INCREASING FORAGE PRODUCTION ON A SEMIARID RANGELAND WATERSHED

by

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About 500 million acres in the Western United States contributes less than 1 inch depth of water yearly to major streams. Hickok (1968) reported that 90 percent of Arizona yields less than 1/2 inch of runoff. While total water production is important because of the extremely large areal extent of these watersheds, the most beneficial and economical use of precipitation may well be to maximize onsite forage production while minimizing surface runoff and sedimentation.

Southwestern rangeland is usually seeded from March through June, characteristically a very dry period with little to no precipitation. The grass seed must remain viable in the ground until adequate soil water becomes available for germination.

Establishment of native grass would be very much enhanced if the planting date coincided with a period of adequate soil water for seed germination and seedling establishment. Available soil water is particularly important for sideoats and blue grama, since these grass species do not exhibit seed dormancy. Seed dormancy, such as is found in some species of lovegrass (Eragrostis spp.), permits a longer period in which to accomplish seeding and still ratain possibilities for stand establishment. The introduced lovegrass species, commonly seeded in the Southwest, are less palatable than sideoats and blue grama. Native grasses often suffer from selective overgrazing in areas reseeded to introduced lovegrasses. Therefore, rangeland improvement might be enhanced if stands of these two more palatable native grass species could be established.

In most, if not all of the Western United States, sufficient precipitation data are available to compute the most probable times during the growing season when soil moisture would be adequate for germination and plant establishment. Such an analysis was made for the experimental area near Tombstone, Arizona.

Average annual precipitation for Tombstone is 14.2 inches (Renard, 1970). Low humidity with the accompanying high evaporation rates, commonly occurs. From July through September, moist unstable air masses advance into Arizona from the Gulf of Mexico. These air masses often produce moderate to intense thunderstorms, which develop over heated terrain in the afternoon (Sellers, 1960).

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Records indicate that summer precipitation starts about July 15. A precipitation "plateau", when rainfall is most likely, continues until after the first week of August, providing a 3-week period of probable rainfall.

Schreiber and Sutter (1972) utilized available hydrologic information for the Walnut Gulch Watershed to compute the most probable times for soil water availability during the summer growing season. The growing season for perennial range grasses was defined as starting when rainfall provided sufficient soil water to satisfy evapotranspiration demands for 4 consecutive days.

They showed that normally sufficient summer precipitation is received from July 15 to August 5 to provide adequate soil moisture for grass seedling growth.

Utilizing this information (H.A. Schreiber, personal communication, 1971), we established a planting date that would coincide with the most probable dates of sufficient soil water for seedling establishment. The NM-28 sideoats grama was seeded on August 2, 1971. Planting of Vaughn sideoats grama was completed on July 24, 1972, and the blue grama was seeded on July 27, 1972.

The effectiveness of any particular rainfall event on an area is governed by the amount of precipitation, the amount of runoff, and the temperature and relative humidity immediately following the event. Part of each event is ineffective because of runoff and evaporation. Isolated rains of less than 0.10 inch are probably not effective for plant growth.

Proper distribution of rainfall is important, as well as the effectiveness of each individual storm. The distribution of precipitation events for July, August, and September is given in Figure 1 for 1971 and 1972. The planting date for each year occurred on the rainfall "plateau", as described by Schreiber and Sutter (1972). The dashed line in Figure 1 expresses the conventional or unconditional probability of available soil water based on the 73 year record. For example, on July 20 the probability is 0.4 that available soil moisture would be present.

In 1971, 11 precipitation events, totalling 2.53 inches, occurred between the initial event on July 17 and August 3, when seeding had been completed. During this period, the smallest recorded event was 0.02 inch, and the largest was 0.76 inch. Effective summer rainfall--events greater than 0.10 inch and discounting surface runoff--was 6.96 inches. Six precipitation events, totalling 1.99 inches, occurred between July 15 and July 28, 1972. The effective summer rainfall for 1972 was 9.16 inches. These events provided adequate soil moisture for seed germination and seedling emergence. Total summer precipitation was average for the 2 years of seeding. This indicates that if seeding of these native grasses can be timed to take advantage of summer precipitation, the seeding risk can be reduced. Regulating the seeding date by the time period most likely to receive precipitation was successful in establishing a native grass stand.

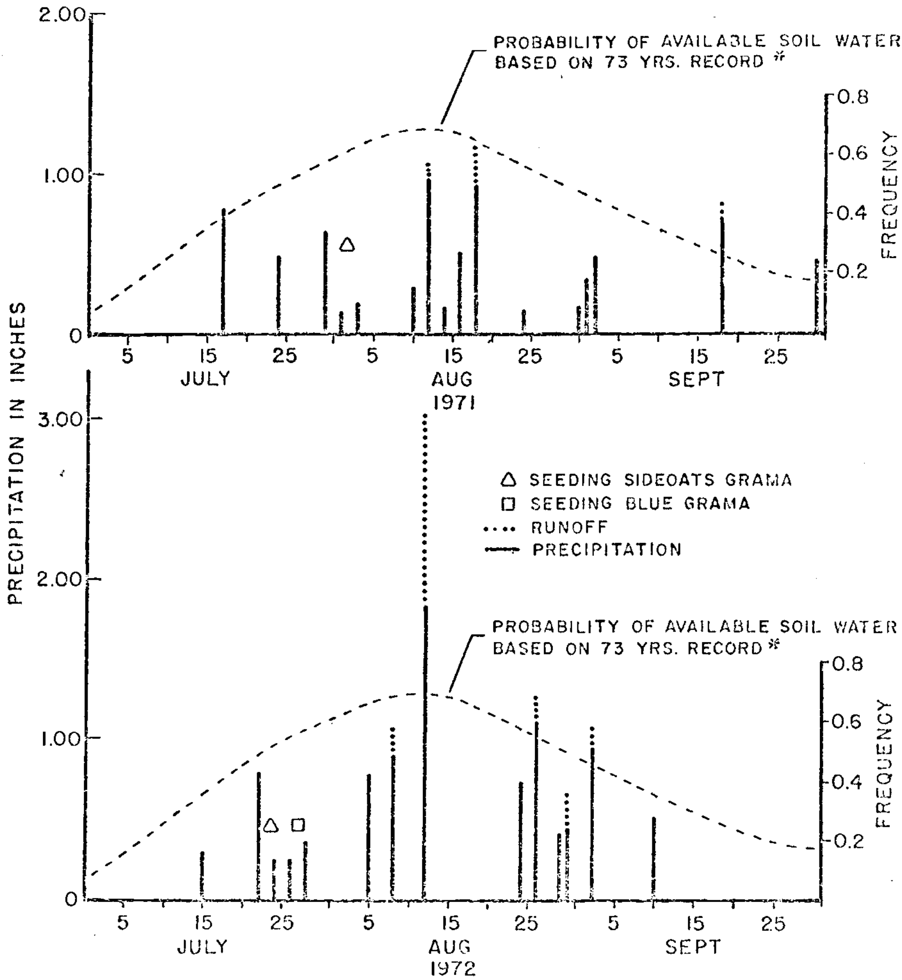

Figure 1. Distribution of precipitation that exceeded 0.10 inches during July, August, and September of 1971 and 1972.

* adapted from Schreiber and Sutter, 1972.

Tests conducted on the Walnut Gulch Experimental Watershed support the hypothesis that seeding native grass species is more likely to be successful if programmed according to soil-moisture probablilities.

The Walnut Gulch Experimental Watershed, located in Southeast Arizona, is a typical semiarid rangeland watershed. The climax vegetation is desert grassland with black grama (Bouteloua eriopoda), tobosa grass (Hilaria mutica), and curly mesquite (Hilaria Belangeri), the predominant grass species (Walnut Gulch Experimental Watershed, 1967). However, more than 50 percent of the experimental area described by early explorers as grassland is now covered by shrubs. The predominant shrubs are whitethorn (Acacia constricta), tarbush (Flourensia cernua), and creosote bush (Larrea divaricata).

The experimental area is a 109 acre subwatershed located within the 58-square-mile Walnut Gulch Watershed. The U.S. Soil Conservation Service classified the site as marginal for establishing a grass stand. The soils are a Rillito-Karro gravelly loam, 3 to 15 percent slope, with 20 percent gravel in the upper 6 inches. Surface runoff from the subwatershed drains into a stockwater pond which is instrumented to measure rate and volume of runoff. Root-plowing (Soil Conservation Service, 1964), an eradication method that severs shrubs just below the root crown, was accomplished in June 1971, followed by seeding in 1971 and 1972, using a rangeland drill. Thus, two operations were required, root-plowing, which was completed before the summer rains, and then drilling during optimum soil moisture conditions. Two native grass species, sideoats (Bouteloua curtipendula) and blue grama (Bouteloua gracilis), were planted. The NM-28 selection of sideoats was seeded in 1971. The 1972 planting was Vaughn sideoats and blue grama. The blue grama seed was broadcast and then covered using the rangeland drill.

The problem of weed control on disturbed rangelands is recognized and maybe important on some sites. However, on the gravelly loam upland sites, characteristic of Walnut Gulch, weeds were not abundant enough to present problems.

Vegetation density, composition, and forage production data were collected before and after treatment. Point-line transects (Levy and Madden, 1933) each 100 feet long, were used for measuring vegetation and surface characteristics. Forage production was determined by clipping the grass on 1 x 4-foot plots at a 1-inch stubble height and weighing the oven dried material.

Average crown cover and basal area for all plant species before treatment was 45 and 2 percent, respectively (Table 1). This comparatively high crown cover and low basal area is characteristic of the shrub biomass. Two years after rootplowing and seeding, the surface characteristics for the experimental area were measured again in the fall of 1973 (Table 1).

Table 1. Surface characteristics (percent) for the experimental area seeded in 1971 to sideoats grama (NM-28).

	Before Treatment	2 years After Treatment
CHARACTERISTIC	PERCENT	
crown cover	45	64
basal area	2	10
gravel	21	34
rock	30	26
litter	26	14
soil	21	16

Measurements made in the fall of 1973 showed generally small non-significant differences between corresponding surface characteristics for areas seeded to the blue grama and sideoats in 1972, indicating similar surface conditions between sites (Table 2). Approximately 7 percent more crown cover was measured on the blue grama site than on the sideoats site, with a correspondingly larger percentage of exposed soil on the sideoats site.

Table 2. Surface characteristics (percent) for the two experimental areas seeded in 1972. Data were collected in the fall of 1973.

	EXPERIMENTAL AREAS	
characteristic	Blue grama*	Sideoats*
	-percent-	
crown cover	37.33	39.67
basal area	8.67	7.00
gravel	27.22	25.53
rock	23.35	18.86
litter	21.13	17.66
soil	20.58	27.93

* Average values for three replications taken at each site.

Comparison of forage production between the control and the root-plowed and seeded area demonstrates the inherent forage production *capabilities of the site, if management includes commonly-used range conservation practices in conjunction with readily available precipitation information. Forage production of oven dried material (grass) was 25 pounds per acre on the untreated site. The NM-28 sideoats produced 1,950 and 2,643 pounds per acre, respectively, for 1972 and 1973 on the root-plowed and seeded area. Thus, approximately a 100-fold increase in forage production resulted from the range renovation treatment. Forage production for Vaughn sideoats, the year following seeding, was 800 pounds per acre, or a 30-fold increase over the untreated area.*

Controlling the undesirable shrubs by root-plowing, and converting the area to native grass was remarkably successful. This successful establishment of grama grasses was attributable mostly to timing the seeding operation to coincide with the most probable time for receiving summer precipitation with the consequent availability of soil water. Although grass establishment would not be successful every year, the probabilities for success are increased.

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SUMMARY

Two native grass species were successfully seed on marginal semiarid rangeland. Grass stands were established two years in succession with average summer precipitation. Selections of the optimum seeding date for successful native grass stand establishment was regulated by the time period most likely to receive precipitation.

The successful establishment of a grama grass stand was accomplished by seeding during the time of the "precipitation plateau" when chances were highest for available soil water.

Shrubs were killed by root-plowing at a depth of 14 inches below the soil surface. Root-plowing was an effective range treatment of controlling sprouting shrub species with a kill in excess of 95 percent.

Forage production measurements were taken on NM-28 and Vaughn sideoats. The NM-28 selection produced 1,950 and 2,643 pounds of forage per acre, respectively, for the 2 years following seeding. Forage production for Vaughn was 820 pounds per acre the year following seeding. Untreated control sites produced 23 and 25 pounds per acre of forage, respectively, for corresponding years. Results indicate that success in establishing a stand of native grass is increased through use of existing hydrologic data.

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