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Drought Management on Range and Pastureland

A handbook for Nebraska and South Dakota

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DROUGHT MANAGEMENT ON RANGE AND PASTURELAND

A Handbook for Nebraska and South Dakota

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A Drought Management Handbook for Range and Pastureland in Nebraska and South Dakota

Drought is generally defined as a prolonged period during which annual precipitation is less than 75 percent of average. Based upon this definition, drought has occurred in 21 percent of the years in the northern Great Plains since 1940 (Holechek et al. 1989). Poor distribution of precipitation in a single year or less than average precipitation in successive years can also cause drought conditions.

Drought is a major factor in range management. In any given year, rangeland vegetation is either in the recovery phase or under the direct influence of drought. Drought causes long-term effects and recovery is a long-term process. Management strategies must provide plants with opportunities to maintain or improve vigor.

Stocking rate is the most important tool for grazing management, especially under drought conditions. There are no tricks to compensate for overgrazing. Stocking rates for individual pastures should be based upon target levels of defoliation for key species. As range condition increases the relative effects of drought decrease. The most effective method of drought management is preparation in the years preceding drought. The best time to begin preparation is now.

Drought will always be a nemesis for the range livestock industry, especially for ranchers who become complacent during wet cycles. Ranchers need to capitalize on above average levels of forage produced in good years, but timely adjustments must be made to balance livestock requirements with available forage and feed resources when drought occurs. Management flexibility is critical for survival.

The fundamental objectives of drought management are to (1) minimize damage to rangeland resources during and after drought and (2) minimize economic loss. Ranchers who achieve both of these objectives can quickly capitalize on additional forage in good years. Damage to forage and

land resources is reduced and potential profit is increased when ranchers make timely decisions.

Ranchers can benefit from the substantial amount of information gained during past droughts. Numerous alternatives for the development of drought management plans are discussed in this handbook. Crisis decisions can be avoided with timely evaluation of alternatives and implementation of sound drought management plans. Success depends upon viewing drought as a normal part of the range livestock production environment, not as a catastrophic event.

Historical Perspective

The unpredictable yet certain recurrence of drought is the major factor limiting the use and development of resources in the Great Plains (Schumacher 1974). Wet and dry cycles have had an impressive effect on land prices, population, and government programs in the Great Plains. In the 1890's droughts caused emigration from affected areas. Emigration from areas affected by recent droughts has been limited because intervening government programs have reduced the economic impact of drought.

The Agricultural Adjustment Administration (AAA), the Soil Conservation Service (SCS), and state soil conservation districts were established during the drought of the 1930's. Tracts of land deemed submarginal for cultivation were purchased by the federal government to remain in grass or to be reseeded to grass. These lands have been administered by the U S Forest Service since 1954 as national grasslands. Legislation authorizing the Soil Bank Program and the Great Plains Conservation Program was passed during the drought of the 1950's. These programs were to bring about more permanent solutions to problems resulting from drought and the cultivation of land unsuited for crop production.

During periods of optimism between drought, many people became convinced that the climate had changed and would be better. In the days of early settlement, land promoters and spokesmen for the railroads claimed that, "rainfall follows the plow". Although this concept had no scientific basis, the myth persisted for years. During wet cycles or periods of favorable commodity prices, land values have increased and additional rangeland has been broken and farmed. For example, from 1974 through 1977 approximately 690,000 acres of rangeland were plowed for crop production in South Dakota.

Droughts in the Great Plains are associated with abnormal atmospheric circulation patterns caused by several factors including sunspot cycles and surface temperatures of the Pacific Ocean. However, while the probability of a drought can be determined, meteorologists are not yet able to predict a severe drought in advance. Consequently, drought contingency plans need to be a part of each year's overall management plan.

Early Ecological Observations of Drought

Dramatic shifts in species composition and productivity of native grasslands were documented in the Great Plains during and following the major drought of the 1930's. Drought depleted surface soil moisture in 1930 and 1931, but had little effect on the deeply rooted prairie vegetation. The summer of 1934 was described by Weaver (1968) as the greatest drought ever recorded in the true prairie. As the dry conditions continued, the impacts became more severe and persisted until 1941.

Species composition changed dramatically as the drought progressed. As the least drought tolerant species died, openings began to appear in the tallgrass prairie (Weaver 1968). Big bluestem, indiagrass, prairie

dropseed, and little bluestem gave way to dense patches of annuals such as pepperweed and six-weeks fescue. Between 1930 and 1935, 36 to 75 percent of the basal area of all perennial plant species was lost on tallgrass prairies in Nebraska and Kansas.

Plants common to more arid environments, such as western wheatgrass, blue grama, and buffalograss, increased as dominant tallgrass prairie species declined (Weaver 1968). Western wheatgrass, which was initially a minor component of the tallgrass prairie, became a dominant species as the grasslands deteriorated. Early spring growth, prolific seed production and ability to migrate into new areas by means of long, slender rhizomes provided western wheatgrass with tremendous competitive advantages for limited soil moisture (Weaver 1968). By 1941, large areas of the tallgrass prairie were dominated by western wheatgrass.

The boundaries between the major vegetation types in the Great Plains shifted eastward as a result of the drought. After seven years of deficient soil moisture the mixed prairie zone had moved 100-150 miles eastward into what was previously tallgrass prairie (Weaver 1943). Even without grazing, much of the mixed prairie type vegetation was reduced to shortgrass plant communities (Albertson and Weaver 1946).

From 1933 to 1935, soil water in the mixed prairie of western Kansas was exhausted beyond the depth of little bluestem root penetration (Albertson 1937). Where initially intermixed and in competition with shortgrasses, 90 to 100 percent of little bluestem plants died. Although more deeply rooted, sideoats grama and big bluestem also suffered losses, but made some recovery during intermittent periods of favorable growing conditions. Shortgrass prairie dominated by blue grama and buffalograss suffered relatively small losses when ungrazed, although several species of forbs disappeared entirely. Rapid stolon growth allowed buffalograss to quickly reclaim bare areas when moisture conditions improved temporarily. Consequently, basal cover of

buffalograss more than doubled in some years during the 1930's. Native drought resistant shrubs and forbs with spreading or very deep root systems also increased during the great drought. Species that commonly increased included broom snakeweed, snowberry, heath aster, goldenrod, western ragweed, and scarlet globe-mallow.

When intermittent precipitation did occur, the growth of large numbers of opportunistic annuals caused a dramatic change in the appearance of rangeland. Areas which had been covered by wind-blown soil and were devoid of perennial vegetation were ideal germination sites. Seeds were spread by wind throughout the Great Plains. Consequently, most prairies were infested with lambsquarters, pigweed, stinkgrass, ticklegrass, green foxtail, buffalo burr, pepperweed, Russian thistle, downy brome, and little barley. Weaver (1968) stated that, "so abundant were the weeds that the prairies often appeared more like abandoned fields than grasslands".

The drought of the 1930's was ended by favorable precipitation in 1940 and 1941 and yield of perennial grasses increased dramatically (Albertson and Weaver 1944). However, annual weeds also produced a substantial amount of herbage in 1940 and 1941 because of drought caused reductions in perennial plant cover. Although major changes in prairie vegetation had occurred during the drought, remnants of most species survived (Weaver and Albertson 1943). After intensive investigation of the effects of serious droughts in the 1930's and 1950's, Albertson et al. (1957) concluded:

"Presumably native vegetation developed under conditions similar to these, and it is also safe to assume that native plants will continue to dominate the prairies if not continuously overgrazed by livestock or buried too deeply by soil blown from cultivated fields. Therefore, if our native vegetation is completely destroyed, man should be held accountable."

PLANT RESPONSE TO DROUGHT

Understanding how moisture stress affects plant physiology is essential when designing drought management practices. Native prairie plants are well adapted to low and variable precipitation. However, substantial reductions in plant cover and vigor occur under serious, prolonged drought. Initial growth after winter or summer dormancy is produced with stored energy reserves. Short flushes of growth terminated by drought, grazing, hail or frost often deplete energy reserves and reduce forage production the following year. Plant survival during dormancy depends totally upon energy reserves. Plants must rely on stored energy for long periods of time when drought-induced summer dormancy is added to winter dormancy.

Drought reduces both root and shoot growth. Extensive root systems

are critical for the use of limited soil moisture supplies even in an average year. More than 50 percent of the roots in grass plants die each year, even under average conditions. If leaf growth is limited, adequate carbohydrates will not be available for root replacement. Consequently, substantial reductions in root production can occur under drought conditions when healthy root systems are most critical.

Each year's forage crop is produced by a new set of tillers that develops from buds located in the crown or on rhizomes or stolons. These buds are the mechanisms for growth. The degree to which drought impairs a plant's potential for future forage production depends upon the stage of plant development at which growth stops. Reduced plant growth under drought conditions or excessive grazing before grasses head may

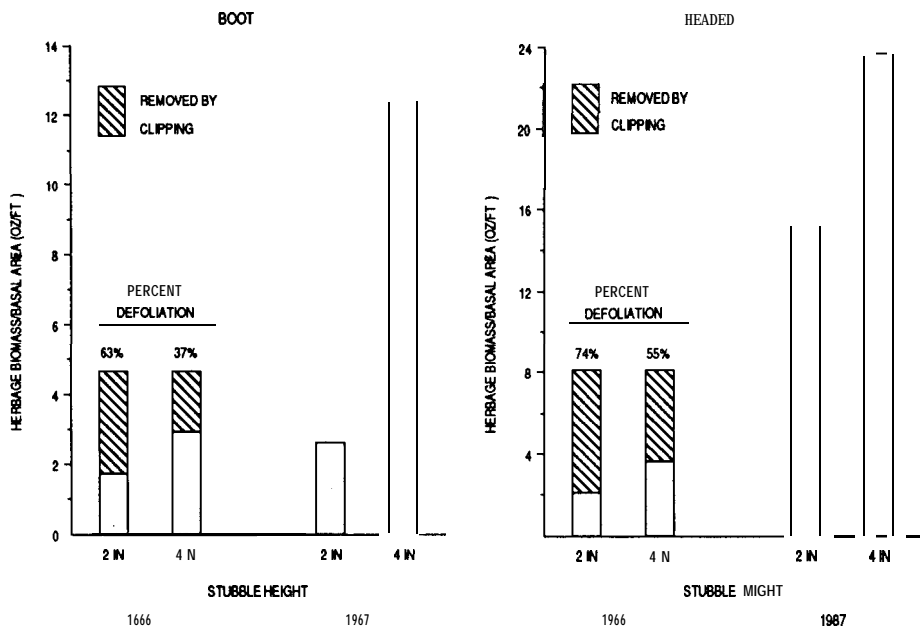


Figure 1. Herbage yield and the amount of herbage removed in 1986 when individual needleandthread plants were clipped at a 2 or 4 in. stubble height. Plants were clipped only once on May 15 (late boot stage) or on June 15 (fully headed stage). Total herbage production was measured one year after clipping. Precipitation was above average in both years.

reduce or eliminate formation of new buds. Fortunately, buds in perennial grasses can be carried over from the preceding one to three years. Although the total number of buds available for next year's tiller production is often reduced by drought, the presence of some buds from preceding years allows perennial grasses to produce tillers the following year.

Plant Response to Grazing

Many native, perennial grasses are most sensitive to heavy defoliation from the late boot to early heading stage. Heavy grazing during a single growing season will reduce forage production in following years. Reductions in forage can be dramatic even when growing conditions are favorable. The following conclusions were drawn from a study in which needleandthread plants were clipped at two stubble heights in western Nebraska during two consecutive years (Figure 1). Precipitation was above average in both years of this study.

- (1) Heavily defoliated plants were unable to fully capitalize on favorable precipitation the following year.

- (2) Needleandthread was more sensitive to heavy defoliation when in the late boot compared to the fully headed stage.

The combination of drought and heavy grazing can cause severe reductions in forage production and plant vigor. Grazing intensity had a dramatic impact on the reduction of perennial plant cover during the 1950's drought (Weaver 1968).

Conditions were the most severe in the west central part of the mixed prairie. Moderate grazing generally caused little change in cover compared to ungrazed sites. Heavy grazing nearly doubled the loss of perennial plant cover caused by drought alone.

Proper utilization during the growing season is generally the removal of 50 percent or less of the present, current year leaf and stem tissue by weight. A simple procedure can be used to develop a visual perception of percentage forage utilization. Clip the current year growth from random bunches or tillers at the ground level. Wrap the samples with string or tape. Balance the sample on your finger. The point of balance is the height at which 50 percent of the leaf and stem material would be removed. Clip the sample at this point and balance each half to estimate heights for 25 and 75 percent utilization. Since utilization often differs across the pasture, you will need to monitor average height of utilization throughout each pasture. Estimates of the stubble height at which a target level of utilization will occur should be made when the cattle enter each pasture.

Proper utilization will cause little reduction in root growth and plant vigor. Grazing in excess of 60 percent will cause dramatic reduction in amount and depth of root growth (Figure 2). If drought reduces plant

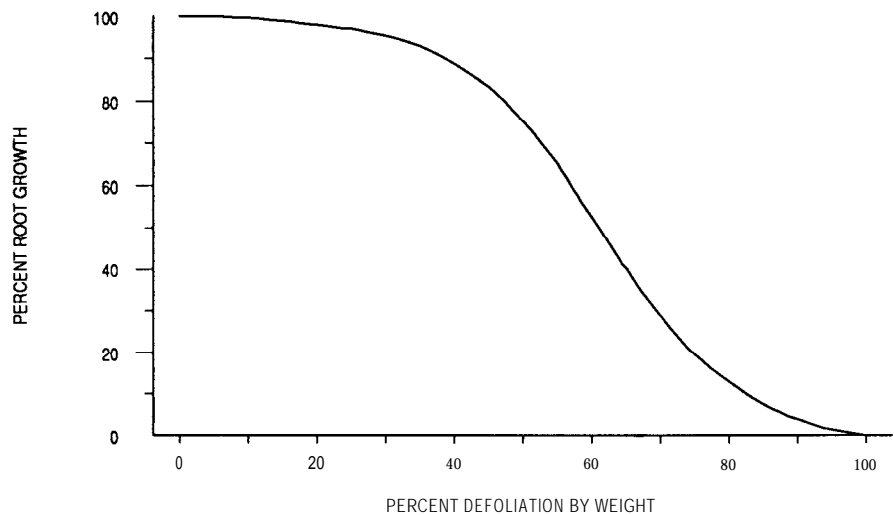


Figure 2. Weight of root tissue in response to degree of defoliation based upon removal of current year leaf and stem biomass (Olsen and Lacey 1988). Maximum root growth (100%) occurs with no defoliation.

height and seed stalk production, average utilization of key forage species should not exceed 50 percent even after grasses become dormant. It may be necessary to manage for lower levels of utilization to provide enough remaining plant cover for site stability.

Key species are perennial plant species that are important forage producers or have value as an indicator of range condition. They are often decreaser species that are preferred by livestock and are generally indicative of good to excellent range condition. Common key species are western wheatgrass, prairie sandreed, and the bluestems.

Late season or secondary "green-up" in a drought year is not necessarily a bonus forage resource. Ranchers should use secondary green-up with extreme care. When plants break drought induced-summer dormancy, the initial growth will be produced from meager levels of stored energy, further reducing reserves needed for winter survival and spring green-up the following year. While this principle most often applies to cool season grasses in the fall, it is also important in the management of warm season grasses following a mid-summer break in dormancy.

Value of Plant Cover

Grazing management influences the effectiveness of precipitation. Practices that increase plant cover or plant vigor lead to an increase in the amount of precipitation that enters the soil. Retention of precipitation from snow or rain increases as plant cover increases. Plant cover breaks the impact of rain drops on the soil and is a physical barrier to runoff and wind related snow loss. As plant vigor improves, root systems become more extensive and provide surface openings for water movement into the soil profile. Plant litter and standing plants reduce evaporation losses by moderating extremes in soil surface temperatures and by protecting the soil against drying winds. Removal of all litter from mixed grass prairie in good to excellent condition may reduce forage production by as much as 60 percent

(Adams 1988).

During the growing season, moisture is the most limiting plant growth factor on rangelands. Manipulation of plant cover and maintenance of healthy root systems are the best approaches available for ranchers to optimize use of precipitation. Overgrazing or wildlife may cause drought-like conditions even with average precipitation. Dramatic reductions in plant cover can cause severe and long-lasting modifications of plant environments. Inadequate plant cover can lead to substantial wind or water erosion of valuable top soil.

Influence of Range Condition

The effects of drought are intensified at lower range conditions. Rangeland in fair condition is more severely affected by drought than rangeland in good to excellent condition. The diversity of perennial grasses tends to increase as range condition increases. Increased diversity of species with different growth seasons and rooting habits increases the number of opportunities for forage production under the limited and irregular precipitation patterns characteristic of drought.

As the number of grass species increases, there is a greater opportu-

nity for livestock to select different grasses during the growing season. The preference for different grasses by cattle is strongly influenced by stage of plant development. Since different species begin growth and mature at different times, livestock tend to select different grasses as the summer grazing season progresses. Streeter *et al.* (1968) documented pronounced, seasonal shifts in preference by yearling steers from needleandthread to prairie sandreed to blue grama (Figure 3). Under proper stocking, these natural shifts in preference result in reduced frequency and intensity of grazing on individual plants. Because rangeland in fair condition offers a less diverse selection, cattle graze the same species more frequently over a longer period of time.

Range condition also influences the rate of recovery in forage production after drought (Hanson *et al.* 1978). After drought from 1961 to 1962, pastures in excellent condition recovered more rapidly than pastures in fair range condition from 1963 to 1965 at Cottonwood, South Dakota (Figure 4). Severe drought in 1966 caused a dramatic reduction in forage production regardless of range condition. With above average precipitation, forage production the year following drought

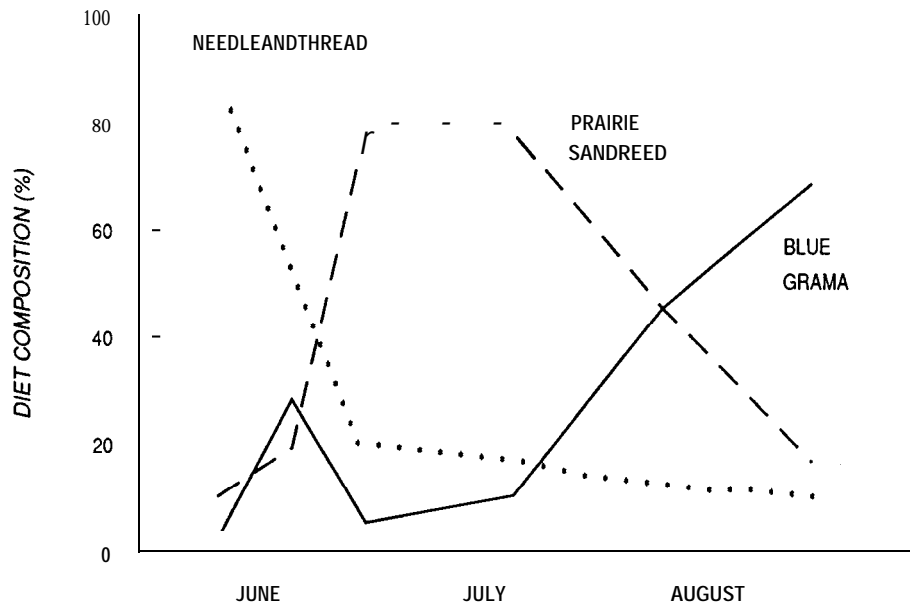


Figure 3. Each line represents the percent of steer diets composed of needleandthread, prairie sandreed or blue grama from early June to late August on a sands range site in western Nebraska (Streeter *et al.* 1968).

was much greater on excellent versus fair condition rangeland in 1967. Pronounced differences in levels of production between condition categories did not occur in 1968 because most of the precipitation occurred after June 1. Consequently, the cool season species which composed 40 percent of the vegetation on excellent condition sites were unable to respond. Herbage production was still greater for rangeland in excellent compared to fair range condition in all years.

The trend in range condition over preceding years is also important in range recovery. If the trend is downward, pastures in any condition will have plants with poorly developed root systems and limited protective plant cover before drought. Under these conditions recovery after drought will require sound management over an extended period of time. Even with sound management, plant vigor may not fully recover for 5 or more years if heavy grazing occurred prior to and during drought.

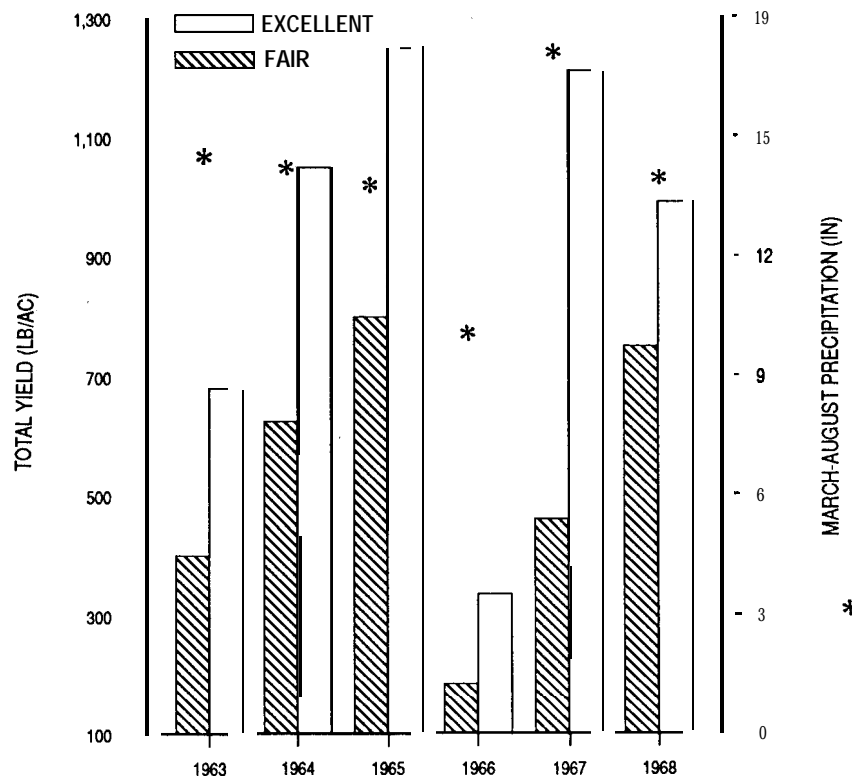


Figure 4. The influence of range condition and drought on perennial grass and forh production on a clayey range site near Cottonwood, South Dakota (Hanson et al. 1978).

MANAGEMENT PREPARATION FOR DROUGHT

Drought will challenge the mental toughness of even the best of managers. Diverse practices can be used to maintain ownership of cows under drought conditions. Some ranches will liquidate or relocate part or all of their breeding stock. The value of keeping breeding herds on the ranch must be weighed against the additional costs that are probable when drought continues. Recovery of additional production costs will depend upon: (1) productivity of livestock, (2) productivity of rangelands, and (3) livestock market prices during and following drought. Several additional questions will help you determine how much risk you can afford to accept:

- (1) What is your current financial position, including financial assets and obligations?
- (2) What are your short- and long-term family needs?
- (3) What are your family and ranch goals?
- (4) How secure is your relationship with the banker?
- (5) Are you prepared to accept the additional stress of added risk?
- (6) How soon must losses incurred during and following drought be recovered?
- (7) Would you rather risk the loss of the ranch and/or breeding herd than sell out?

Desperation caused by financial problems can lead to the use of excessive stocking rates that reduce animal performance and cause dramatic reductions in plant vigor. Overgrazed land is also worth less to future buyers or renters. If serious financial problems exist before drought, it may be best to sell before remaining equity is lost or additional debt is incurred. Even when range livestock operations are solvent, it may be prudent to liquidate or relocate part or all of the breeding herd to avoid additional production costs or to avoid damaging rangeland. Under severe or prolonged drought conditions the cost of replacing livestock is almost always less than the cost of long-term reductions in rangeland productivity. Additional considerations are discussed in C225 "Ranch Management", a South Dakota Extension Publication.

HERD MANAGEMENT

The best alternative for drought management is to reduce total forage requirements. Reducing stocking rates during drought pays dividends in terms of:

- (1) optimized animal performance,
- (2) reduced supplemental and winter feeding costs,
- (3) minimized damage to forage resources, and
- (4) enhanced range and pasture recovery following drought.

Sell or relocate livestock as soon as shortages in forage and feed resources are anticipated because market value tends to be highest at the beginning of a regional drought. If additional shortages in forage occur, calculate the additional costs associated with keeping cows on the ranch (feed, interest, labor, etc.) or transporting cows to another location with adequate feed or forage. If your calculations show an unreasonably high cost of producing a weaned calf, it may be prudent to sell or relocate part or all of the cow herd (See Appendix). The following practices can help to minimize liquidation of the breeding herd:

- (1) **Early weaning can extend the forage base.** By shifting cows from a negative energy balance while suckling calves to a positive balance while dry, cow condition can often be improved or maintained for a longer period of time. Improved cow condition will reduce winter feed requirements and improve conception rates the following year. It is usually more economical to wean calves early and to feed cows and calves separately. Weaning calves in mid-September versus mid to late October could prevent significant declines in cow condition. It is also possible to wean calves at an early age, 40 to 80 days, with excellent management and proper nutrition. The cost of feeding early weaned calves can be high

because of the need for high quality feed. In Nebraska request a copy of "Management of Early Weaned Calves" (G83-655) through your local Extension office.

- (2) **Practice early and heavy culling of less productive cows such as late calving cows and older cattle.**
- (3) **Remove yearlings from summer pastures early.** Sell or place yearlings on alternate forages or on full feed in drylots as soon as shortages in range or tame pasture forage are anticipated (See Appendix). Do not hold yearlings on rangeland with supplemental feed unless you have a clear economic reason for doing so. Livestock receiving substitute or replacement feeds should be placed in pens or small paddocks to minimize damage to rangeland.
- (4) **Consider curtailing production of replacement heifers for one year.** The nutritional requirements are higher for replacement heifers than older cows in the herd especially for wintering. Unless the average age in the cow herd is high, or there is a sound reason to cull a large number of cows, the curtailment of replacement heifer production for 1 to 2 years will have little impact of animal performance in many commercial operations.
- (5) **Bulls may need to be supplemented earlier than other classes of livestock to be in acceptable condition when the breeding season begins.** This is especially true for yearling bulls used for a long breeding season.
- (6) **Maintain a percentage of the livestock herd as a readily marketable class of stock, such as yearlings or stockers.** Optimum flexibility is generally obtained when

the forage requirements of the breeding herd are equal to 60 to 70 percent of the total Animal Unit Months (AUM's) available from range and pastureland resources. Calculate the amount of required forage and available forage for each season during a 12-month period to determine the appropriate size of the breeding herd. Assistance in developing a balanced year-round feed and forage program is available from the Soil Conservation Service, US Forest Service, and Cooperative Extension. "A Guide For Planning and Analyzing A Year-Round Forage Program" (EC 86- 113) is available from the Nebraska Cooperative Extension. This handbook contains an explanation of standard procedures for calculating stocking rates.

Past and Future Stocking Rates

Grazing management during years preceding drought is a major factor in range vegetation response to drought. Managers may have assumed that no change in stocking rate has occurred on their ranches because they have not increased livestock numbers. The amount of forage consumed in a pasture depends upon animal size as well as animal numbers and days of grazing. The average size of cows, calves, and yearlings has increased on many ranches over the past 10 years. A 10 to 40 percent increase in average animal weight should be equated to a 10 to 40 percent increase in stocking rate. Inadvertent increases in stocking rates may lead to overgrazing and reduced plant vigor before drought. All range livestock producers need to critically evaluate their animal weights and use an appropriate animal unit (AU) equivalent when calculating stocking rates. Under present guidelines, each 100 lb of beef animal body weight is equal to approximately 0.1 AU. Inadvertent overstocking may reduce animal performance and will damage the forage resource.

ANIMAL RESPONSE TO DROUGHT

Performance of livestock is a function of nutrient requirements and intake. Quantity and quality of available forage are primary regulators of nutrient intake in grazing cattle. Grazing pressure is the relationship between the total quantity of available forage in a pasture and total daily forage requirements of livestock at a given point in time. Stocking rate decisions regulate grazing pressure and hence forage quantity and quality. Excessive grazing pressure may occur under drought even when stocking rates are reduced. Stocking rates are often expressed in terms of animals/acre/season. Animals graze forage, not acres. Therefore stocking rates must be reduced to the level of available forage or animal performance will suffer.

If additional plant growth does not occur, forage quantity declines as forage is removed. Forage quality also declines because livestock selectively graze the highest quality forage first. The rate of decline in forage quantity and quality during drought is much more pronounced than in an average growing season. Even under average growing conditions, animal performance declines rapidly during the latter part of the summer grazing season (Figure 5). This decline is because forage quality deteriorates as plants mature. During drought, calf gain may be entirely from the "back fat of the cow".

Under any circumstance there will be a level of remaining forage below which animal performance will de-

cline. Minimal levels of remaining forage on shortgrass prairie dominated by blue grama in north central Colorado were 350 to 400 lb/acre (Bement 1969). These values are based upon average daily gains over three stocking rates for 19 years. Given the differences in plant morphology between shortgrasses and tallgrasses, minimum levels of remaining forage for animal performance on tall grass and sandhills rangeland in good to excellent condition appear to be from 600 to 700 lb/ac. End of season remaining forage on these sites would have a higher ratio of stem to leaf tissue compared to shortgrass sites. It is unlikely that smaller amounts of total remaining herbage would provide the necessary protection against wind and water erosion on sandhills sites.

Excessive stocking rates will reduce animal performance when the quantity and/or quality of forage available per animal is less than nutritional requirements for maintenance, growth, gestation, and/or lactation. Puberty or sexual maturity in cattle is correlated with body weight and is relatively independent of age. If calf growth is reduced by excessive grazing pressure during the summer, the onset of puberty in replacement heifers could be delayed.

Nutritional deficiencies also have an adverse effect on conception rates, especially if cows are thin at calving. Conception rates will first decline in lactating first-calf heifers. Lactation increases cow nutrient requirements substantially. Continued nursing further delays a cow's return to estrus when nutritional deficiencies occur. Early weaning of calves may be the most efficient management practice available for maintaining reproductive performance when nutritional stress occurs (Wallace and Foster 1975).

Drought may dramatically reduce the period of time during which green forage is available to livestock. However, forage that cures at early stages of plant development is often of higher than average quality. While mid- and late-season forage quality may be higher than normal, the quantity of forage is reduced. As a consequence, ranchers who reduce stocking rates to

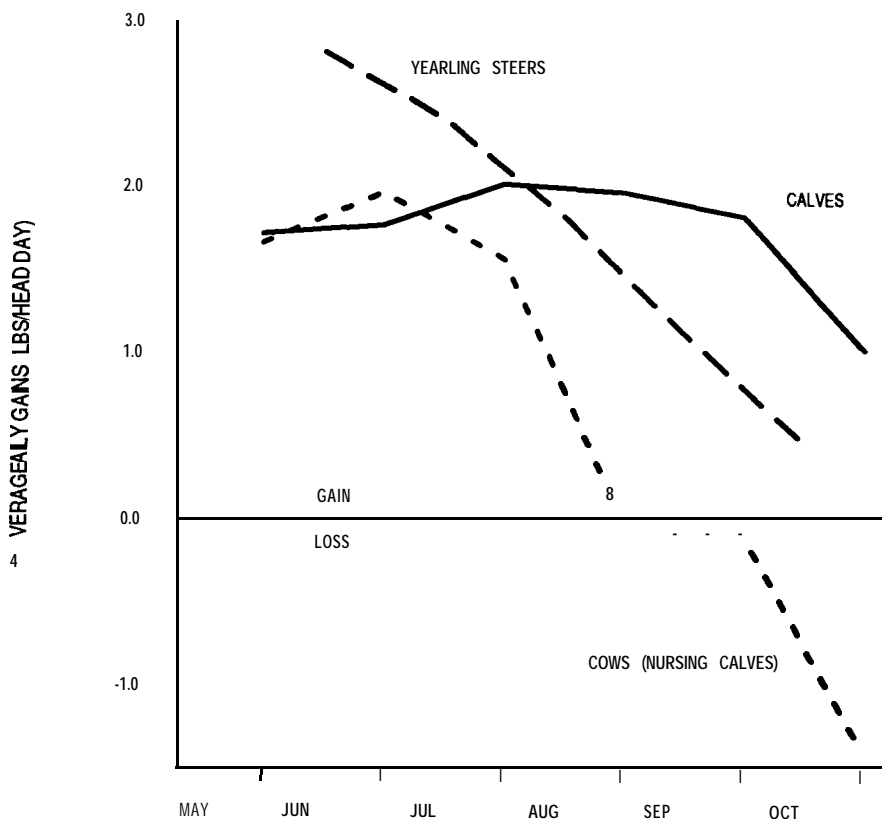


Figure 5. Seasonal patterns in average daily gain of different classes of livestock during the summer grazing season over a 15 year time period in north central Colorado (Klippel and Costello 1960).

account for reduced quantity of forage under drought conditions often experience above average animal performance through the end of September.

Supplementation

Supplements can be fed to correct nutrient deficiencies and/or to improve the digestibility of existing forage. Livestock can also be drawn into underutilized areas with supplements. This practice can be effective even when contrasting range sites or topographic differences occur within pastures. The economic efficiency of supplements declines as the difference between livestock requirements and forage quality increases. The cost of supplements may exceed the potential

return from improved animal performance. Supplements are generally more valuable in the first year of drought because the amount of carryover forage declines dramatically as drought continues. There are several critical issues that must be addressed when considering supplements:

- (1) What are the other alternatives?
- (2) What type of supplement is needed?
- (3) What effect will it have on animal performance?
- (4) How will the product affect range or pastureland?
- (5) What is the total cost of the supplementation program?

Supplementation should not be used to maintain livestock in pastures

after proper levels of forage have been removed (Figure 6). Excessive grazing and mechanical damage of drought weakened perennials, even though dormant, will cause long-term delays in range recovery. Daily feeding of more than 3 to 4 lb of a grain base supplement should be considered as replacement feeding, not supplementation. When replacement feeds are used after forage supplies have been depleted, livestock should be placed in pens or small paddocks to minimize damage to rangeland.

Protein and energy are the two major nutrients that will most likely be considered. If the quantity of forage is adequate, but quality is low because of inadequate protein, supplementation can be beneficial (Figure 6). The relative composition of current year and carryover forage must be considered when making decisions on supplements. The average maturity of current year forage is also a key factor. Immature forages contain about 12 to 15 percent crude protein on a dry matter basis. Plants in the early heading stage contain about seven to 10 percent crude protein. Protein content of cured forages declines as stem/leaf ratios increase. Carryover tall and midgrass forages generally contain less than four percent protein. The protein content of carryover shortgrass and upland sedge forage may be five to seven percent.

Protein in range and pastureland supplements should consist of all natural sources. Non-protein nitrogen is poorly utilized when fed with low quality forage. When an adequate quantity of forage is available natural protein supplements will improve forage digestibility, intake, and animal performance. Proper utilization will occur sooner and total days of grazing will be reduced because the rate of forage removal increases (Figure 6). Even though pastures are grazed for fewer days, the value of the forage for animal performance can be improved substantially. Protein supplements can be fed two or three times weekly with satisfactory results.

Protein supplements that increase forage digestibility will also increase the amount of energy obtained from

DECISION RULES FOR DROUGHT STRICKEN RANGELAND

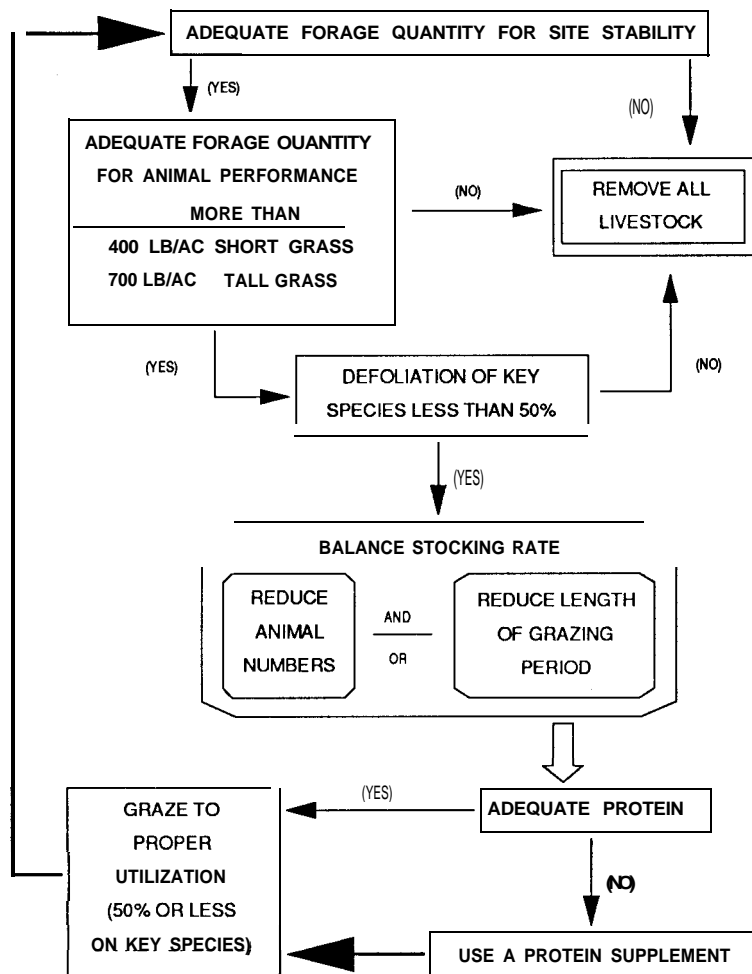


Figure 6. Flow chart demonstrating a sequence of decision making processes for the management of drought stricken rangeland.

the diet when adequate quantities of forage are available. While protein supplementation may improve the energy status of the animal, energy supplementation will not offset a protein deficiency. If protein levels are inadequate, supplementation with energy alone will generally reduce digestibility of forage consumed. Energy in range grasses is rarely deficient for mature beef cows when dietary protein content is high.

Creep feeding is often considered when forages are in short supply. Under most conditions it is more cost effective to wean early and feed calves in confinement. For more information refer to "Creep Feeding Beef Calves" (G74-166), available through the Nebraska Cooperative Extension or "Creep Feeding" (GPE 1550) in the Beef Cattle Handbook available in most Extension offices.

Early weaning is generally more economically efficient than supplementation of pairs. For example, crude protein requirements decline from 10-12 percent for a lactating cow, to seven percent for a dry cow. Thus, a forage resource that will not support milk production may be adequate for maintenance of dry cows. Weaning calves will reduce cow energy requirements by about 30 percent and crude protein requirements by about 50 percent (Table 1).

Table 1. Daily nutrient requirements of a superior milking 1100 lb cow when dry and when producing 20 pounds of milk each day.

	<i>TDN</i>	<i>Crude Protein</i>
Dry Cow	9.5 pounds	1.4 pounds
Lactating Cow	14.5 pounds	2.6 pounds

Feeding high levels of properly balanced protein-energy concentrates on rangeland can "stretch" available forages. However, this practice is generally not recommended because of the following three points:

- (1) Utilization of concentrates is often relatively poor on grasslands compared to feeding in confinement,
- (2) Protein/energy balances of concentrates can only be roughly estimated because of our inability to measure the

quantity and quality of forage consumed over time from the pasture.

- (3) Grazing will continue because of habit or boredom, regardless of supplementation. This can cause serious long-term deterioration of rangeland.

Vitamin A deficiencies can occur during drought. Vitamin A should be supplemented when cattle do not have access to adequate green forage for 90 days or more. Cattle convert carotene from green forages into vitamin A. When plants cure, carotene content declines rapidly. Cattle store large amounts of vitamin A in the liver, but these reserves may be depleted during drought. For more information on feeding beef cattle request a copy of "Feeding the Beef Cow Herd Part II- Managing the Feeding Program (G80-497) from the Nebraska Cooperative Extension.

Toxicity Associated with Drought

The potential for poisonous plant problems increases under drought conditions. Because less desirable forage is available, livestock losses may occur even where problems have not been observed in preceding years. Some poisonous plant species are drought tolerant and produce green foliage under dry conditions. When combined with reduced opportunity for selective grazing, the risk of poisonous plant problems increases dramatically. Larkspur, Riddell groundsel, death camas and poison-vetches are examples of native species that occur even on rangeland in good or excellent condition. The identification and management recommendations for common poisonous plants are summarized in "Nebraska Poisonous Range Plants" (EC85-198), available through the Nebraska Cooperative Extension.

Forages high in nitrates are another nemesis for livestock during drought. High nitrate accumulations may occur in warm season annual forages or cereal crops that are used for emergency feed. Nitrates should be suspected if plant growth is reduced or stopped because of drought. Nitrogen fertilized crops are most hazardous. Nitrates are intermediate products of protein formation

in plants. If plant growth is reduced by drought, protein formation is stopped and the nitrate concentration increases. After ingestion, nitrate is converted to nitrite in the rumen. Nitrite interferes with oxygen transport in the blood. High nitrate intake may cause abortions or death by asphyxiation. Management recommendations for the evaluation and use of high nitrate forage are presented in the section on Using Annual Forages in this handbook.

The potential for grass tetany increases following drought. Reductions in standing dead plant material lead to high percentages of lush, current year forage in livestock diets in the spring. Management recommendations for prevention of grass tetany are contained in "Grass Tetany" (G73-32) in Nebraska and "Grass Tetany in Cattle" (FS586) in South Dakota, available through your local Extension office. Ranchers should evaluate their pasture conditions well before turnout, and if appropriate, start magnesium supplementation programs to reduce grass tetany.

Clinical symptoms of grass tetany and larkspur consumption are similar. The highest potential hazard period for both occurs in the spring. It is important to have a specific diagnosis because while both affect the central nervous system and animal coordination, treatments are different. Animals with grass tetany often respond to prescribed treatment but, there is no treatment for larkspur poisoning. Animals poisoned by larkspur should be left to recover on their own. The stress of movement or attempted treatment may cause death in what may have been a sublethal dose from which the animal could have fully recovered if left alone. If grass tetany symptoms are seen check for the presence of grazed larkspur plants. If plant poisoning is confirmed, move all able livestock to a pasture without larkspur and with adequate grass forage as soon as possible. If grass tetany is confirmed, begin treatment and prevention immediately.

During drought, water quality often declines in stock ponds where soil has been deposited by runoff. Salt

concentrations increase with higher than average evaporation and reduced water inflow during drought conditions. Where stock ponds are the only water source, pastures should be grazed early in the season before extensive evaporation. Livestock water requirements will also be lower when cool temperatures occur. When water quality is poor, most livestock reduce their water intake which reduces performance. When animals become thirsty enough, they will eventually drink a large quantity of salty water. These animals may die rapidly (Table 2). This situation may become even more dangerous if livestock are forced to eat drought stricken forages with a high salt content, such as saltgrass or greasewood.

Table 2. Dangerous levels of salt content in livestock water.

Livestock	Total Dissolved Solids
Cattle	3,000 ppm
Sheep	7,000 ppnl

Under certain conditions pond water may develop lethal concentrations of blue-green algae. Algae multiplies rapidly under hot and dry weather conditions. Winds accumulate the algae along downwind shorelines on the surface of water. Under drought conditions water quality can change from non-toxic to toxic in several hours. Livestock that drink can die before traveling a few hundred yards or may suffer for a day before death. Animals that recover may slough white hide. Determining the cause of death is difficult because changes in weather can eliminate the problem and positive identification of blue-green algae requires microscopic examination.

PREDICTING FORAGE PRODUCTION AND STOCKING RATES

Weather variables and soil moisture content can be used to estimate forage production in the coming growing season. The level of predictability is influenced by soil texture and therefore differs among range sites. Regardless of site, the length and severity of past drought must be considered. The following methods are based upon vegetation not impaired by long-term drought. If drought has reduced perennial plant cover, grass yields will be over-estimated with these methods.

Sandy Soils-Spring Decisions

Methods of predicting forage production on sandhills rangeland in good condition, on Valentine soils, were

examined by Dahl(1963) in northeast Colorado. The soils and vegetation in the study area are similar to sandhills rangeland in Nebraska and South Dakota. The depth of moist soil on April 15 was highly correlated with forage production from May 1 to August 7, the primary growing season. There is usually a distinct color change between moist and dry soil on sandhills range sites. Conventional post hole diggers or soil augers can be used to randomly sample depth of moist soil in pastures. The relationship of probable stocking rate and depth of moist soil in April is presented in Figure 7. Since the initiation of the growing season is delayed northward from Colorado, depth of moist soil could be

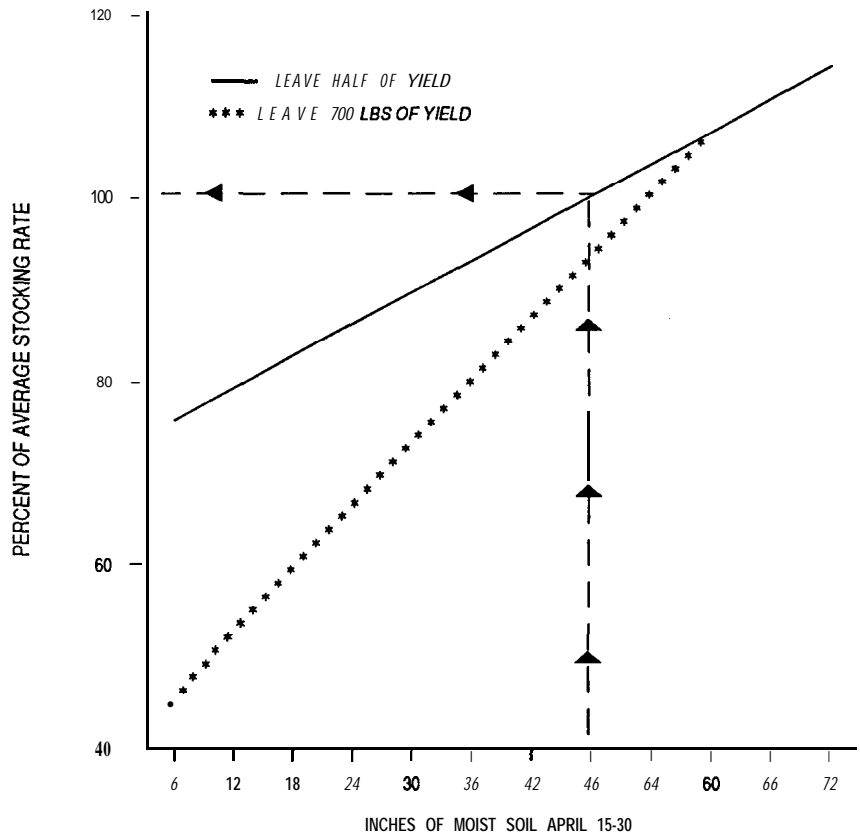


Figure 7. The relationship of depth of moist sand in mid- to late-April and probable stocking rates for sandy and sands range sites in good to excellent range condition in western Nebraska and western South Dakota. Rangeland in fair or poor condition may not produce enough forage to sustain these predicted stocking rates. Drought and/or overgrazing in preceding years will reduce the carrying capacity of rangeland (modified from Dahl 1963).

checked as late as April 30 in South Dakota and northern Nebraska.

Because of the decline in herbage production under drought conditions, it may be necessary to reduce stocking rates the following year, regardless of moisture conditions, to leave enough cover for site protection. Locate the average depth of moist soil observed in your pastures in Figure 7, move up to the bottom stocking rate line and then to the left hand scale to determine the stocking rate necessary to leave adequate plant cover on unstable sandhill pastures. If plant growth and survival were dramatically reduced by preceding drought and wind erosion has increased, it may be necessary to rest pastures or to defer grazing until fall or early winter. If sandhill pastures are stable, move up to the top stocking rate line and left to the stocking rate scale.

Loamy Soils-Spring Decisions

Forage production on loam to gravel loam soils near Cheyenne, Wyoming was highly correlated with total precipitation from March through May (Hart 1987). Spring precipitation accounted for 94 percent of the annual variation in forage production. Needle-andthread, western wheatgrass, and blue grama dominate the sites where this study was conducted. These sites would be similar to silty and limy upland range sites in western Nebraska and South Dakota. The relationship of probable stocking rates and total precipitation from March through May is presented in Figure 8.

Clayey Upland-Spring Decisions

The most reliable model for predicting yield on clay uplands in Kansas was based upon total precipitation in May and June during the current growing season (Hulett and Tomanek 1969). The sites in this study were dominated by blue grama and buffalo-grass in association with mid-grass species. This method does not provide as much lead time nor was it as accurate as the procedures described for sand and loam soils. Warm season shortgrasses often respond to precipita-

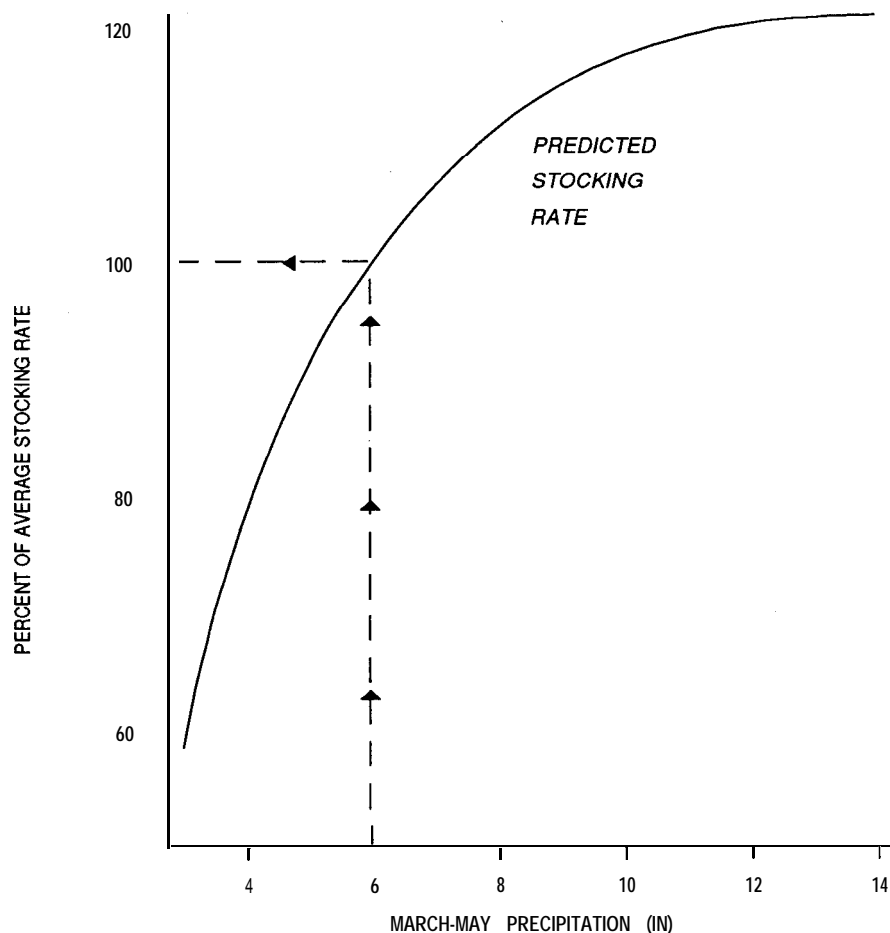


Figure 8. The relationship between total precipitation from March through May and probable stocking rates on silty and limy upland range sites in western Nebraska and western South Dakota (modified from Hart 1987).

tion in July and August. Even so, low precipitation in April and May on clayey range sites does provide an indication of pending shortages in forage resources.

Clayey/Loamy Upland-Fall Decisions

Some range livestock producers have used a flexible stocking rate based upon total precipitation from October through September during the preceding two years (Ralph Cole Personal Communication). Precipitation from the preceding two years has a direct influence on forage production and range recovery in the upcoming year. Greatest emphasis is placed on precipitation in the year just past because it has the greatest influence on vegetation in the upcoming year. The

flexible stocking method provides an opportunity to capitalize on vegetation surpluses during favorable years, and enhance vegetation recovery after drought. This method also provides an opportunity to reduce livestock numbers before wintering costs are incurred. This prediction assumes that precipitation in the upcoming winter and spring will be near average. If they differ dramatically from average stocking rates will need to be adjusted further.

The following example of calculating flexible stocking rates is presented for a ranch with a long-term average stocking of 2700 AUM's for its rangeland forage base. Precipitation in the year just past is weighted at 75 percent while precipitation from two years ago is weighted at 25 percent.

Precipitation Records

Long-term average precipitation = 16 inches
 1985 forage year (Oct 84-Sep 85) precipitation = 12 inches
 1986 forage year (Oct 85-Sep 86) precipitation = 22 inches
 1987 forage year (Oct 86-Sep 87) precipitation = 18 inches
 1988 forage year (Oct 87-Sep 88) precipitation = 12 inches
 1989 forage year (Oct 88-Sep 89) precipitation = 8 inches

Stocking for an Average Grazing Year = 2700 AUM's

PREDICTIONS

RATIONALE

Stocking for 1987 Grazing Year:

(1985) 12 in x .25 = 3
 (1986) 22 in x .75 = 16.5
 3 + 16.5 = 19.5
 19.5/16 x 100 = 121.9 percent
 121.9 percent x 2700 = 3291 AUM's

Increased stocking takes advantage of good forage carryover and improved plant vigor from 1986.

Stocking for 1988 Grazing Year:

(1986) 22 in x .25 = 5.5
 (1987) 18 in x .75 = 13.5
 5.5 + 13.5 = 19.0
 19.0/16 x 100 = 118.75 percent
 118.75 percent x 2700 = 3206 AUM's

Predicts good vigor and likely high production as a result of above average precipitation in 1986 and 1987.

Stocking for 1989 Grazing Year:

(1987) 18 in x .25 = 4.5
 (1988) 12 in x .75 = 9.0
 4.5 + 9.0 = 13.5
 13.5/16 x 100 = 84.4 percent
 84.4 percent x 2700 = 2278 AUM's

Anticipates decreased carryover and plant vigor resulting from a relatively dry year in 1988.

Stocking for 1990 Grazing Year:

(1988) 12 in x .25 = 3
 (1989) 8 in x .75 = 6
 3 + 6 = 9
 9/16 x 100 = 56.25 percent
 56.25 percent x 2700 = 1519 AUM's

Stocking is greatly reduced after two dry years in anticipation of diminished forage supply and to allow for range recovery.

Yield After Prolonged Soil Moisture Shortages

Soil and air temperatures influence plant ability to produce forage when adequate soil moisture occurs. Optimum temperatures for rapid plant growth generally occur for only 2 to 4 weeks. If moisture stress inhibits plant development, the remaining amount of time during which plants can grow rapidly is reduced because air temperatures either become too high or too low for optimum plant growth.

Plants grow rapidly near the mid-point of their growing season when optimum temperatures and adequate soil moisture occur. If a prolonged shortage in soil moisture limits plant growth beyond the mid-point of the primary growing season, forage production will often be less than half of average yield, even with the advent of adequate soil moisture, unless unseasonable temperatures occur.

Primary growing seasons for different forage species differ across our region. Precipitation and the length of the frost free period increase from west to east in Nebraska and South Dakota. Average annual precipitation ranges from 12 to more than 30 inches. The average frost free period ranges from 135 to 210 days. Opportunities to use alternative forage resources increase as the frost free period increases.

Drought stress early in the growing season may reduce the number of shoots that develop in perennial grasses and some annual forages. The approximate time at which prolonged soil moisture shortages will cause significant reductions in yield are presented for different forage resources in 12-16 and 20-24 inch precipitation zones in Figure 9.

Using Annual Forages

Where suitable cropland exists, annual forages can be used to reduce grazing pressure or to provide periods of critical deferment for range and pastureland. Annual crops can also be used for hay production to offset drought induced shortages in feed. If annuals are not grazed or cut for hay,

Cool Season Pastures-Spring Decisions

The depth of moist soil in the spring is a good predictor of probable forage production on tame wheatgrass and bromegrass pastures. If good stands exist and root systems have not been reduced by drought and/or over-

grazing, 40 inches of moist soil on April 15 would show a high probability that average stocking rates can be sustained. Limited production will occur with less than 20 inches of moist soil. Maximum forage production will occur with 60 inches of moist soil (Johnson 1988).

PROBABLE REDUCTIONS IN FORAGE PRODUCTION WITH PROLONGED SOIL MOISTURE DEFICITS

12-16 Precipitation Zone

20-24 Precipitation Zone

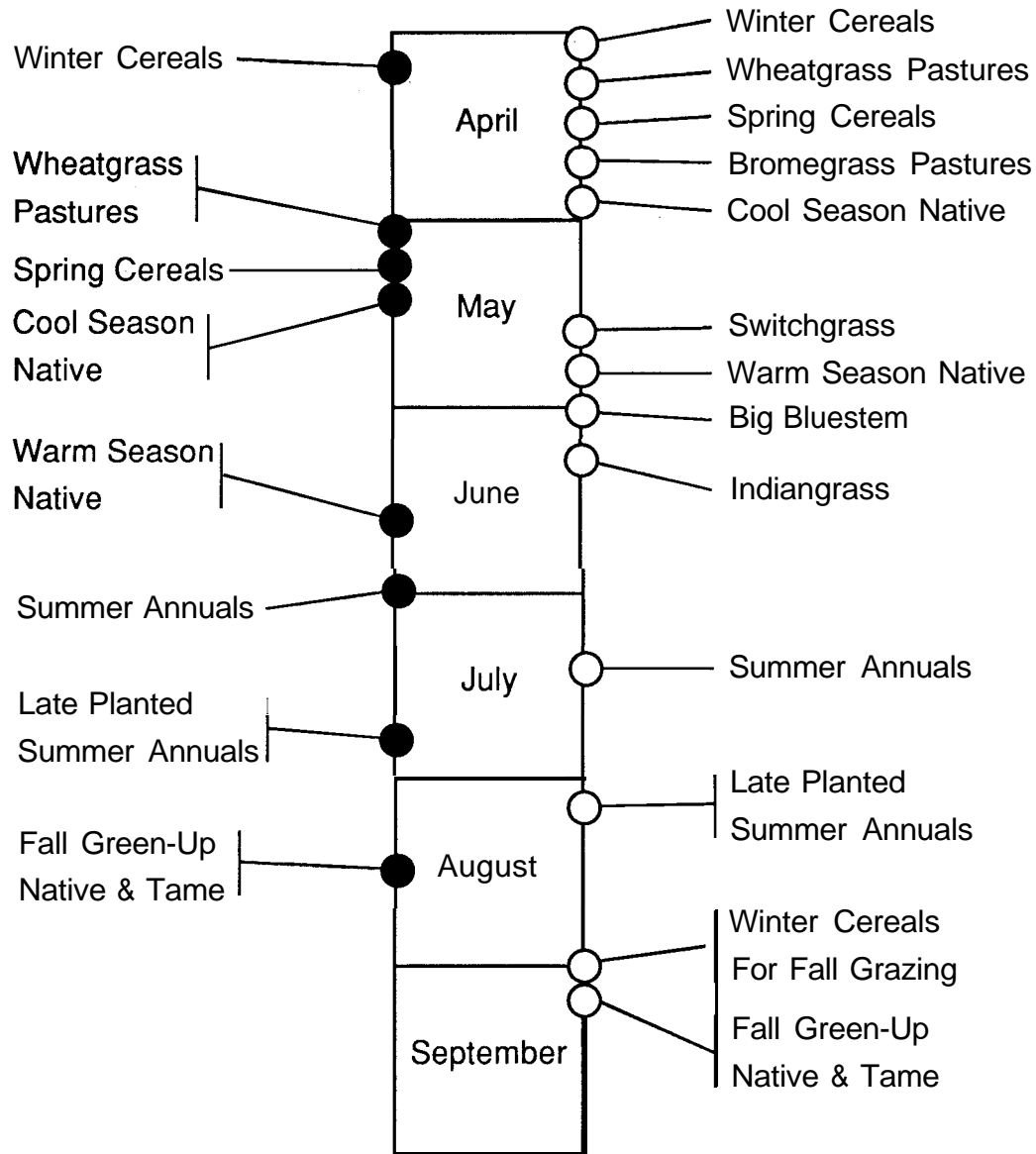


Figure 9. Approximate date after which prolonged soil water deficits will cause measurable reduction in yield of different forage resources in 12-16 and 20-24 inch precipitation zones. Timing of the critical periods in the 16-20 inch precipitation zone will fall between the above dates.

most can be harvested for grain. The benefits of annual forages cannot be fully realized without advanced planning. Delay in seed purchases and seedbed preparation will reduce the number of crop alternatives (Table 3). Forage yield and quality depend upon seeding date, rate and method. Efficient selection and use of annual forages will depend upon land,

equipment, and labor resources.

There are three categories of annual forage grasses based upon season of growth and probable date at which grazing could begin (Table 4): (1) winter cereals, (2) spring cereals, and (3) summer annual forage grasses. Winter cereals such as triticale and standard height wheat can be used to produce early spring forage and delay

turnout on range or pastureland.

Winter triticale is more aggressive than winter wheat and less prone to weed infestations. Spring cereals such as late maturing oats can also be used as a spring forage 15 to 30 days after winter cereals.

Summer annual forage grasses can be used as a mid-summer, late summer or fall grazing resource. Under irriga-

Table 3. Cultural practices for annual forage grasses.

	Winter Cereals	Spring Cereals	Summer Annuals
TYPE:	Standard height winter wheat, winter triticale	Late maturing oats	Forage sorghum, sudangrass, sorghum x sudangrass crosses and millets.
SEEDING DATE:	Early fall September 1-20	Early spring March 15 - April 15	Two weeks after corn, up to mid-July. Sudangrass, forage sorghum and sorghum x sudangrass crosses: soil temp. above 60° F. Millets: Soil temp. 65-70°F.
SEEDING RATES:	1.2-1.5 bu/ac	2 bu/ac	Sudangrass, sorghum x sudangrass crosses and foxtail millet: 15-20 lb/ac. Forage sorghum and pearl millet: 6-12 lb/ac.
FERTILIZER:	Nitrogen and phosphorous are primary nutrient concerns. Fertilizer should be applied according to soil tests. Excessive application of nitrogen will increase the potential for high nitrate content in forages. Adequate phosphorus is essential for root development.		

¹Select types and varieties within types that are adapted to the local environment. Assistance is available through the local Extension Office.

Table 4. Grazing management recommendations for annual forage grasses.

	Winter Cereals	Spring Cereals	Summer Annuals
EARLIEST PROBABLE GRAZING DATE:	April 1-15	May 1-15	July 1-15
GRAZING MANAGEMENT:	Begin at 6-8 in. (5 leaf) but no later than boot. Graze continuously or 2-3 pasture rotation. Graze to 2 in., defer 2 weeks.	Grazeable in 30 days. Begin at 6-8 in. (5 leaf) but no later than boot. Graze continuously. Provides 6-8 weeks grazing season.	Grazeable in 40-45 days. Begin at 15-20 in. (sudangrass and pearl millet), 18-24 in. (sorghum and sorghum x sudangrass crosses). Use two or more pastures with staggered planting dates. Graze rapidly to 6 in. Defer 3 weeks.
PROBABLE STOCKING RATE:	1.5-3.0 AUM/ac (Not fallowed) 2.5-3.5 AUM/ac (Fallowed)	1.0-2.5 AUM/ac (Not fallowed) 1.5-3.5 AUM/ac (Fallowed)	1.5-3.5 AUM/ac 1st grazing cycle. Possibility of regrowth

tion or **with** timely precipitation some of these forages may be used in haying and grazing combinations during the same year. Species and varieties in this category differ considerably in height, stem diameter, length of growing season, forage production potential, regrowth, and content of antiquality or toxic compounds. There are five types of summer annual forage grasses: forage sorghum, sudangrass, sorghum x sudangrass crosses, pearl millet, and foxtail millet.

Young plants and young leaves in sorghum, sudangrass and sorghum x sudangrass hybrids contain a chemical that breaks down and is released as prussic acid. Use varieties in these three types that have been selected for low prussic acid content such as Piper sudangrass. Danger of prussic acid poisoning is low when sorghum, sudangrass or sorghum x sudangrass crosses are not grazed until plants are 18 to 24 inches tall. Prussic acid concentrations increase when plants are stressed by frost or drought. Prussic acid breaks down rapidly in dead plant tissue. If new tillering does not occur and plants are 18 to 24 inches tall, grazing can begin 5 days after plants have died. Forage and hay should be analyzed for prussic acid content when uncertainty occurs.

Millets do not contain prussic acid. Foxtail millet matures early and has limited regrowth potential. It is poorly rooted and may be pulled up during grazing. It is best suited for haying or single periods of intensive grazing. Foxtail hay is excellent for cattle and sheep but not recommended for horses. Pearl millet is well rooted and has good regrowth potential. It may be grazed when plants are 15 to 20 inches tall. Specific information for localized conditions can be obtained through your local Extension office. For more information, request a copy of "Summer Annual Forage Grasses" (G74-171) in Nebraska or "Small Grains for Forage" (FS662) in South Dakota.

Nitrate accumulation can occur in any annual forage crop if growing conditions are droughty. Excessive nitrates are more likely to occur on sites that were fallowed or heavily fer-

tilized with nitrogen in the current and/or preceding year. Nitrates tend to concentrate in stem bases, but they are generally not a problem unless livestock consume the lower one-third of plants. Content of nitrates in hay can be reduced by raising the cutting height. Nitrate concentrations can also be reduced by ensiling the crop. When

in doubt, send a representative forage or feed sample to a laboratory for analysis. Contact your local Extension office for more information on nitrates. In Nebraska refer to NebGuide G74-170, "Nitrates in Livestock Feeding" and in South Dakota refer to Extension Bulletin FS420 "Forage Nitrate Poisoning".

When a production year has been completed under short- or long-term drought, identify and address the weakest components of the management plan that have the greatest effect on production costs. Modify plans for adjusting livestock numbers or forage and feed resources for next year or for the next drought. For more information on estimating forage supplies and balancing livestock requirements with forage and feed resources refer to "A Guide For Planning and Analyzing A year-Round Forage Program" (EC 86-1 13) available from Nebraska Cooperative Extension.

DROUGHT MANAGEMENT PLANS

A drought plan should minimize financial hardships and hasten vegetation recovery after drought. Drought plans identify action to be taken at the first sign of drought as well as with continued indications of pending forage shortages. Plans for stocking rate adjustments need to be specific in terms of method and date. The timing of actions should be based upon seasonal check points. Critical evaluation dates at which livestock requirements are balanced with available forage and feed resources are:

April 15-30:

- Determine average depth of moist soil on sandy, sands and choppy sands range sites and estimate probable stocking rates.
- Assess growth of introduced cool season pastures.
- Evaluate stand quality and probable forage production of winter and spring cereals.

May 1-30:

- Estimate probable stocking rates on silty and limy upland rangeland, based upon March through May precipitation.
- Determine if yield of native cool season species on rangeland is above or below average.
- Monitor green-up of native warm season species on rangeland. Alternate forages, stocking rate reductions and/or modifications of grazing strategies may be needed if there is a delay in green-up.

June 1-30:

- Assess establishment and stand quality of summer annual forages and soil moisture conditions.

July 1-30:

- Determine if yield of native warm season species on rangeland is above or below average.
- Assess establishment and stand quality of late planted summer annual forages and soil moisture conditions.

August 1-30:

- Estimate or measure yield of summer annuals harvested for feed or grown for late season grazing.

September 1-30:

- Inventory current year, carry-over, and purchased hay resources.
- Make a final assessment of yield of annual forages grown for late season grazing.
- Inventory other harvested feed and determine the quantity of crop residue on cropland.
- Estimate amount of forage in winter pastures.

October 1-30:

- Use October through September precipitation to predict stocking rates for the next summer on clayey/loamy range sites.

The color green can have profound psychological effects on range livestock producers. Even a small amount of spring or fall green-up can cause a false sense of security and the delay of prudent management decisions outlined in drought plans.

Pastures with an abundance of rhizomatous grasses can also look like a dream come true following a drought. Even though perennial grasses often produce many seed stalks the year after drought, total quantity of forage is still well below average. This is one of nature's cruel deceptions. Loss of plants during drought reduces plant competition. When adequate soil moisture occurs, the remaining plants grow to above average height because of reduced competition for nutrients and moisture. Grasslands cannot recover fully and cannot sustain pre-drought stocking rates in the first year after drought.

A plan of action should be developed for best and worst case scenarios. If drought breaks early the following year a gradual restocking plan may be appropriate. Premature, aggressive restocking can cause serious economic loss because of long-term reductions in the rate of vegetation recovery. If vegetation recovery is slow or restricted by continued drought, a destocking plan will be needed. Normally, stocking rates in the year that drought breaks should not be increased above levels in the last year of the drought. If animal performance or remaining herbage were unacceptable during the preceding drought year, stocking rates may need

to be reduced by 10-30 percent in the following year. Important considerations for drought management plans are outlined below:

- (1) **Resist the temptation to restock to former levels in the year following drought.** As much as possible, next year's forage production should be devoted to restoring protective plant litter and improving plant vigor.
- (2) **Plan to delay the initiation of the summer grazing season by 1 to 2 weeks to enhance plant recovery.** This delay may result in a 10 to 20 percent increase in forage production during the growing season.
- (3) **Use rangeland resources efficiently.** Critically evaluate distribution of livestock grazing in all pastures. Use the least expensive methods available to increase use of lightly grazed areas and reduce use in over grazed areas. Distribution of grazing may be improved by changing time or season of use or by strategic short-term placement of salt or mineral. Tools used to improve distribution are discussed in "Proper Livestock Grazing Distribution" (G80-504), available through Nebraska Cooperative Extension.
- (4) **Determine the availability of alternative or reserve forages.** These could be used to reduce grazing pressure on rangeland.
- (5) **Reserve 10 to 20 percent of your forage resources in case vegetation recovery falls short of expectations.**
- (6) **Calculate stocking rates for each pasture.** Use animal unit (AU) equivalents that are representative measures of animal weight and/or forage requirements. Keep and use accurate grazing records for each pasture.

- (7) **Make and implement decisions early to avoid crises.** Delays often lead to intensification of the problem, economic loss, and long-term damage to the forage resource.

Questionable Practices

Some management and improvement alternatives are questionable under drought conditions. Higher than normal risk is associated with the start of intensive rotational grazing, installation of cross fences and water developments and initiation of weed control, pasture renovation and fertilization projects.

Even with adequate preparation, errors in intensive rotational grazing management will occur during implementation. Conservative stocking rates and experience are needed to fine tune intensive management practices. The number of management decisions increases as the number of pastures and number of grazing periods per pasture increase. Consequently, the potential for error also increases.

Limited investment in water development and cross fencing on a priority basis may be warranted.

Possible examples include:

- (1) Provision of livestock water for the use of significant forage resources that would otherwise be unusable without water development.
- (2) Separation of range sites or seeded pastures that are capable of producing measurably more forage with improved control over time and/or stocking density. This may involve separating cool season seeded pasture from rangeland or cross fencing subirrigated meadows.

Opportunities to recover investments for range or pasture improvements often decline dramatically under drought. The probability of success in weed control, reseeding, and fertilization on dryland sites declines drastically during drought.

Without adequate soil moisture, plants cannot use fertilizer efficiently. Forage yield of smooth brome on a silty clay loam soil in Lincoln, Nebraska was studied for eight years (Colville et al. 1963). Excellent stands were established and evaluated without irrigation. Precipitation ranged from 6.5 to 20.5 inches from December 1 to June 20, the time of harvest. Conclusions from this and other studies of nitrogen fertilization on dryland brome pastures in eastern Nebraska and South Dakota are summarized below:

- (1) The increase in yield from each pound of fertilizer declines as the total application increases.
- (2) As application rates increase, the amount of precipitation required to recover total fertilizer costs also increases (Table 5).
- (3) Nitrogen should not be applied to dryland pastures in any location under severe drought conditions.
- (4) Under moderate drought conditions, application of nitrogen fertilizer should not exceed 50 to 80 lb/ac in eastern Nebraska or eastern South Dakota.
- (5) Recovery of fertilizer costs for up to 80 lb N/ac in eastern areas of Nebraska or South Dakota will require 9 to 10 inches of precipitation from December 1 to June 20 (Table 5).

In the western parts of both states tame dryland pastures will not respond to nitrogen fertilization unless winter through spring precipitation is average or above. Nitrogen fertilizer should not be applied to tame pastures in this region unless depth of moist soil exceeds 20 inches by April 1 to April 15. Application rates should be 35 to 45 lb/ac for wheatgrass pastures. Only the best stands on the best soils should be fertilized.

Table 5. The influence of total precipitation from December 1 to June 20 on additional smooth brome forage production from 40, 80, or 120 lb/ac of nitrogen fertilizer compared to unfertilized yield at the first cut (Colville et al. 1963).

Precipitation Dec 1-June 10 (in)	Unfertilized Yield	Additional Forage Yield Compared to Unfertilized		
		40	80	120
7	350	310	400	610
8 DROUGHTY	350	400	650	880
9	470	460	780	1170
10	940	690	1120	1380
11 AVERAGE	1750	940	1430	2270
12	2350	1650	2460	3860
13 ABOVE AVERAGE	2470	2040	3400	4150
14	2350	2303	3890	4470

RANGELAND RESOURCE INVENTORY

Ranchers who know the current capability and condition of their resources can make more efficient drought management plans than those without a resource inventory. Grazing records also provide valuable insight into the present condition of forage resources.

Pasture evaluations should be made within a 1 or 2 day period, well in advance of each grazing season. Plant vigor, range condition and the amount of remaining forage should be estimated in each pasture. Plant vigor is indicated by the relative size of plants and the height and frequency of seed stalks. Range condition is directly related to the amount and diversity of desirable grass species. The remaining forage has a direct influence on site stability and also provides an indication of how well root systems grew in the preceding year. Assistance in range evaluation is available through local Soil Conservation Service offices.

The relative contribution of cool and warm season grasses to the total amount of forage produced on the ranch is a major factor in drought management strategies. The percentage of forage produced by cool and warm season grasses should be estimated in each pasture. Plans for pasture use can then be modified to capitalize on precipitation that favors either cool or warm season grasses. Cool season grasses grow primarily from late April to early June. Warm season grasses grow primarily from early June through July. If adequate soil moisture is not available by the midpoint of a species' primary growing season, substantial reductions in forage production will occur (Figure 9). Information on the identification and season of growth of grasses is contained in "Nebraska Range and Pasture Grasses" (EC85-170), available through Nebraska Cooperative Extension.

Rank pastures into high, moder-

ate, and low categories based upon their current ability to produce forage. Forage production potential depends upon site characteristics as well as range condition and plant vigor. Potential production of different sites is discussed in the following Nebraska Extension publications "Nebraska Range Judging Handbook" (EC 84-109) and "A Guide For Planning and Analyzing A Year-Round Forage Balance Program" (EC 86-113). The Soil Conservation Service has developed comprehensive summaries of range site forage production potentials.

High-ranked pastures need to be managed for optimal yield during drought. Moderate-ranked pastures will produce more forage than low ranked pastures and provide flexibility in the development of grazing strategies. Moderate-ranked pastures can be used for early or mid-season grazing to provide an extended period of uninterrupted plant growth for optimal forage production in high ranked pastures.

Conduct a careful review of low-ranked pastures. First, identify the low-ranked pastures composed of range sites that are capable of producing abundant forage. Determine if the low rank of these pastures is a result of recent abuse, drought, or long-term abuse. If the pasture is ranked low because of one year of overgrazing or drought, it is possible that plants will be able to recover rapidly. If the forage from these pastures makes up a small percentage of the total forage base, these pastures should be deferred until after key grass species have headed to optimize recovery rate.

Some pastures may be ranked low because they are range sites incapable of producing abundant forage or they have a long history of abuse. The recovery of these pastures is not a part of your drought recovery plan, but instead is a part of a long-term, ranch-wide range improvement program. Recovery of these pastures may need to be delayed until better pastures can be returned to near optimal production. These low ranked pastures may be grazed when providing deferment to higher priority pastures. Increases in forage production that occur in moderate and high ranked pastures will pro-

vide the best opportunity for future deferment and recovery of long-term abused pastures. An adequate level of protective cover must still be maintained when grazing low ranked pastures.

Use grazing records to calculate the stocking rate for each pasture during the previous year(s). Determine if stocking rates or time of grazing have influenced the rank of pastures. Deter-

mine what stocking rate and time of grazing combinations were least and most detrimental during preceding years. If good grazing records are not available, now is the time to begin. Record the class and number of livestock, and all dates of entry and removal for all livestock for each pasture. Long-term pasture records are essential for making intelligent grazing management decisions.

intermittent forage resources can reduce grazing pressure on range and pastureland. Large amounts of forage can be produced by annual brome grasses, annual sunflower, Russian thistle, kochia, and sweetclover. Moderate to heavy defoliation of annual or biennial species can enhance forage production of primary perennial grasses by reducing plant competition and minimizing soil moisture depletion.

Efficient use of annual weeds often requires control over time of grazing and stocking density. It may be necessary to use a single wire electric fence to concentrate livestock or to hold cattle on infested areas. Annual plants grow and produce seed rapidly. Once heading or flowering begins, palatability drops dramatically. Consequently, livestock must be heavily concentrated to fully use these forage resources before maturity.

Annual bromes such as cheatgrass or Japanese brome can provide a valuable forage resource under drought conditions. They also present a logistical challenge because these species head 2 to 4 weeks before native range is normally ready for summer grazing. Livestock will graze annual bromes for a longer period of time if a large percentage of developing seedheads are removed in the boot stage. When livestock stop grazing annual bromes, and primary perennial forage producing species in pastures are not ready for grazing, several options can be considered:

- (1) Feed hay on feed grounds or in drylots.
- (2) Graze winter cereals.
- (3) Graze wheatgrass or brome-grass pastures.
- (4) Graze early-developing cool season perennials on subirrigated meadows.
- (5) Skim or flash graze upland pastures for early developing cool season grasses or sedges.

Broadleaf annual weeds and sweetclover can be grazed incidently or intensively during the summer grazing season depending upon relative abundance. It may also be desirable to harvest large areas of sweetclover for hay.

GRAZING MANAGEMENT

Drought management should capitalize on all forage resources and minimize overgrazing. Conservative stocking rates and frequent pasture observations are necessary to minimize overgrazing regardless of grazing strategy. Livestock distribution and time of grazing determine how well forage resources are used. Techniques and management options are discussed in "Proper Livestock Grazing Distribution" (G80-504) available through Nebraska Cooperative Extension.

Rotational grazing can be used to control grazing time. Livestock are concentrated into one or a limited number of pastures. The time at which pastures are used or deferred under rotational grazing should be based upon a resource inventory and management objectives for each pasture. Livestock water supply must be carefully assessed before implementing rotational grazing. Daily consumption and evaporation may total 20 to 25 gal. per cow-calf pair during July and August.

The benefits of rotational grazing are accrued when used during the years before drought. Proper stocking in conjunction with rotation grazing will improve plant vigor and range condition. These improvements will moderate the effect of drought. Ranchers must balance practices designed for optimum pasture recovery after drought with short-term cash flow requirements. While production costs must be minimized, rapid recovery of forage resources after drought will

allow operations to return to profitable levels of stocking more quickly.

Destocking can be minimized by optimizing production and harvest of available forage resources. Optimum yield of forage can be attained by deferring summer grazing of high ranked pastures until primary forage grasses have headed (See Rangeland Resource Inventory Section). High ranked pastures will also tend to have the greatest potential for recovery when growing conditions improve. Key species in these pastures should not be grazed in excess of 50 percent utilization. Begin early season grazing in low or moderate ranked pastures with an abundance of cool season grasses.

Plant response to grazing depends upon suitability of environmental conditions for plant growth. Plants do not grow without adequate soil moisture regardless of the grazing strategy. If soil moisture is available at the end of a grazing period, additional forage production increases as the amount of remaining green leaf area increases. Simply stated, "grass grows grass". Under drought conditions, maximum forage production will occur in pastures that are deferred until soil moisture is depleted.

Capitalizing On Weed Forage Resources

Timely precipitation during and following drought can lead to substantial forage production from annual or biennial plant species. Use of these

Skim Or Flash Grazing

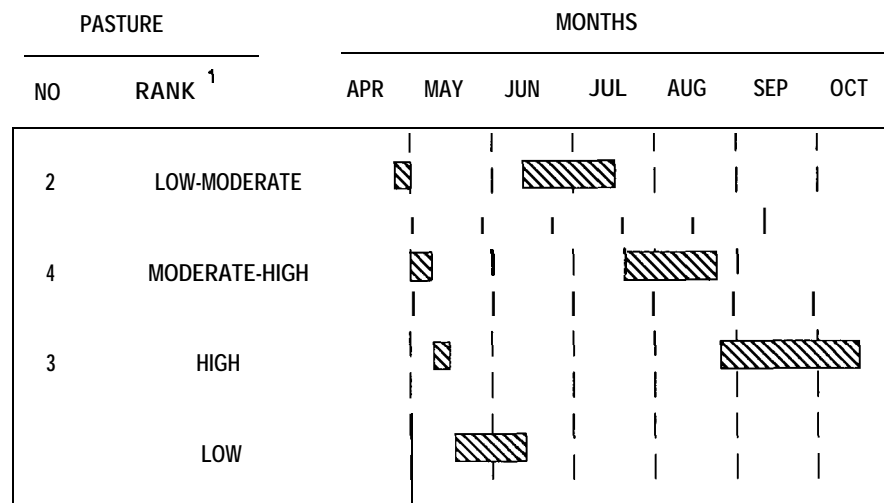
Skim or flash grazing is the practice of briefly grazing a pasture with a high concentration of livestock before the normal grazing period begins. While skim grazing can work with as few as two pastures, three or more pastures are preferable. In a drought management strategy, skim grazing can be used to capitalize on forage species that are often ungrazed because they mature before livestock enter pastures.

Typically, underutilized species include sedges, early spring forbs, junegrass, bluegrass, and crested wheatgrass. All of these species are palatable if grazed early enough. When available in sufficient quantities, they can be grazed before preference shifts to primary forage species such as western wheatgrass or needlegrasses. Skim grazing may also be used to capitalize on needlegrasses in pastures dominated by warm season grasses.

Figure 10 demonstrates skim grazing in pastures normally used under deferred rotation grazing. In this drought strategy, three of the pastures are skim grazed before the normally scheduled use. The length of each skim grazing period will depend upon the amount of early season forage. Livestock should be moved to the next pasture when early developing cool season forage species have been utilized at 40 to 60 percent. Utilization of primary forage producing species should not exceed **20 to 30** percent. All livestock should be moved to an ungrazed pasture for a full grazing period when preference shifts to primary forage species.

Optimizing Forage Production

If drought and/or overgrazing have reduced plant vigor, it may be more efficient to minimize or delay all early season grazing. Carbohydrates produced by early leaf tissue are critical for initial root and shoot development in plants that have been stressed in preceding years. A 1- to 2-week delay in the normal turn-out date can result in a 10 to 20 percent increase in



¹Rank based upon potential to produce forage in the current year in terms of total AUM's and probable yield increases with extended deferment.

Figure 10. An example of skim grazing from late April to mid-May. Early maturing forage species in pastures 2 through 4 are skim grazed. The lowest ranked pasture (1) is not skim grazed. Forage in pasture number 1 is fully utilized from mid-May to early June to provide deferment to pastures with higher forage production potential.

forage production. Minimizing use of early season growth can be accomplished in several ways:

- (1) **Delay turn-out by extending the feeding period or by grazing tame cool season grass pastures, winter cereals, spring cereals, or subirrigated meadows.**

Upper benches of some hay meadows are dominated by cool season grasses. Some sandhills meadows also have an abundance of sedges that green up early in the spring. Because of favorable moisture conditions, vegetation on meadows has a high potential for recovery after grazing. Livestock should be removed from meadows by mid-May. Harvest date will be delayed and hay yields may be reduced significantly if cattle are left on meadows until June 1.

- (2) **Disperse cattle throughout pastures for the first 1 to 2 weeks of the typical grazing season to minimize grazing pressure.** This may not be feasible with some breeding programs.
- (3) **Concentrate livestock in a limited number of pastures and provide early season deferment to the balance of pastures.** Select moderate-ranked pastures with the highest composition of cool season forage species for this practice and manage for 50 percent or less utilization. This practice will enhance production of forage in high ranked pastures. Defer early grazed pastures until after frost or seed set in key grass species.

PLANT RECOVERY AFTER DROUGHT

When drought ends, vegetation recovery should become a primary management objective. Pastures most likely to provide the largest increases in forage production should be given management priority. Specific management practices that are most beneficial for plant recovery are listed below in order from most to least benefit:

- (1) Rest the pasture for an entire year.
- (2) Use the designated pasture(s) only for winter grazing for 1 or more years when location and protection are adequate.
- (3) Use pastures intensively when

the least desirable species, such as annual bromes, are green and palatable. Remove livestock as soon as winter annuals have headed or when livestock begin to graze the key grass species.

- (4) Defer grazing until key grass species have developed mature seed. Control level of utilization at 50 percent or less.
- (5) Graze in late spring after abundant spring growth, when grasses are in the 4 to 5 leaf stage. Remove cattle when key grass species reach the late boot stage. Control level

of utilization at 50 percent or less.

- (6) Graze at a time when the key grass species is least preferred by livestock. This is often after heading. It may also occur when another grass species initiates growth while the key species is in late boot to early heading stage. Changes in cattle preference from needleandthread to prairie sandreed and from prairie sandreed to blue grama often follow this pattern (Figure 3). Control level of utilization at 50 percent or less.

SUMMARY

Drought is a constant and normal part of the rangeland environment. It is not a question of whether drought will occur, but when and how severe. In the Northern Great Plains, ranchers are always in some phase of drought management. Ranchers who understand the need to prepare for, endure, and recover rapidly from drought will survive the guaranteed, but unpredictable drought cycles.

There is no special prescription

for drought management. Good range management is good drought management. This embodies proper livestock distribution, season of use, and stocking rate as well as kind and class of livestock. Of these, stocking rate is singularly most important. There are no tricks to compensate for overgrazing.

A basic understanding of the potential capabilities and limitations of all ranch resources is fundamental to

sound management. High levels of plant vigor and range condition are critical for the endurance of and rapid recovery from drought. It is equally important to know which practices optimize livestock performance, and minimize risk of financial loss. Drought considerations must be incorporated into each year's management plan.

APPENDIX

Share Arrangements

Livestock can be relocated while reducing financial outlay with share arrangement contracts (Robb et al. 1989). Typically, ranchers enter into share arrangements by providing range, feed, facilities, labor, and management with another party that provides livestock and related inputs.

From a livestock owner's perspective, share arrangements are a method of acquiring the use of certain resources without making a direct investment or borrowing funds. For both the land owner and the livestock owner, share arrangements provide a method to remove some of the risk associated with owning livestock.

Disadvantages of share arrangements are that both the livestock owner and the land owner give up some individual control and income earning potential. The success of the venture depends on both individuals and the trust they have of each other. Like any joint venture, a share arrangement takes time and effort to be successful.

Negotiation is an important aspect in developing share arrangements. From an economic standpoint, a share arrangement is considered reasonably fair if total production is divided in the same proportion as are the contributions to the share venture. Sharing the proceeds based on contributions measured in dollars, provides both parties with the incentive to perform to the best of their ability. Unplanned expenses such as additional feed required in a drought year should also be considered. The duration of the agreement needs to be long enough so that it benefits both parties, and the expenses average out over time.

A comprehensive discussion of cow share agreements, worksheets, and computer software for evaluating alternatives is presented in the Nebraska Cooperative Extension publication "Share Arrangements for Cow-Calf or Cow-Yearling Operations" (CP2).

Tax Rules for Drought Induced Sale of Livestock

Reporting of proceeds from the sale of calves or lambs may be postponed for one year if the sale was due to drought conditions. This election applies to all livestock held for sale, whether raised or bought for resale. It also applies to livestock used for draft, breeding, dairy, or sporting purposes, regardless of the period of time that the animals have been in ownership.

A drought sale of livestock held for draft, breeding, or dairy purposes may be an involuntary exchange. If, because of drought conditions, more animals were sold than would have been sold under usual business practice, producers may elect to include proceeds from the sale of the additional animals in next year's income instead of this year, but only if all of the following conditions are met:

- (1) The principal business is ranching or farming,
- (2) The cash method of accounting is used,
- (3) Producers can show that, under their usual business practices the sale would not have occurred this year except for the drought.
- (4) The drought has resulted in an area being designated as eligible for assistance by the federal government. Sales made before the area became eligible for federal assistance still qualify, as long as the drought that caused the sale also caused the area to be designated as eligible for federal assistance.

If producers can treat disposition of livestock as an involuntary conversion and replace the livestock within specified time limits with qualified animals, they may defer gain from the involuntary conversion until disposition of the replacement livestock. The specified time limit is known as the re-

placement period. This period begins on the date that livestock were sold and ends two years after the close of the first year in which any part of replacement livestock are sold. Producers may also apply for an extension of the replacement period. Extensions of replacement periods may be based upon delayed recovery of rangeland vegetation.

Livestock do not have to be raised in a drought area and the sale does not have to take place in a drought area to qualify for this postponement. However, the sale must occur solely because of drought conditions that affected the water, grazing, or other requirements of the livestock to the extent that the sale became necessary.

Check with an accountant, lawyer, and/or federal government agency representatives when considering these actions. Complete rules for postponing income due to drought are in Sec. 1033(e) and Regulation 1.1033(e)-1 and Sec. 451(e) and Regulation 1.451-7 of the Internal Revenue Code. An explanation of procedures and calculations is contained in the Farmer's Tax Guide (IRS Publication 225).

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RECOMMENDED EXTENSION PUBLICATIONS

Nebraska	Title	Publication Number
Publications Distribution Room 108 Dept. of Ag Communications University of Nebraska Lincoln, NE 68583-0918 (402) 472-3023	A Guide for Planning and Analyzing a Year-Round Forage Program	EC 86-1 13
	Annual Forage Grasses	G 74-171
	Creep Feeding Beef Calves	G 74-166
	Feeding the Beef Cow Herd Part III - Managing the Feeding Program	G 80-497
	Grass Tetany	G 73-32
	Management of Early Weaned Calves	G 83-655
	Nebraska Poisonous Range Plants	EC 85-198
	Nebraska Range and Pasture Grasses	EC 85-170
	Nebraska Range Judging Handbook	EC 84- 109
	Nitrates in Livestock Feeding	G 74-170
	Proper Livestock Grazing Distribution	G 80-504
	Share Arrangements for Cow-Calf or Cow-Yearling Operations	CP 2
South Dakota	Title	Publication Number
Ag. Comm. Center Box 223 1 South Dakota State University Brookings, SD 57007 (605) 688-5628	Forage Nitrate Poisoning	FS 420
	Grass Tetany in Cattle	FS 586
	Ranch Management	C 225
	Small Grains for Forage	FS 662
		Publication Number
Great Plains Regional	Title	Publication Number
	Creep Feeding (In) The Beef Cattle Handbook	GPE 1550