RANGELANDS IN DRY YEARS:
DROUGHT EFFECTS ON RANGE, CATTLE, AND MANAGEMENT

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"Drought is a common experience of every stockman living in the Southwest for any extended period. In spite of plants being well adapted to low and variable rainfall, when serious drought occurs, range vegetation-particularly perennial grasses-exhibits obvious losses in abundance and vigor. Such conditions result in livestock reductions, loss in production, and can lead to range deterioration. Learning to live with drought has always presented a real challenge to the livestock industry of the Southwest. The challenge is that of adopting grazing management procedures which will efficiently utilize a variable forage supply, maintain a high level of production, and avoid range deterioration" (Reynolds 1954).

INTRODUCTION

Drought, as the above statement implies, is a "way of life" for Texas ranchers since "dry" years occur more frequently than "wet" years. Rainfall effects on forage production is the most critical factor affecting livestock and wildlife grazing and, thus, production. This was emphasized in 1984 when many ranchers ran out of forage and had to depend upon brush and prickly pear to feed their livestock.

Varying amounts and distribution of rainfall may be received on different areas of a region during any time interval (Fig. 1). The effectiveness of this precipitation will then depend upon many factors. It is impossible to grow forage without rain, but management can improve the effectiveness of the rainfall received and can buffer the effects of dry periods.

Table 1. Precipitation totals and average annual rainfall at eight locations in south Texas, 1984.

	$\bar{x}$ Annual	Ppt. 1984	(%)
McMullen	20.6	16.5	(80%)
Webb	19.4	9.7	(50%)
Duval	20.2	10.2	(50%)
Duval	23.0	18.5	(80%)
Zapata	20.2	8.3	(41%)
Zapata	20.2	8.5	(42%)
Hidalgo	20.1	16.9	(84%)
Hidalgo	20.1	18.6	(93%)

WATER INFILTRATION-SOIL WATER SUPPLY

Water must infiltrate into the soil before it can be used by plants. "Once a raindrop reaches the soil surface, it must ultimately infiltrate the soil, evaporate, or become a part of overland flow and eventual runoff" (Bronson, Gifford, and Owen 1972). Several factors affect the rate of water infiltration into the soil. These include: (1) litter and rock cover, (2) vegetal canopy coverage, (3) surface crusting, (4) rainfall energy, (5) soil texture, and (6) slope. If runoff occurs then erosion is accelerated. Soil erosion will decrease storage capacity and nutrient availability.

Rangelands with undesirable soil and vegetation characteristics have such decreased water storage capacities that drought is inevitable when frequent rains do not occur. A good vegetative cover will reduce rainfall impact, will slow water runoff, and will increase surface openings for water movement. Bunchgrasses have greater vegetation cover, standing crop, mulch accumulation, etc. than sodgrasses and provide greater opportunities for water infiltration.

In summary, the severity of a drought is related to many factors, including soils and kind and amount of vegetation. In some situations, drought may be "man-induced" due to mismanagement of the vegetation. Drought is thus a relative term and water shortages may be more severe under differing conditions.

PLANT RESPONSES TO DROUGHT

The most common physiological stress affecting plants on semi-arid and arid rangelands results from water deficits (Brown 1977). Water stress affects virtually every physiological and biochemical process in plants and may alter anatomy and morphology as well.

Water stress develops in tissues when transpiration exceeds water absorption by the roots. Absorption is regulated by the kind of soil, amount of soil moisture, and the strength and ability of the roots to absorb available moisture.

As water deficits progress, a series of sequential effects are manifested in plants. The earliest is a slowing of shoot and leaf growth as a result of reduced cell turgor. Cell division slows down, enzyme levels decline and chloropyll formation ceases. The leaf stomata begin to close thus slowing transpiration and photosynthesis. Under severe water stress, CO_2 assimilation ceases and xylem tissue is blocked, senescence is induced, and, eventually, lethal damage to tissues occurs.

Water stress damages some of the buds of perennial grasses which normally develop into leaves and seed heads may not develop. Death of part or all of the root crown further reduces plant density and production. Seed germination is also lowered and seedlings cannot establish and survive extra-dry soil conditions.

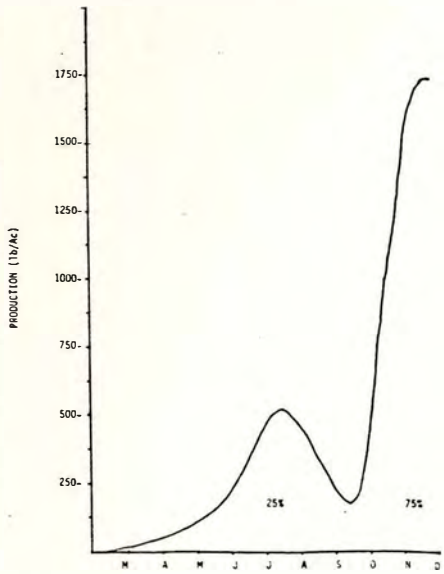
PLANT GROWTH-ANIMAL PRODUCTION

The rancher is primarily a user of grass and other range plants and only incidentally a livestock raiser (Lush, et al 1930). He must understand the relationships between plants, animals, and environmental factors in order to properly manage his pastures under all conditions.

Plants must continuously accumulate foliage in order to sustain themselves and grazing animals. They also must store adequate carbohydrate reserves to withstand stresses and periods of dormancy. To do this, they must be healthy and vigorous with well-developed root systems.

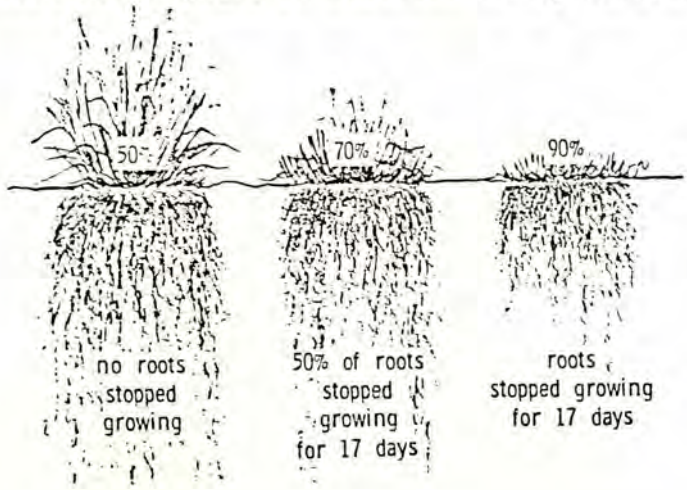
Plants will grow at a rapid rate when temperatures (70-90°F) and soil moisture are favorable. Normally, south Texas enjoys two peak periods of rainfall-spring and fall. This results in two growth periods for most warm season perennial grasses. These grasses generally produce 70% of their growth in the spring and 30% in the fall. However, buffelgrass, a major introduced range grass in the area, produced more growth in the fall in 1984, a "drought" year (Fig. 1). This occurred despite the fact that more total precipitation was received during the spring months. A longer, temperature related, fall growing season may be the explanation for this growth distribution.

Figure 1. Average buffelgrass production distribution, 1984.



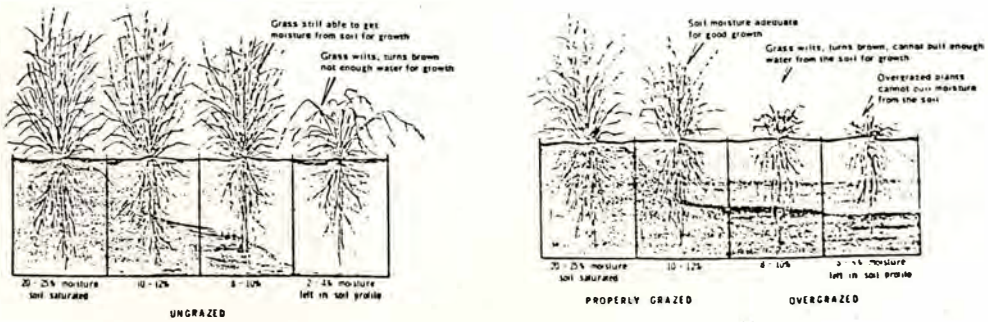
Production and drought resistance of any plant is dependent to a large degree in proportion to root development - the number of roots and depth of penetration (Leithead 1979). Foliage removal disrupts root growth and the carbohydrate production and storage systems. Since 25-50 percent of the root system of perennial grasses must be replaced each year, overuse can seriously affect the health of the plant (Fig. 2).

Figure 2. Root development in relation to top removal (Leithead 1979)



Weakened root systems, in turn, affect the ability of the plant to pull moisture from the soil. When less than 50% of the leaves are removed, a grass plant can utilize soil moisture until the soil has only 1-2 percent moisture left. Conversely, a closely-grazed plant will permanently wilt when there is still 6-8 percent moisture in the soil (Fig. 3).

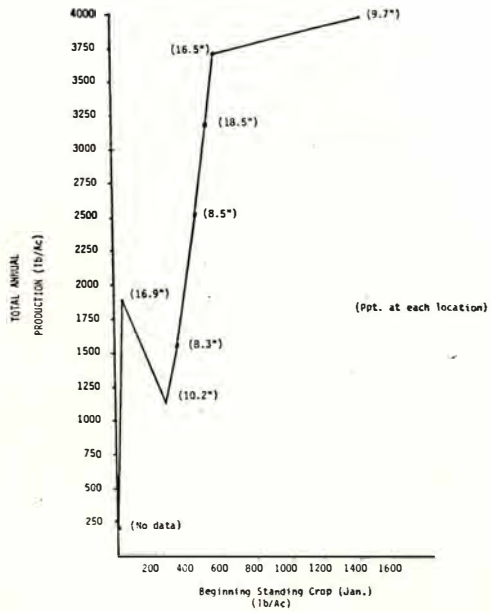
Figure 3. The ability of grasses to pull moisture from a loamy soil (Leithead 1979).



Stubble mass is very important when considering plant-moisture-grazing relationships. From observations and from the literature it appears that bunchgrasses should have 500 lbs/acre of forage remaining at all times. In sodgrass areas approximately 300 lb/acre would be the minimum residue for maximum production. These amounts are emphasized from data collected on buffelgrass in 1984. Pastures with greater than 400 lbs/acre outproduced those with less than 400 lb/ac regardless of rainfall amounts received (Fig. 4). Nearly 17 inches of rainfall on pastures with only 200 lb/acre stubble resulted in less than half the

production of pastures that received only 10 inches of rainfall but had 1500 lb/acre stubble. This plant residue allows each plant to remain healthy and insulates the soil against unusually cold temperatures. Drought resistance is also enhanced.

Figure 4. The influence of beginning standing crop on total annual production.



Proper use of range forage by livestock allows the plants to survive dry periods, recover quickly, and provide cover to protect the soil and promote water infiltration. Various management strategies are available to promote proper use and to assist desirable plants to better compete in the rangeland ecosystem.

RANGE MANAGEMENT

Livestock and wildlife grazing and other management techniques can vary from extensive to very intensive. The key to successful management lies in the ability of the rancher to predict and/or monitor future and current conditions and make the necessary changes. Weather is uncontrollable, but certain aspects are reasonably predictable. However, no ranch is average and on-ranch conditions must be monitored frequently and compared to the predicted if changes are to be timely and produce the most benefits. A rancher who survives a drought in the best possible financial situation with a range capable of growing abundant quality forage can quickly capitalize on good rainfall years. The basic principle then becomes one of protecting the ranch resources before and during drought years so that faster recovery and higher returns can be realized.

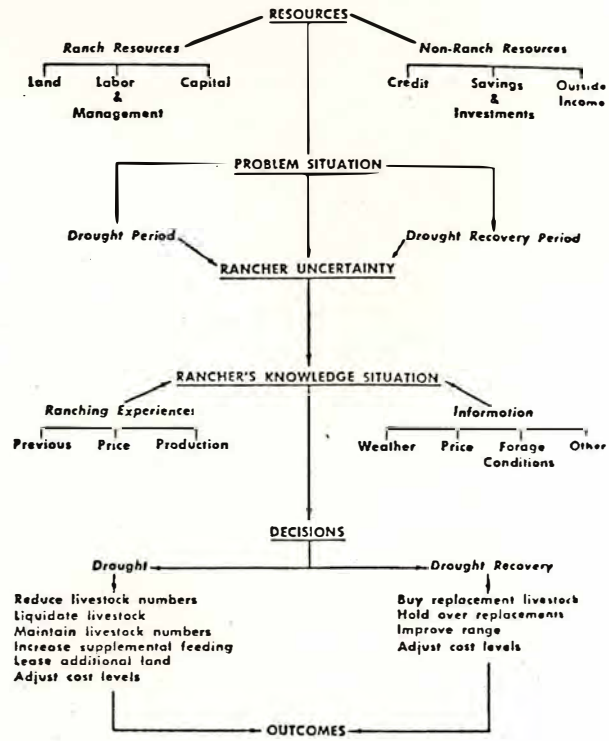
Drought, of course, is not new to rangelands and must be considered a routine management constraint. Hence, practices that allow the rancher to better face a drought must be adopted if a healthy enterprise

is to be maintained. Drought conditions along with alternating periods of high precipitation appear rather regularly over time throughout range areas of the world. If drought is defined as less than 75% of average rainfall, south Texas experienced 10 years of drought from 1901 to 1970. In the last 10 years only 1977, 1979 and 1983 qualify. However, the seasonal distribution of rainfall is more important than the total annual rainfall. Looking at the last 10 years for Cotulla, Texas, fall drought occurred in 1977, 1979, 1982 an 1983. Spring drought occurred in 1983 and 1984.

The length of drought is important to use carryover forage from the previous year. In south Texas, 89% of the droughts in the past were only one year in length while 11% were two or more years in length. Obviously, a below average rainfall year between two drought years may not allow recovery of the forage resource unless plants can respond quickly. This emphasizes the need for careful management at all times.

Drought is easily recognized once it has its full impact; however, its development begins slowly and can end abruptly when sufficient rainfall occurs. Hence, the critical ranch decisions going into a drought are difficult to make for fear of premature decisions that can affect future income. These decisions should be based upon rancher objectives, ranch and non-ranch resources, and goals of the ranch operation (Fig. 5). All levels of the organization -the strategic or top policy makers, the tactical or livestock policy level, and the operational level-should be involved in drought planning (Parsons 1983).

Figure 5. Drought decision theory (Gray 1968).



Good grazing management is the key for forage conversion to animal products, sustained forage production, increasing water infiltration and reducing runoff and soil erosion. In all cases, conservative or well planned grazing that allows for maintenance of high vigor among desirable plants is good insurance against drought. The basic cow herd should be based upon forage production during poor to average rainfall years. Seasonal grazing and the use of stocker animals relative to available forage should be encouraged to avoid overuse. Therefore, varying the stocking rate from season to season and from year to year to prevent excessive grazing during dry years is important for sustained yield of forage. Heavy use of plants during drought results in permanent damage and high death loss of forage plants.

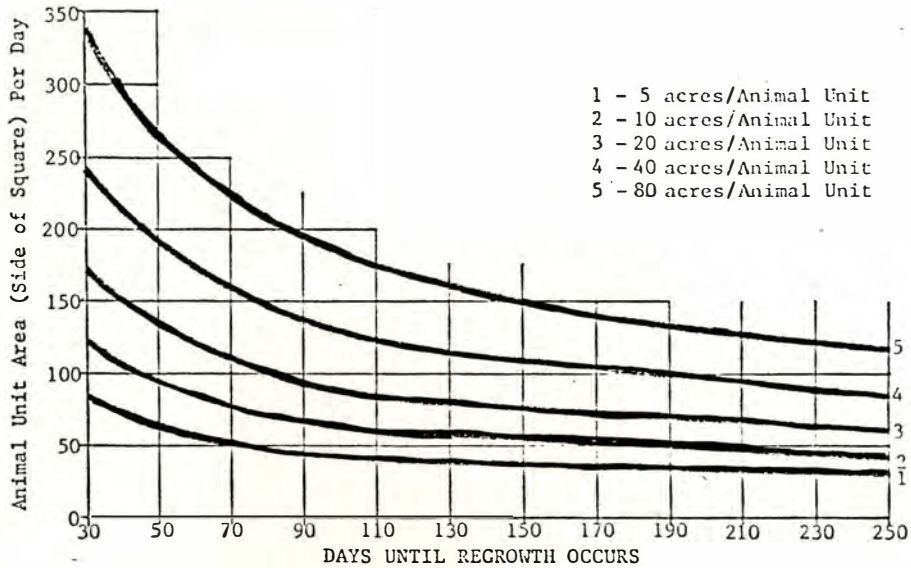
Stocking rate of livestock must be based on the forage production from the spring and fall growth periods. Hence, ranchers should evaluate their forage supply and adjust stocking rates, if needed, in July, November and March of each year or more frequently if conditions warrant. Since rainfall normally peaks in May and September, two growth and stress periods occur. November is the traditional adjustment period with the sale of spring calves and anticipated limited winter forage growth. At this time a rancher should know how many animals he plans to hold over, but will the accumulated forage supply the quantity needed? Animal condition, forage remaining, birth percentages and amount of purchased feed are evidence of a rancher's success in balancing numbers into March when spring growth should begin.

A March evaluation provides hindsight as to success and a plan for how long grazing can last if spring growth is late. The July evaluation indicates how much spring growth has occurred and if there is adequate forage to last during the summer drought until September rains grow new forage. If September rains fail or there is inadequate forage to carry the foundation herd during the summer and into the winter, then early weaning in June or July may be necessary to market quality offspring. This also reduces nutritional requirements of livestock for maintaining body condition and reproductive ability for future income.

How can a rancher better evaluate if the forage supply is adequate during these three critical periods? First, a rancher must know how many animals of different nutritional requirements are on hand at any given time. Second, the acreage of grazable forage must be known. Then a rancher calculates how large an area will be required to feed one animal unit for one day during the period in question. (A rancher should allow a graze period to overlap into each succeeding period so that some carryover forage results allowing time to market stock without loss of condition.) Then, the pastures should be evaluated in an unbiased manner to determine if enough grazable forage actually occurs on the "animal unit area" to meet forage requirements with some residue left to maintain range health.

Figure 6 indicates how the size of the area to be observed is determined.

Figure 6. Daily livestock feed volume as related to days until regrowth occurs.



For example, if a rancher is stocked at one animal unit per 20 acres, he would select line 3 on the graph. If the time of year is October, the days until regrowth are 198. Follow line 3 across until it intersects 198 days and read area size from the left of the chart. In this case, the size of the area to be observed is 66 feet on each side. In other words, an area 66 feet by 66 feet will be required each day for a graze period from October 15 through May 1 (198 days).

By evaluating enough locations in each pasture to be grazed, an average can be determined as well as which pastures have more or less forage to be utilized. The rancher paces off the area and asks himself if there is sufficient forage to feed one animal for one day (don't forget they will not eat some kinds of plants). If the rancher feels comfortable that sufficient forage exists, a check mark is given; if excess forage, add a plus; if less than adequate, a minus. Tally the locations and reduce animal numbers if there are more minuses than pluses or vice versa. At each minus location recalculate an area for a reduced herd size until an adequate area is reached. Then when tallying he will be able to determine the number of animals that should be stocked.

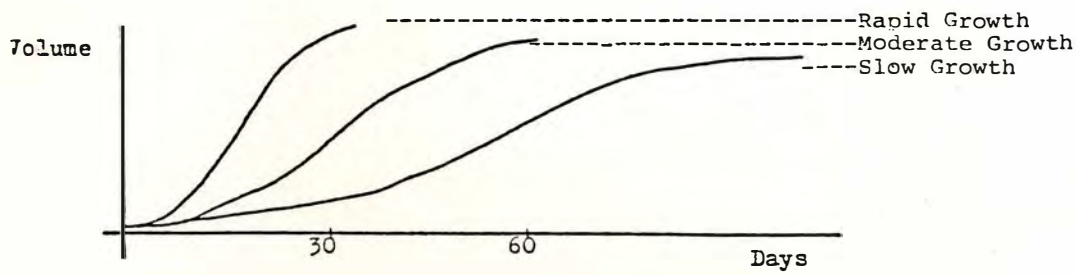
A total grazing program adapted to the area must take into account the normal growing seasons, a proper stocking rate to allow carryover forage, and a system that promotes healthy production of desirable forage plants and livestock and wildlife. Properly designed grazing systems will include these considerations and should buffer effects of drought. Parsons (1983) lists several principles that should be an integral part of every grazing system. These are:

(1) Fluctuate stocking rate according to carrying capacity.

(2) Check and adjust stocking rates frequently.

(3) Lengthen rest periods in drought. Periods of deferment should be varied according to the rate of grass growth. Livestock diet quality is highest when plants are young and should be allowed only 30 days rest before regrazing during periods of rapid growth (Fig. 7). However, during stress periods such as drought, growth slows and should be rested longer. Parsons suggests that this rest period may need to be from 60-120 days.

Figure 7. Theoretical growth curves of grasses at different growth rates.



(4) Combine pastures to reduce the graze period. During slow growth periods, the length of the graze period should be shortened so as not to overuse the forage and to minimize stock stress.

(5) Combine drought feeding and/or short rest periods with plans to market the livestock.

(6) Determine a destocking policy.

(7) Plan long term water availability. This is very important in south Texas since a large part of the area depends upon stock tanks for livestock drinking water. Many tanks dried up before the grass supply declined in 1984.

(8) Ensure that enterprise mix is compatible with drought risk.

Any system of grazing needs to include these principles. Grazing systems research on the Rio Grande Plain Experimental Ranch near Spofford, Texas, is an excellent demonstration of the potential benefits. Drought occurred in 1978 and in 1980. During the first drought year all grazing systems survived without necessary reduction in livestock numbers or change in grazing practices. However, the 1978 drought appeared to have greater impact on the year-long grazed system stocked at one animal unit per 22 acres than on the 4 pasture-3 herd

system stocked at one animal unit per 22 acres or the 6 pasture-1 herd short duration grazing system stocked at one animal unit per 16 acres.

In 1980, the year-long system failed in March, and all livestock had to be removed from the pasture until May rains occurred. These cattle were drylot fed in order to keep the cow herd intact. Calves were sold at light weights averaging about 300 pounds. Feed costs were approximately $2.00 per head per day from April-May. The major objective of feeding was to provide for breedback promoting a good calf crop for next year as a means to recover financially if forage became available. If rains had failed completely, the year-long grazing cattle would have been sold or provided total supplement. On the other hand, cattle on the 4-pasture and 6-pasture systems had plenty of grass even though the 6-pasture system was stocked 33 percent heavier. Supplemental feeding of cottonseed meal/salt mixture was continued until the May rains. These systems held up well during the drought and responded with good growth of forage following the May rains. Forage production was sufficient to meet livestock needs well into the winter. In contrast, the year-long system even after two month's rest did not respond as well following the May and September rains. The year-long system had sufficient forage to last into the winter although it was made up of lower quality species.

Palpation of livestock in November showed a 96% breed-back on year-long cows, 95% on the 4-pasture cows and 92% on the short duration herd. Most of the calves on the latter two systems were born in December and January. The year-long system was two months later calving; again indicating a calf crop failure if confinement feeding had not been undertaken. The late calving meant lighter calves the following year on the year-long system. These results demonstrate the benefits that can be derived by using a planned grazing system, especially during drought.

DROUGHT MANAGEMENT STRATEGIES

The objective of grazing management is to make optimum use of forage resources for optimum production of livestock and wildlife while maintaining or improving the resources. Moderate grazing during severe drought may benefit forage plants by removing foliage and thus reducing the transpiring leaf surface. During the severe drought of the 1930's mortality of short grass vegetation was extremely high, particularly on areas previously ungrazed for several years and on over-grazed areas. Deep-rooted trees such as mesquite sometimes gain from drought at the expense of perennial grasses, thus further reducing forage production after favorable moisture conditions resume.

Planned grazing provides greater flexibility in a ranching operation. The following summarizes certain points to consider in dealing with drought:

(1) Adequate forage must be left to provide a reserve for the inevitable periods of drought.

(2) Healthy vigorous perennial grasses with a good root system can

maintain some production longer into a drought and recover more quickly once rainfall occurs.

(3) Light rains are more effective if some litter and plant residues remain.

(4) There will be a few preference plants by each class of livestock that can serve as a barometer of use and health of a range for determining when management adjustments are needed.

(5) Realizing that drought is inevitable, a drought plan should be developed. Flexibility in forage use, livestock numbers, livestock classes, marketing strategies, etc. allow greater management decisions.

(6) Maintain a percentage of the livestock herd as a readily marketable class of stock.

(7) Set an annual timetable for decisions on stock numbers, improvement practices, supplementation, and marketing in relation to seasonal forage production and quality patterns.

(8) If moisture becomes available within the first two or three weeks after time for plant growth to start, near-normal production may be expected. However, if available moisture is delayed until near or after the mid-point of the growing season, forage production will be greatly reduced, regardless of the condition of the range. Initiation of growth after the mid-point of the growing season results in emphasis on development of reproduction processes and leaf growth will be reduced to a minimum.

(9) Distribute livestock to use existing forage uniformly.

(10) Organize a grazing management program involving pasture deferment

(11) Install range improvements such as fencing, permanent water facilities, etc.

(12) Set up a program of judicious weed and brush control to reduce competition for water always considering livestock and wildlife needs.

(13) Store silage, hay and other feeds while plentiful and inexpensive.

(14) Encourage prickly pear growth in certain pasture areas and configurations to allow ease of "burning" at an economical price.

(15) Seed abandoned fields and barren range areas to adapted forage plants.

(16) During a recognized drought:

(a) Top priority should be on range recovery once the drought

breaks. This means quicker, higher forage responses as well as potential animal production.

(b) The ranch can sell out entirely; sell the herd only; gradually reduce the herd; or maintain the herd through feed purchases.

(c) When reducing the herd gradually, cull borderline and older animals with the least reproductive potential.

(d) Curtail replacement animal development.

(e) Sell light offspring earlier than normal.

(f) Determine the amount of money that can be spent on animal feed purchases.

(g) Utilize drylot all-concentrate feeding to maintain livestock, thus reducing needless energy expenditure in search for food and allowing forage to fully utilize light rains. Plants can then be grazed after sufficient growth or dormancy occurs.

CONCLUSION

Many ranchers in drought stricken areas have been forced to greatly reduce or liquidate their herds, have excessively grazed the range, and have lost considerable amounts of money. The use of planned grazing is certainly not going to solve all of a rancher's problems, but it is obvious that range improvement, higher net returns and greater beef production can be obtained from proper grazing. In addition, flexibility is maintained and drought survival is enhanced. Planning for the next drought must begin now since, once in a drought, fewer options are available to a rancher. However, if he will initiate an adapted grazing system for his location as soon as possible, he should be better prepared to weather future adverse forage conditions. Those who choose to continue under current management practices can expect similar adverse impacts in the future on their ranching business; for drought is inevitable in south Texas and must be a part of the total management operation.

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