that are not being used. It is suggested that they might be used with good effect in attaining better distribution of cattle on larger range units. They might also be of value in extending the range of cattle away from the watering facilities.

The shade shelters in use are approximately eight by sixteen feet and six feet in height. The original shelters were constructed as a spare time employment from corral rails and used lumber. Similar shelters can be built in less than a day and for a cost not exceeding $20.00. Originally the shelters were covered with black plastic sheeting, which lasted for one year. Presently the roof is of cage wire and brush. The roof shown has been in use for four years, and the brush is now in need of replenishment. A shelter of the size shown is adequate for twenty yearling animals. Shelters up to six years old are still in use, none having yet required repairs other than re-roofing.

THE SAN JOAQUIN CAGE

STANLEY E. WESTFALL AND DON A. DUNCAN

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Certain aspects of range grazing studies, such as herbage production, vegetation composition, and plant growth and height, require that small areas be protected from grazing animals. Often large numbers of such areas or plots are needed; therefore, protection must be provided easily and economically. Various kinds and arrangements of wire and wood have been used successfully, depending on the vegetation and kind of animals involved.

The San Joaquin cage (Figure 1) was developed for use on California annual foothill ranges

FIGURE 1. The San Joaquin cage provides adequate protection to low-growing, herbaceous vegetation.

grazed by cattle. Constructed of 18 gage, 1½-inch mesh, 24-inch galvanized-after-weaving wire at the rate of three units per man-hour, the total cost per cage was $1.21. This cost combined $0.54 for 12 feet of wire and $0.67 for ⅓ man-hour of labor at $2.00.

The cage is 24 inches tall and tapers from a 29-inch square base to a 22-inch square top. This size is adequate for protecting square-foot sampling plots. Fastened to the ground by short metal or wooden stakes, it is sufficiently rigid without braces. Light weight and easy nesting facilitate transportation, installation, and storage. In past experience, with reasonable care, this type of cage has served for a 5- to 10-year period.

In 1961 more than 500 San Joaquin cages were built and used at the San Joaquin Experimental Range near O'Neals, California. A 3-step construction operation—cutting, shaping, and attaching the top—proved most efficient (Figure 2). This cage is recommended for use on low-growing herbaceous vegetation.

BASAL COVER AND PRODUCTION OF WEEPING LOVEGRASS UNDER VARYING AMOUNTS OF SHRUB LIVE OAK CROWN COVER

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Shrub live oak (*Quercus turbinella* Greene) is one of the major components of the Arizona chaparral. Where the oak is dense, herbaceous vegetation tends to be sparse. To give a better ground cover and increase

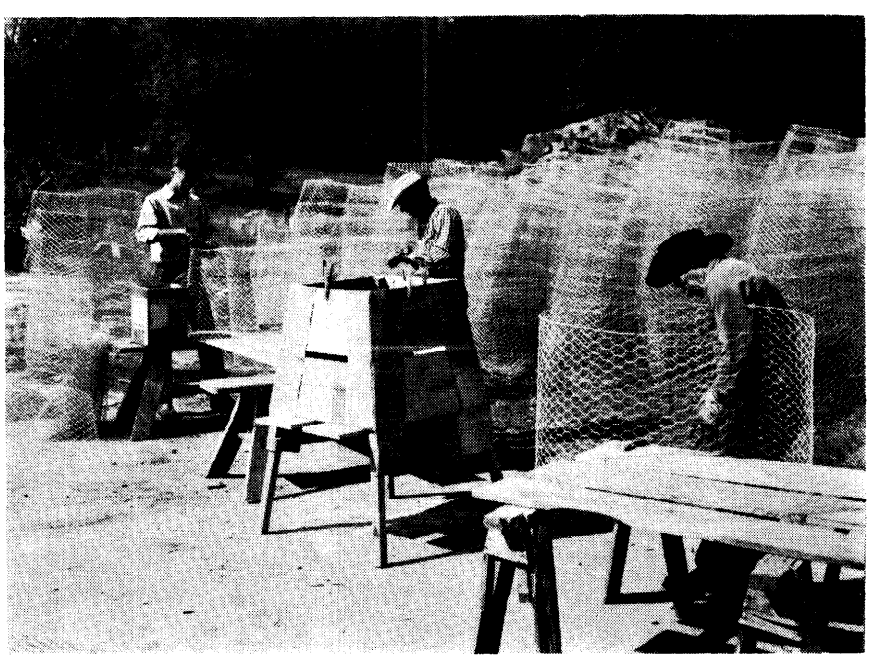

FIGURE 2. Three-step construction—cutting, shaping, and attaching top—proved most efficient.

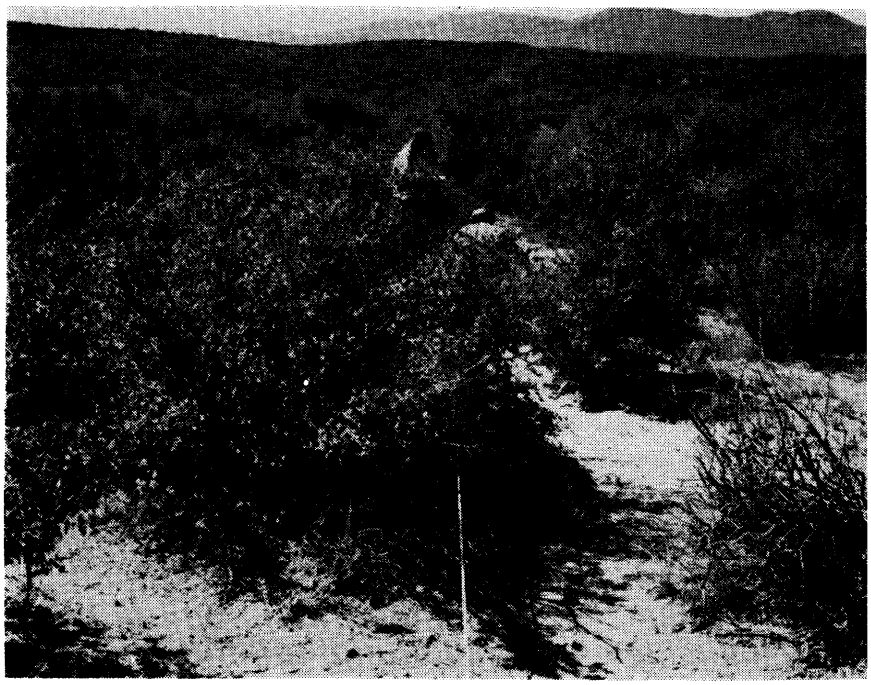

FIGURE 1. A relatively dense stand of chaparral with few herbaceous plants beneath the shrubs or in the interspaces.

forage values, weeping lovegrass *(Eragrostis curvula* (Schrad.) Nees.) has been planted following burns in many areas. Studies have shown that the weeping lovegrass tends to die out as the reestablishing oak brush thickens. The study reported here was made to determine the relationship between the production and cover of weeping lovegrass and the density of shrub live oak.

Methods

The study was located on the Pinal Burn near Globe, Arizona. The area, burned in 1952, was seeded to weeping lovegrass and fenced against grazing shortly after the fire. A good grass cover was developed, but by 1957, it had thinned as the shrubs became reestablished (Figure 1). Shrub live oak had an average cover of 30 percent.

Twenty-two areas, 50 by 87.1 feet in size, were located in the exclosure and two were reduced to each of 11 crown cover classes: 0, 10, 20 . . . , 90 and 100 percent (30 percent cover).

All shrubs, other than shrub live oak, were eliminated. Crown cover of the oak was reduced to the various densities on randomly selected areas by basal application of a mixture of 2,4-D and 2,4,5-T in diesel oil. All subsequent sprouts were killed by reapplication of the chemicals. Weeping lovegrass was seeded on all areas.

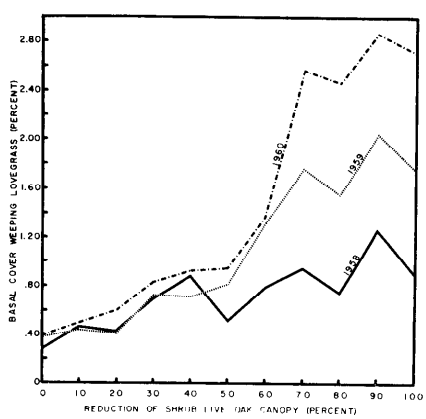

FIGURE 2. Basal cover of weeping lovegrass growing under various percentages of maximum shrub live oak cover.

Ten line transects were randomly located on each area by the Canfield method (1942). No line was closer than four feet to another line or to the edge of the area.

Production of the seeded grass was measured each year by the weight estimate method (Pechanec and Pickford, 1937). Ten 9.6-square-foot plots were placed at five foot intervals along the right side of each of two of the ten lines. Five of the ten permanent plots were estimated each year. Of the remaining five, grass production on one was estimated and clipped each year by the double sampling technique of Wilm, Costello and Klipple (1944).

Results

Basal cover of weeping lovegrass tended to be inversely proportional to shrub live oak cover (Figure 2). Percent basal cover on the various areas ranged from 0.28 to 1.26 in 1958, from 0.37 to 2.04 in 1959 and from 0.39 to 2.86 in 1960.

Although there was a good linear relationship between basal cover of grass and reduction in oak canopy the first year following canopy reduction, the relationship tended to depart from linearity more each year. On areas where less than 50 percent of the shrub live oak cover was removed, the weeping lovegrass remained approximately the same during all three years. Where more than 50 percent of the oak cover was killed, the basal cover of the grass continued to increase markedly during the second and third years.

Production of weeping lovegrass (Y) was also inversely proportional to reduction of shrub live oak canopy (X) (Figure 3). The regression equations for the three years, all significant at P=.05, are shown below.

Year	*Regression Equation*
1958	Y=269.2 + 3.74X
1959	Y=250.4 + 12.98X
1960	Y=131.0 + 15.21X

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

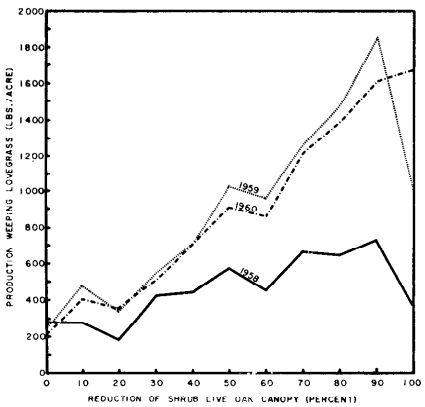

FIGURE 3. Production of weeping lovegrass growing under various percentages of maximum shrub live oak cover.

Grass production increased during the second year on all plots where the oak was reduced. Largest increases were found on plots where more than half of the oak cover was killed. Even though basal cover of the grass increased on some areas between the second and third years, the grass production of 1960 varied little from the grass production of 1959. This small variation may be due to low rainfall in the spring and summer of 1960. Production in pounds per acre on the various areas and total February-through-July rainfall for each year is tabulated below:

Year	Range in Production (lbs./acre)	Rainfall (inches)
1958	180 to 730	9.61
1959	250 to 1840	4.82
1960	220 to 1660	2.91

Summary and Conclusions

Basal cover and production of weeping lovegrass, under varying amounts of shrub live oak cover, were measured for three consecutive years. Both basal cover and production of the grass tended to be inversely proportional to amount of oak cover. With less than 50 percent reduction of oak cover, basal cover remained about the same during the three years of observation. With more than 50 percent reduction of oak cover, grass cover continued to increase during the second and third year. Grass production increased on all treated plots during both the first and second years following treatment and the increases were roughly proportional to oak canopy reduction. Production the third year following treatment closely approximated that of the second year, probably due to low rainfall.

These findings indicate that some grass production may be obtained from seeding weeping lovegrass in areas where reduction of oak cover is slight. However, to obtain good stands and high production, more than half of the oak canopy should be eliminated.

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A DURABLE, ECONOMICAL CAGE FOR UTILIZATION OR PRODUCTION STUDIES

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Many types of temporary cages are used by field workers to protect small areas from grazing in range utilization and herbage production studies. Some are of a particular design or shape to meet a specific problem or need. Most of the cages in use have several serious limitations. They are fairly expensive, difficult to construct and transport under field conditions, and are subject to damage from grazing animals.

In an attempt to overcome some of these limitations, several types of wire and various shapes of construction were tried and evaluated under field conditions. The relatively, inexpensive, easily constructed, sturdy cage described here proved satisfactory in all trials and is now being used throughout Wyoming by Soil Conservation Service personnel.

This cage is circular, of gal-

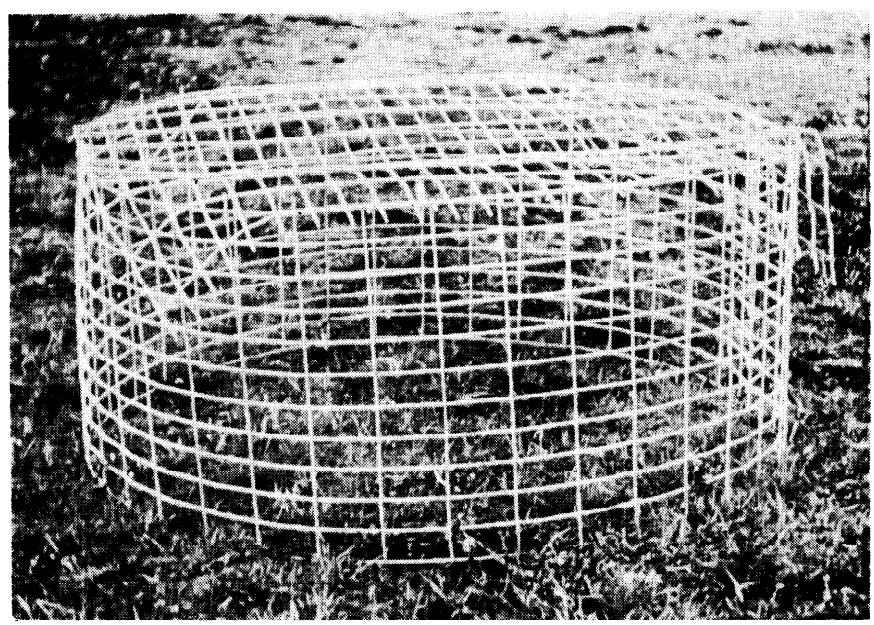

FIGURE 1. The completed exclosure. On this cage, the square corners of the top were simply bent down but can easily be trimmed off.