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IMPROVING ARID RANGELANDS[1/]

by

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1/ This paper reports research involving pesticides. It does not contain recommendations for their use nor does it imply that the uses discussed have been registered. All uses of pesticides in the United States must be registered by appropriate State and/or Federal Agencies, before they are recommended.

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The productivity of arid rangelands has been greatly reduced by droughts, a rapid increase of noxious shrubs, and improper grazing. An increase of brush is responsible for the loss of grazing lands that formerly contributed significantly to the production of livestock and wildlife. As undesirable shrubs increase, there is a corresponding loss of protective forage species and an increase in wind and water erosion.

Drought periods are frequent and expected. We must consider fluctuating moisture conditions in all our decisions involving arid rangelands because this resource is easily damaged by abuse. Even when the source of abuse is removed, improvement is often very slow. Arid rangelands are indeed very fragile, and they must be handled accordingly.

Stands or perennial grasses are often severely reduced by drought. On the Jornada Experimental Range in south-central New Mexico, the basal cover of black grama (Bouteloua eriopoda) was reduced to 42% of its predrought cover during the drought of 1916-1918, 11% in 1921-26, and 23% in 1934 (Nelson, 1934). During the Great Drought of 1951-56, black grama cover was reduced to 1 to 50% of its predrought average, depending on soil type (Herbel et al., 1972). Furthermore, where black grama was reduced, there has been no recovery following the drought.

The damage and impact of rodents and rabbits are easily underestimated. On mesquite sand dune sites in southern New Mexico, there were 81 kg per km^2 (462 lb/mi^2) of rodent biomass (Wood, 1969). This, plus rabbit populations that may range up to 5 per ha (2/acre) exerts as much pressure on desirable vegetation as one cow per km^2 (3 $cows/mi^2$). This rate of grazing by rodents and rabbits may maintain the range in a deteriorated condition. Rodents and rabbits eat vegetation, destroy roots and above-ground plant parts, and collect seed that would otherwise aid in natural revegetation. Even in good grassland areas, the bannertailed kangaroo rats (*Dipodomys spectabilis*) kept 10% of the area out of vegetative production by denuding the ground in the vicinity of their mounds (Wood, 1969). Arid rangelands in good condition have fewer rodents and rabbits than those in poor condition.

The objective of this paper is to discuss some of the problems in managing arid rangelands and to discuss methods for maintaining or improving the resource. The area under discussion is southeastern Arizona, southern New Mexico, western Texas, and northern Mexico. The average annual precipitation ranges from 20-30 cm (8-12 inches). The precipitation is highly variable from time to time and from place to place. The growing season is governed by the occurrence of rain from April through September. Plants grow in brief periods after effective rainfall.

Brush Problems

On the Jornada Experimental Range, only 4.8% of the area was dominated by honey mesquite (*Prosopis juliflora* var. *glandulosa*) in 1858 (Buffington and Herbel, 1965). By 1963, 50.3% of the area was dominated by mesquite. The initial infestations of mesquite were generally associated with earlier Indian activities. The rapid increase in mesquite in recent years is a result of dispersal of mesquite seed by livestock. Creosotebush (*Larrea tridentata*) dominated 0.4% of the area in 1858 and 14.2% in 1963. It initially was confined to dry, rocky ridges. As mesquite and tarbush (*Flourensia cernua*) began to dominate the slopes adjacent to mountains, the original grass stands were thinned. Eventually, creosotebush moved on to those sites and dominated the mesquite, tarbush, and remaining grass stands. Tarbush dominated 0.4% of the area in 1858 and 8.6% in 1963. It originally grew on the slopes adjacent to mountains.

It was replaced on those slopes by creosotebush and is now most prevalent on heavier soils where it competes with tobosa (Hilaria mutica) and burrograss (Scleropogon brevifolius).

Trends toward dominance by noxious plants can be halted or reduced, and revegetation by forage species can be promoted by judicious use of mechanical and chemical control methods, seeding where necessary, and control of the numbers of grazing animals and the season of grazing. Once established, woody plants such as mesquite, creosotebush, and tarbush cannot be eliminated in any reasonable time period, if ever, by good grazing practices alone. On rangelands dominated by brush, control measures are essential before benefits can be achieved from other practices such as a grazing management plan, seeding, or waterspreading.

Mesquite. There are several methods of controlling mesquite. The method selected depends on degree of infestation and site conditions. Handgrubbing can be used where most mesquite plants are less than 1 meter (3 feet) in canopy diameter and the stand has fewer than 250 mesquites per hectare (100 plants/acre). Mechanical grubbing of individual plants can be used where the residual grass stand is good and the stand has no more than 500 mesquites per hectare (200 plants/acre). Individual plant treatments with dry herbicides can be used where mesquite plants are less than 2 meters (6 feet) in canopy diameter and the stand has no more than 250 plants per hectare (100 plants/acre). Ground spraying can be used on only light to medium mesquite stands. Aerial spraying can be used on heavy mesquite stands on sandy soils. Rootplowing can be used on dense mesquite stands on medium- to heavy-textured soils.

In any mechanical treatment, the mesquite must be completely severed from their roots below the budding zone. Large areas infested with light to moderate stands of mesquites have been cleared by mechanical grubbing in eastern New Mexico (Herbel et al., 1973). The equipment consists of a large, wheel-type front-end 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. Costs with the larger equipment averaged $0.03 to $0.05 per plant.

Individual plant applications of 3 g active ingredient per meter (1 g/foot) canopy diameter of fenuron pellets and monuron powder killed an average of 56% of the mesquites (Herbel et al., 1973). The average cost ranged from $0.03 to $0.09 per plant, depending on plant size and density. Picloram granules, monuron-trichloroacetate granules, and bromacil powder or pellets have also been found effective. Pelleted or granular materials can be applied from horseback.

For good results from any spraying, the mesquites must be growing vigorously. Generally, the January 1-May 15 precipitation must be at least 5 cm (2 inches). The best time of the year to spray is when the leaves are fully developed and the plants are in full flower or the seed pods are forming. This generally is June 1-15 in southern New Mexico.

An effective spray mixture for ground equipment is 150 g of low volatile ester of 2,4,5-T per 100 liters of water (1-1/4 lb/100 gal). The spray must cover all parts of the plant (Valentine and Norris, 1960).

Aerial spraying of mesquites on the Jornada Experimental Range resulted in plant kills of 8-57% during 11 years (Herbel et al., 1973). Control was best in years when there was available soil moisture before and at the time of spraying and the plants were fully leafed and growing vigorously. Control was poor in years when there was no or little available soil moisture during the winter-spring period before spraying. The standard treatment for aerial spraying of mesquite has been 0.56 kg 2,4,5-T per ha (1/2 lb/acre) in a 1:7 diesel oil to water emulsion at a total volume of 47 liters per ha (5 gal/acre). Kills with combinations of 2,4,5-T with either picloram or dicamba at the same total rate (0.56 kg/ha) were slightly higher than kills with the standard treatment. Approximately additive effects have been obtained by repeated applications of standard 2,4,5-T treatment in successive or alternate years. Kills with total volumes of 1.5, 3.8, and 7.7 liters per ha (1, 2.5, and 5 gal/acre) were compared. In these aerial applications, 0.56 kg 2,4,5-T per ha (1/2 lb/acre) in a total volume of 1.5 liters per ha was as effective as in 7.7 liters per ha and more effective than in 3.8 liters per ha (Herbel et al., 1973).

On the Jornada Experimental Range, an area aerially sprayed twice for mesquite control during 1958-61 has produced an annual average of 260 kg per ha (232 lb/acre) of perennial grass herbage during the last 8 years compared to 36 kg per ha (32 lb/acre) on an adjacent unsprayed area. The major perennial grass species was mesa dropseed (*Sporobolus flexuosus*). The sand dunes on that sprayed area have levelled appreciably, and there is a marked reduction in wind erosion.

Creosotebush and tarbush. Individual plant treatments effectively control both creosotebush and tarbush on stands up to 370 plants per hectare (150 plants/acre). On creosotebush, 2 g active ingredient per meter canopy diameter of bromacil, fenuron, picloram, fenuron-trichloroacetate, isocil, and dicamba killed more than 80% of the plants on sandy loam soils. On tarbush, 1 g active ingredient per meter canopy diameter of isocil, bromacil, fenuron-trichloroacetate, monuron-trichloroacetate, monuron, fenuron, and dicamba killed more than 85% of the plants on clay loam soils (Herbel and Gould, 1970).

The most effective aerial spray treatment on creosotebush has been repeated applications of dicamba at 2.2 kg per ha (2 lb/acre) in successive years. The most effective and economical spray treatment on tarbush has been a mixture of 0.56 kg per ha (0.5 lb/acre) of dicamba plus 2.2 kg per ha (2 lb/acre) of 2,4-D (Herbel et al., 1973).

Creosotebush and tarbush are readily killed by mechanical methods such as rootplowing, disking, and grubbing of individual plants.

Seeding

Natural recovery of desirable vegetation may take a long time on some sites in arid areas. Seeding desirable species is the only way to improve some sites where natural recovery is slow or nonexistent. However, establishing seeded species is difficult in arid areas. Most species adapted to semidesert ranges have small seeds and therefore must be seeded no deeper than 1.3 cm (0.5 inch). Establishing seedlings is often difficult because of an adverse microenvironment (rapid drying, unfavorable temperatures, and crusting of the soil surface). Accordingly, the primary objective of seeding procedures is to place the seed in an environment favorable for germination and establishment of the seedling. This often requires varying the procedure to fit the site (Herbel, 1972b). Broadcasting is the poorest method of seeding because the seed is placed in the harshest possible environment.

Good seedbed preparation for range seeding in some areas involves retaining a firm seedbed that favors infiltration and storage of moisture, and leaving a trash-covered surface (Pearse, 1952). Either shallow disking or using a broad sweep at a shallow depth will accomplish these objectives. Seeding success was limited after pitter disk or ripping followed by seeding (Herbel, 1972b). Part of the problem with pits made with a pitter disk is that the cut made by the disk is smooth and slightly compacted. In pitter disk seeding, the seeds are generally broadcast in the pitted area and part covered by drag chains. Whitney et al. (1967) used opener blades and a packer wheel to improve pitter disk seeding. Frost and Hamilton (1965) used a basin-forming machine to make broad, shallow pits for a good seedbed. Moore (1960) used a bulldozer blade to make basin pits. Waterponding relatively large basins effectively reclaimed bare scald areas with seeded species (Newman, 1966) and by natural revegetation (Cunningham, 1970). Pitting and waterponding are generally most successful on medium- to heavy-textured soils on flat or gently sloping sites.

Concentrating water, as with various land-forming procedures, does not always insure seedling establishment. The surface soil still dries rapidly, particularly in hot arid and semiarid areas (Herbel, 1972a). Soil moisture and temperature conditions in pits can be improved with a cover of dead brush (Abernathy and Herbel, 1973). The soil temperatures on a flat area were studied during a summer period on the Jornada Experimental Range (Herbel, 1972a). The average daily maximum soil temperature at the 1.3 cm (0.5 inch) depth was 57 C (135 F) under no cover, 49 C (120 F) under one dead shrub, and 36 C (97 F) under three dead shrubs. The average maximum air temperature 10 cm (4 inches) above the ground surface for that summer period was 33 C (92 F).

A light chamber study showed the effects of soil temperatures on emergence and initial growth of 12 grass species and one shrub (Sosebee and Herbel, 1969). The two maximum daily soil temperatures were 39 C

(103 F) and 53 C (128 F), and the soil moisture was maintained at field capacity. Under the high temperature regime, survival of 11 species was reduced and all species had stopped growing or were growing very slowly at the close of the 21-day trial. Under the lower temperatures, all species grew normally. In a similar study with various moisture levels, about 7 cm (2.8 inches) of water was necessary for survival in the low temperature regime for the 21-day period and 23 cm (9.1 inches) in the high temperature regime (Herbel and Sosebee, 1969).

With this information as background, Abernathy and Herbel (1973) developed a one-unit piece of equipment for seeding rangeland infested with brush. The unit consists of a rootplow, brush conveyor, basin-forming blade, and seeder. The rootplow kills the brush and other competing vegetation. A hydraulically operated blade between the rootplow and seeder forms basin pits. The seedbed left by the rootplow is loose and fluffy, so a seeder with individually suspended press wheels firms the soil. The seed is placed in a V-shaped groove pressed into the soil and covered with drag chains. The brush conveyor picks up the brush from behind the rootplow and windrows it over the seeded area. Thus, water is concentrated and shade provided for part of the seeded area.

The species used in range seedings varies according to climatic and site conditions, and the management of a specific ranch. Using the equipment just described for seeding arid rangelands infested with brush, Herbel et al. (1973) seeded a number of species at several sites across southern New Mexico. The species most easily established on the sandy to loamy sites infested with creosotebush were: Lehmann lovegrass (Eragrostis lehmanniana), Boer lovegrass (E. chloromelas), black grama, sideoats grama (Bouteloua curtipendula), yellow bluestem (Bothriochloa ischaemum), blue panic (Panicum antidotale), and fourwing saltbush (Atriplex canescens). On heavier soils infested with tarbush, the best species were sideoats grama, yellow bluestem, alkali sacaton (Sporobolus airoides), and fourwing saltbush.

Grazing Management

Manipulation of the season and intensity of grazing by livestock is another means to increase productivity of arid rangelands. Livestock grazing must be managed properly after an improvement practice such as brush control or seeding to obtain the maximum benefit from the practice.

Poor distribution of livestock on the extensive arid rangelands often results in both overgrazed and undergrazed areas in the same pasture. This distribution can be improved by adding watering places and by placing minerals and supplemental feed away from permanent watering places.

The growing season for most plants in arid areas is limited to short periods when soil moisture is available. Grazing plants during the early part of the growing season will deplete their carbohydrate root reserves. However, this is probably not important in arid regions because under proper stocking on a yearlong basis, only a small percentage of the plants of key species would be grazed. Also, during most growing seasons, some growth of annual forbs and grasses would relieve the grazing pressure on the key perennial species. Livestock are very selective in the species and plant parts they consume. This selectivity can vary considerably seasonally and even during different times of the same day. The proportion of the species grazed often is not related to the abundance of the species available to the animal (Herbel and Nelson, 1966).

Key perennial grasses on semidesert ranges should never be overutilized. During 53 years of record on the Jornada Experimental Range, 45% of the years were classified as drought years (Herbel and Nelson, 1969). Any overuse of the key perennial grasses followed by a prolonged drought can result in a high mortality of perennial grasses.

Using weather and plant information and considering livestock needs, Herbel and Nelson (1969) developed the Best Pasture Grazing System. It consists of establishing an objective for each pasture and stocking it accordingly. The System is opportunistic in that the use of forbs and short-lived grasses is maximized. They are of little value to the permanent range resource but contribute much to livestock nutrition (Nelson et al., 1970). No set stocking plan is established by the System for a specific time period because of considerable variations in weather conditions that affect plant growth. The System involves a rotation scheme where the livestock are moved only when the vegetation on another pasture or another part of the same pasture can be grazed to the advantage of both plants and animals. In large pastures in arid regions, periodic opening and closing of watering places can be used to rotate grazing pressure to different areas within a pasture (Martin and Ward, 1970).

Because of a highly variable forage crop in arid areas, Flexible Herd Management should be used to adjust stocking to maximize livestock production and minimize damage from grazing during drought years (Paulsen and Ares, 1962). In years of average precipitation, the herd is composed of not more than 55-60% breeding animals; the remainder of the herd is composed of yearlings and replacement heifers. In years of below-average precipitation and low forage production, adjustments in the size of the herd bring the numbers within the capacity of the range. In the years of above-average precipitation, part or all of the natural increase from the breeding herd can be held over until the next spring or fall.

Summary

The detrimental factors reducing productivity of arid rangelands in southwestern United States and northern Mexico are improper grazing, droughts, and an increase of noxious shrubs. Fluctuating moisture conditions must be considered in all decisions involving arid rangelands because this resource is easily damaged by abuse. Natural recovery is often very slow on these arid rangelands.

The major noxious shrub species in this region, honey mesquite, creosotebush, and tarbush, have increased considerably in the last 100 years. These species cannot be eliminated by removing livestock or by improved grazing practices. Sparse stands of mesquite can be controlled by handgrubbing, mechanical grubbing, or individual plant treatments with herbicides. In any mechanical treatment, mesquite roots must be severed below the budding zone. A hydraulically operated stinger blade mounted on a tractor is used to grub the mesquite plants. Individual mesquite, creosotebush, and tarbush plants can be effectively controlled with basal applications of fenuron and bromacil, preferably in a pelleted or granular form. Mesquite plants on sand dunes can be effectively controlled with broadcast aerial applications of 2,4,5-T, with accompanying increase of grass production and decrease of wind erosion.

In seeding arid rangelands, the primary objective is to place the seed in an environment favorable for germination and establishment of the seedling. A brush conveyor-pitting-seeding machine was developed for seeding rangeland infested with brush. In a single operation, the brush is killed by a rootplow, basin pits are formed, seed is planted on a firm seedbed, and the dead brush is windrowed over the seeded area. Some of the species most easily established were Lehmann lovegrass, black grama,

sideoats grama, yellow bluestem, and fourwing saltbush.

Varying the season and intensity of grazing will increase range productivity. Poor livestock distribution can be improved by adding water places and by feeding away from water. The use of forbs and short-lived grasses is maximized in the Best Pasture Grazing System. Livestock are moved only when the vegetation on another pasture can be grazed to the advantage of both plants and animals. Flexibility in livestock numbers is recommended to adjust to the fluctuating forage crop.

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