Short-duration grazing: Experiences from the Edwards Plateau region in Texas

By Charles A. Taylor, Jr.

BY the turn of the century, the Edwards Plateau region of Texas had developed into a major livestock area (*27*). Continuous, heavy grazing by domestic livestock and the prevention of natural fires since that time have significantly changed the vegetative complex (*15, 16*). Long-term, excessive removal of vegetation on the plateau by grazing animals reduced the protective herbaceous cover, broke down soil aggregates, reduced infiltration rates, increased erosion, and accelerated the ingress of undesireable brush. Today, the range resource manager is faced with deteriorated rangeland, poisonous plants, predators, animal health problems, brush infestation, variable precipitation patterns, escalating operating costs, an unstable economy, and erratic markets.

Ranchers must respond effectively to these biological, physical, and economic factors if they are to make a profit from year to year.

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Most producers recognize that long-term profitability is affected primarily by proper grazing management. Grazing systems based on the rotation of livestock with periodic grazing and resting of pastures represent an important part of grazing management. In recent decades, researchers at the Texas Agricultural Experiment Station, Sonora, have investigated the response of vegetation, livestock, and soil hydrology to multipasture, one-herd grazing systems.

The Sonora site

The 3,460-acre Sonora research station is characterized by a rolling, stony, hilly topography. It is typical of the Edwards Plateau resource area, which encompasses about 37,000 square miles, including all or parts of 28 Texas counties. The region is predominantly rangeland; cultivation is confined to the deeper soils (*2*). The region's vegetation is a complex mixture of grasses, forbs, and woody species (*5, 17*). The most common bunch grasses are sideoats grama (*Bouteloua curtipendula*) Texas wintergrass (*Stipa leucotricha*), cane bluestem (*Bothriochloa barbinodis*), Texas cupgrass (*Eriochloa sericea*), and Wright's threeawn (*Aristida wrightii*). Dominant short grasses are curly mesquite (*Hilaria belangeri*), red grama (*Bouteloua trifida*), hairy tridens (*Erioneuron pilosum*), and hairy grama (*Bouteloua hirsuta*). Dominant woody plants include live oak (*Quercus virginiana*), ashe juniper (*Juniperus ashei*), Mexican persimmon (*Diospyros texana*), and honey mesquite (*Prosopis glandulosa*).

The elevation at the research station is about 2,100 feet. The average growing season is 240 days. Summers are warm and winters mild. Most soils at the station are Tarrant silty clay and Tarrant stony clay, which overlay a fractured limestone substrate.

Precipitation is highly variable, which is typical for semiarid rangelands. Annual totals ranged from 6.3 inches to 41.5 inches over a 79-year period. Long-term annual precipitation averages 22.6 inches, while the median precipitation has been considerably lower, 17.3 inches.

Effects of short-duration grazing

The ranching industry in the region receives most of its income from livestock, wildlife, and recreation. Profitability depends directly upon the stability and health of the soil and its associated vegetation. This implies that the soil and forage resource must be maintained or improved over time. Therefore, it is important that the response of both the soil and vegetation be considered equally in determining proper grazing management.

Grazing management is defined as "the manipulation of livestock grazing to accomplish a desired result" (*18*). Of the biotic factors affecting the stability of Edwards Plateau rangeland, livestock has the greatest effect.

Grazing systems generally have been designed to improve or maintain range condition. Grazing systems designed for use on tame pastures generally seek to maximize animal production. During the past decade, grazing systems developed for tame pastures have been applied to rangeland in an effort to increase livestock production. Unfortunately, this has been attempted on many Texas ranches without the managers fully understanding the effects of increased animal impact, for example, increased stocking rate, increased stock density, and increased hoof action, on vegetation and soils.

Why is there a difference between range management and tame pasture management? Tame pastures usually have a few plant species that are highly resistant to grazing. Expensive cultural practices, such as fertilization and irrigation, may be used to increase forage quality and quantity. 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 an immature growth stage.) Grazing usually is restricted to the growing season, thus removing the need to conserve forage for dormant season grazing. Tame pastures usually are 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.

Contrary to tame pastures, rangeland consists of irregular terrain and complex mixtures of plant species that vary in palatability and resistance to grazing. Most rangeland is located in arid or semiarid regions of the world where precipitation is low and variable. Soils may be very shallow or rocky, heterogeneous, and subject to severe erosion if adequate amounts of vegetation are not present. Grazing pressure and animal densities generally are 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 usually is limited to short periods during the year. Regrowth following defoliation may be slow or nonexistent because of a lack of moisture, and livestock diets may consist only of dormant vegetation for extended periods.

Because of this variation in climate, soils, and vegetation, confusion can exist under the best of management. But to impose tame pasture grazing management on rangeland in the semiarid regions of the Edwards Plateau without a comprehensive knowledge of range complexity is a one-way ticket to disaster. Unfortunately, this has been attempted recently in Texas. Supporters of intensive rotational grazing systems, such as the short-duration grazing method, propose that increased animal impact, such as hoof action, created by high livestock densities may be advantageous to the range ecosystem (*11, 12*). Alan Savory stated that implementation of a short-duration grazing system would improve rangeland productivity and double or triple livestock carrying capacity (*11, 13*). Unfortunately, this claim was made without supportive scientific data.

Effects on vegetation and soils

Multipasture, one-herd grazing system research was initiated at the Sonora experiment station in 1970. The first attempt involved seven equal-sized pastures with one herd of livestock. Each pasture was grazed for 22 days, then rested for about 132 days. The term high-intensity, low-frequency was used to identify this grazing system.

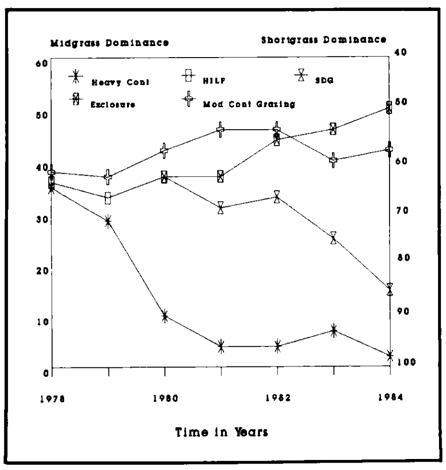
Livestock movement was based on a calendar date and stocking rate was set initially to approximate moderate grazing pressure. Higher successional grasses, for example, sideoats grama and Texas cupgrass, responded favorably to the grazing system. However, livestock performance was less than optimum, especially at heavier stocking rates and during periods of either limited plant growth or dormancy (*19*).

About seven years after the high-intensity, low-frequency grazing system was established, the grazing rest periods were changed to a seven-day grazing period with a 42-day rest period. To distinguish short-duration grazing (SDG) from high-intensity, low-frequency (HILF) grazing, M. M. Kothmann (*6*) commented: "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."

Livestock production improved with the change from a high-intensity, low-frequency system to a short-duration grazing system. But a decline in the standing crop resulted. The amount of available vegetation under short-duration grazing was only one-third of that under high-intensity, low-frequency grazing and 25 percent lower than the standing crop of a four-pasture, three-herd grazing system (*19*).

A stocking rate study was initiated on the Sonora station in 1980 and continued through 1985. Four stocking rate treatments, ranging from the recommended rate for moderate continuous grazing to 2.7 times the recommended rate in a simulated short-duration grazing system, evaluated the effects on standing crop and species changes (*10*). Pastures were grazed alternately for 3 days and rested for 51 days. In this study, warm-season bunch grasses, such as sideoats grama, declined and stoloniferous short grasses, such as common curly mesquite, increased under short-duration grazing across all stocking rates. Forage availability declined in direct proportion to increased 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.

Relative dominance of the midgrass and shortgrass life forms under different grazing systems, Sonora research station. (*20*).



A study on the same range site also found a substantial reduction in bunch grass cover under short-duration grazing (stocked 1.76 times the moderate stocking rate) over a six-year period (*22*). Bunch grass cover declined 50 percent under short-duration grazing compared with moderate continuous grazing. Species composition in the short-duration grazing treatment changed from bunch grasses to stoloniferous short grasses, with a substantial increase in soil erosion. The data indicated that a shift in species composition—bunch grass to sod grass—reduced total herbaceous plant cover. Also, the bunch grass biomass was more persistent during the dormant season than the short grass cover, which quickly deteriorated. Bunch grasses and total standing crop for the high-intensity, low-frequency and continuous grazing management systems remained fairly constant. T. L. Thurow and associates concluded that "microrelief caused by bunchgrasses serves as barriers to surface runoff and sediment transport by causing surface runoff to move in a slower, more torturous path" (*21*). Bunch grasses not only produce more grazable forage than stoloneferous short grasses (*19*), but they also provide an important deterrent to surface runoff and soil erosion (*20*).

Research in the Rolling Plains of Texas also suggested that total standing crop declined under short-duration grazing compared with moderate continuous grazing (*3*). This reduction was attributed to the increased stocking rate, which was 60 percent greater in the short-duration grazing system.

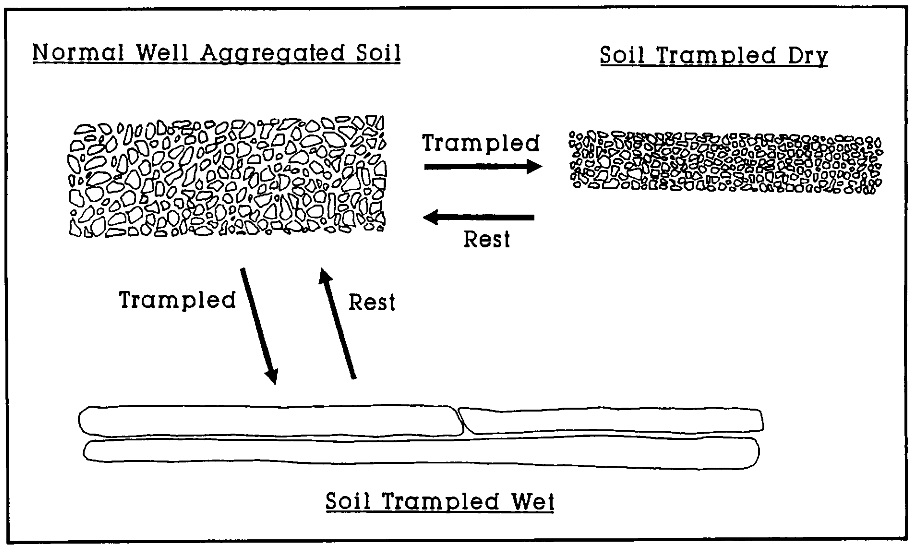
Clipping common curly mesquite at heights of two inches and above reduced yields compared to more intense defoliations (*8*). Researchers recommended clipping at one-inch heights at four-week intervals for optimum forage production and quality. It is obvious from the previous studies that curly mesquite is well adapted to and promoted by short-duration grazing; unfortunately, this occurs at the expense of the higher successional, more productive bunch grasses. Ralphs and associates concluded that under the high stocking density of short-duration grazing bunch grasses would not maintain themselves even under light stocking rates (*10*).

As mentioned, soils on the Edwards Plateau are shallow and subject to accelerated erosion if adequate plant protection is not maintained. The loss of soil can result in a permanent reduction in site potential. Range managers must be concerned with the loss of soil above the expected natural rate of erosion.

Recent research projects at Sonora have examined the impacts of livestock, both trampling and grazing, under short-duration grazing on soil hydrologic characteristics (*7, 20, 21, 25, 26*). These experiments were conducted on sites with bare soil and on sites with natural vegetative cover.

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 short-duration grazing compared with control pastures (no livestock). Thurow and associates (*20*) 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" (*20*). These results indicate that a minimum of 300 to 500 pounds per acre of total organic cover is necessary to minimize soil erosion.

Many soil and vegetation properties, for example, bulk density, litter, standing biomass, microrelief, and aggregate size, correlate significantly with infiltration rate and sediment production (*24, 25, 26*). Excessive removal of forage and changes in vegetative composition are two major areas that result in direct impacts on soil and vegetative properties. Mechanical breakdown of the soil by animal impact (hoof action) is a third cause. Studies conducted on bare soil to test the effects of animals at different stock densities on the soil structure showed that as animal numbers increased there was a decline in water infiltration and an increase in soil erosion. This occurred because of an increase in soil bulk density and because of a change in aggregate size distribution and aggregate stability. Changes in soil structure caused by the hoof-action effect depended upon whether the soil was wet or dry. On dry soil, the soil aggregates were broken down and compacted into a much tighter arrangement. On wet soil, it appeared that the soil aggregates were compressed into large clods that greatly reduced pore space. Both conditions greatly reduced water infiltration and increased runoff.



Conceptual drawing showing changes in soil structure caused by animal hoof action under wet and dry conditions.

The clay soils at the Sonora station, although subject to deterioration when abused, are resilient. If given proper management—moderate stocking rate and proper rest period—they will recover. Therefore, in terms of short-duration grazing, three important questions should be asked: What is the optimum number of pastures needed? What is a moderate stocking rate? What is a proper rest period for soils on the Edwards Plateau?

Research began at Sonora in 1948 to determine the proper stocking rates for these ranges, grazed continuously with different kinds and combinations of animals. This work continued for more than 30 years. During the past eight years, studies have been conducted to determine the correct stocking rate, optimal number of pastures, and the proper rest period needed for short-duration grazing systems. Results indicate that (a) implementation of short-duration grazing does not allow a sustained increase in stocking rate over other conventional grazing systems stocked at moderate rates (moderate rate of stocking is when efficiency of forage harvested by the grazing animals is about 25 percent), (b) seven to eight pastures is the maximum number needed, and (c) at least a 90-day rest may be needed for the soil to completely recover, after a grazing event, under most environmental conditions. Thus, by definition, short-duration grazing may not be a viable alternative for the Edwards Plateau.

Current research at Sonora is directed at identifying the positive characteristics of both high-intensity, low-frequency and short-duration grazing systems. Although preliminary, results to date indicate that high-intensity, low-frequency grazing tactics should be used during the major part of the growing season (May-September). This provides long rest periods to allow both the soil and vegetation to recover. For the remaining months of the year, short-duration grazing tactics can be used to enhance livestock production without damaging the warm-season bunch grasses. Adopting this type of grazing system management in conjunction with moderate stocking rates will allow the resource manager to meet the goals of soil stability and vegetation improvement. However, expectations for rapidly improving deteriorated rangeland using high-intensity, low-frequency or short-duration grazing tactics would be a "false-positive." Regeneration of preferred species always will be a slow process because of the presence of competing vegetation and will be strongly influenced by precipitation, soil type, intensity and frequency of grazing, and length of deferment.

The inherent low potential productivity of Edwards Plateau rangeland severely limits the alternatives available to ranchers to enhance productivity or to correct management mistakes. Because 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.

Effects on livestock production

During the past 20 years, new grazing schemes have evolved for rangelands using several pastures and fewer herds of livestock (*1, 6*). South African researchers (*1*) described two types of intensive rotational grazing systems: "high utilization grazing" is comparable to high-intensity, low-frequency grazing used in Texas and "high-performance grazing" is comparable to short-duration grazing. Short-duration grazing systems use short grazing periods to reduce grazing pressure in an effort to improve livestock performance. Research at Sonora showed that there were fewer changes in diet selection patterns of cattle during the seven-day grazing periods of a short-duration grazing system compared with 21-day grazing periods in a high-intensity, low-frequency grazing system (*19*). The short-duration grazing system also maintained higher diet digestibility and crude protein levels. The 21-day grazing periods during the dormant period of the year produced significantly greater effects on diet quality than during the growing season. In almost all pastures, crude protein levels were significantly higher during the first three days of grazing (days 1, 2, and 3) than the last three days of grazing (days 19, 20, and 21). Results from this study indicated that by reducing the length of the grazing period livestock performance could be improved.

However, although livestock production can be increased under certain environmental conditions with shorter grazing periods, this may be only a short-term improvement if the botanical composition is changed to a lower successional stage. Excessive emphasis on livestock production may be at the expense of both vegetation and soils. Again, principles developed for improved tame or annual pastures should not be applied generally to semiarid rangelands without the proper understanding of how the range resource functions or the use of some monitoring system to measure accurately vegetation and soil effects.

Current short-duration grazing/high-intensity, low-frequency grazing research at Sonora is not designed just to compare multipasture grazing systems with continuous or other types of grazing systems. This would not be sufficient. Some of the main questions being studied are the optimum number of pastures needed, proper stocking rate, proper length of grazing and rest periods, and interactions with other management practices.

To address these questions, tests currently are underway with two seven-pasture, one-herd grazing systems. One has a grazing cycle of 49 days with a seven-day grazing period and a 42-day rest period—short-duration grazing. The other seven-pasture grazing system has a 14-day grazing period with an 84-day rest period and a 98-day cycle—high-intensity, low-frequency grazing. There is also a 14-pasture, one-herd grazing system with a variable cycle length, depending upon weather and growing conditions. Two complete four-pasture, three-herd grazing systems, one with brush control and one without, also are being tested. All of these grazing systems have the same stocking rate and same ratio of grazing animals among cattle, sheep, and goats. Heifers represent the cattle component; Rambouillet ewes and Angora nannies represent the sheep and goat component, respectively. Also, in 1979 a station pasture was subdivided into two blocks of four pastures each, roughly along the soil boundary. Four stocking rates ranging from moderate to heavy were applied randomly to each block. Pastures are grazed alternately three days and rested 51 days (*9*).

Results showed that heifer gains on the four-pasture, three-herd, brush control treatment were considerably greater for each year of the study compared with the other treatments. Heifer production was 22, 17, 32, and 22 percent greater in the four-pasture, brush control treatment relative to seven-pasture, 49-day; seven-pasture, 98-day cycle; 14-pasture flexible cycle; and four-pasture, no brush control, respectively. One might conclude, therefore, that brush control had more to do with the increased livestock production than the grazing treatment.

While the benefits of brush control are beyond the scope of this article, I would offer these hypotheses to enhance the understanding of these data. Juniper is a fire-intolerant brush species that rapidly invades the Edwards Plateau region of Texas and significantly reduces herbaceous forage production. All four pastures of the four-pasture, three-herd system had been treated with some type of mechanical brush control in 1969 (two pastures were root-plowed, one was front-end grubbed, and the remaining pasture was chained in two directions with a heavy anchor chain). Thus, juniper occurs in limited amounts relative to the other grazing system, and pastures in the four-pasture, brush control treatment are more productive in terms of the higher successional grasses. Although the stocking rates are the same for all treatments, the grazing pressure, that is, the ratio between animal demand and available forage at any instant (*14*), is significantly lower for the animals grazing in the four-pasture, brush control treatment.

Juniper removal has two important benefits. First, selective grazing pressure is lower for more productive grasses, allowing for faster range improvement. In other words, juniper reduces the pasture area available for grazing, which increases grazing pressure on remaining herbaceous forage species. Second, lower grazing pressure provides grazing animals with a greater quantity and quality of forage, which results in greater livestock production.

While it is easy to understand why livestock production was greater in the four-pasture, brush control treatment, it is difficult to understand why livestock production was considerably less in the 14-pasture, flexible grazing treatment. Management in the 14-pasture system was flexible relative to rate of rotation and length of stay in any given pasture. Rotation cycles ranged from 45 days to about 90 days. Length of stay in any given pasture ranged from 1 day to 13 days, depending upon the relative carrying capacity of a pasture and the desired rate of rotation (amount of vegetation was measured in each pasture at least three times per year). However, all of this intensive management did not result in either increased vegetation or livestock production.

Proponents of short-duration grazing or intensively managed grazing systems suggest that a significant increase in livestock production can be expected following implementation of the system. This was not the case for this study, and I think it is important to understand why livestock production was not enhanced with the adoption of intensive management practices. The important biotic and abiotic factors were similar among all treatments. Stocking rate and animal species were the same. Supplemental feeding and other livestock management practices were the same. Even pasture size was similar for each treatment, 20 to 80 acres per pastures. Because all of these factors were similar, what made the difference?

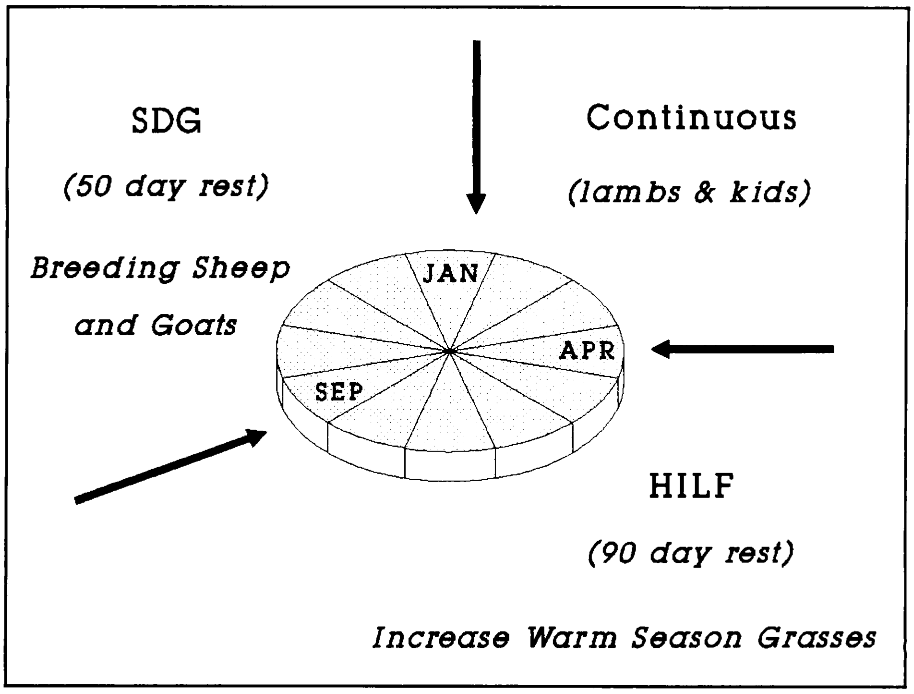
First of all, animals are selective grazers; they don't uniformly graze all plant species. This is the basic tenet for subdivision and implementation of grazing systems on rangelands—to provide some control over the frequency and intensity of plant harvest. Because animals are selective grazers, grazing distribution problems always occur, especially on rangeland.

Grazing distribution problems can be classified into three principal categories: spatial-selective grazing, topographic-selective grazing, and species-selective grazing. Spatial-selective grazing is related to the uniformity of forage use between and within different range sites and at varying distances from water. This problem partially can be solved by creating smaller pastures, using different mixtures of animal species, and establishing additional watering and mineral locations. Topographic-selective grazing problems are related to the type of terrain. Species-selective grazing is related to individual animal preference for plants. Both topographic- and species-selective grazing problems can be reduced by grazing more than one animal species.

There is ample evidence from previous

research to support the above statements. Furthermore, grazing management directed at solving grazing distribution problems and determining optimum plant harvest are two of the few positive practices that can be used on semiarid rangelands to increase livestock production within economic bounds. The 14-pasture, flexible system offered nothing significantly different in terms of improving grazing distribution or enhancing forage harvest efficiency, relative to the other grazing treatments. Thus, continually moving dense herds of livestock over the land does nothing to enhance forage or livestock production.

What was significantly different about the 14-pasture system compared with the other grazing treatments was an increase in the number of pastures, which significantly increased the livestock density—the number of specified animals per unit area of land at any instant (*18*). Livestock density averaged 3.8 acres per animal unit for the two seven-pasture systems; 20 acres per animal unit for the two four-pasture, three-herd grazing systems; and varied from .56 to 2.2 acres per animal unit for the 14-pasture, intensive grazing system. According to previous research, an increase in livestock density should not reduce livestock performance (*4, 19*). However, a large increase in the number of pastures could increase the amount of livestock travel, which would increase the animal's maintenance requirements (*23*). Animals in the 14-pasture system were moved twice as often as animals in the seven-pasture, 49-day cycle and three times as often as the animals in the seven-pasture, 98-day cycle. Thus, livestock in the 14-pasture system probably had higher maintenance requirements, relative to other treatments, because of four factors: more frequent moves, additional stress associated with these moves, disruption of grazing activity, and a grazing pressure great enough at the time to restrict livestock selectivity.



Suggested rest periods for pastures managed under systems of intensive grazing throughout a 12-month period, Edwards Plateau region of Texas.

Some lessons learned

Grazing systems based on the rotation of livestock with periodic grazing and resting of pastures represent only a part of grazing management. Designing and implementing grazing systems before the other basics of grazing management have been properly planned and implemented will generally result in failure. Proper grazing management should conserve soil and other natural resources, achieve management goals for forage production and range improvement, meet specified livestock goals, be compatable with personal goals and objectives of the manager, and be profitable.

If a range manager decides that an intensive grazing system, such as short-duration grazing, is needed for a particular operation, the following is recommended for the Edwards Plateau region of Texas:

► Stocking rates should not be increased due to implementation of short-duration grazing.

► Seven to eight pastures is the maximum number of pastures needed to manage short-duration grazing systems.

► Long grazing cycles, for example, a high-intensity, low-frequency system with about a 100-day-cycle length, should be used during the major part of the growing season, mid-April to mid-September.

► Short-duration grazing strategies with a cycle length of about 50 days should be used from mid-September until mid-January.

► Continuous grazing should be implemented from mid-January until mid-April for ranches that carry breeding sheep and goats, based on lambing and kidding dates. Based on carrying capacity of each pasture, the sheep and goats should be distributed among all of the pastures. Annual forbs can represent a rather large portion of the vegetative complex during the late dormant and early spring period. The most efficient way to harvest these plants is to disperse the sheep and goats over the entire grazing system, allowing them to graze each pasture continuously. Cattle can continue with their normal rotation schedule during this time.

► Rest rather than intensive livestock activity appears to be the key to soil hydrologic stability. The potential for altering the length of the rest period is greatest where the number of pastures is small, from seven to eight. Preliminary results indicate that a minimum of 90 days of rest is needed for the soil to recover from a moderate intensity of livestock grazing.

► The expectations for rapidly improving deteriorated rangeland using short-duration grazing is a "false-positive" perception. Regeneration of preferred species always will be a slow process due to the presence of competing vegetation and influenced by precipitation, soil type, and intensity and frequency of grazing.

► Short-duration grazing systems stocked at greater than moderate stocking rates—grazing pressure greater than .25—significantly reduce the midgrass component of the vegetative complex.

► The protection of soil structure from direct raindrop impact is the primary function of cover on infiltration. Midgrasses, such as sideoats grama, cane bluestem, and Texas cupgrass, allow significantly greater amounts of water infiltration and significantly less amounts of soil erosion than short grasses, such as common curly mesquite, red grama, and hairy tridens.

► 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 mostly decline immediately after trampling. This would seem to accelerate drought conditions due to an immediate, mechanically induced reduction in infiltration rates due to trampling.

► Livestock production generally is not significantly different between intensive and nonintensive grazing systems. Grazing systems are a minor component of grazing management. They should be left to the final and not the initial stage of ranch planning. Grazing systems should be implemented to facilitate the goals and objectives of resource managers.

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