Managing Semidesert Ranges of the Southwest

NEW MEXICO STATE UNIVERSITY

COOPERATIVE EXTENSION SERVICE • CIRCULAR 456

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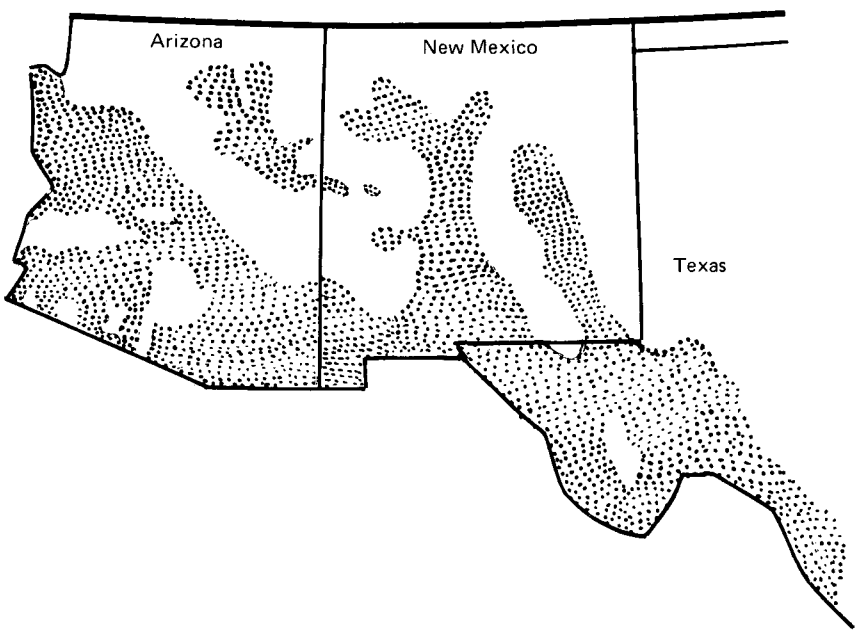
Semidesert Ranges of the Southwest



About the Authors

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Managing Semidesert Ranges of the Southwest

Carlton H. Herbel, Robert Steger, and Walter L. Gould

Some people call the arid ranges of the Southwest "Big Country." The ranges may seem limitless. But as a renewable resource for livestock grazing, these ranges are fragile, easily damaged by abuse and subject to droughts. Many have already been damaged by a combination of grazing, droughts, and a rapid increase of unwanted shrubs.

Range managers work to produce the highest possible net return from rangeland while preserving it as a renewable resource. Because each ranch is different, each rancher has to tailor his own management plan to fit his range and his livestock.

This publication brings together conclusions from research and experience in the management of southwestern arid ranges for ranchers to consider as they select management practices for their ranches.

NATURAL HAZARDS TO RANGE PLANTS

Droughts Occur Often

For many people, the romance of the Southwest is the favorable climate—winters are warm and dry, and summers are relatively dry so the heat is rarely oppressive. For the range manager, the key word in these descriptions is "dry."

Over the arid Southwest, the average annual precipitation is 8 to 12 inches. Averages, however, mean very little. Precipitation varies widely from one time to another and from one place to another,

only a few miles away. Rainfall from April through September governs the growing season for range forage. West of the Sacramento Mountains, about 55 percent of the average annual precipitation falls from July through September; springs are usually dry and windy. East of the Sacramento Mountains, growing-season precipitation is more evenly distributed between spring and summer. The average annual evaporation from Weather Bureau pans is about 90 inches—about 10 times as much as the precipitation. The range plants, therefore, grow in brief bursts, when soil moisture is available immediately after rainfall.

Droughts are frequent and expected. Infrequent wet spells may bring a false sense of security, but chances are that drought—hopefully short, but possibly of several years' duration—will follow.

Stands of perennial grasses are often severely reduced by drought. On the Jornada Experimental Range, near Las Cruces, the basal cover of black grama was reduced to 42 percent of its predrought cover during the 1916-18 drought, 11 percent during the 1921-26 drought, and 23 percent in 1934. During the Great Drought from 1951 to 1956, black grama cover was reduced to 1 to 50 percent of its predrought average, depending on soil type. The drought loss was much more severe on deep sandy sites than on sites with shallower sands. Where 99 percent of the black grama was lost, there has been no recovery.

Droughts are a fact of life in this region and must be anticipated in the management of any southwestern range. There is no evidence that the climate is getting drier.

This droughty sandy site on the Jornada Experimental Range supported an excellent stand of black grama before the severe drought of the 1950s. Without seeding, the site will take many years to recover.

Brush Invasion Reduces Grass Stands

Stands of brush increase the cost of handling livestock, reduce livestock production, increase parasite damage, and make necessary the use of more breeding males. Brush-infested areas also support less wildlife than comparable rangeland in good condition. As undesirable shrubs increase, protective forage grasses decrease, and wind and water erosion increases. In this region, part of the dust during the inevitable spring windstorms and part of the sedimentation in streams and reservoirs come from brush-infested ranges.

On the Jornada Experimental Range, honey mesquite dominated only 4.8 percent of the area in 1858, but this had increased to 50.3 percent by 1963. As mesquite begins to dominate a sandy site, low dunes form, and grass cover is greatly reduced. The first infestations of mesquite on the Jornada are generally attributed to earlier Indian activities. The rapid increase in recent years is due to dispersal of mesquite seed by livestock.

Creosotebush dominated 0.4 percent of the area in 1858 and 14.2 percent of the area in 1963. This shrub was mainly confined to the dry, rocky ridges in the 1850s. Tarbush dominated 0.4 percent of the area in 1858 and 8.6 percent of the area in 1963. It originally grew on the slopes next to mountains, but it has moved down the slopes and is

One site, different years, on the Jornada Range. In 1920, the site had a cover of black grama (left), with tarbush as a major shrub and a few plants of creosotebush and mormontea. By 1972, creosotebush had taken over (right).

now most prevalent on heavier soils, where it competes with tobosa and burrograss.

As mesquite and tarbush began to dominate the slopes next to mountains, the original grass stands were thinned. Eventually creosotebush moved onto those sites and gained dominance over the mesquite, tarbush, and the residual grass stand. Four to six inches of topsoil have been lost from slopes now dominated by creosotebush, leaving the larger pebbles and stones to form an erosion pavement. Creosotebush generally invades sites where the original grass stand has been depleted.

Rodents and Rabbits Can Prevent Improvement

The impact of damage by rodents and rabbits is often underestimated. On deteriorated mesquite-sand dune sites in southern New Mexico, 462 pounds of rodent biomass were found per section. This plus rabbit populations, which may be as high as one or two per acre, exert as much pressure on desirable vegetation as one to three cows per section. It may keep the range in a deteriorated condition. Rodents and rabbits consume vegetation, destroy roots and aboveground plant parts, and collect seed that would otherwise aid in natural revegetation. Even in good grassland areas, the bannertailed kangaroo rats kept 10 percent of the area out of vegetative production by denuding the ground in the vicinity of their mounds. Rodent and rabbit populations are usually greater on poor than on good-condition ranges.

HOW TO CONTROL BRUSH

Undesirable plants can be controlled and ranges can be revegetated with forage species, but it takes judicious use of control methods and sound grazing practices. Woody plants such as mesquite, creosotebush, tarbush, and shinnery oak cannot be eliminated by good grazing practices alone. The brush has to be controlled before the range can benefit from other practices such as a grazing management plan, seeding, or waterspreading.

The most effective method for control of woody plants depends upon the site, the specific vegetation, and the degree of infestation. Any control job requires considerable attention to detail for maximum benefit per dollar spent. Here are some general guidelines for selecting control methods:

- Brush control generally costs less when invasion is just beginning and the plants are small and scattered. In this situation, the best method is one that will not destroy the residual forage plants.

- On sandy soils heavily infested with brush, a broadcast chemical method will control the undesirable plants and result in an increase of forage plants. Mechanical control methods are generally avoided on sandy soils, because of the wind-erosion hazard if a good plant cover is not maintained. Fortunately, natural revegetation is often quite rapid on sandy soils after chemical control of the brush.
- On soils with a medium to heavy texture, a heavy infestation of brush, and a poor stand of desirable plants, a mechanical method accompanied by seeding may be required. Natural revegetation after brush control is often very slow on medium- to heavy-textured soils.
- Controlling stands of mixed brush species with a single spray application is often difficult, because species vary in degree and time of susceptibility to herbicides.

Mesquite

The best way to control mesquite depends on degree of infestation, site condition, and available equipment. The following methods have been proven successful:

Hand-grubbing. Eradicate sparse stands (less than 75 plants per acre) of relatively small mesquites (less than three feet in canopy diameter) with a grubbing hoe or mattock. The plants must be completely severed from their roots, below the budding zone. On small plants, the budding zone is generally three to six inches below the surface of the ground.

If a crew is used, provide good supervision to keep the laborers well spaced (about 30 feet apart) and in line across the treatment swath so that they do not miss plants.

Where labor is available and not too expensive, hand-grubbing is an effective and economical method for cleaning up a potentially serious infestation while the mesquites are small and before the grass stand has been reduced. On one field-scale job, it took 0.6 man-hour per acre to hand-grub an average of 51 mesquites per acre.

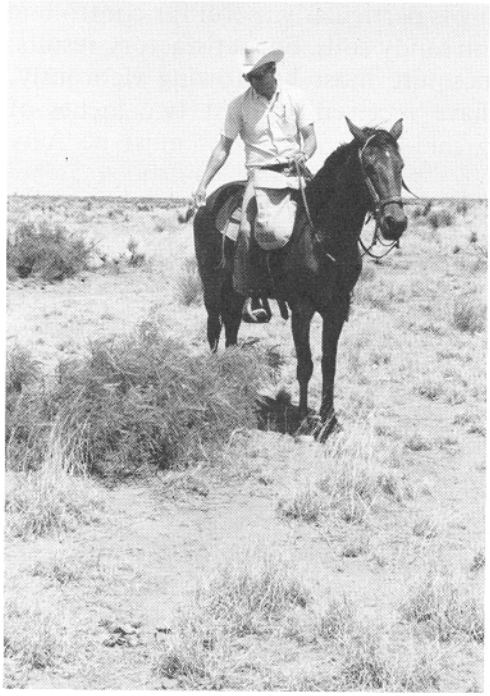
Mechanical grubbing. Mechanical grubbing is used to control mesquite where the grass stand is good, mesquite plants are mostly large, and the stand is no denser than about 200 plants per acre. The method is particularly suited to areas with medium- to heavy-textured soils and good residual stands of desirable grasses. Areas that are duned and subject to wind erosion should not be grubbed.

Large acreages infested with light to moderate stands of mesquite are being cleared by mechanical grubbing in eastern New Mexico. The equipment often used consists of a large, wheel-type, front-end

Viewers see a demonstration, near Elida, of a grubber blade on a front-end loader uprooting mesquite plants without damaging the grass sod. The plants were grubbed below the bud zone, to prevent resprouting.

loader equipped with a hydraulically-operated stinger blade in place of the bucket. A farm-type wheel tractor with a drawbar-mounted stinger blade will handle small plants more economically than the larger equipment and can be used to advantage as a companion to the heavier equipment. A track-type tractor with a stinger blade extending below the dozer blade is needed on loose sandy sites.

Grubbing may be done any time except when the soil is wet. In some instances, the pits left after grubbing can be seeded. The mesquite plants must be grubbed below the budding zone. Costs average about three to five cents per plant.



Before mesquite dominates a site, single plants can be controlled relatively inexpensively and effectively with a dry herbicide.

Basal treatment with dry herbicides. Herbicidal pellets, granules, or powders, placed around the base of each plant, control relatively small mesquites (up to about six feet in canopy diameter) in sparse stands (up to about 100 plants per acre). The pellets and granules can be applied from horseback. Each horseman can cover a swath about 100 feet wide.

Such treatments should be applied immediately before, or in the early part of, an expected rainy season. The materials lose their effectiveness if they lie on the surface of the ground for more than about 60 days.

Ground spraying. Mesquite plants of any size can be sprayed from the ground, but the stands should be no denser than 200 plants per acre. The mesquites must be growing vigorously when they are sprayed. Generally, the January to May 15 precipitation before spraying must be at least two inches. The best time of the year to spray is after the leaves are fully developed and dark green, and the plants are in full flower or are forming seed pods. This is generally June 1 to 15 in southern New Mexico. Materials recommended for the spray are listed on page 16. Cover all parts of the plant with the spray.

Aerial spraying. Aerial spraying is particularly useful for controlling heavy infestations of mesquite on sandy soils. For satisfactory results, attend to every detail. The mesquite must be growing vigorously, which means that it should have received at least two inches of precipitation from January to mid-May. The leaves must be fully developed and dark green, and the plants should be in the stage between full flower and seed pods that are elongated but not filled. The percentage of kill will be reduced if the plants have been damaged by insects, late frost, hail, or wind, or if they are suffering from drought stress.

Here are some details that are important in applying aerial sprays properly:

- Have good mixing equipment and keep the mixture properly agitated in the aircraft.
- Do not spray when the wind velocity averages more than five mph or the air temperature exceeds 90°F. Do not spray near susceptible crops or with volatile formulations.
- Check the calibration of the aircraft sprayer before each job.

Aerial spraying was tested for 11 years on the Jornada Experimental Range, with extremely variable results, as the table shows. Control ranged from 8 to 57 percent. The best control was obtained in years when the soil moisture was plentiful before and at the time of spraying, and the plants were fully leafed and growing vigorously.

Mesquite control from aerial sprays of 2,4,5-T (½ lb in 5 gal. of spray mixture per acre), Jornada Experimental Range, 1958 to 1969

Year of Application	Percent Control	Soil Moisture Status	Foliage Condition
1958	18	good	Vigorous
1959	34	good	Fully leaved, vigorous
1960	9	very dry	Good
1961	14	fair	Vigorous
1962	8	good	Fair, topgrowth of many plants killed back by cold
1963	57	good	Well-leaved, vigorous
1965	32	fair	Fair
1966	22	fair	Fair
1967	9	very dry	Poor
1968	43	very good	Good, vigorous
1969	22	fair	Fair

Spraying to control mesquite on a site which supported a cover of perennial grasses as recently as the 1930s. Aerial spraying is a specialized job, requiring attention to details. A good stand of mesa dropseed and forbs (below) grew in two years after the second of two aerial sprays, in 1958 and 1961, for the control of dense mesquite. Wind erosion on this site was virtually eliminated.

Poor control was obtained in extremely dry years, and when the foliage was scant because of dieback caused by extremely cold weather in January. Since 1959, more years have been favorable for spraying mesquite in southeastern New Mexico than in southwestern New Mexico.

Many herbicides, herbicide mixtures, and various kinds and quantities of spray material have been tested for mesquite control. Of the materials registered for use, the most effective treatments are listed on page 16.

Research indicates that the best rates of 2,4,5-T for mesquite control are 0.75 pound per acre in southeastern New Mexico and 0.50 pound per acre in southwestern New Mexico.

For four years, mesquite control averaged 30 percent with the combination of 0.25 pound each of dicamba and 2,4,5-T, but only 23 percent with 0.5 pound of 2,4,5-T alone. In the one year it was tested, doubling the rate of herbicides in the combination treatment increased the mesquite kill by 50 percent.

Spraying with 0.25 pound or more of 2,4,5-T per acre usually defoliates mesquite at least for one season. This practice increases forage production on ranges where the stand of desirable grasses is fair or better, because it reduces competition from mesquite. But on severely depleted ranges, three or more years may be needed for a stand of grass to develop enough to increase production. With light control of mesquite, the mesquite may recover before the grass density increases much. The length of time that the increased production persists depends on the degree of mesquite control obtained; the better the control, the greater the level of forage production and the longer it persists.

A single aerial spray treatment generally gives 80 to 95 percent defoliation and from a trace to 50 percent kill, depending on the season. When soil moisture is good and mesquite plants are in good physiological condition and at the proper stage of growth, properly applied herbicides should kill at least 20 percent of the plants. The degree of control from repeated treatments is about additive, and there appears to be some advantage in respraying within two or three years.

Defer grazing during the growing season for one to three years after spraying mesquite to give desirable forage species an opportunity to increase. Grass production has increased significantly after mesquite spraying, particularly on sandy sites with a source of viable grass seeds. On the Jornada Experimental Range, an area sprayed twice for mesquite control from 1958 to 1961 has produced an annual average yield of 232 pounds of herbage per acre during the past eight years. An adjacent unsprayed area averaged 32 pounds per acre for the same period. The major perennial grass species on that area was mesa

dropseed. The mesquite canopy has remained virtually unchanged during that period, indicating that the area may not need respraying for another 10 to 15 years. About 55 percent of the mesquites were killed by the two aerial applications. The sand dunes on that spray area have leveled appreciably, and there has been a marked reduction in wind erosion.

On the Brininstool Ranch, southeast of Carlsbad, an aerial spray in 1965 killed half of the mesquite plants. By 1967, perennial grass production on the sprayed area was 463 pounds per acre, while the production on an adjacent unsprayed area was 84 pounds per acre. The major grasses on the range were dropseeds, black grama, plains bristlegrass, and threeawns.

When only part of a mesquite-infested pasture is sprayed, livestock and wildlife tend to graze mostly on the sprayed area. Overgrazing and further deterioration of the site can occur unless livestock are removed after proper forage utilization in the treated area. Treatment of all infested areas within a pasture as soon as possible will help alleviate this problem.

Creosotebush and Tarbush

Creosotebush is often the dominant plant on gravelly soils on the piedmont slopes of southwestern mountains. Tarbush has invaded the heavier soils in basins.

Where these species are scattered in grassland, select control methods that will not injure the desirable perennial grasses. Except to clean up a few scattered plants that may furnish seed to infest adjacent areas, treat sites with deeper soils in preference to those with limited soil depth.

Basal treatment with dry herbicides. Treating single plants with dry herbicides is an economical and effective method of controlling both creosotebush and tarbush in stands up to about 150 plants per acre. On creosotebush, one gram active ingredient of dicamba per 1.5 - foot canopy diameter killed more than 80 percent of the plants on sandy loam soils. On tarbush, one gram active ingredient of dicamba per three-foot canopy diameter killed more than 85 percent of the plants on clay loam soils. The herbicide must be applied immediately before, or in the early part of, an expected rainy season.

Aerial spraying. Various herbicides have been tested as aerial sprays to control creosotebush and tarbush in southern New Mexico. The most effective treatments are shown on page 16.

Creosotebush is most susceptible to herbicides about 30 to 40

days after summer rains start. The best results from a single treatment were obtained in years with above-average rainfall, when the plants were thrifty. Grass production increases after the competition from creosotebush is reduced, but at current prices, production from rangeland in good condition is not enough to justify the expense of the treatment.

On tarbush, the best time to spray is after the plants have two-thirds of their full foliage but before they start to bloom. Spraying in September has generally been the most effective. Aerial spraying of tarbush is also expensive.

Since new chemicals are constantly being introduced and tested, and prices change, keep in touch with your county agent for the latest information about aerial spraying of creosotebush and tarbush.

Mechanical methods. Neither creosotebush nor tarbush has as extensive a bud zone below the surface of the ground as mesquite has. Therefore, both are relatively easy to kill by rootplowing, disking, or grubbing. Creosotebush may resprout from major lateral roots.

A rootplow is a horizontal blade attached to a track-type tractor, the size of a D-6 or larger. The blade is pulled at a uniform depth below the soil surface. A drag chain, mounted with swivels to drag behind the plow, increases the uprooting of plants. For creosotebush and tarbush, adjust the blade to plow to a depth of 7 to 10 inches. Rootplowing kills 90 percent or more of all the vegetation growing on an area. The method is best adapted to dense brush stands on medium- to heavy-textured soils, where little or no grass remains and where seeding of desirable plants is to follow.

A large disk plow or tandem disk is also used to plow up brush. It also destroys any grass on the area. Because it leaves less brush on the ground surface, disking leaves a less satisfactory seedbed than rootplowing.

Creosotebush and tarbush are grubbed in the same way as mesquite. See the discussion of how to do it on pages 7 and 8.

Since tarbush becomes quite dry and brittle in the winter, chaining or railing at that time substantially reduces its cover. Chaining does little damage to residual grasses, so a reduction in tarbush cover would probably permit a substantial increase in grass production, where grass is already present.

Shinnery Oak

Shinnery oak is a small, thicket-forming shrub that grows on sandy soils, especially in eastern New Mexico, northern Texas, and western Oklahoma. It spreads from underground stems.

Shinnery presents a double hazard to range management. The young buds, stems, leaves, and acorns are poisonous to livestock, so livestock must be removed from shinnery-infested pastures in the spring during leaf development. Shinnery also competes strongly with desirable forage species for moisture and nutrients. Forage production has increased significantly after shinnery has been sprayed one or more times. The object of spraying, however, is not to eradicate the shrub. Generally, there is greater forage production when shinnery makes up a small part of the vegetation than when it is absent. When the shinnery becomes so dense that it is seriously reducing forage production, it can be sprayed to increase grass production.

Grassland areas treated to suppress shinnery oak support more prairie chickens than untreated areas. The lesser prairie chicken prefers a mosaic composed of grassland and motts of shinnery oak.

Spray shinnery oak after the leaves turn blue-green but before a lower leaf cracks when it is doubled over. In southeastern New Mexico, this is usually in May. Do not spray in drought years, after frost, hail, or insect damage, or after grazing of terminal growth. For materials to use, see p. 16. Do not spray aerially when the wind velocity averages more than five mph or the air temperature exceeds

Adjoining areas near Milnesand. One is dominated by shinnery oak (left), and the other was aerially sprayed for oak control (right). Aerial spraying for control of shinnery oak provides considerable additional forage for livestock and wildlife, reduces wind erosion, and provides a better habitat for the lesser prairie chicken.

Summary of chemical control practices on brush

Species	Individual Plant Treatment, Dry Herbicides	Ground Spraying	Aerial Spraying
Mesquite	See county agent	1.25 lb low volatile ester 2,4,5-T/100 gal. water for individual plants	0.5 to 0.75 lb/A of 2,4,5-T, or 0.25 to 0.5 lb/A of 2,4,5-T plus 0.25 to 0.5 lb/A of dicamba
Creosotebush	1 gram dicamba/1.5 ft. canopy diameter	- - -	2 lb/A of dicamba in 2 successive yearly applications or 0.5 lb/A of dicamba plus 0.5 lb/A of 2,4-D followed by 2 lb/A dicamba the following year
Tarbush	1 gram dicamba/3 ft. canopy diameter	- - -	2 lb/A of 2,4-D plus 0.5 lb/A dicamba
Shinnery oak (pure stands) or mixed shinnery, sand sagebrush, and yucca	- - -	- - -	0.5 lb/A Silvex
Mixed shinnery and mesquite	- - -	- - -	0.5 lb/A 2,4,5-T

[1]All agricultural chemicals recommended for use in this report have been registered by the Environmental Protection Agency. They should be applied in accordance with the directions on the manufacturer's label as registered under the Federal Insecticide, Fungicide, and Rodenticide Act of 1972. Contact your county agricultural agent or pesticide dealer for additional information.

90°F. Do not spray near susceptible crops or with volatile formulations of herbicide.

A single spray, properly applied, usually kills 20 to 30 percent of the roots and 70 to 95 percent of the top growth. For maximum recovery of the forage grasses, sprayed areas should be deferred from grazing during the growing season after treatment.

SEEDING PRESENTS PROBLEMS

Where vegetation has been severely depleted by past grazing abuses, droughts, and encroachment of brush, natural recovery may take years, or it may never occur. On such sites, seeding is the only hope of revegetation. But establishing seeded species is difficult in arid areas. Since summer is the only season with reliable rainfall, the seedlings must be established in hot weather. Many species are small-seeded, requiring shallow planting. Precipitation is limited, evaporation is rapid, and soil surfaces often crust over.

How to Seed Range Plants

The procedures that are best for germinating and establishing seedlings on semidesert ranges depend upon the site.

Before seeding, some sites may be shallow-disked to reduce competition from weeds, increase infiltration of moisture, and leave a trash-covered surface. More intensive tillage is usually avoided, where possible, not only to prevent disturbing the soil surface excessively (bringing up heavier subsoils or burying the friable top soil and litter) but also because of the cost. Furthermore, wind erosion is a serious problem on loose, unprotected seedbeds.

Broadcasting is the poorest method of seeding, particularly on unprepared seedbeds.

Only limited success has been obtained on seedbeds prepared with a pitting disk or a ripper. Ripping lines often seal over within a year or so. Narrow pits can fill with soil rather rapidly on some sites. Seeding success is improved if the pitting disk has opener blades following the disk and a packer wheel.

Broad, shallow pits made with a basin-forming machine or a bulldozer blade make a good seedbed for a drill. Such pits are successful on medium- to heavy-textured soils on flat or gently sloping sites.

Contour furrows form good seedbeds on medium- to heavy-textured soils. Interrupted furrows prevent a large water loss if a furrow wall breaks, and they preclude the necessity of furrowing exactly on the contour.

Concentrating water with various land-forming procedures does not always insure seedling establishment. The surface soil still dries rapidly. This often leads to the formation of a heavy crust on medium- to heavy-textured soils. If such soil surfaces can be protected to reduce evaporation, seedling emergence and establishment are improved.

A cover of brush or litter over seeded areas substantially reduces soil temperatures and evaporation of the limited moisture. A method has been developed to seed brush-infested areas in a once-over operation. The brush and other competing vegetation is killed by a rootplow. The rootplowed seedbed is loose and fluffy, so a seeder is used that firms the soil into a V-shaped groove and places the seed in it. Drag chains cover the seed with loose soil to a depth up to 0.5 inch. A brush conveyor designed and developed by George Abernathy, agricultural engineer at New Mexico State University, picks up the brush behind the rootplow and deposits it behind the seeder. The brush is concentrated on a seeded strip about 40 percent as wide as the rootplowed swath. In addition, there is a hydraulically operated bulldozer blade in front of the seeder which forms basin pits. Thus, in one once-over operation, the competing vegetation is killed; a seedbed is prepared; the seed is placed in a firm seedbed; the dead brush is used for partial shade on the seeded area, thereby substantially reducing maximum soil temperatures during the summer; and water is concentrated on the seeded area.

Basins formed by the special equipment (top right) are concentrating water on the seeded area. The equipment kills undesirable brush and seeds desirable forage species in a favorable environment, in one operation.

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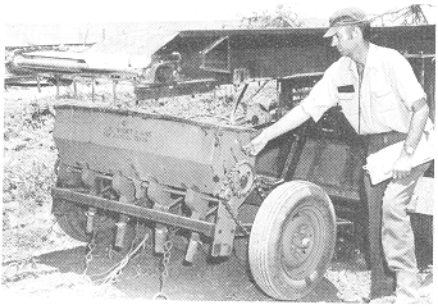
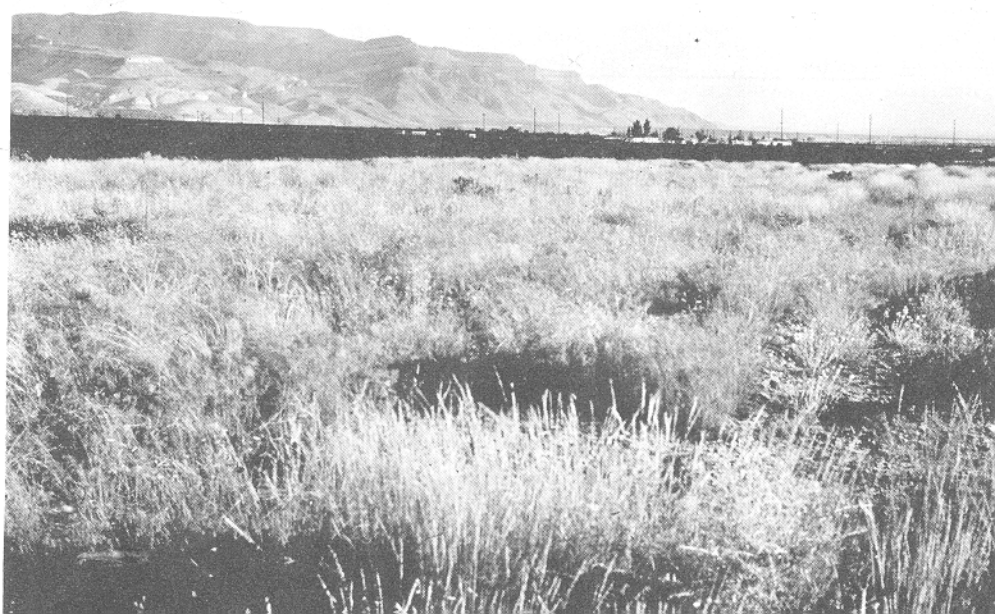


This equipment converts the cover on sites dominated by worthless brush to useful plants, in a once-over pass. It grubs undesirable brush, forms basins to catch water, prepares the seedbed and seeds desirable species, and deposits shade on the seeded area. The seeder (right) places seed in a firmed seedbed, and drag chains cover it lightly.

An excellent stand of Lehmann lovegrass, black grama, sideoats grama, and fourwing saltbush was established with the equipment (above) on an area previously dominated by creosotebush.



Species to Seed

Species used in range seedings vary according to climatic and site conditions, and ranch management. Many range managers plant native species, harvested from ranges. If you do this, choose native varieties or strains of local origin, generally within 200 miles north and 300 miles south of your area.

Light- to medium-textured soils. Species adapted for seeding on sandy sites are black grama, sideoats grama, blue grama, Lehmann lovegrass, Boer lovegrass, blue panic, and fourwing saltbush. A typical seeding might include a mixture of some or all of these species. Generally, Lehmann lovegrass comes up to a reasonably good stand within a year of seeding, while there may only be scattered plants of the other species. Within two or three years, there may be more plants of the longer-lived gramas and saltbush. After the seeding is established, grazing it when the lovegrass is green and succulent may favor the longer-lived species.

Medium- to heavy-textured soils. Species adapted for seeding on loamy sites are sideoats grama, blue grama, alkali sacaton, sacaton, vine mesquite, yellow bluestem, *Sorghum almum,* blue panic, Boer lovegrass, and fourwing saltbush. Typically, a mixture of some or all of these would be planted in pits or other conformations that would concentrate water. The species easiest to establish are sideoats grama, *Sorghum almum,* blue panic, and yellow bluestem.

Seed characteristics of some of the species adapted for seeding on semidesert rangelands

Species	Seed per Pound	Seeds per sq. ft. at 1 lb/A	Avg. Purity	Avg. Germination
			percent	percent
Yellow bluestem	1,409,000	32	60	70
Sideoats grama	143,000	3	60	50
Blue grama	712,000	16	40	60
Black grama	1,335,000	31	40	60
Lehmann lovegrass	4,245,000	99	90	60
Boer lovegrass	2,922,000	67	90	70
Blue panic	679,000	16	70	60
Vine mesquite	143,000	3	50	30
Alkali sacaton	1,750,000	40	98	80
Fourwing saltbush	30,000	1	80	50

Seeding Rates and Dates

Use enough seed to get a good stand, but not more than necessary. Too much seed may produce a stand of seedlings so dense that there will be excessive competition among plants. Use the number of pure live seed (PLS) per pound to determine your seeding rate. For the percentage of PLS in a seed lot, multiply the germination times the purity. A 100-pound bag of seed with a germination of 80 percent and a purity of 90 percent would have a PLS of 72 percent (80% X 90% = 72%). If you seed by drilling, use a seeding rate of 20 to 25 PLS per square foot. Double the rates for broadcast seeding.

A typical mixture to be drilled on a sandy loam site would be calculated as follows:

	Desired PLS/sq.ft.[1]	*Number of PLS/lb.*[2]	*Mixture lb./A.*[3]
Black grama	11	320,400	1½
Fourwing saltbush	1	12,000	3½
Sideoats grama	5	42,900	5
Lehmann lovegrass	7	2,292,300	1/8

[1]Desired mixture.

[2]Calculated by multiplying germination x purity x number of seed per pound. See page 20 for this information.

[3]Calculated by multiplying the desired PLS/sq. ft. by 43,560 (sq. ft/A) and dividing the product by PLS/lb.

The best time of the year to seed is just before the most reliable seasonal rainfall. Since the most reliable rainfall in most of the semi-desert region occurs in summer, the best time to seed is in June or early July.

How to Manage New Seedings

Protect new range seedings from grazing through the second growing season, or until the seeded species are well established. Manage seeded areas separately from other rangelands.

Sometimes, a dense crop of weeds may compete with the new seedlings. Spraying to control the weeds may prevent the loss of the seeding.

Rodent and rabbit activity can also cause the failure of any seeding. Where forage-destroying animals such as jackrabbits, cottontail

rabbits, kangaroo rats, and field mice are a problem, they should be controlled before seeding or shortly after.

SHOULD YOU FERTILIZE RANGE PLANTS?

Limited fertilizer trials on semidesert rangelands indicate that fertilizing may be profitable under certain conditions.

On the Jornada Experimental Range, tobosa growing on a floodplain was fertilized annually for five years. Nitrogen generally increased the production and protein content of the grass, but the increases were substantial only in one year, when the floodplain was exceptionally wet.

That year, rainfall amounted to 7.8 inches. Herbage production ranged from 3,394 pounds per acre, without any fertilizer, to 6,705 pounds per acre, with 90 pounds of nitrogen per acre, and protein percentages ranged from 5.2 to 6.1. When annual rainfall was only 3.6 inches, herbage production ranged from 1,660 pounds per acre, without any fertilizer, to 2,020 pounds per acre, with 60 pounds of nitrogen per acre, and the protein percentages were similarly reduced. Phosphorus contributed little to herbage production or protein content in these experiments.

It may be profitable to fertilize tobosa floodplains on ranches with limited amounts of tobosa, to provide more summer grazing. Then the upland areas on such ranches could be deferred for longer during the growing season. Areas to be fertilized should have dense stands of tobosa and be so situated that they would be likely to be flooded even in droughty years.

If you decide to try fertilizing rangeland, select areas that receive water from runoff or water-spreading practices. Nitrogen has given the best results. Broadcast the fertilizer, from the ground or from the air, just before summer rains.

MEETING NUTRITIONAL NEEDS ON THE RANGE

Ranchers with cow-calf operations on semidesert ranges want a high conception rate for the cows first, and then a high weaning weight for the calves. Where forage is produced mostly in the last half of summer and calves are born in the spring, nutrition may be a problem in getting the cows ready for breeding in the late spring and early summer. A cow requires enough forage (air-dried) each day to equal about two percent of its body weight. This forage must provide the cow's requirements for energy, protein, calcium, phosphorus, and vitamin A.

Chemical Composition of Forage Plants

Cows graze many different plants during a year, if they have a chance. On the Jornada Experimental Range, for example, in a pasture with a variety of plant species, cows made up about half their diets from grasses, except during summer, when about 75 percent of the diets came from grasses (see the table below). The cows also consumed the leaves of soaptree yucca, particularly during droughty winters and spring.

Samples of the plant parts generally consumed by the cattle were collected for chemical analyses. These showed that the nutritive quality declines with increasing maturity more in grasses than in forbs and shrubs (see page 25). The forbs and shrubs tend to have higher nutritive values than the grasses.

Average seasonal diet (percent) of cows on the Jornada Experimental Range

Species	Fall	Winter	Spring	Summer
Alkali sacaton	4.4	3.3	19.3	9.7
Black grama	5.9	23.1	3.2	5.5
Burrograss	9.2	8.9	3.8	13.4
Mesa dropseed	13.3	12.8	12.6	20.4
Red threeawn	4.0	0.8	6.0	4.6
Tobosa	2.4	0.8	0.8	11.6
Other perennial grasses	7.9	3.2	1.1	6.4
Total perennial grasses	47.1	52.9	46.8	71.6
Sixweeks grama	2.5	4.5	0	4.7
Other annual grasses	0.2	0	0	0.1
Total annual grasses	2.7	4.5	0	4.8
Leatherweed croton	9.1	2.9	9.6	11.0
Woolly paperflower	5.9	3.8	13.6	1.0
Other perennial forbs	14.2	2.5	3.4	3.5
Total perennial forbs	29.2	9.2	26.6	15.5
Russianthistle	5.2	0.8	3.4	4.1
Other annual forbs	7.7	13.5	4.9	0.1
Total annual forbs	12.9	14.3	8.3	4.2
Longleaf mormontea	4.7	1.3	1.2	0.5
Soaptree yucca	1.6	16.8	15.5	2.0
Other shrubs	1.8	1.0	1.6	1.4
Total shrubs	8.1	19.1	18.3	3.9

The minimum protein requirement for dry, pregnant cows is 5.9 percent; for lactating cows it is 9.2 percent. The protein contents of black grama and mesa dropseed collected in February and December, respectively, were below that required to maintain dry cows. The protein contents of all the grass samples, except burrograss collected in August, were below the minimum required for lactating cows. However, except for mormontea, the forbs and shrubs had higher protein contents than that required by lactating cows.

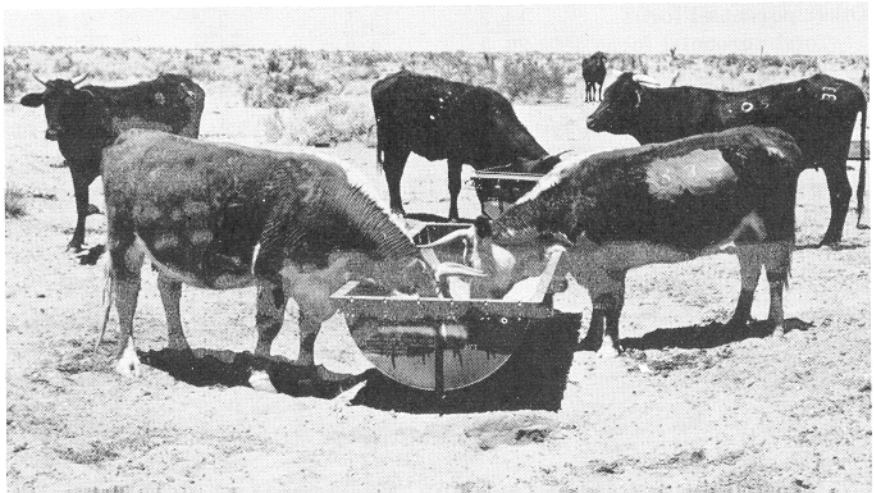
The minimum calcium requirement for dry cows is 0.16 percent and for lactating cows, 0.29 percent. All the forage samples except two of grass met the minimum requirement for lactating cows. Forbs and shrubs have a much higher calcium content than grasses.

The minimum phosphorus requirement for dry cows is 0.16 percent and for lactating cows, 0.23 percent. All the forage samples had less phosphorus than the minimum required for lactating cows.

Supplemental Feeding

In semidesert areas, range cattle diets are most likely to be deficient in energy and phosphorus. During drought or high or low temperatures, forage quality may be so low that lactating cattle cannot consume enough to meet their requirements for lactation plus body maintenance. The most obvious symptom of energy deficiency is a loss of body weight and failure to conceive. Mature cows can lose 150 pounds shortly after parturition, but within 80 days they should be gaining to conceive and stay on a 12-month calving cycle.

Livestock often need a concentrate-salt supplement during prolonged drought. On the Jornada Range, feed troughs were placed away from water for better livestock distribution. Shearing the hair over the number brands on these experimental cows made identification easier for recording calf birth dates and cow weights.



The energy-protein ratio must be reasonably balanced. If a cow is consuming forage with adequate protein but not enough energy, feeding a protein supplement would aggravate the situation. Sources of supplemental energy include grains, molasses, and fat.

Livestock needs supplemental phosphorus at all times. Common sources of supplemental phosphorus are defluorinated rock phosphate, dicalcium phosphate, and bone meal. These are often mixed with salt and fed free-choice. They may also be mixed in with supplemental feed, particularly where salt is used to regulate intake of supplemental feed.

Replacement heifers need at least 10 to 11 percent protein in their diets, and bulls need 11 to 13 percent. To prepare them for the breeding season, it is a good practice to feed a grain-protein supplement (16 to 20 percent protein).

Chemical composition (percent) of forage grazed by cows at the Jornada Experimental Range

Month and Species	Protein	Acid-Detergent Fiber[1]	Calcium	Phosphorus
February				
Black grama	5.0	46.0	0.23	0.09
Soaptree yucca	10.6	43.5	1.58	0.16
April				
Alkali sacaton	8.2	47.3	0.33	0.11
Red threeawn	8.2	48.7	0.56	0.12
June				
Woolly paperflower	16.0	32.3	2.32	0.16
July				
Tobosa	8.6	47.2	0.38	0.19
August				
Burrograss	11.8	44.2	0.52	0.17
Mesa dropseed	7.2	46.0	0.41	0.14
October				
Russianthistle	16.2	31.5	2.53	0.20
November				
Leatherweed croton	11.1	42.2	2.00	0.13
December				
Burrograss	7.7	44.9	0.33	0.10
Mesa dropseed	4.4	54.3	0.26	0.07
Longleaf mormontea	10.6	43.5	1.58	0.16

[1]Acid-detergent fiber contains constituents such as lignin, cellulose, and silica. Acid-detergent fiber values are higher than values obtained by conventional crude fiber analysis, but they express the tough and fibrous portions of these plants better than the conventional values.

Growing heifers fed for several months require about 1,000 International Units of vitamin A per pound of dry ration; pregnant cows about 1,275 IU; and lactating cows and breeding bulls about 1,775 IU. Cattle store vitamin A and carotene in the liver and body fat when green forage is available on the range. These reserves may be large enough to reduce or meet the needs of older animals for as long as six months. Stress conditions, such as extremely hot weather or viral infections, have been suggested as causes for reduced conversion of carotene to vitamin A in the animal. Some cows on the Jornada Experimental Range were injected with one or two million IU of vitamin A in the spring, because droughty winters and springs often make late spring and early summer the most stressful periods for cows. The cows that received the vitamin A were no better than untreated cows in weight, conception rate, calf weaning weight, or calf age at weaning time. Even in droughty springs, cows will select some green forage such as yucca leaves.

HOW TO MANAGE GRAZING

One way to increase range productivity is to manipulate the season and intensity of livestock grazing. Distributing livestock over the range is also important.

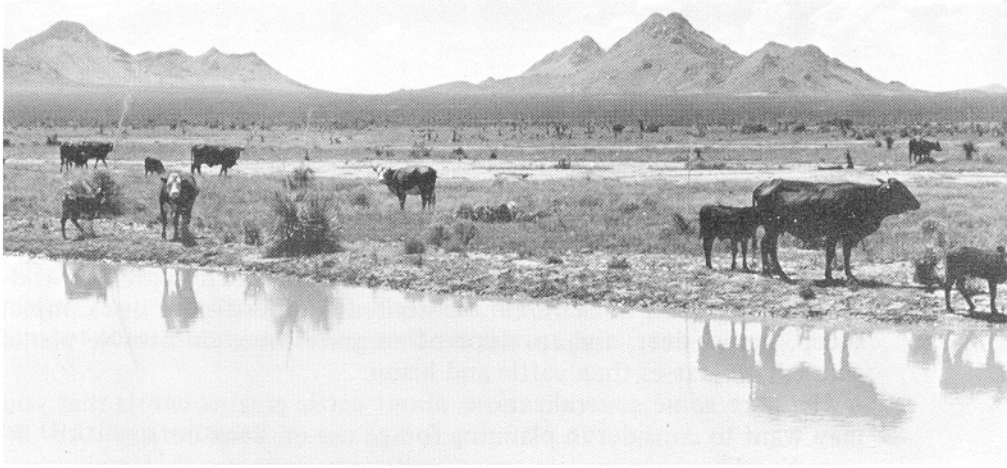
Distribute Livestock Over the Range

Livestock moves over any pasture in response to number and location of water places, distribution of plant species within the pasture, topography, and size of pasture. Check each pasture for areas of underutilization, so that you can take corrective measures.

Livestock must have enough water. Minimum daily requirements for water are: cow with calf, 10 gallons; ewe with lamb, 1 gallon; horse, 12 gallons.

Animals will not graze far from water. They tend to stay close to it and overgraze and trample the vegetation in that vicinity. If there is a surface flow of water in the pasture, constructing earthen tanks will aid in distributing livestock over the range. Plastic pipes are often used to distribute water to tanks away from water wells. In pastures with more than one watering tank, periodic opening and closing of watering places can be used to rotate grazing pressure to different areas within a pasture.

A variety of palatable plants two or three miles from water will attract cattle and thus distribute them more evenly in a pasture. In a pasture dominated by a single species, such as black grama, the degree



Temporary watering places, such as this earthen tank, are important on semi-desert ranges. Permanent water places may be closed while there is water in these tanks, to obtain better livestock distribution over the range.

of use declines with distance from water. However, such species as mesa dropseed, leatherweed croton, woolly paperflower, spectaclepod, and Russianthistle, all of which are particularly palatable to cattle during part of the year, can be used to draw the animals away from water.

In rolling terrain, it is common to see ranges with the bottomland overgrazed but with good forage on the slopes. On a 10 percent slope, about 75 percent of the grazing use occurs in the first 0.5 mile from water. In rough topography, it is important to have more watering places.

Placing salt and supplemental feed away from permanent water tanks will also help distribute livestock to areas that otherwise would be lightly used. Animals do not require, or necessarily use, salt and water at the same time. Often they will water, graze, and then return for salt. Average salt requirements per month are: cattle, 2 pounds per head; sheep, 0.5 pound per head; horses, 2.5 pounds per head. Salt requirements increase during the growing season and decrease when the forage is dormant.

Shade and rubbing posts located away from water also attract livestock to undergrazed areas. Move feeding and salting places, shade, and rubbing posts periodically to avoid "sacrifice" areas.

Construction of "drift" fences to prevent livestock from continually grazing in certain favorite places within a pasture can be helpful. Consider cross-fencing to make smaller pastures where economical. Fencing along vegetational type lines as nearly as possible simplifies management. Trails and roads are also useful in getting livestock away from water.

Graze the Proper Kind, Class, and Age of Livestock

If all plants are uniformly grazed, the less-desired species do not gain dominance. Each species of animal is selective in the plant species it will graze. The preference varies with season. Therefore, several kinds or classes of animals, either domestic livestock or wildlife, may be used to maintain the desired composition. For example, sheep, goats, deer, and antelope often graze more on browse plants and less on grasses than cattle and bison.

Here are some generalizations about cattle grazing habits that you may want to consider in planning forage use on your ranch:

- Yearlings use grasses more uniformly over rough terrain than cows with calves or mixed cattle classes.
- Yearling heifers are more active than yearling steers on steep, rocky terrain.
- Young cows and calves use open grasslands more than old cows.
- Cattle moved onto a new area may eat poisonous plants more readily than cattle familiar with the vegetation of an area.

Protect Perennials During Growth

In semidesert areas, most plants grow in short periods when soil moisture is available. Grazing plants during the growing season depletes their carbohydrate root reserves. Perennial species need protection from overuse at this time.

Providing such protection is not difficult. Under proper stocking, only a small percentage of the plants of key species are grazed. Furthermore, during most growing seasons, the growth of annual forbs and grasses relieves grazing pressure on key perennial grasses. Generally, when the annual species are available, livestock prefer them to the perennials.

To protect the key perennial species, therefore, ranchers need only make sure that their pastures are not overstocked and that the livestock are not grazing the perennials excessively.

Keep Grazed Plants Growing

Proper forage use is grazing at an intensity that will maintain or improve the desired vegetation for conservation of the range. Generally, this means "take half and leave half." But on some critical sites—those that are highly erosive and need more protective ground cover—proper use is removing no more than 40 percent of the wieght of the current year's forage growth.

It is always unwise to overgraze the key perennial grasses on semidesert ranges. On black grama and tobosa, this means leaving a 2.5-inch stubble. During 53 years of record on the Jornada Experimental Range, 24 were drought years. Any overuse of the key perennial grasses, coupled with drought, might kill much of those grasses.

The long-lived perennial grasses reproduce primarily by vegetative means. They produce few viable seed. Therefore, grazing that kills many of these plants seriously depletes the range.

Use Grazing Strategies

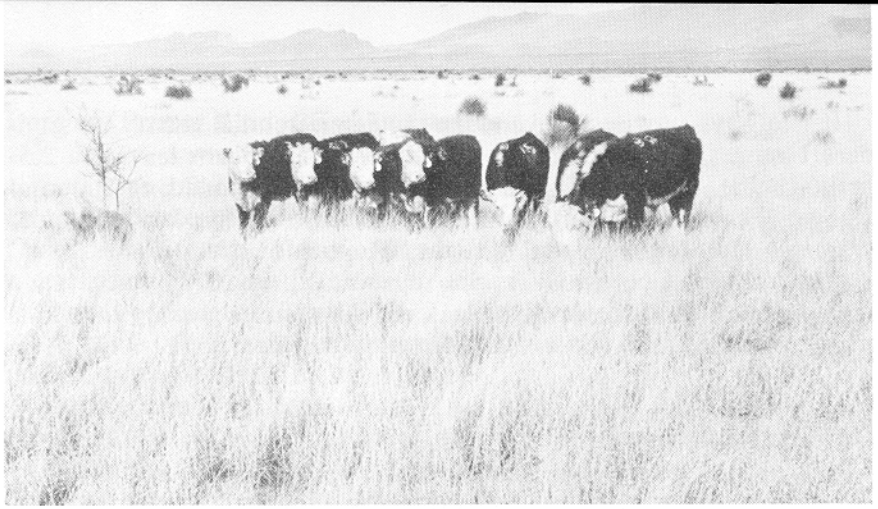
Grazing plans are highly individualistic. Some of the variables to consider in designing a grazing plan for a particular ranch are:

- Physical facilities, such as number and size of pastures, and number of watering places.
- Soil types, topography, and vegetation types.
- Range condition.
- Livestock management, such as kind and class of livestock, number of breeding herds, and marketing practices.
- Nutrient requirements of livestock.
- Location of poisonous plants.

The overall management plan must be flexible enough to permit adjustments during droughts.

Best-Pasture System. Studies on the Jornada Experimental Range led to the design of this basic grazing system for use on semidesert ranges. Under this system, when cattle are moved, they are put on the pasture with the best forage at that time. In essence, the system consists of establishing a grazing plan for each pasture and stocking it accordingly. Here is how the system works in various vegetation types:

- Mesquite-sand dunes. Some fourwing saltbush and mormontea often grow in the mesquite-sand dune vegetation type. These plants are valuable in late winter. If there has been some effective winter-spring precipitation, this type may also have a stand of forbs such as spectaclepod, bladderpod, globemallow, and Russianthistle. These forbs are excellent for grazing in the spring. (When the mesquite is sprayed, grazing should be deferred during the growing season for two to four years to permit perennial grasses, such as mesa dropseed, to become established.)
- Poor to fair range on sandy soils. This vegetation type is made up of mesa dropseed, sixweeks grama, and forbs such as desert baileya. leatherweed croton, woolly paperflower, globemallow, Russianthistle, deer's tongue, and whitestem stickleaf. There is also a remnant of black grama, as well as some soaptree yucca. If the objective for this



Grazing this tobosa floodplain during the growing season permits deferment on grasses that would be damaged by grazing at this time. Tobosa is most palatable when green, but it can be grazed dormant, if the livestock are given a supplemental concentrate.

vegetation type is to improve the stand of black grama, cattle may be placed on this type any time other species are available, except in late winter, when cattle will graze black grama.

- Good to excellent black grama range on sandy soils. This vegetation type is best grazed only in the winter and in droughty springs. When there is an abundance of yucca blooms in this type and a shortage of forage elsewhere, it would be desirable to graze this type in late spring.
- Tobosa-burrograss floodplains. This vegetation type is best grazed during the growing season. The type occurs primarily on medium- to heavy-textured soils and will occasionally also have a spring crop of forbs, such as verbena and sumpweed.

The best-pasture system is opportunistic in that it makes as much use as possible of forbs and short-lived grasses. These species are of little value to the permanent range resource, but they contribute much to livestock nutrition. No set stocking plan is established for a specific time period, because the considerable variations in weather conditions affect plant growth. If it rains in a part of a rested pasture so that green forbs and yucca blooms develop, livestock can be moved to that area to take advantage of this ephemeral growth. Flexibility in stocking each pasture, both in time and numbers, is the key to managing semidesert ranges.

Flexible herd management. Ranchers with semidesert ranges often have to adjust stocking to compensate for variations in the forage

crop. Flexible herd management (or keeping a cow-yearling herd) is the best way to produce as much livestock as possible without damaging the range during droughts. Under this plan, breeding animals make up not more than 55 to 60 percent of the herd. The remainder of the herd consists of yearlings and replacement heifers. Each fall, after the growing season, the available forage is appraised. Where forage production has been low, adjustments in the size and composition of the herd are planned for the winter-spring season to bring the herd within the capacity indicated by the forage appraisal. These adjustments are made as follows: 1) holdover yearlings are marketed; 2) weaner calves are sold: 3) the cow herd is culled heavily; and 4) when necessary, even some of the replacement heifers are sold.

When forage production has been above average, stock is added to the herd for the winter-spring period. All the natural increase from the breeding herd can be held over until spring, and, if there is enough forage, additional weaner calves can be purchased for winter pasturing. Depending on the market and forage conditions, these yearlings are sold in the spring or the next fall, when forage production is again appraised, and the herd is adjusted to meet the new situation.

The key to flexible herd management is keeping records—records of stocking by pastures, records of precipitation, records of forage conditions in the fall, and records of degree of grazing use actually obtained on the pasture before the next growing season begins. Such records over several years provide a basis for appraisal and development of future plans. With longtime records, a manager knows how the forage plants respond to fluctuating weather conditions, and how he can adjust his livestock numbers to fit the environment that prevails on his ranch. No constant stocking rate can compare with flexible stocking, because the latter takes into account forage availability.

Emergency feed. Another strategy for meeting the problems of drought is to provide emergency feed. If you have to provide livestock with emergency feed, remove the animals from the range to prevent overgrazing. Economical sources of roughage might include cotton-gin trash, waste from canneries, rain-damaged alfalfa, and hay harvested on the ranch during years with above-average precipitation. Another possibility would be to have access to some irrigated pasture. A rancher has to plan the strategy he will use during the inevitable drought periods.

Deferred-rotation systems. Several forms of deferred-rotation grazing systems are being used. The main idea is to defer each pasture from grazing during a growing season once in every three or four years. This system is particularly useful in conjunction with improvement practices such as seeding and brush control. The pasture

scheduled for deferment can be treated to take advantage of the deferment. However, in semidesert areas, pastures treated by seeding or for brush control should be deferred during the growing season for two to four years.

A special form of deferred-rotation grazing was developed by Dr. Leo Merrill at Sonora, Texas, where rainfall any time benefits some species. In a four-pasture situation, each pasture is grazed 12 months and deferred four months. Only one pasture is deferred at a time. Thus, each pasture is deferred once during a four-year cycle for each of the four-month periods.

Except as it fits in with planned improvement practices, a deferred-rotation grazing system generally is not profitable until enough improvement has been obtained to increase the stocking rate. However, a great advantage in using a deferred-grazing system on a ranch is that it focuses the operator's attention on his marketable resource, the forage plants.

PLAN FOR LONG-TERM BENEFITS

Few, if any range improvement practices yield economic returns, by standard short-run economic evaluations. But there are other considerations. For example, what is a stand of grass worth on a semidesert range? If the stand is lost and renovation is possible, it would cost much more than the land value. The encroachment of undesirable species and resulting soil loss would be felt by numerous groups of people through erosion, air pollution, and depletion of the resource. Therefore, a lost stand of grass represents a cost to society as well as to the landowner.

Practicing the "propers" of managing semidesert rangelands have significant economic considerations. The "propers" are to select the *proper* kind, class, and age of livestock to use the range; graze at the *proper* season; obtain *proper* livestock distribution on the range; and graze the *proper* number of animals to maintain a balance with the forage resources. Following these principles is the best way known to keep a range as a renewable resource.

Unfortunately, ranchers cannot always follow these principles entirely. They may be restricted by a range's past history of use, rough topography, or phenomena such as encroachment of weeds, brush, predators, or poisonous plants. These restrictions will in turn reduce the ranchers' long-term economic returns.

The close supervision needed for a good management is not always possible. Animals are distributed over large acreages in the semidesert Southwest. Livestock losses may be incurred without the rancher knowing why.

Therefore, ranchers have to take the long-range objective of providing maximum forage production and best livestock performance. Sound grazing systems and water production are the most popular and productive means of meeting this objective, from an economic point of view. Brush control for forage increase has also shown much promise as an economic program.

MANAGING POISONOUS-PLANT PROBLEMS

Poisonous-plant problems are frustrating. Symptoms of poisoning in livestock can be confused with those caused by disease or other toxic agents. Some plants may be grazed without any trouble most of the time but may be extremely toxic at certain times. Poisoning may occur in lush pastures at one time and under conditions of drought at another. Several species of plants may have the same poisonous ingredient and cause similar symptoms. One single species may be poisonous in several ways, so that the symptoms vary, depending on which ingredient is most active at a particular time.

More than 100 species of plants in the arid Southwest are poisonous, but most losses are caused by fewer than 30 species. The average annual lifestock death loss from poisonous plants is estimated at two to five percent, although the specific cause of death frequently is not determined. In certain years on some ranches, losses may be much larger. Besides death losses, there are losses from weight reduction, poor reproduction, and weakness, which may cause an animal to drown or be taken by a predator.

Whorled milkweed, a poisonous plant that cattle will consume even when green grass is growing nearby. A small intake is lethal, so cattle must be removed from sites infested with this weed. Check with your county agent for herbicides that have been cleared for use on this pest.

Livestock losses from poisonous plants are often related to poor management, poor range condition, or kind of animals. Animals most commonly graze poisonous plants on poor-condition range that lacks palatable forage. Most poisonous species are unpalatable but are eaten because an animal is hungry and the plants are readily available. Some, however, are relished by certain animals and may be taken in preference to other forage. Some poisonous plants are succulent when desirable species are dormant. Animals new to an area may be poisoned in a pasture already being grazed safely by the same type of livestock adjusted to the area. Small amounts of one plant may be lethal shortly after consumption, while the toxic substance from other plants is cumulative, and those plants must be grazed for some time before symptoms of poisoning appear. Even a sudden change in the weather may cause a species that is being grazed safely to become toxic.

Toxic Agents in Plants

Of the many toxic substances in plants, alkaloids are the most powerful. They are generally distributed throughout the plant and commonly remain after a plant matures or freezes. Poisoned animals show symptoms of nervous disorders such as trembling muscles, intoxication, salivation, bloating, and difficulty in breathing. Poisoning is often acute, but if a lethal amount is not consumed, the animal usually recovers completely in a short time. There are no antidotes for most alkaloids, so prevention of poisoning and sick care are the only remedial measures. Plants in the semidesert regions of southern and eastern New Mexico that contain alkaloids include larkspur, locoweed, peavine, groundsel, lupine, bitterweed, nightshade, and poisonous hemlock.

A second group of substances found in plants that cause poisoning are known as glycosides. These compounds are normally not toxic, but under special conditions, they are broken down and toxic substances are formed. A common glycoside found in plants under range conditions is one that yields hydrocyanic (prussic) acid on hydrolysis. Natural events such as freezing, wilting, or crushing may cause the release of prussic acid (HCN) within plants, but enzyme activity by the rumen microflora can also release the HCN in the paunches of cattle, sheep, and goats. Death results within a few minutes after a toxic amount of HCN is absorbed. Water causes an increased release of HCN, so animals may be found dead near water. Because HCN blocks the release of oxygen from the blood, the venous blood of poisoned animals is bright red for some time after death. Plants that contain glycosides include johnsongrass, mountainmahogany, *Acacia* spp., and chokecherry.

High levels of nitrates in plants frequently cause livestock poisoning. Common weedy plants as pigweed, Russianthistle, lambsquarters, and ragweed are the species most frequently involved, but many other plants also cause nitrate poisoning. Plants growing on nitrogen-rich soils or under drought conditions and lowered light tend to have a high nitrate content. Also, plants treated with herbicides such as 2,4-D may accumulate excess nitrate and at the same time become more palatable, thus increasing the possibility of poisoning. Plants containing more than 1.5 percent nitrate can kill livestock. Death occurs rapidly after symptoms appear. In nitrate poisoning the blood is unable to carry oxygen, so the ultimate cause of death is asphyxiation, as in HCN poisoning. In nitrate poisoning, however, the blood is a dark, chocolate color. Also, the mucous membranes have a bluish tinge, and the whites of the eyes are brownish.

Some plant species, such as johnsongrass, may cause HCN or nitrate poisoning, depending on conditions. Diagnosis of the poisonous principle is critical for treatment, because the treatments used for HCN poisoning are lethal to animals suffering from nitrates.

Some plants contain photosensitizing substances that can cause a swelling of the head and ears and sloughing of the skin in light-colored animals exposed to sunlight. These substances poison the liver and prevent the breakdown of certain pigmented materials during digestion. The pigmented substances are absorbed and circulated in the peripheral circulatory system and, when exposed to sunlight, irritate the skin, especially in light-colored animals. Range plants causing photosensitization include sacahuista (beargrass), goathead, and lechuguilla.

Other substances in plants cause poisoning. Tannic acid is the toxic substance in the developing buds and leaves of Gambel and shinnery oaks. An alcohol in burroweed and rayless goldenrod produces a condition known as "trembles" when these species are grazed for two or three weeks.

The poisonous substances in many plants have not been determined. These plants include the snakeweeds, pines, and juniper, which cause abortion in cattle. Tansy mustard and mesquite cause a condition called paralyzed tongue or "wooden tongue" when large amounts are eaten. Inkweed, desert marigold, and annual goldeneye cause heavy losses in some years.

Distribution of Poisonous Plants

Poisonous plants are not uniformly distributed over southwestern ranges. The more common poisonous plants of the semidesert area, their location, and season of greatest toxicity are as follows:

Plant Name	*Gila Basin*	*Rio Grande Basin*	*Pecos Basin*	*Tularosa Basin*	*Period of Greatest Toxicity*
Groundsel		x	x	x	All year
Rayless goldenrod		x	x		All year
Silverleaf nightshade	x	x	x	x	All year
Burroweed	x				Spring
Cocklebur	x	x	x	x	Spring
Locoweed	x	x	x	x	Spring
Larkspur	x	x	x	x	Spring
Oak	x	x	x	x	Spring
Peavine	x	x	x	x	Spring
Sacahuista	x		x		Spring
Tansy mustard	x	x	x	x	Spring
Desert marigold	x	x	x	x	Spring-summer
Lambsquarter	x	x	x	x	Spring-summer
Mesquite	x	x	x	x	Spring-summer
Pigweed	x	x	x	x	Spring-summer
Russianthistle	x	x	x	x	Spring-summer
Whorled milkweed		x	x		Spring-summer
Inkweed		x		x	Summer-fall
Lupine	x	x			Summer-fall
Annual goldeneye	x	x			Fall
Mountainmahogany	x	x	x	x	Fall
Bitterweed	x	x	x	x	Winter-spring
Lechuguilla	x		x		Winter-srping
Snakeweed	x	x	x	x	Late winter-spring

How to Prevent Livestock Poisoning

Sound management is the best prevention of livestock poisoning from plants. Generally, removing poisonous plants does not increase forage production. Consequently, the extent of livestock loss dictates how much money is expendable for controlling toxic plants. Few antidotes to plant toxins are available, but you can prevent most losses with the following management practices:

- Make sure that animals have an adequate supply of good-quality feed. Most poisonous plants are relatively unpalatable, so animals seldom consume enought to cause poisoning, except when they are hungry. They may need supplemental feed in the early spring, when the quality of native grass is low, to keep them from consuming evergreen or early-growing poisonous plants.
- Provide livestock with an adequate supply of salt and minerals at all times. Animals on deprived diets may seek out poisonous plants with high salt or high phosphorus content.
- Feed animals before placing them on a range with many poisonous

Common poisonous weeds and suggested herbicide treatments for control[1]

Plant	Chemical	Rate lb/A	Stage of Growth
Bitterweed, Hymenoxys odorata	2,4-D ester	1	Prebloom or bud stage
Deathcamas, Zigadenus venenosus, Z. paniculatus, Z. elegans	2,4-D ester or 2,4,5-T	$1\frac{1}{2}$ $1\frac{1}{2}$	3- to 6-leaf stage, before flower buds appear
Low larkspur, Delphinium menziesii, D. bicolor	2,4-D ester	$1-1\frac{1}{2}$	Before flower stems are 2 inches tall
Tall larkspur, D. occidentale	2,4,5-T or Silvex	3-4 lb in 30-40 gal/A	Prebud stage--wet plants thoroughly
Wooly loco, Astragalus mollissimus	2,4-D ester	1	January through April
Lupine, Lupinus sp.	2,4-D ester	2	Plants 5 inches tall, but before bloom
Snakeweed, Gutierrezia sarothrae, G. microcephala	2,4-D ester, 2,4,5-T ester, or Silvex	1-2	New twig growth 3-5 inches long before budding
Orange sneezeweed, Helenium hoopesii	2,4-D ester	2-4	Prebloom
Waterhemlock, Cicuta sp.	2,4-D ester or 2,4,5-T	2	Prebud
Rayless goldenrod, Haplopappus heterophyllus	2,4-D ester	1.7 to 3.5 lb/100 gal.	April-May spot treatment

Common poisonous weeds (continued)

Plant	Chemical	Rate	Stage of Growth
		lb/A	
Burroweed, Haplopappus tenuisectus	2,4-D ester	1	March-April
Threadleaf groundsel, Senecio longilobus	2,4-D ester	1	April-June
Broom groundsel, Senecio riddellii	2,4-D ester	1	Summer and fall after effective rainfall
Cocklebur, Xanthium sp.	2,4-D	$\frac{1}{2}$-1	Before burr set
Desert marigold, Baileya multiradiata	2,4-D	$3\frac{1}{2}$ lb/100 gal.	Spot treat when plants are vigorous
Western whorled milkweed, Asclepias subverticillata	2,4,5-T or Silvex	4 lb/100 gal.	Repeated spot treatment
Redstem peavine, Astragalus emoryanus	2,4-D plus	2+	Prebloom
A. nuttallianus	2,4,5-T	2	
Rattle-weed loco, Astragalus wootonii	2,4-D plus	2+	Prebloom
	2,4,5-T	2	
Inkweed, Drymaria pachyphylla	2,4-D ester	1 lb/100 gal.	Spot treat before flowering

[1]Other plants with the same common names may not be susceptible to the same treatment. Contact one of the authors for the most recent recommendations. On all pesticides, follow directions on the label and observe precautions. Generally, herbicides are effective only when plants are actively growing and soil-moisture conditions are good.

plants. This applies to animals being trailed, after hauling, or being worked. Avoid trailing hungry animals through or holding animals on dense stands of poisonous plants.

- Do not move livestock to fresh pasture where poisonous plants are growing abundantly. Livestock may be poisoned when grazing unfamiliar range, even though animals accustomed to the area are not poisoned.
- Know what poisonous plants grow on your range. Learn which parts of the plants are poisonous, when they are most toxic, conditions under which poisoning occurs, the kind of livestock affected, symptoms of poisoning, how to treat poisoned animals, and how to control the plants. (See pages 37 and 38 for some of the common poisonous weeds and suggested herbicide treatments.)
- Remove animals from pastures that are treated with herbicides to control the poisonous species or other noxious plants. Some plants become more palatable and/or more poisonous after treatment with herbicides.
- Put livestock on pastures at the proper season, when the desirable plants are at the proper stage of growth, not when poisonous plants are most dangerous. Fencing may be necessary to keep livestock off areas infested with poisonous plants during critical periods, or the plants may need to be removed from some pastures.
- Prevent the introduction of noxious plants. Before putting strange animals into an area, hold them in dry-lot for 24 hours or longer to permit foreign seeds to pass through the animal.

USE WILD WATER

Substantial increases in forage production and significant decreases in erosion could be obtained through watershed management. Many ranches in semidesert areas could make beneficial use of arroyo water as well as sheet flow on slopes.

Waterspreading is diverting runoff from natural arroyos by means of a system of dams, dikes, or ditches and spreading it over relatively flat areas. Areas that receive the flood water should have soils with a moderate to high water-holding capacity (loams or clay loams). Intake rates should be slow enough to permit flood waters to spread across the surface of the area. The spreading area must be relatively flat and free of channels that would concentrate the water. The plants on such areas must be able to benefit from intermittent flows and to withstand some periods of surface inundation. Plants such as sacaton, alkali sacaton, tobosa, and yellow bluestem are adapted to these conditions. Ranchers have to comply with all applicable state laws or water rights in designing and constructing such diversion systems.

A waterspreading scheme on the Prather Ranch, south of Alamogordo. Wild water on rangeland can often be used to increase forage production and substantially reduce erosion.

Net wire stretched across shallow arroyos diverts and spreads runoff water over adjacent areas. The spreading area should have uniform slopes, preferably one percent or less. Net wire diversions can also be used to divert surface runoff away from active gullies.

Other water conservation practices are contour furrows, ripping, and pitting. Contour furrows form good seedbeds on medium- to heavy-textured soils. Interrupted furrows prevent a large water loss if a furrow wall breaks and preclude the necessity of furrowing exactly on the contour. On slopes, leave spoil from the furrow on the downslope side. Ripping is used to fracture impervious layers in the subsoil, but generally the ripped lines seal over in a year or so. Pitting forms a series of indentations in the surface soil to collect water. Narrow pits often can fill with soil rapidly on some erodible sites. Broad, shallow pits made with a basin-forming machine or a bulldozer blade will last longer. Pitting is generally most successful on medium- to heavy-textured soils on gently sloping sites.

Select conservation practices on the basis of 1) the amount of runoff and erosion, 2) the effectiveness of a given piece of equipment on a certain soil type and slope, 3) the increased forage production obtained from the practice, and 4) control of livestock. New seedings accompanying these practices must be protected from grazing during the growing season for one to three years to permit new plants to become established.

IMPROVING GAME HABITAT

The principal game species on semidesert ranges are scaled and Gambel quail, mourning doves, antelope, and mule deer. Habitats for

these animals can often be improved without reducing the livestock capacity of a range.

Where a mixture of shrubs and grasses grow, an occasional burn seems to improve the browse. The old bushes sprout from the roots and put out new growth after a fire. This growth is more available to animals. Competition between livestock and game can be severe in desert mountains if the livestock has to browse the mountainmahogany, ceanothus, and other shrubs. Under good management, however, livestock use is limited mostly to grass so that the browse is left mostly for game.

Many kinds of animals consume mesquite beans, and the seeds are widely scattered in the droppings of wildlife and livestock. Passing through an animal increases germinability of these seeds. Because mesquite outcompetes grass for soil moisture, replace it with other species wherever possible. Using plants that furnish protection for wildlife improves the range as a game habitat. Antelope and game birds prefer mixed grass-forb vegetation types over mesquite types.

On areas infested with creosotebush, any treatment that increases the grasses and forbs should help wildlife. It is not necessary to leave areas untreated for wildlife habitat.

Generally, where water facilities are far apart, increasing the number of facilities will benefit wildlife. In extensively fenced areas, be sure that antelope can negotiate the fences so that they can range freely.

The major objective for game-range improvement is to break up homogenous vegetation patterns into heterogenous mosaic patterns. This gives the variety of feeding, nesting, and resting cover that is vital for wildlife. In some areas, you can obtain heterogenous vegetation patterns by removing brush from the best sites and leaving the areas of poorest soils untreated.

In general, good range-management practices and good wildlife conditions are highly compatible, but some modifications in some range practices may improve conditions for game. For example, since antelope prefer forbs and succulents, keeping livestock away from these plants would insure an adequate supply for the antelope. Land-forming treatments such as furrowing and pitting sometimes increase the forbs and thus improve the habitat for antelope.

RANGE PLANTS AS ORNAMENTALS

Ranchers and other persons who appreciate natural beauty have long been impressed with the variety of plants on rangelands. Many urban homeowners like these plants for landscaping their homes. With the growth of urban areas, the demand for native plants is increasing.

While range plants appear to be available in an endless supply, this may not be true. The Southwest is arid, and many native plants reproduce slowly. Collecting such plants from state or federal lands is illegal without a permit. A landowner, however, can dispose of his own plants as he pleases. Here are some concepts about the use of native plants as ornamentals that ranchers may want to consider:

• *Using some range plants for ornamentals may facilitate the conservation of soil and water.*

Soil is conserved when plants that provide the soil with little protection are removed from the range. For example, shrubs such as creosotebush and mesquite provide little soil protection from wind and water erosion. Research results indicate that as much as seven inches of soil have been lost from areas invaded by creosotebush. The result is that rocks and pebbles are accumulated on the soil surface, producing an erosion pavement.

Water may be conserved in at least two ways. Removing plants that use larger amounts of water from the range will allow plants that use water more efficiently to grow. Some desert plants, such as mesquite and salt cedar, use large amounts of water when it is available but survive on limited amounts during dry periods. Since these plants can survive with little water, their use as ornamentals would conserve domestic water in towns.

• *Quality of the environment is often as important as its conservation.*

Range plants have developed under a regime of low fertility, so they require little if any fertilizer in ornamental plantings. Furthermore, the plants have evolved with natural immunities to disease and insects. This is not to say that problems do not exist when individual plants are isolated. However, some balance of predators and prey has been established for native plants, and usually they do not have the disease and insect problems that plague exotic ornamental plants.

• *Some plants can be taken from the range advantageously; others cannot.*

Plants that offer little or no recognized value to the habitat can be removed for use as ornamentals. These plants can be beautiful in a landscape.

Other plants provide forage to both livestock and wildlife. Some of these plants are ephedra, apache plume, cliffrose, winterfat, and yucca. In addition, lechuguilla and candelilla are especially critical as mule deer forage. Deer may eat these plants yearlong, and if they are removed from a critical deer range, care should be taken that they are not replaced by an undesirable or unpalatable species.

Many plant species are representative or characteristic of recognized vegetative type and have aesthetic value on native areas. If you re-

move such plants for ornamentals, be sure to leave representatives of the species on the range. Some of these plants are the yuccas, ocotillo, sotol, Spanish dagger, century plant, and several small cacti.

Other species are apparently endemic. They are characteristic of an earlier flora that occupied the area and are neither abundant nor widespread today. These species no longer reproduce naturally. Many of them occur in a very limited habitat. If these are removed, they will probably not be replaced by a similar species. Madrone and certain species of Spanish daggers are included in this group.

In summary, selling range plants for ornamentals can provide some ranchers with an opportunity to use sound ecological principles in making a little economic gain. A rancher can sell plants that have no economic significance from his private lands. Undesirable plants that cannot otherwise be economically controlled may be removed for horticultural use at no cost to the rancher.

Some range plants useful as ornamentals are partly described in the table on pages 44 to 46.

THE RANCH AS A SYSTEM

Each ranch has different characteristics and must be managed accordingly. Ranches differ in the amount of improvements (fencing, water developments, equipment), the proportion of various soil and vegetation types, wildlife values, recreational opportunities, livestock characteristics (kind, breed, and class), supplemental feeding practices, and management objectives of the operator. On some ranches, productivity may be increased by brush control, seeding, or water-spreading, or a combination of these practices. All of these various factors must be considered collectively to maximize production while maintaining the resource. In addition, on semidesert ranches one must always be wary of a drought period that may extend for several months or for several years. When a variable, such as brush control or drouth, is introduced, it affects the entire management plan for a ranch. During a drought, it is imperative to adjust livestock numbers to the available forage resources. This adjustment should be made in the fall, if the forage crop is short, so as to avoid forced sales later in the following winter or spring.

When improvement practices such as brush control and seeding are initiated on a ranch, the rancher should also initiate a program of deferred-rotation grazing. Then the treated areas could be deferred during the growing season for one to three years to permit seedling establishment. After treatments have been completed, the rancher may modify his grazing plans to maximize profits while maintaining the resource.

Attractive features, usual landscaping use, and forage value of some range plants used as ornamentals

Plant Name	Ornamental Attractiveness:			Homeowners Use:			Forage Value for:	
	Leaves	Flowers	Spines	Hedge	Solitary	Mixture	Livestock	Wildlife[1]
Algerita, *Berberis* spp.[2]	X	X			X	X		X
Apache plume, *Fallugia paradoxa*	X	X			X	X	X	X
Brittlebush, *Brickellia incana*	X	X			X	X		
Buckeye, *Ungnadia speciosa*	X				X	X		
Candelilla, *Euphorbia antisyphilitica*					X	X		X
Cenizo, *Leucophyllum* spp.	X	X		X	X	X		
Century plant, *Agave americana*	X	X			X	X		
Cholla, *Opuntia* spp.	X	X	X	X	X	X		X
Creosotebush, *Larrea tridentata*	X	X		X	X	X		
Crucifixion thorn, *Holacantha stewartii*			X		X	X		
Daleas, *Dalea* spp.	X	X			X	X	X	X
Desert-willow, *Chilopsis linearis*	X	X			X	X		
Fendler bush, *Fendlera rupicola*	X				X	X		
Flowering forbs: *Lupinus* spp.		X				X	X	X
Verbena spp.		X				X	X	X
Machaeranthera spp.		X				X		

Astragalus spp.		X				X		
Fourwing saltbush, Atriplex canescens	X	X		X	X	X	X	X
Juniper, Juniperus spp.	X				X	X		
Lechuguilla, Agave lecheguilla	X	X			X	X		
Madrone, Arbutus texana	X	X			X	X	X	X
Mescalbean, Sophora secundiflora	X	X			X	X		
Mesquite, Prosopis glandulosa	X				X	X		X
Mormontea, Ephedra spp.	X				X	X	X	X
Mountainmahogany, Cercocarpus montanus	X	X		X	X	X	X	X
Oaks, Quercus spp.	X							
Ocotillo, Fouquieria splendens		X	X	X	X	X		
Perennial broomweeds, Gutierrezia spp.	X	X			X	X		
Pinyon, Pinus spp.	X				X	X		
Pricklypear, Opuntia spp.	X	X	X		X	X		X
Rabbitbrush, Chrysothamnus spp.	X	X			X	X		
Retama, Parkinsonia aculeata	X				X	X		
Sacahuista, Nolina spp.	X				X	X		

Range plants used as ornamentals (continued)

Plant Name	Ornamental Attractiveness			Homeowners Use:			Forage Value for:	
	Leaves	Flowers	Spines	Hedge	Solitary	Mixture	Livestock	Wildlife[1]
Saltcedar, *Tamarix* spp.	X	X		X	X	X		
Silktassel, *Garrya wrightii*	X	X			X	X	X	X
Small cacti: *Ancistrocactus* spp.	X	X	X		X	X		
Ariocarpus spp.	X	X	X		X	X		
Cereus spp.	X	X	X		X	X		
Echinocactus spp.	X	X	X		X	X		
Echinocereus spp.	X	X	X		X	X		
Mammillaria spp.	X	X	X		X	X		
Soaptree yucca, *Yucca* spp.	X	X			X	X	X	X
Sotol, *Dasylirion* spp.	X	X			X	X		
Spanishdagger, *Yucca* spp.	X	X			X	X		X
Sumacs, *Rhus* spp.	X	X			X	X		
Winterfat, *Eurotia lanata*	X	X			X	X	X	X
Wolfberry, *Lycium* spp.	X	X			X	X		X
Yellow elder, *Tecoma stans*	X	X			X	X		

[1]Herbivore, where known.

[2]"spp." indicates several species.

SCIENTIFIC NAMES OF RANGE PLANTS

Forage Plants

Black grama *(Bouteloua eriopoda)*
Blue grama *(Bouteloua gracilis)*
Blue panic *(Panicum antidotale)*
Boer lovegrass *(Eragrostis chloromelas)*
Fourwing saltbush *(Atriplex canescens)*
Leatherweed croton *(Croton corymbulosus)*
Lehmann lovegrass *(Eragrostis lehmanniana)*
Mesa dropseed *(Sporobolus flexuosus)*
Plains bristlegrass *(Setaria macrostachya)*
Russianthistle *(Salsola kali)*
Sacaton *(Sporobolus wrightii)*
Sideoats grama *(Bouteloua curtipendula)*
Sorghum almum *(Sorghum almum)*
Spectaclepod *(Dithyrea wislizenii)*
Three-awns *(Aristida* spp.*)*
Vine mesquite *(Panicum obtusum)*
Woolly paperflower *(Psilostrophe tagetinae)*
Yellow bluestem *(Bothriochloa ischaemum)*

Invaders

Creosotebush *(Larrea tridentata)*
Honey mesquite *(Prosopsis juliflora* var. *glandulosa)*
Shinnery oak *(Quercus havardii)*
Tarbush *(Flourensia cernua)*

Poisonous Plants

Alkaloids

Bitterweed *(Hymenoxys odorata)*
Groundsel *(Senecio* spp.*)*
Larkspur *(Delphinium* spp.*)*
Locoweed *(Astragalus* and *Oxytropis* spp.*)*
Lupine *(Lupinus* spp.*)*
Nightshade *(Solanum* spp.*)*
Peavine *(Astragalus* spp.*)*
Poisonous hemlock *(Conium maculatum)*

Poisonous Plants (continued)

Glycosides

Acacia *(Acacia* spp.*)*
Chokecherry *(Prunus* spp.*)*
Mountainmahogany *(Cercocarpus montanus)*

Nitrates

Lambsquarters *(Chenopodium* spp.*)*
Pigweed *(Amaranthus* spp.*)*
Ragweed *(Ambrosia* spp.*)*
Russianthistle *(Salsola* spp.*)*

Photosensitizing Substances

Goathead *(Tribulus terrestris)*
Lechuguilla *(Agave lecheguilla)*
Sacahuista or beargrass *(Nolina* spp.*)*

Other Poisonous Substances

Burroweed *(Haplopappus tenuisectus)*
Gambel's oak *(Quercus gambelii)*
Rayless goldenrod *(Haplopappus heterophyllus)*
Shinnery oak *(Quercus havardii)*

Undetermined

Annual goldeneye *(Viguiera annua)*
Desert marigold *(Baileya multiradiata)*
Inkweed *(Drymaria* spp.*)*
Juniper *(Juniperus* spp.*)*
Mesquite *(Prosopsis juliflora)*
Pine *(Pinus* spp.*)*
Snakeweeds *(Gutierrezia* spp.*)*
Tansy mustard *(Descurainia pinnata)*

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