August 20 distribution of a mimeographed letter was begun to 858 range men. This letter set forth the consensus of the Moscow panel discussion and briefly listed arguments advanced for setting up a separate organization, and for affiliating as a section within an existent society. Enclosed was a card to be filled out and returned, asking whether the man favored an organization of range men, whether this should be a separate organization or a section of an existent society, whether he would become a member in either event, and whether such an organization should publish a journal.

The spirited discussion at Moscow was wan and sickly compared to the pungency of some of the replies. There were those who felt no need existed. Others expressed themselves strongly in favor of affiliating with the Society of American Foresters. Still others were equally positive about the American Society of Animal Production being the appropriate haven for range men. There were those, too, that favored the American Society of Agronomy.

Strong interest in the formation of a range organization was, however, displayed by the 505 replies. On only two points were they conclusive: 495 men favored a range management organization, and 390 favored publication of a journal. The issue of whether the organization should be separate or affiliated with an existent society was still not absolutely clear; 286 favored a separate organization as compared to 237 for affiliation, and 371 indicated they would become members of a separate organization as compared to 319 who would become members of a section if membership requirements permitted.

This history of the development and activities of the American Society of Range Management was presented by J. F. Pechanec at the Tenth Annual Meeting of the Society at Great Falls, Montana, January 29-February 1, 1957. Given as part of the Tenth Anniversary Panel, this article constitutes a permanent historical record of the development of the Society from its inception to January, 1957.

From these replies, the committee concluded that the advantages of a separate organization of range men more than offset the advantages of affiliating with an older society. It was their opinion that only if enough members could not be secured to set up a separate society and finance a publication, should the alternative be considered.

We were still plagued by the lack of knowledge as to how many range men there were. Some estimates gave only 500 to 600 as a potential. We didn't know how much in the way of dues could be charged, or what it would cost to finance a publication. Several other existing societies were in sad financial shape, and we didn't want to start still another. Doubts were many!

Moreover, it was clear from some correspondence received that at least three older and existing societies were considering making overtures to range men. The Society of American Foresters had already set up a subject matter division, and there were several in both the American Society of Agronomy and the American Society of Animal Production who felt these societies should take in the range men. There was the possibility that many of our potential members would be drained off into other societies and that a unified group could not be achieved.

Formation of the Society

From November 1946 until midsummer in 1947 the committee members contacted many leading range men to obtain their advice as to what course to pursue. Also, inquiry was made of several societies concerning their policies, possibilities of affiliation, details and costs of publishing a journal, and many other organizational problems. The outlook was still clouded, but it was evident that an organization was needed. Strength was needed to even discuss affiliation effectively—to negotiate with existing societies and secure the objectives that range men wanted. Interest awakened by the original letter in 1946 and efforts by other societies to encompass range men in their fold made time of the essence.

The committee decided to move ahead with setting up a skeleton organization. Accordingly, a second letter was sent in mid-July of 1947 to about 850 persons summarizing the results of the mail canvass, establishing a range society with objectives listed above, and requesting payment of a $3.00 dues. The society being formed was to explore completely possibilities for setting up a separate organization or ends that could be achieved by affiliating with one of the existent societies, and to plan a two-day meeting during the winter of 1947-48.

This letter also requested vote on members for a temporary council to assist and help guide the committee until officers could be elected, and vote on a name for the society.

No small factor in the success of this venture were two displays of support. First, both the 1946 and 1947 mailings of letters cost money. To cover these costs several leading range men in the country and members of the committee contributed as much as $25.00 apiece. Second, official actions by two of the major federal agencies in the field of range conservation resolved any doubts as to their attitudes. On the same day, W. L. Dutton and W. R. Chapline of the Forest Service, and Fred Renner of the Soil Conservation Service sent similar letters to range men in their respective agencies informing them of developments and strongly urging that they join the new society and give it their support. Later, the Chiefs of both the Soil Conservation Service and Forest Service, when they were informed of the objectives of the new range society, sent letters to all their regions, expressing official interest and support of their agencies. Later, G. M. Kerr of the Bureau of Land Management sent a similar message to the range men of that agency. These official attitudes toward the new organization did much to stimulate interest and increase membership in the new society.

Five committees were appointed by the original committee to assist in work of the embryonic society. An organization committee, to develop objectives and a constitution and bylaws for the organization, to study scope of the organization, and to select a name for the organization, was formed under the chairmanship of Fred Renner. A membership committee, to conduct an extensive membership campaign, to make suggestions regarding the nature of membership requirements, and to determine how much would be needed for dues, was set up under the chairmanship of C. Kenneth Pearse. A program committee, under the chairmanship of Dave Costello, and an arrangements committee, under the chairmanship of George Stewart, were established to prepare for the first meeting at Salt Lake. A journal committee was appointed to present their ideas on possibilities of publication of a journal, format, contents, and estimated cost.

By early November the replies to the letters sent out during the late summer were sufficiently complete that the selection of a temporary council was clear. Elected were B. W. Allred, David F. Costello, Fred G. Renner, George Stewart, L. A. Stoddart, and Vernon A. Young.

Thus, by the end of 1947, as a result of very active work by the original committee, the temporary council, and each of the five appointed committees, arrangements were completed for the first annual meeting to be held in Salt Lake City, Utah. A first draft of the constitution and bylaws had been completed. Membership stood at somewhat more than 400, and an encouraging report on the possibilities of a journal had been prepared.

First Meeting at Salt Lake

The meeting in Salt Lake City, just nine years ago today and tomorrow, was a memorable one. Doubts that lingered in the minds of many of us were quickly and positively dispelled shortly after the meeting opened. The attendance of 192 clearly indicated positive interest in a range organization. Everyone seemed imbued with the idea that they were there to organize an active, worthwhile society that would stand on its feet and go places. The great majority were in favor of a separate society instead of affiliation with some existing society. The die was cast. We were on our way.

Considerable discussion during the business session on the morning of the 30th revolved around a name for the new society. Even though the organization committee had chosen the name "American Society of Range Management" on the basis of voting in response to the letter sent out in July 1947, there still seemed to be considerable dissatisfaction. An alternate name proposed was the "American Grassland Society." As a result of the ensuing discussion it was decided to submit by mail the two choices to the full membership for vote, together with a full explanation of the relative merits.

Membership requirements also came up for considerable discussion. There were clearly two schools of thought. One group favored requirements broad enough to include anyone sufficiently interested in joining the Society and supporting its objectives. The other thought that such a liberal policy would detract from the professional standing of the Society, particularly if those without scientific scholastic training in range management were admitted.

There seemed general agreement on the admission of those actually engaged in technical aspects of range management, but lack of agreement on the admission of ranchers, especially those some members thought had exploited their lands. The proposal was made from the floor that ranchers be admitted only if they were "conservation ranchers," and after examination by Society representatives revealed they actually had "a good crop of grass" on their lands.

Chairman Renner, of the Organization Committee, who was then presiding, "innocently" suggested that this sounded reasonable, but pointed out that in a democratic organization, any such requirements ought to be applied to all classes of members. He went on to suggest that if it were applied to L.U. project managers, national forest supervisors, district graziers, or other technicians managing rangelands, the Society might find itself in the position of having to refund the membership dues of a considerable number who had already joined. The ensuing laughter settled the point and the group went on to vote the inclusion of broad membership requirements as they stand today.

Numerous recommendations were made for consideration in revision of the draft of the constitution and bylaws. These were passed on to the Organization Committee with the recommendation that the revised constitution and bylaws be referred by mail to the full membership for approval.

It was agreed that those range men who came in during 1947 before the range society had become a reality deserved some mark of distinction for their support. Accordingly, it was decided to designate these men as Charter Members, and their membership cards would henceforth bear the name "Charter." Those who became members prior to July 1, 1948, by payment of 1947 as well as 1948 dues could also become charter members.

A resolution from the floor was passed by unanimous vote of those in attendance at the Salt Lake meeting "that the present executive group and council be retained and placed in office for the year 1948." As a result the officers chosen to guide the Society through its first year were: for Council members—Fred G. Renner, David F. Costello, George Stewart, L. A.

Stoddart, B. W. Allred, and Vernon A. Young; for Secretary-Treasurer—Harold Heady; for Vice President—W. T. White; and for President—Joseph F. Pechanec.

Developments in 1948

The year 1948 continued to add other significant events to the history of the American Society of Range Management. The constitution and by-laws were approved by the membership during the summer, and our present name was chosen by an overwhelming majority. Life memberships were set up by action of the Council. The Journal Committee of R. S. Campbell, Robert A. Darrow, H. R. Hochmuth under the able chairmanship of H. H. Biswell developed and published the first issue of the Journal of Range Management in October. The Wyoming Section, first one of the Society, was formed by A. A. Beetle and his associates and was approved by the Council in December 1948.

In addition, the Society began its work with other allied societies and organizations in bringing the importance of rangelands and range management to the fore. They participated officially in the Inter-American Conference on Conservation of Renewable Resources, and met jointly with the American Society of Agronomy during 1948.

The first election of officers by mail ballot was held late in 1948. Those selected by voters for guidance of the Society starting after the Second Annual meeting were: Fred G. Renner, President; D. A. Savage, Vice President; Melvin S. Morris, Secretary-Treasurer; members of the Council: W. L. Dutton and A. W. Sampson for 3-year terms, Milo H. Deming and Kenneth W. Parker for 2-year terms and Dan Fulton and R. S. Campbell for 1-year terms. Through provisions of the Constitution I was continued as a member of the Council for 1949.

Officers of the Society rather early met the issue of what it should do regarding its views on existing or pending legislation, or other similar national matters. It was decided that the Society would state its view on such matters before civic, professional or other groups, in the pages of the Journal, and before legislative groups. Such action would be taken, however, only on specific authority of the Council, in accordance with a course of action which it would outline, and by representatives which the Council would name.

Additional Developments

During 1949 the Society incorporated in the State of Wyoming. Articles of Incorporation were filed with the Secretary of State at Cheyenne, Wyoming. Under the terms of the Articles, the Society was recognized in perpetuity as a legal entity, authorized as a non-profit organization to take and hold property and conduct its activities anywhere in the United States or its Territories or Possessions as the officers and Directors may direct.

Growth of the Society was rapid during 1949. Membership nearly doubled, six new local sections were formed—Colorado, Utah, Texas, Pacific Northwest, California, and Northern Great Plains. Thirteen life memberships were taken out. Financial strength of the Society materially improved. The first full volume of the Journal, composed of four issues, was published under the guidance of Editor Biswell. Official Society representatives continued to participate in the meetings of other societies and organizations.

The succeeding years, too, are not without significant events that shaped the course that the Society has taken. I do not mean to relegate activities of these years to minor importance. Since, however, these events are largely well documented in the files of the Journal, and because I am pressed for time I will mention only a few of these events here.

The "Trail Boss" became the official and permanent brand of the Society in 1950 and first appeared on the cover of the Journal in 1951. The cut, from the Russell collection of Past President Renner, was first used by the Society on the cover of the Program for the Third Annual Meeting. The many favorable comments received led to its proffer for use, an offer which the Board of Directors enthusiastically accepted.

The position of Executive Secretary was approved by the Board of Directors in 1950 to be established as of January 1, 1952. W. T. White, our beloved and self-sacrificing "Exec," occupied that position from the time it was established until he passed away in December, 1956. No one can fully appreciate the importance of what he did for the Society from its very beginning, and especially during the years he served as Executive Secretary.

In 1950, the Board of Directors approved the establishment of Utah State Agricultural College Library as a depository for storage of materials selected by the Library Committee.

In recognition of the importance of our range management students to the future of the Society the September 1951 issue of the Journal was designated as a Student Issue with articles by students and news about them. This commendable practice has been followed each year since.

The importance of strong Sections was early recognized, but it was not until 1952 that steps were taken for them to have a unified and major voice in Society affairs. With the first annual meeting of Section representatives at Albuquerque in January 1952 this essential step was taken and has been continued.

During the period from 1948 through 1956 a large number of men have contributed to the success and the accomplishments of our Society. When I think of the hundreds of men that have served as active members, as section officers or committeemen, as national society officers and committeemen, on the editorial board, and in other capacities, it is extremely difficult to single any out for specific mention. Nevertheless, I feel it would be amiss not to name for the record your Presidents Renner, Savage, Fulton, Stoddart, Allred, Larson, Atkins and Freeman; your Editors Biswell, Campbell, and Darrow; and Executive Secretary White and before him Secretary-Treasurers Pearse, Jim Anderson, Payne, Morris, and Heady. Most of these have been with the Society nearly from 1946 to its present high stage of development.

Significant Accomplishments

Now just what significant things have we accomplished?

We have provided a common meeting

ground for 3,000 members. This number is in marked contrast to the forecasts in 1946 and 1947 of 500 to 600 members. Even so, it falls far short of our potential membership. The fact that our present membership, made up of ranchers, range technicians, teachers, and many other groups, has a place to discuss common problems demonstrates the wisdom of the decision at the first annual meeting to have broad membership requirements. The impacts of our Society through these varied members have spread far and wide. Its influence can be seen in far-off sections of the Middle East, South America, and Africa.

We have a highly respected bimonthly journal, now in its 10th volume, with thousands of copies going to all corners of the globe. These volumes contain technical and semi-technical articles far in excess of the forecast of one of my early correspondents, who said: "I am convinced that your reports favoring a publication in range management separate from the Journal of Forestry indicate merely a desire for such a journal and not a studied thought as to its feasibility. I believe it impossible to support a credible independent publication." This has been done without materially lessening flow to other journals.

We now have 18 active sections, three which we share with our good friends to the north—Canada—and one in the Middle East. The fact that these sections are possible and active is in direct contrast to early forecasts that range men were too scattered to support meetings. These sections, through their field tours, annual meetings, news letters, youth activities such as range camps and judging schools, erection of signs and many other activities, are truly the foundation for the Society.

We have built a better understanding of importance of rangelands and range management problems through our numerous meetings with other societies and organizations. By moving our national meetings around to Salt Lake City, Denver, San Antonio, Billings, Boise, Albuquerque, Omaha, San Jose, Denver—and now Great Falls—we have brought emphasis to the importance of ranges in various sections of our country.

We should take pride in these major accomplishments. But by no means should we get complacent. Let's take each part of our objectives and see if we are doing all we can and should. We need membership and we need finances. This is only part. At this, our Tenth Annual Meeting, we should scrutinize carefully and critically. Out of this should come a course for the Society during the next 10 years, a course which would bring to fruition the objectives spelled out for the Society.

WITH THE SECTIONS

ARIZONA

The program for the summer Section meeting at Showlow, July 30-31, will have the theme of "Range Management." Talks, panels, and discussions are scheduled for Tuesday, July 30. Rev. Arthur Guenther will speak on "Indian Lore and Customs of the Apache Indians" at the Tuesday evening banquet. A field trip on the Fort Apache Indian Reservation is scheduled for Wednesday, with the meeting ending in the field that evening.

The State Fair Exhibit Committee with Robert V. Boyle as chairman and Louis Hamilton, Darwin Anderson, Ted Moeller, Perl Charles, Warren Crough, and Wayne Kessler as members, are arranging an exhibit of potted range plants for the State Fair this fall.

By April 6, 11 new members had been gained by the Section. Prospects for reaching 300 Arizona Section members by the end of the year continue to look good.—*Wayne Kessler.*

INTERNATIONAL MOUNTAIN

The spring meeting of the Section was held at Milk River on June 13 and 14. The meeting concentrated on range plants and featured an exhibit of range grasses and other range plants. Dr. R. T. Coupland, Professor of Plant Ecology at the University of Saskatchewan, was the guest speaker at the banquet on the evening of June 13.

The range tour on June 14 included the Writing-On-Stone area, the Howard Leslie ranch, Joe Gilchrist's Deer Creek ranch, and the Dave Thomas ranch in the Sweetgrass Hills.

John Cross, Nanton, Alberta, Section member and Society director, was re-elected president of the Western Stock Growers Association. Eion Chisholm, Calgary, continues as Secretary of the association.

NEBRASKA

Membership in the Section showed an increase of about 20 percent by the end of April. Twenty-four new members had been obtained by this date. The Membership Committee, chairmaned by Lorenz Bredemeier, consists of 27 men from all sections of the state. Each man on the committee has been charged with the responsibility of getting two new members this year.

Five Range Judging Days and a State Range Judging Contest have been planned for the summer. The Section is acting as a co-sponsor of these judging contests.—*George Wiseman.*

NORTHERN GREAT PLAINS

The summer meeting of the Section will be held at the Dominion Range Experimental Station southeast of Manyberries, Alberta, on July 10-11, 1957. Arrangements are being made to accommodate the Section members. Meals will be provided by the Boarding House at a nominal fee; however, sleeping accommodations are lacking. Members can bring their sleeping bags and bunk in the auditorium, or they can commute from Havre, Montana.

Membership in the Section has shown a substantial increase. At the end of March there were 105 paid-up members and only 14 delinquents. Last year at the same time there were 67 paid-up members and 30 delinquents.—*Carl Graham.*

PACIFIC NORTHWEST

The summer meeting of the Section was held at Burns, Oregon, July 1 and 2, 1957. The meeting featured the work of the Malheur Game Refuge and the Squaw Butte-Harney Experiment Station. A full report of the meeting will be given later.

The Summer Range Camp for the boys from Oregon will be held July 29-August 3 at the Tupper Guard Station in the Umatilla National Forest near Heppner. Included in the program will be plant identification, principles of plant growth, range livestock and game management, and range reseeding.

The 1957 annual business meeting of the Section will be held at Bend, Oregon, December 1 and 2.

SOUTHERN

Five members of the Southern Section attended the 1957 Annual Meeting of the Society at Great Falls, Montana, last January. These were: BOB WILLIAMS, JOE PECHANEC, BOB RUMMELL, BOB CAMPBELL, and HURLON RAY. HURLON RAY was Grand champion in the photograph contest at the meeting.

Plans are taking shape for the annual Section meeting, which will be held in Arkansas next October. FRED A. PEEVY is chairman of the Program Committee for the fall meeting.

The membership goal for the Southern Section is 100 members by the end of the year. As of April 1 Section membership totaled 58. — *Lowell K. Halls.*

TEXAS

The Program Committee met at Abilene in March and scheduled five Section meetings for the year. These are: (1) Brownwood—range watersheds, May 4; (2) Midsummer meeting, probably in Chihuahua City, old Mexico; (3) Spur—range research, September 27; (4) Madisonville—post oak range, probably November 1 or 2; (5) Fort Worth, Annual meeting December 7-8. Part of the program at the annual meeting may be devoted to papers by women ranchers.

The grass display board owned by the Texas Section was displayed at the Fort Worth Stock Show this spring. The board has grass mounts and lights that blink on when the right button is pushed. This board is available for display by Society members wherever it may be of value.

UTAH

A joint meeting of the Utah Sections of ASRM and the Society of American Foresters was held at Utah State on April 13. Featured speakers included LINCOLN ELLISON, E. E. KOTOK, ALLEN W. STOKES, OLAUS J. MURIE, WALTER P. COTTAM, and FLOYD IVERSON.

A field day was held at Tintic Benmore on May 24. Research studies dealing with methods of sagebrush and juniper eradication were observed. Other experimental trials examined included studies of forage consumption by rabbits and rodents, reseeding hazards, and utilization on native and reseeded ranges.

A fall field trip is planned to observe range management practices on winter range and private ranches near Box Elder.

SECTION CHAIRMEN AND SECRETARY-TREASURERS FOR 1957

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Charles C. Michaels
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Don Sylvester
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Charles Mowry
Soil Conservation Service
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Nevada

Tom E. Brierley
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International Mountain

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Dominion Exp. Station
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J. Deloy Hansen
Federal Bldg., Room 465
Salt Lake City, Utah

Wyoming

Jack W. Wilson
Box 665, B.L.M.
Rawlins, Wyoming

Alan A. Beetle
Agronomy Dept., U. of Wyoming
Laramie, Wyoming

National Capital

Royale K. Pierson
B.L.M., Dept of Interior
Washington 25, D. C.

Max W. Bridge
928 Oakwood Drive
Falls Church, Virginia

Program for the Summer Field Meeting Sponsored by the Wyoming Section

Registration: Begins at noon on July 25 in the Wort Hotel, Jackson, Wyoming. Full details on meeting places, times, camp grounds, and eating facilities will be available.

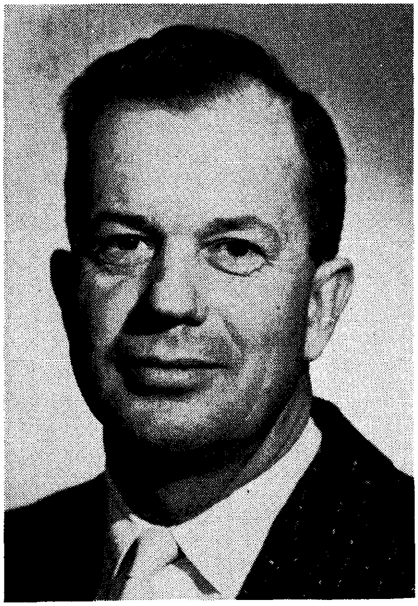
Thursday: **July 25**, 7:30 to 9:30 p.m. Technical panel discussion: Walter H. Kittams, moderator, Biologist, Yellowstone National Park; Odell Julander, Range Conservationist, Forest Service, Intermountain Forest and Range Experiment Station, Utah; Robert L. Casebeer, Habitat Improvement Leader, Department of Game and Fish, Idaho; Margaret Altman, Research Investigator, National Science Foundation, Wyoming; Richard Taber, Assistant Prof. of Forestry, Montana State University.

Friday: **July 26**, Field Day. National Elk Refuge, Gros Ventre area. Big game, Teton National Forest cattle allotments, Grosvont slide area, winter feeding stations, exclosures, excellent fishing.

Saturday: **July 27**, Optional Field Day. Southern Jackson Hole and Hobach Canyon. Glacial erratics, dramatic scenery, route of the Astor fur trappers, sagebrush, juniper, aspen, pine, and fir and spruce associations, Granite Creek Falls, excellent hot springs swimming pool.

A point-by-point mileage chart will be passed out to those registering for the meeting. At predetermined stops speakers will discuss geology, soils, forage, history, ownership, game, livestock, and other points of interest.

Hervey to Head Range Management Department at Colorado



DONALD F. HERVEY

DR. DONALD F. HERVEY, Associate Professor of Range Management, has been appointed head of the Department of Range Management of the School of Forestry and Range Management at Colorado A. & M. College, Fort Collins. DON's appointment was effective July 1, 1957.

DON is a 1939 graduate of Colorado A. & M. School of Forestry, and has his MS from the University of California and his PhD from Texas A. & M. He is a charter member of the American Society of Range Management and is currently serving the Society as a member of the Board of Directors.

In addition to his new position, DON will continue as Chief of the Forestry and Range Management Section of the Colorado Agricultural Experiment Station.

Arnold to Head California Forest and Range Experiment Station

Appointment of R. KEITH ARNOLD as Director of the California Forest and Range Experiment Station was announced May 6 by the Forest Service, U. S. Dept. of Agriculture. ARNOLD succeeds GEORGE M. JEMISON, who becomes Deputy Assistant Chief for Research, U. S. Forest Service, Washington, D. C.

DR. ARNOLD has been a member of the staff of the California Forest and Range Experiment Station for the past six years, and since 1955 has been in charge of its program of forest fire research. ARNOLD is a native Californian. He has his BS in Forestry from the University of California, his MS from Yale, and PhD from the University of Michigan.

As Director of the California Station, which is maintained at Berkeley by the Forest Service in cooperation with the University of California, DR. ARNOLD will have charge of all Forest Service research activities throughout the state.

Hormay Given Service Award by USDA

AUGUST L. HORMAY, research center leader for the U. S. Forest Service at Susanville, California, was granted a Superior Service Award by the Department of Agriculture in Washington, D. C. May 21, 1957, for "invaluable initiative and accomplishment" in developing an improved grazing system for bunchgrass ranges in the California mountains.

As the result of 15 years experimental work on the Burgess Spring Experimental Range, HORMAY determined the cause of deterioration of the bunchgrass range and worked out a system of grazing that allows the plants the equivalent of 3 full years of rest from grazing out of any 5-year period. Full-scale tests of the system on the 32,000-acre Harvey Valley Range allotment of the Lassen National Forest have been outstandingly successful. HORMAY is a charter life member of the Society.

Doran Transferred to Albuquerque

CLYDE DORAN, charter member of the Society and Chairman of the Colorado Section, transferred from the Regional office of the Forest Service, Denver, to the Supervisor's staff on the Cibola National Forest, Albuquerque, New Mexico, on March 23, 1957.

In his new position CLYDE is chief of range management on the Cibolo. At Denver he had been heading up the range analysis work for Region 2. The DORANS are residing at 3005 Marble St. N.E., Albuquerque.

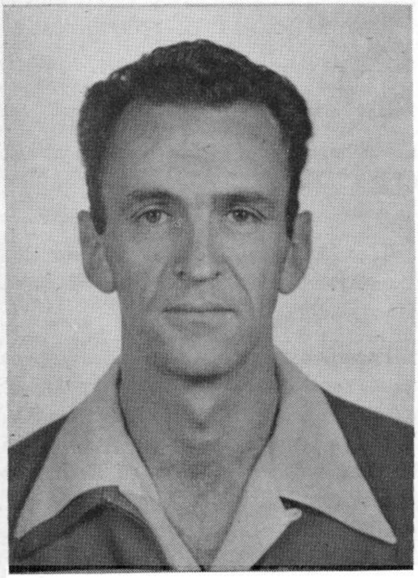
Bentley Receives Incentive Award

JAY R. BENTLEY, California Forest and Range Experiment Station, Berkeley, has been awarded $150 in recognition of superior work in planning and carrying out research on conversion of foothill brushland to grass range and for his efforts in assisting with the development of a long-range research program for the San Joaquin Experimental Range, near Fresno.

Announcement of the award was made by GEORGE M. JEMISON, Station director. The award was made under USDA's incentive awards program, authorized by the 83rd Congress to recognize outstanding work by civil service employees.

BENTLEY has been on the Station staff since 1933 and is a charter life member of the Society.

Halls Made Assistant Research Chief



Lowell K. Halls

Lowell K. Halls has been appointed assistant chief of the Division of Range and Watershed Management Research in the New Orleans office of the Southern Forest Experiment Station, Forest Service, USDA. Dr. R. S. Campbell is the Division chief. Halls will be responsible for developing and coordinating Forest Service research on wildlife habitat and livestock grazing in forests of the Midsouth.

Lowell has been a member of the Society since 1948 and is currently chairman of the Southern Section. Born in Utah, Halls received his bachelor's degree in forest and range management at Colorado A. & M. College and his master's degree at Texas A. & M.

In his new position Halls succeeds Hubert D. Burke, who is now in charge of studies of soil moisture relations being carried on at Vicksburg, Miss., in cooperation with the U. S. Army Corps of Engineers.

Student Member Wins Award

Merwyn Eshelman, 17, of Centerville, Washington, high school senior and student member of the Society, was named Washington's outstanding Future Farmer of the year at the 26th annual Washington F.F.A. conference on the Washington State College campus, April 6, 1957. Merwyn received the state farmer award of $100.

Hoblitzelle Award

The Hoblitzelle National Award in the agricultural sciences will be presented May 21, 1958, to the scientist who has made the outstanding research contribution to American agriculture in the four-year period January 1, 1953 through December 31, 1956. The award consists of $5,000 cash, and will be given to the winner at the 1958 Annual Field Day and Awards Dinner of the Texas Research Foundation at Renner, Texas.

Nominations for the award are now being solicited. Individuals, groups, or agencies may make nominations. The term "agricultural sciences" is interpreted broadly, including agricultural chemistry, engineering, and physics, agronomy, bacteriology, biology, botany, entomology, forestry, genetics, nutrition, veterinary science, presumably range management, etc. For information on how candidates for the Award are nominated write to: Permanent Secretary, The Hoblitzelle Awards, Texas Research Foundation, Renner, Texas.

RANGE MEN ABROAD

FLOYD D. LARSON, chief of the Division of Agriculture and Water Resources in the U. S. Operations mission to Libya, left Tripoli with his family for home leave in the States on June 5. Travel will be by way of Italy and France. After a period of leave the LARSONS will return to Tripoli for another tour of duty.

ART SEMPLE, formerly with FAD in Rome, has transferred to the ICA and is presently working with FLOYD LARSON and DON DAVIS on range management programs in Libya. SEMPLE is teamed with JOHN STEWART, formerly of the BIA, at Billings, Montana, in developing work plans for the conservation and management of the drainage system of the Wadi Megenin range above the city of Tripoli.

JOE MAST left Jordan last fall, when things got too unsettled, and has been working at Benghazi in the position left vacant when RICHARD JOHNSON, Forest Service, returned to the States. The MASTS expect to return to Jordan soon.

BARRY PARK, Forest Service, Missoula, Montana, will take a permanent range management position with the U. S. Operations mission in Tripoli.

DON DAVIS has been promoted to Deputy Chief of the Division of Agriculture and Water Resources, U. S. Operations mission, Libya.

MARVIN KLEMME returned on April 6, 1957, to Monrovia, Liberia, after a five-month journey that took him over most of Africa. Countries visited included Somalia, Ethiopia, British Somaliland, Kenya, and the Rhodesias.

Notice

H. B. STELFOX, Agronomist (Forage Crops), Experimental Farm, Lacombe, Alberta, Canada, died on April 1, 1957, as a result of injuries received in an auto accident. At the time of his death MR. STELFOX was preparing an article on pasture cages for the Journal. The article has been completed by his assistant, W. J. DORAN.

In Memoriam

TOM I. DUDLEY, charter member of the Society, died from a heart attack at his home in Tehran, Iran, on May 3, 1957.

TOM will be remembered for his many years with the Bureau of Land Management in Montana.

Previous to going to Iran he spent two years in Jordan with the International Cooperation Administration. TOM had been in Iran since 1956, where he was head of the Water Resources and Watershed Management Section in the Division of Agriculture of the ICA.

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

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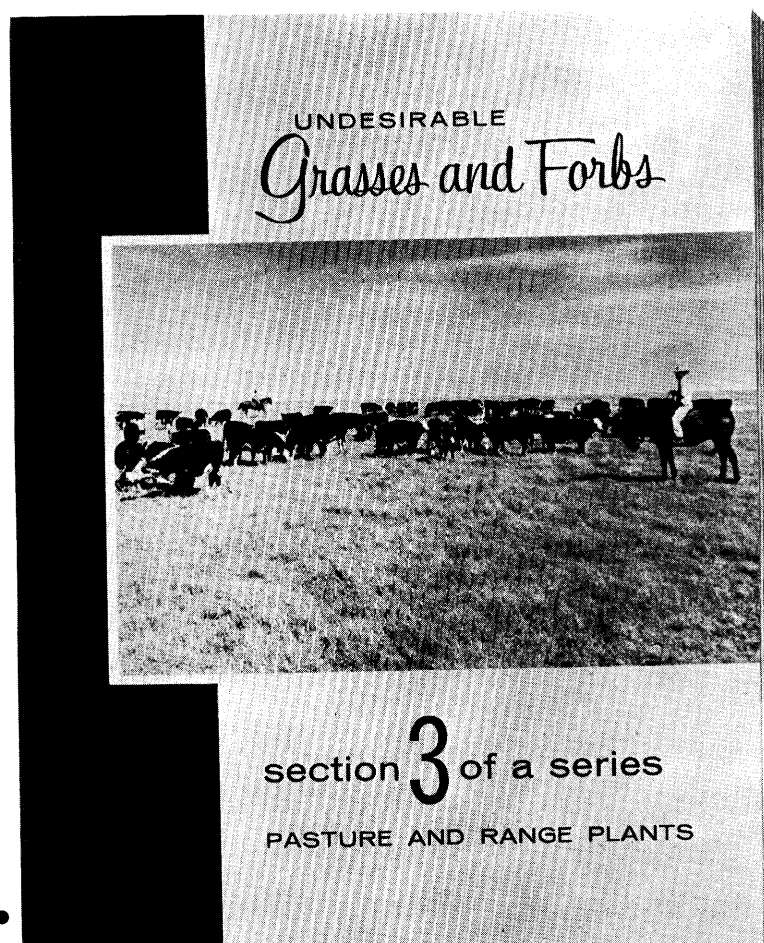

Remember

The AMERICAN SOCIETY OF RANGE MANAGEMENT

holds its 11th Annual Meeting at

PHOENIX, ARIZONA

January 29-31, 1958