Grazing Systems on the Edwards Plateau of Texas: Are They Worth the Trouble? I. Soil and Vegetation Response

Charles A. Taylor, Jr., Nick E. Garza, Jr., and Terry D. Brooks

By the turn of the century, the Edwards Plateau region of Texas had a well-developed livestock industry (Youngblood and Cox 1922). Continuous heavy grazing by livestock and the suppression of natural fires from this time until the drought of the 1950s significantly changed the vegetative complex (Smeins 1980). Excessive grazing reduced the protective plant cover, decreased infiltration rates, increased erosion, and accelerated the ingress of undesirable brush.

Today, many Edwards Plateau ranchers are faced with deteriorated rangeland, poisonous plants, predators, animal health problems, brush infestation, variable precipitation patterns, expensive operating costs, unstable economy, and erratic markets.

The modern rancher must effectively respond to all biological, physical, and economic factors to make a profit. Most producers recognize that long-term profitability is affected by grazing management. Grazing systems based on livestock rotation with periodic grazing and resting of pastures represent an important part of grazing management. Following are some features of several different grazing systems in the Edwards Plateau.

Why Do We Use Grazing Systems?

Because grazing animals are selective, preferred plants are often excessively grazed. Over time, preferred plants may be reduced in size and productivity or totally eliminated. Grazing systems for *rangelands* were initially developed to provide rest periods to allow heavily grazed plants to recover.

The Sonora Site

The 3,460-acre Sonora Research Station is characterized by rolling stony hill topography typical of the Edwards Plateau. The Edwards Plateau resource area encompasses approximately 24 million acres in west central Texas and is predominately rangeland with some cultivation largely confined to the deeper soils (Fig. 1). Currently, the region's vegetation is a complex mixture of grasses, forbs, and woody species (Smeins et al. 1976, Huston et al. 1981). The Station is primarily composed of the low stony hill range sites, and most soils of the Station are Tarrant silty clay or Tarrant stony clay which overlays a fractured limestone substrate. The most common midgrasses are sideoats grama, Texas wintergrass, cane

Authors are with the Texas A&M University Research Station, P.O. Box 918, Sonora, Texas 76950.

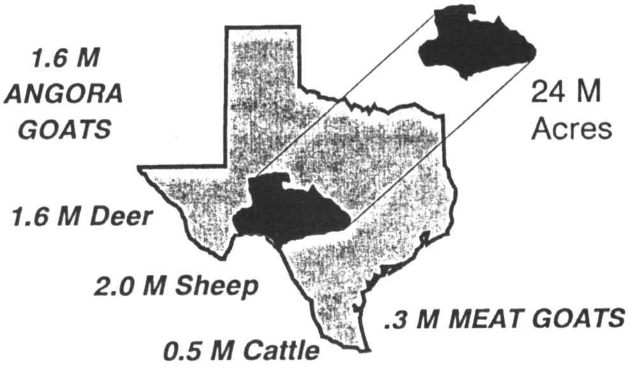


Fig. 1. *The Edwards Plateau Region of Texas.*

(bluestem, Texas cupgrass, and Wright's threeawn. Dominant short grasses are curlymesquite, red grama, hairy tridens, and hairy grama. Dominant woody plants include live oak, ashe juniper, Mexican persimmon, and honey mesquite.

The elevation of the Experiment Station is approximately 2,100 ft. The average growing season is 240 days with warm summers and mild winters.

Meteorological data has been collected on the Experiment Station since 1918 (Fig. 2). Precipitation is highly variable, typical for semi-arid rangelands, and has ranged from 6.3 inches to 41.5 inches per year over a 79-year

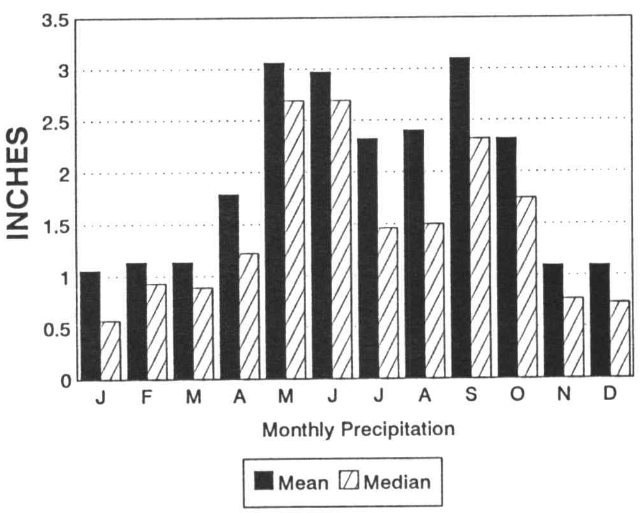


Fig. 2. *Mean and Median Precipitation (1919–*1992) on the Sonora Research Station.

period. Long-term annual precipitation has averaged 22.6 inches while the median precipitation has been considerably lower with a value of 17.3 inches.

How Many Different Grazing Systems Are There?

The number of possible grazing and resting combinations used on rangeland is almost infinite. Our research encompasses deferred-rotation and intensive grazing systems.

1) Deferred-rotation grazing systems have no more than two pastures per herd of livestock, and the length of grazing periods equals or exceeds resting periods. Rest periods generally vary from 3 to 6 months, but may be as long as 12 months. An example of this type of grazing system is the 4-pasture, 3-herd. Each pasture is grazed for 12 months and then rested for 4 months.

2) Intensive grazing generally utilizes three or more pastures per herd. Two examples of intensive grazing management are short-duration grazing (SDG) and high-intensity, low-frequency grazing (HILF). To prevent confusion about what distinguishes SDG from HILF, I offer this definition of the two as reported by Kothmann (1980): "criteria for separation are that HILF systems generally have grazing periods greater than two weeks, rest periods longer than 60 days, and grazing cycles greater than 90 days; both systems have three or more pastures per herd, but SDG is characterized by relatively short grazing periods (less than 14 days) and rest periods not exceeding 60 days".

Where Is The Research Information?

Research was begun on the Sonora Research Station in 1948 to determine the proper stocking rates for these ranges grazed continuously with different kinds and combinations of animals. This work was continued for over 30 years, and during the past 10 years, studies have been conducted to determine the correct stocking rate, optimal number of pastures, and proper rest period needed for SDG systems.

Deferred-rotation grazing system research was initiated in 1949. Dr. Leo Merrill developed and implemented the 4-pasture, 3-herd grazing system and compared livestock and vegetation responses from this system (stocked at 32 animal units/section) to continuously grazed systems at three rates of stocking (16, 32, and 48 animal units/section). No advantage in livestock gains was recorded for the early years of this study; however, vegetation in the deferred pastures was obviously improving; there was a steady trend toward improved range conditions. Following the severe 6-year drought of the '50's ($\bar{x}$ = 11 inches per year), pastures with light stocking rates or under deferred-rotational grazing at moderate stocking rates improved in range condition (i.e., sideoats grama, Texas cupgrass, and other midgrasses and perennial forbs increased in the vegetative complex). The deferred rotation pastures were originally stocked at 32 au/section, but in 1959 the rate was increased to 43 au/section because excess forage was being produced. Range condition was maintained under the deferred grazing systems until 1968. However, because of the increased stocking rate and continual increase of juniper, improvement in range condition in the deferred grazing system was halted and for some years, the trend was actually downward.

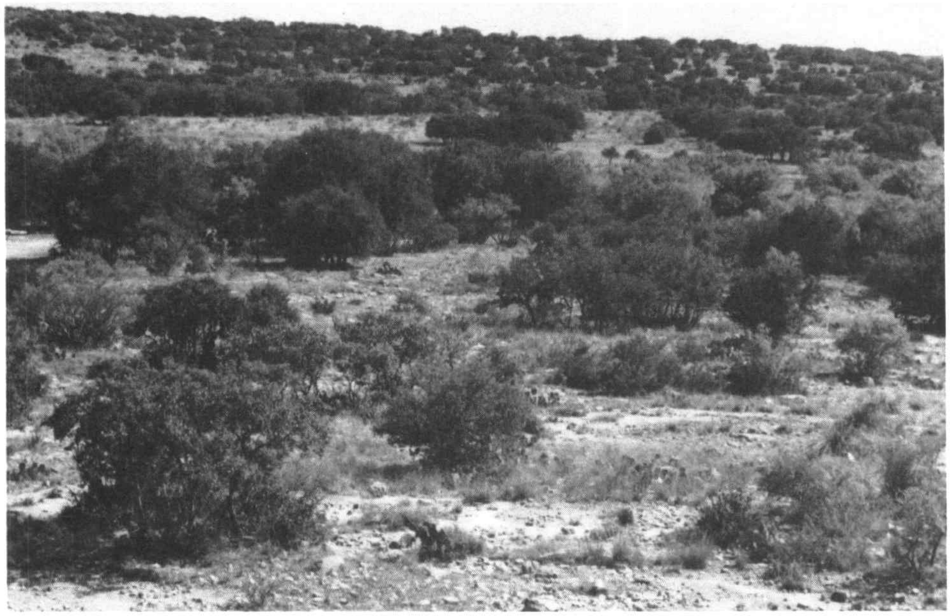
Intensive grazing system research was initiated on the Sonora Research Station in 1970. The first attempt at this type of grazing system involved 7 equal size pastures with one herd of livestock. Each pasture was grazed for 22 days and then rested for approximately 132 days; the term high-intensity, low-frequency (HILF) was coined and used to identify this type of grazing system.

Livestock movement was based on a calendar date and stocking rate was initially set to approximate a moderate grazing pressure. Higher successional grasses (i.e., sideoats grama, Texas cupgrass) responded very favorably to this type of grazing system; however, livestock performance was less than optimum, especially at heavier stocking rates and during periods of either limited plant growth or dormancy (Taylor et al. 1980).

Approximately 7 years after the HILF grazing system had been established, the graze/rest periods were changed to a 7-day graze period with a 42-day rest period, thus a SDG system. Livestock production was enhanced by changing from a HILF to a SDG system, but a decrease in standing crop resulted. Available vegetation under SDG was only one third of HILF and was 25% lower than the standing crop of a 4-pasture, 3-herd grazing system.

A stocking rate study representing a simulated SDG system was initiated in 1980 and continued through 1985 (Ralphs et al. 1990). Four stocking rate treatments ranging from the recommended rate for moderate continuous grazing to 2.7 times the recommended rate evaluated the effects on standing crop and plant species changes. Pastures were alternately grazed for 3 days and rested for 51 days. For this study, warm-season midgrasses (i.e., sideoats grama) declined and stoloniferous short grasses (common curlymesquite) increased under SDG across all stocking rates. Forage availability declined in direct proportion to increasing stocking rates. At the beginning of the study, sideoats grama occurred in large robust bunches. As the study progressed, heavy grazing removed the old growth and caused the clumps to break down into individual tillers.

Another study conducted adjacent to the stocking rate study, on the sample range site, also resulted in a substantial decrease in midgrass cover under SDG (stocked 1.76 times moderate stocking rate) over a six-year period. Midgrass cover declined 50% in the SDG compared to moderate continuous grazing. Species composition in the SDG treatment changed from midgrasses to stoloniferous short grasses with a substantially increased rate of erosion. The data indicated that a shift in species composition (midgrass to sodgrass) reduced total plant cover and that the midgrass cover was more persistent during the dormant season than the shortgrass cover, which quickly deteriorated when dormant. Midgrasses and total standing crop for the HILF and continuous grazing man-



agement systems remained fairly constant. Midgrasses not only produce more grazeable forage than stoloneferous shortgrasses but they also help reduce surface runoff and erosion (Taylor et al. 1980, Thurow et al. 1987).

Research projects, on the Sonora Research Station, have closely examined the effects of livestock impacts under SDG on the soil hydrologic characteristics (McCalla et al. 1984, Warren et al. 1986a, Warren et al. 1986b, Thurow et al. 1986). These experiments were conducted on sites with bare soil (no vegetation cover) and on sites with a natural cover of vegetation.

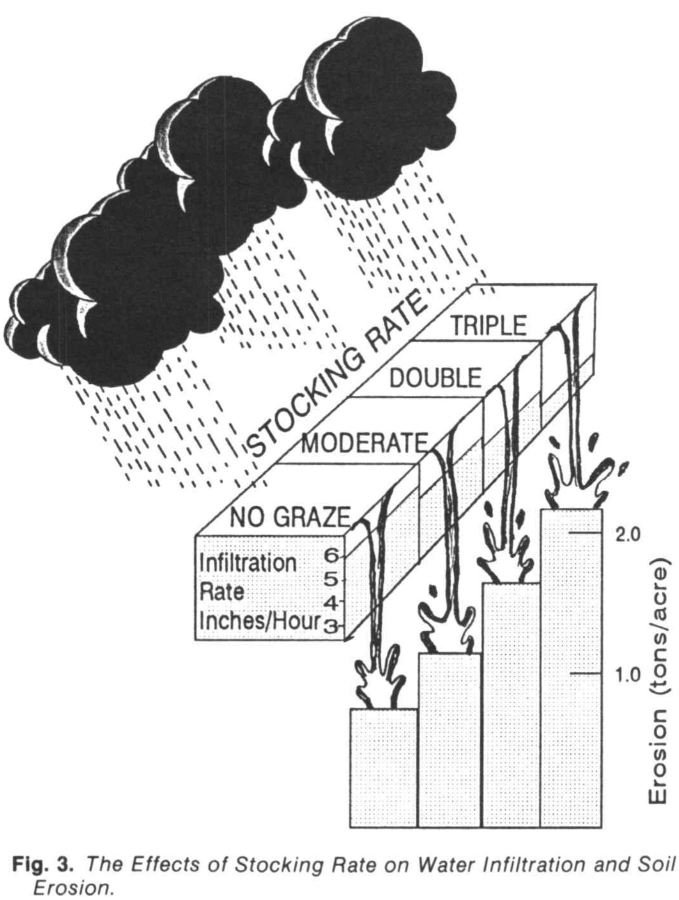


Fig. 3. *The Effects of Stocking Rate on Water Infiltration and Soil Erosion.*

In general, these studies indicated that infiltration rates were lower and sediment production (erosion) was higher for treatment pastures following short-term grazing periods in SDG compared to control pastures (no livestock) (Fig. 3). Thurow et al. (1988) attributed the majority of the treatment effect to the amount of plant cover. "The amount of cover was more important than the type, indicating that protection of soil structure from direct raindrop impact was the primary function of cover on infiltration." These results indicate that a minimum of about 300–500 lb/ac of total organic cover is necessary to reduce the harmful effects of raindrop impact and to provide enough obstacles to slow overland flow of water so that soil erosion is kept to a minimum.

The clayey soils on the Experiment Station, although subject to deterioration when abused, are resilient and if given proper management (i.e., moderate stocking rate, proper rest period) will recover. Livestock churning the soil with their hooves will further break down the remaining soil aggregates (Fig. 4). Therefore, in terms of SDG, three very important questions should be asked, "What is the optimum number of pastures needed, what is moderate stocking rate, and what is a proper rest period for soils of the Edwards Plateau?".

Our results indicate that in the Edwards Plateau, HILF grazing tactics should be employed during the major part of the growing season (May–September) to allow long rest perios for both the soil and vegetation to recover. For the dormant period of the year, SDG tactics can be employed to enhance livestock production, without damaging the warm-season midgrasses.

If breeding sheep and goats are part of the animal mixture, they should be removed from the grazing system during lambing and kidding season or they should be dispersed among all of the pastures and left until kids and lambs are large enough to travel with their dams without being separated. Annual forbs can represent a rather large portion of the vegetation complex during the late

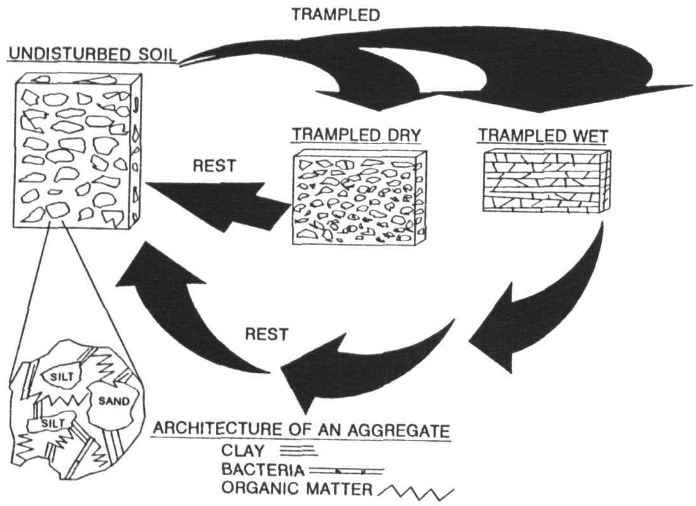


Fig. 4. *Conceptual Architecture of a Soil Aggregate and the Changes in Soil Aggregate Structure caused by Trampling under Wet and Dry Conditions.*

dormant and early spring period. We feel the most efficient way to harvest these plants is to disperse the sheep and goats over the entire grazing system and allow them to graze each pasture continuously. We believe that adopting this type of grazing system management in conjunction with moderate stocking rates will allow the resource manager to meet his goals of soil stability and vegetation improvement.

Based on our previous experience and research results we present the following conclusions relative to vegetation and soil response to intensive grazing systems:

* Rest, rather than intensive livestock activity, appears to be the key to soil hydrologic stability. Results indicate that a minimum of *90 days* of rest may be needed, under certain environmental conditions, for the soil to recover from intensive livestock grazing. Short rest periods of 50 days or less during this growing will favor the shortgrasses (Fig. 5).
* Expectations of rapidly improving deteriorated rangeland using SDG is a *false-positive* perception. Regeneration of preferred species will always be a slow process due to the presence of competing vegetation and influenced by precipitation, soil type, intensity and frequency of grazing, and length of deferment.
* SDG systems stocked at greater than moderate stocking rates significantly reduces the midgrass component of the vegetative complex.
* The protection of soil structure from direct raindrop impact is the primary function of cover on infiltration. A minimum of 300–500 lb/ac of total organic matter cover is necessary to reduce the harmful effects of raindrop impact. Midgrasses (i.e., sideoats grama, cane bluestem, Texas cupgrass) allow significantly greater amounts of water infiltration and significantly less amounts of soil erosion than short grasses (i.e., common curlymesquite, red grama, hairy tridens).

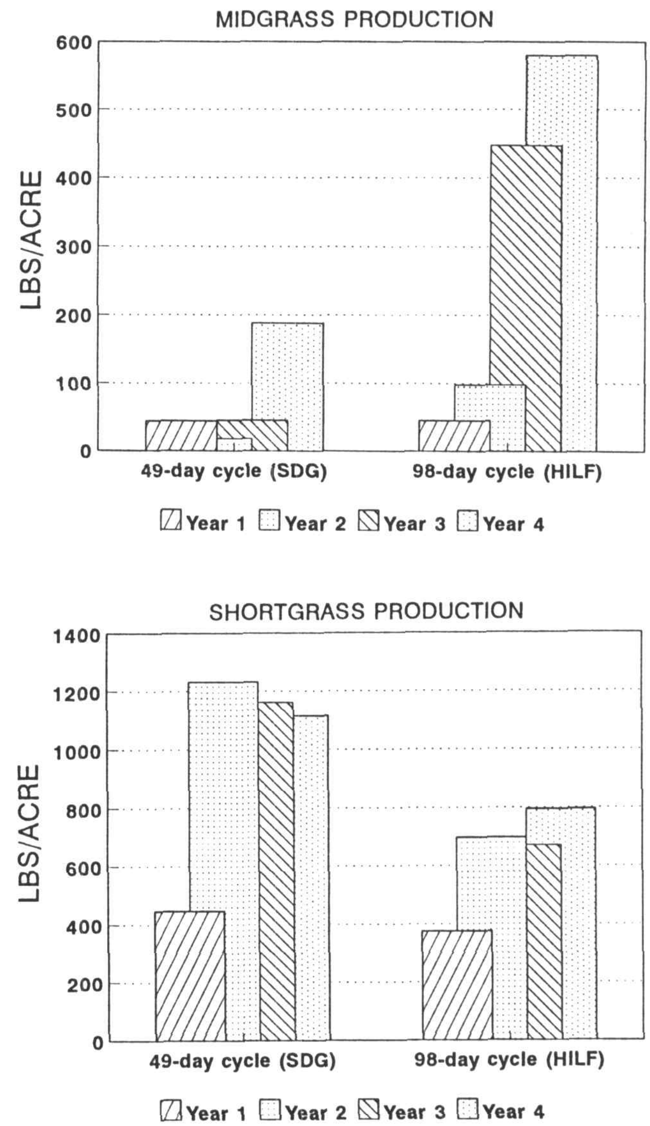


Fig. 5. *Midgrass and Shortgrass Production Measured from SDG and HILF Grazing Systems.*

* There is no evidence of any hydrologic benefit from livestock trampling or "hoof action". However, there is strong evidence that as intensity and frequency of trampling increases, soil hydrologic properties decrease.
* Infiltration rates are mostly reduced immediately after trampling. This would seem to accelerate drought conditions due to an immediate, mechanically induced decrease in infiltration rates due to trampling.

It must be remembered that the inherent low potential productivity of Edwards Plateau rangeland severely limits the alternatives available to ranchers to enhance productivity or correct management mistakes. Since recovery may be slow and expensive, grazing management on these ranges should be planned carefully to avoid mistakes that result in deterioration of the soils and vegetation.

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Grazing Systems on the Edwards Plateau of Texas: Are They Worth the Trouble? II. Livestock Response

Charles A. Taylor, Jr., Nick E. Garza, Jr., and Terry D. Brooks

Grazing systems implemented on *rangelands* have generally been designed to improve or maintain range condition. Grazing systems designed for use on *tame pastures* generally aim to maximize animal production. During the past decade, grazing systems developed for tame pastures have been applied to rangelands in an effort to increase livestock production.

Before we discuss the effects of grazing systems on livestock production, it seems appropriate to discuss differences between range management and tame pasture management. Tame pastures usually have a few plant species that are highly resistant to grazing. Expensive cultural practices may be employed to increase forage quality and quantity (i.e., fertilizer, irrigation, etc.). High stock density and grazing pressure may be necessary to improve grazing distribution and prevent the accumulation of mature forage (most forage is consumed at a immature growth stage). Grazing is usually restricted to the growing season, thus removing the need to conserve forage for dormant season grazing. Tame pastures are usually developed in high rainfall areas or on deep, productive homogeneous soils with access to supplemental irrigation. All of this results in large investments per unit area of land, with increased emphasis on livestock production.

In contrast, rangelands consist of irregular terrain and complex mixtures of plant species that vary in palatability, production and resistance to grazing. Most rangelands are located in arid and semi-arid regions where precipitation is low and variable. Soils may be very shallow or very rocky and may be very heterogeneous and subject to severe erosion if adequate amounts of vegetation are not present. Grazing pressures and animal densities are generally moderate to low; this, in combination with the differential growth and maturation of range vegetation makes grazing distribution problems the rule rather than the exception. Plant growth is usually limited to very short periods during the year; regrowth following defoliation may be very slow or non-existent due to lack of moisture. Livestock may have to survive on dormant vegetation for many months of the year and secondary plant succession is necessary for the forage resource to survive.

Unfortunately, tame pasture management techniques have been attempted on Texas rangelands without a full understanding of the effects of increased animal impact. Some supporters of intensive rotation grazing systems propose that heavy stocking and high livestock densities

Authors are with the Texas A&M University Research Station, P.O. Box 918, Sonora, Texas 76950.