Managing Drought Risk on the Ranch

A Planning Guide for Great Plains Ranchers

University of Nebraska - Lincoln
National Drought Mitigation Center

Available Online at:
www.drought.unl.edu/ranchplan

USDA United States Department of Agriculture Risk Management Agency

University of Nebraska Lincoln

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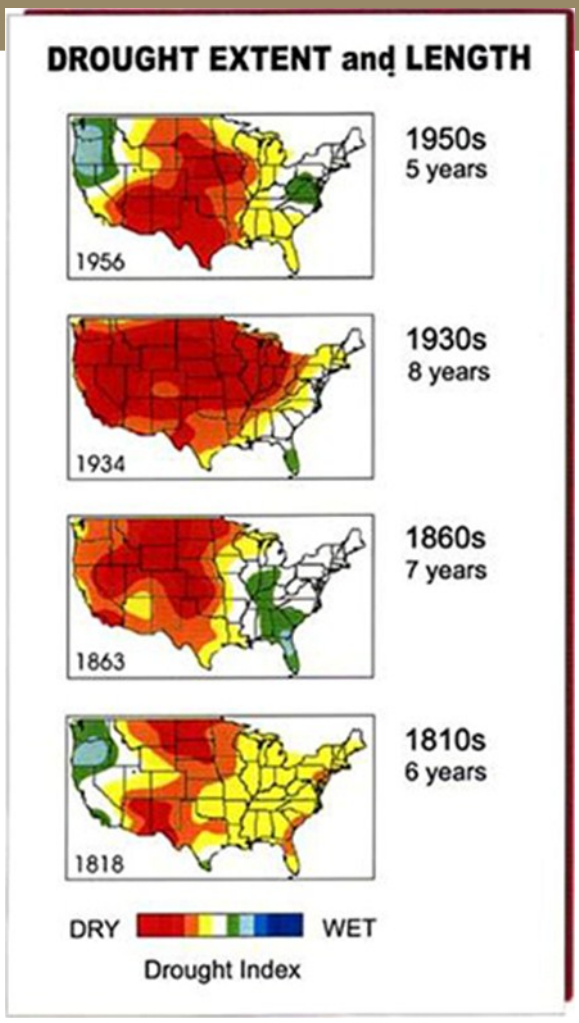
This guide to help rangeland managers better prepare for and manage drought is a project of the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln (UNL) and other collaborators at UNL, South Dakota State University, and Texas A&M Kingsville. This project was made possible through funding from the U.S. Department of Agriculture Risk Management Agency.

Much of the content of this handbook and the companion website was developed with information provided by Dr. Pat Reece, Professor Emeritus at UNL and now owner/consultant with Prairie Montane Enterprises, LLC.

The handbook and website were developed by, and will be maintained by, the National Drought Mitigation Center. Comments and questions about the handbook and website can be directed to the NDMC at ranchplan@unl.edu or 402-472-6781.

Why Plan for Drought?



1. DROUGHT IS INEVITABLE

For ranchers in the United States, drought can be defined as too little soil moisture to meet the needs of dominant forage species during their rapid growth windows. Drought is a natural part of climate in nearly every region on earth.

2. PRE-DROUGHT ACTION SHAPES CHOICES

Producers who focus on increasing flexibility and maximizing the health of resources are more likely to find solutions during drought that minimize painful decisions with limited resources.

3. EFFECTIVE RESPONSES TO DROUGHT ARE EARLY RESPONSES

The longer you wait to make decisions, the fewer options you will have available to you.

4. DROUGHT CREEPS UP ON YOU

Drought conditions occur gradually over time, sometimes making it difficult to take immediate action. A viable plan needs to have decision points.

A short-term drought (lasting one season or year) requires management adjustments, but generally won't impact the ranch's viability over the long term.

In contrast, a multi-year drought may last 3-5 years or more. Each year, drought effects will be multiplied by the management decisions made during previous years. A few years into a multi-year drought, ranch managers may have far fewer management alternatives and resources to work with. Long-term impacts on the ranch's financial health, ecological health, and rancher stress can be devastating.

Having a plan will help producers get through a short- or long-term drought while minimizing damages.

PLANNING LEADS TO EARLIER, MORE EFFECTIVE DECISIONS

The best time to make drought-related decisions is sooner rather than later. Here are some reasons why:

1. PLANT YEAR PRECIPITATION

Precipitation received between last year's killing frost and this year's spring green-up results in greater yield of forage per inch of moisture than does mid- to late-summer precipitation. If little to no precipitation falls during the dormant season, timely destocking is necessary to avoid damaging rangeland vegetation. So if you're entering green-up and have seen no precipitation since before last year's killing frost, or if you are lacking soil moisture, it is already a good time to make changes to this year's stocking rate.

2. CRITICAL RAIN MONTHS

Forage research shows that the most important months for precipitation are the months just prior to the rapid growth periods of your dominant plant species. For much of the Great Plains, those critical rain months occur in spring through early summer. Rainfall that occurs after the rapid growth period of dominant plant species does not result in as much useable forage.

3. DELAYS IN RESPONSE TO PRECIPITATION

Areas mapped on the U.S. Drought Monitor (http://droughtmonitor.unl.edu) as being in extreme or exceptional drought during the growing season are likely to have a one- to two-week delayed response to rainfall. Additionally, the process of "wetting-up" very dry soils in these areas reduces the availability of rainwater to plants. Delays in plant response to precipitation should be expected when current plant-year precipitation in your immediate area is 75 percent or less of long-term average. Excessive grazing pressure during drought will further reduce or preclude yield responses to even measurable amounts of precipitation.

NEBRASKA EXAMPLE - STOCKING DECISIONS DURING 2002-2004 DROUGHT

For example, based on the precipitation information shown at the right, destocking on limy upland ecological sites in the southern Nebraska Panhandle should have been 50 percent by mid May and 100 percent by mid to late June 2002.

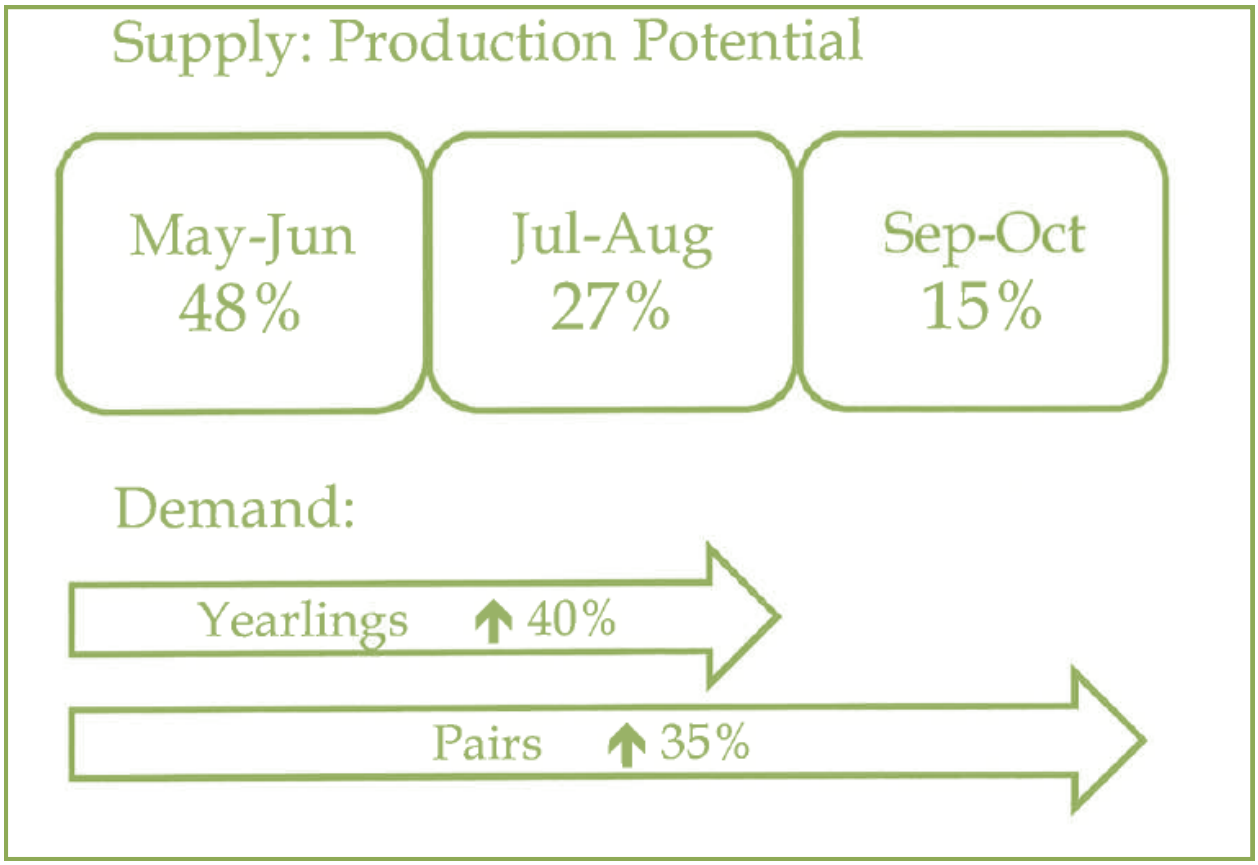
Given the severity of drought in 2002, turnout of cattle onto summer pastures in 2003 should have been delayed by two to four weeks, and stocking rates should have been lower than pre-drought.

Because 2004 pre-growing season precipitation was relatively low, stocking rates should not have increased. Delaying turn-out on summer pastures in 2004 would have been beneficial.

DROUGHT EFFECTS ARE NOT LINEAR, THEY RAMP UP!

This observation is true for many damages from drought. Increases in feed and forage costs, while livestock prices plummet, ramps up weekly. Imbalances between forage supply and forage demand ramp up daily.

Even in non-drought years, herbage production rates decline as the summer grazing season progresses while forage demand increases 35% to 40% as cattle gain weight. In average years, plants "outgrow" livestock on the front half of the season. When this does not happen in drought years, you must be ready to act quickly. Having a plan ahead of time will help you act quickly when necessary.



Relationship between herbage supply and herbage demand on loamy plains sites during years with average precipitation.

Understanding Drought

GRASSES & DROUGHT

Understanding how moisture stress affects plants is essential when designing drought management practices.

PLANT GROWTH

Carbohydrates produced from photosynthesis provide energy for all plant growth and maintenance. When air temperatures are favorable for plant growth, lack of soil moisture is the limiting factor for photosynthesis.

Plant growth is reduced or delayed when green leaf area is removed, or when soil moisture limits the amount of carbohydrates that can be produced. Overgrazing and drought during the plant's rapid growth windows will reduce next year's plant growth.

Plants rely on stored energy to survive during dormancy, and for initial growth after dormancy. Plants must rely on stored energy for unusually long periods of time when drought-induced summer dormancy is added to winter dormancy. Early spring growth that is stopped by drought or frost will deplete the plant's energy reserves and reduce forage production potential the following year.

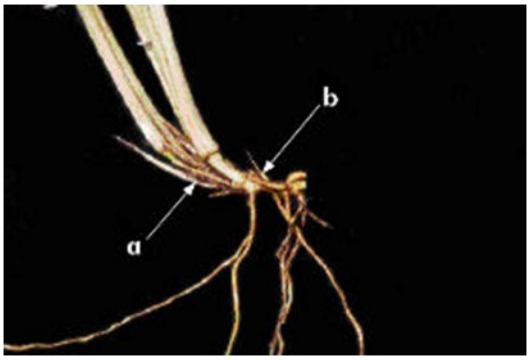
PLANT REPRODUCTION

Each year's forage crop is produced by a new set of tillers that develops from buds located in the crown and on rhizomes or stolons.

Year-to-year replacement of grass tillers primarily depends on the production and survival of vegetative buds on existing plants. Few perennial grasses become established from seed on rangeland.

Reduced plant growth under drought conditions or excessive grazing before grasses head may reduce or eliminate formation of new buds. Severe drought will lead to severe die off of tillers and rhizomes.

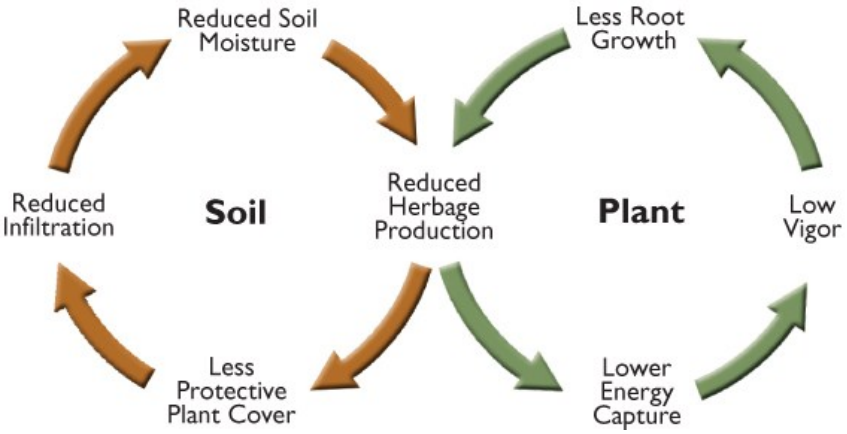
Grazing pastures every year at the same time will reduce next year's forage production of most midgrasses and tallgrasses.



Buds on little bluestem crown ranging from 1-year-old (a) to 3-year-old (b) generations.

GRAZING AND DROUGHT

Understanding the interactions of livestock, plants, and precipitation is important to managing drought risk on the ranch.



Grazing management influences the effectiveness of precipitation. Plant cover and healthy root systems result in better infiltration of moisture into the soil. Overgrazing can cause drought-like conditions even with average precipitation.

The effects of drought are intensified at poorer range conditions. Rangeland in “fair” condition is often more severely affected by drought than rangeland in “good” to “excellent” condition. Range condition also influences the rate of recovery in forage production after drought.

Stocking rate and grazing system decisions are most likely to affect animal performance in the second half of the grazing season. In contrast, these decisions are most likely to affect plant vigor and herbage production potential during the first half of the next summer grazing season.

LIVESTOCK PERFORMANCE AND DROUGHT

Livestock gain and conception rates suffer during drought. If plant growth is stopped by drought, forage quality may decline rapidly 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.

Drought often reduces the number of days during which green forage is available to livestock. However, forage that cures at early stages of plant development can provide higher than average quality during mid and late summer. Ranchers who adequately reduce stocking rates to account for reduced quantities of forage under drought conditions often experience above-average animal performance.

FINANCES AND DROUGHT

The two kinds of risk generally associated with drought are production risk and market risk.

Production risk naturally emanates from the fact that drought limits forage production and availability, which directly limits the total productivity of the operation.

Increased **market risk** is realized when those affected by drought act in unison and dump animals on the market in an untimely manner.

To mitigate as much of this risk as possible, producers should have a viable drought management plan. Such a plan will not only specify all the options of demand and supply management strategies but may also use some form of insurance product where offered.

A viable plan needs to have several characteristics, including being able to identify key decision points. A series of smaller decisions can be effective in mitigating drought impact on the operation.

The key factor to remember in building a plan is that all of the options need to be carefully evaluated based on their cost of implementation. The producer can then use the combination of least cost options. In addition to the demand and supply management strategies one generally thinks about, insurance products and marketing tools should also be integrated where they can help mitigate risk.

SEASONAL AND CYCLICAL BEHAVIOR IN LIVESTOCK MARKETS

Market prices for cattle and beef fluctuate both seasonally and cyclically. When you combine such phenomenon with local conditions, such as drought, the amount of risk may be amplified.

Using drought management strategies, a producer may be able to exploit the market fluctuations and use them to alleviate heavy financial losses.

For example, it is commonly observed that cull cow prices generally bottom out in late fall. If this seasonality effect is preceded by prolonged drought in your area, you could expect that your local market may see a flood of more cull cows than is normal for the season. This even further dampens local prices, and makes a very poor time and place to sell cull cows.

If, however, you had culled heavily in the spring, you would probably have gotten a better price for your culls, and you would have conserved more pasture or range.

The earlier you can anticipate drought and be prepared to manage it, the likelier you are to avoid unfavorable market conditions and decrease your loss. In essence, early drought management provides greater flexibility and enhances your capability to avert unfavorable market conditions and "must sell" situations.

The Ranch Drought Plan

Ranchers with experience managing drought make the following recommendations:

1. Prepare for drought by increasing the health of the overall operation and maximizing flexibility
2. Write a Drought Plan that includes WHAT to do during drought and WHEN
3. When conditions require it, implement the plan and don't second-guess it
4. After drought, have a plan for restoring the health of all parts of the ranch operation
5. Monitor how the drought plan works, and improve it as you learn

Making decisions about what to do during drought, and when, can be overwhelming. Working through the following components may help you make decisions that are appropriate for your operation.

For example, deciding WHAT to do during drought may depend upon your ranch vision and objectives; the strengths, weaknesses, opportunities, and threats to your operation during drought; your ranch inventory; and the management strategies that you use before drought.

Deciding WHEN to take action might be informed by your ranch inventory, including when you can commonly expect precipitation and when your critical forage resources grow. "When" might also depend on your ranch objectives and management strategies. This information will help you set critical decision-making dates.

Finally, build a planning and management team, including on-ranch people and off-ranch mentors or advisors. These folks can help you think through the hard decisions.

DROUGHT MANAGEMENT PLAN COMPONENTS:

- ⇒ Communication and Planning Partners
- ⇒ Ranch Vision and Objectives
- ⇒ Understanding of Strengths, Weaknesses, Opportunities and Threats during Drought
- ⇒ Inventory of Ranch Resources
- ⇒ Critical Dates for Making Decisions
- ⇒ Monitoring Schedule
- ⇒ Management Strategies : Before, During, and After Drought
- ⇒ Ongoing Review of Drought Plan

COMMUNICATION AND PLANNING PARTNERS

Drought affects many aspects of a ranch operation, and there are many strategies that can be implemented to better prepare for and respond to drought. Planning partners can play a critical role in helping to understand the effects of drought and identify strategies that would be most appropriate for a particular situation.

DROUGHT PLANNING TEAM

Involve key family members, business partners, and your banker, as well as advisors with knowledge of range management, business, and marketing in the planning process.

"If you have a plan, even if it's in your head, you need to share it with the people that work with you. Whether it's your children or your employees… it needs to be shared information." (Texas Rancher, 2010)

Identifying relevant planning partners and establishing communication between them early in the drought planning process will help ensure that a range of ideas and perspectives are openly discussed as you develop your plan.

WHO'S ON YOUR TEAM?

"The first thing you're going to do is look at your operation, you're going to make some goals, some plans. If you've got the goals, you've got your plan, then you can start picking out what do if this happens, what do to do if that happens. But for gosh sakes keep it as simple as you can because if you get it too complex it overwhelms you..." (Nebraska Rancher, 2009)

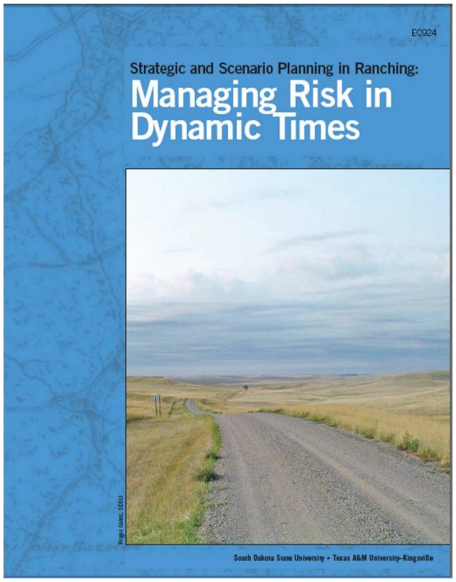
Dealing with drought is just one management aspect of the overall ranch business. Developing a ranch vision and strategic plan makes it possible for the manager to fit drought planning into this larger plan. The strategic planning process described in *Strategic and Scenario Planning in Ranching: Managing Risk in Dynamic Times,* published by South Dakota State University, outlines how to develop a vision statement and objectives, develop scenarios and strategies, implement the plan, and measure success.

Example of a ranch vision statement:

"To manage all integrated resources in order to maximize the production of protein, shape a harmonious existence with nature and maintain economic viability."

Objectives:

1. Regenerate range while using optimum percent of herbage grown
2. Enhance water and nutrient cycling and energy flow
3. Continue the management education process *(Kansas Rancher, 2009)*



While a vision statement can be quite broad, the objectives identified to foster that vision should be more specific and could focus on such areas as how the ranch operation will maintain natural resources (e.g., range health, water resources); production; financial health; customer relations; and lifestyle, learning, and growth. The decisions you make before, during, and after drought should help move you closer to the vision and objectives you have for your ranch.

Worksheet 1 can be used be used to document your ranch vision and strategic objectives.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS (SWOT)

You should understand the threats and benefits drought presents to your operation in order to identify appropriate management strategies. With the ranch resource inventory in hand, you can talk to advisors about the likelihood of drought occurrence, the effects of drought on your operation, the relationship between grazing management and drought, and related topics to gain a better understanding of the role drought plays in your particular operation. *Worksheet 3 can be used to help you better understand how drought affects your ranch.*

A SWOT analysis is another tool that can be beneficial for helping you to understand potential drought risks and benefits. SWOT is an acronym for doing an analysis of strengths, weaknesses, opportunities, and threats posed by drought. The **strengths** (S) and **weaknesses** (W) originate from within the operation; they are internal factors that influence ranch or farm performance. The **opportunities** (O) and **threats** (T) originate from outside the operation; they are external factors. If you've already conducted a SWOT analysis as part of whole-ranch planning, you may want to review it from the perspective of drought readiness. Source: Strategic and Scenario Planning in Ranching: Managing Risk in Dynamic Times

Having conversations with other ranchers and advisers and carrying out these types of assessments will provide a better basis for making more informed management decisions. A hypothetical SWOT analysis is shown below.

Example SWOT Analysis

Strengths • Pasture health on north place is good • Core herd is profitable • Purchase of south place increases AUMs • Custom grazing cattle on south place	**Weaknesses** • Water holes on south place dry up frequently • South place somewhat overgrazed • Ranch debt/asset ratio too high
Opportunities • Two calls asking for hunting leases • New EQIP program • Custom grazing partner interested in increasing cattle numbers	**Threats** • High fuel prices raise cost of shipping hay • "Above Average" likelihood of drought this year

INVENTORY OF RANCH RESOURCES

Ranch management cannot be optimized without accounting for all natural resources. An inventory of your resources helps you and all of your partners know what you have to work with. You may have conducted a whole-ranch inventory with the help of your local NRCS, Extension, or grazing organizations. Below are some recommended items to include in your inventory that are relevant to drought planning. *Worksheet 2 can be used to complete your ranch inventory.*

Resource	Why Inventory?	How?
Precipitation • Historical frequency of drought • Precipitation extremes • Average precipitation and timing	Plan for drought based on past frequency of drought and weather extremes. Knowing when to expect precipitation helps determine critical dates and target states.	Find precipitation and temperature information at http://www.hprcc.unl.edu/data/historical
Range & Forage • Plant composition & growth period • Pasture health/condition • Pasture forage production potential • Other feed supplies	Knowledge of your carrying capacity in years with near-average precipitation and your current rangeland condition and residual herbage will be critical for determining when to reduce forage demand as drought develops.	Ranchers can produce individual pasture maps with range sites at websoilsurvey.nrcs.usda.gov
Herd • Number & class of livestock • AUs throughout the year • Feed needs • Current stocking rate	Develop appropriate grazing system. Plan for feed needs during drought.	See: Doing the Math: Calculating a Sustainable Stocking Rate (http://hdl.handle.net/10365/16832)
Water • Wells/pipelines • Capacity • Water quality	Understand water capacity, and plan for water development, if needed, to support grazing system and withstand drought.	See: Water Resource Inventory and Monitoring (http://drought.unl.edu/ranchplan/InventoryMonitor/WaterResources.aspx)
Finances • Cash flow • Debt/asset ratio • Unit cost of production • Market alternatives	Gauge the ranch financial strengths and weaknesses. Weigh decisions before, during, and after drought against how those decisions might affect ranch finances.	Assessing the Economic Status of Your Beef Cow Herd (http://marketing.uwagec.org/MngTCMkt/EconStat.pdf)
Human Resources • Family members' interests/ abilities • Hired labor resources	Involve family in developing vision/goals, utilize talents, and determine labor needs.	

Liquidity	Not A Problem	Caution	Serious Problem
Net Cash Flow: Annual Inflow -- Outflow	Large Positive	Small Difference	Large Negative
Solvency	**Not A Problem**	**Caution**	**Serious Problem**
Debt/Asset	< 40%	40 - 60%	> 60%
Networth: Total Assets – Total Liabilities	Large	Moderate	Small
Change In Net Worth	Positive	Small	Large Negative
Unit Cost	**Not A Problem**	**Caution**	**Serious Problem**
$/cwt[1]	Low	Above Average	High

[1]Compared to benchmark herds.

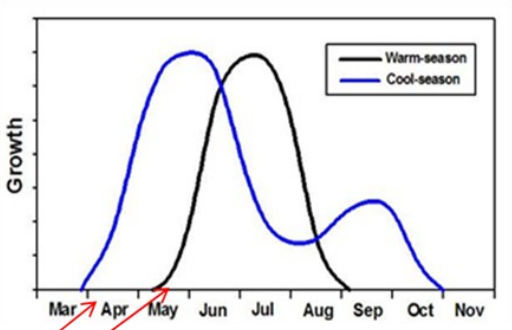
Source: Hughes et al. 2010

CRITICAL DATES AND TARGET POINTS

Identifying "critical" dates when management decisions will need to be made is another important part of drought planning. Critical dates are also timely monitoring points in annual management cycles. On **critical dates**, current and predicted forage resources should be compared to current and predicted forage demand (**target points**), and balancing steps taken (**action plans**). *Worksheet 4 can be used to document your critical dates and target points.*

Critical dates may be based upon midpoints of rapid-growth windows for dominant grass species. Precipitation and soil moisture reserves are most important just prior to and during the rapid growth windows of dominant forage species.

Critical dates will be earlier for cool-season forage resources compared to warm-season species. Many semiarid rangelands are composed of mixtures of cool and warm-season species. It is often helpful to select two critical dates when most species of each growth-season category have headed to evaluate the contribution of each component to total herbage production.



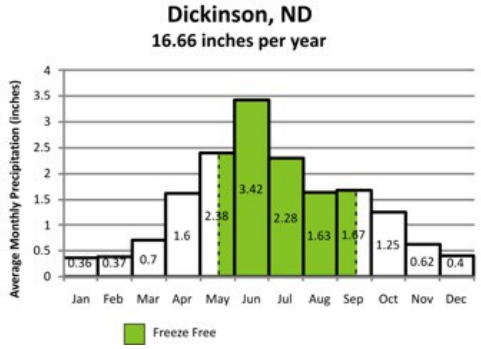
Critical Dates for Monitoring Resources in cool season vs warm season pastures

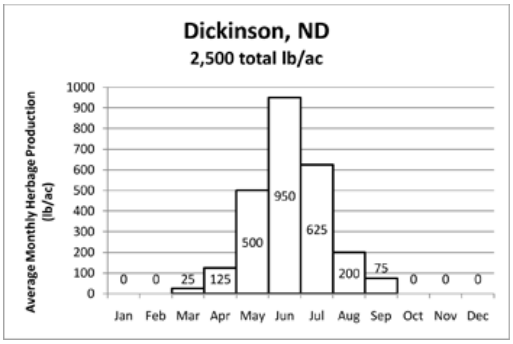
Work with NRCS, university folk, or your own advisors to identify the earliest possible indicators of pending forage deficits. Some possible indicators:

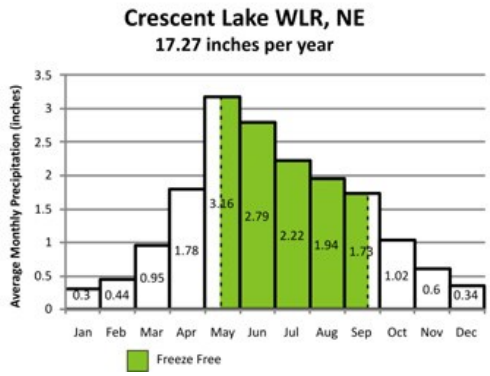
- Soil moisture
- Last year's precipitation and plant growth
- Precipitation starting in October
- Precipitation in recent months
- Short-term precipitation and temperature forecasts
- Current standing herbage
- All residual herbage

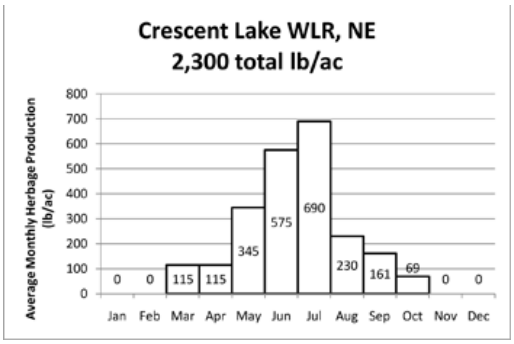
SET DATES BY LINKING PRECIPITATION PATTERNS AND FORAGE GROWTH

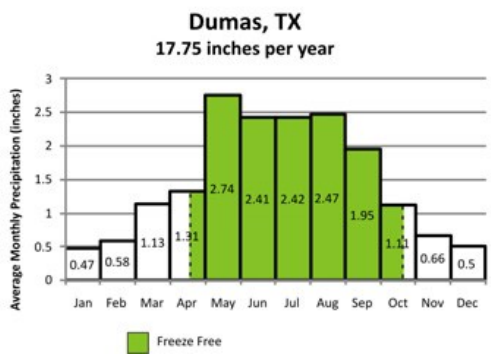
This example looks at three sites with similar soil types and plant communities, located near Dickinson, North Dakota (N 46º 53'), Crescent Lake Wildlife Refuge (WLR), Nebraska (N 41º 43'), and Dumas, Texas (N 35º 52'). In all of these locations, sand bluestem (Andropogon hallii) and prairie sandreed (Calamovilfa longifolia) or big sandreed (Calamovilfa gigantea) co-dominate upland sites in high ecological condition on loamy fine sands.

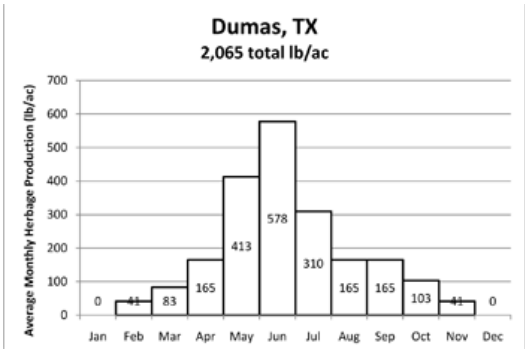












Notice how the timing of precipitation and forage growth varies tremendously among these sites.

Your NRCS, Extension, or other consultant can help you gather this type of information for your location, and use the information to select critical dates that make sense for you.

Target points may be based on carrying capacity of current forage or a prediction of forage growth based upon the percentage of average precipitation received.

In general, drought management plans for semi-arid regions are implemented when cumulative plant-year precipitation is 20 to 25% below average on critical dates. Livestock producers in sub-humid regions may select precipitation deficits of 30 to 35% because of relatively high yield responses to precipitation.

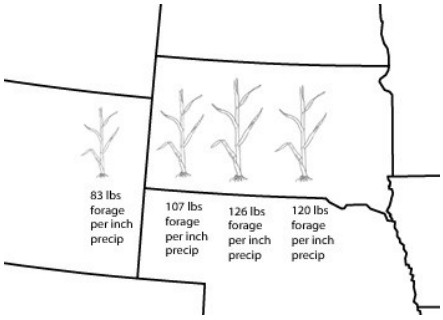
Seasonal growth patterns in the Great Plains correspond to precipitation regimes.

HOW MUCH FORAGE WILL PASTURES PRODUCE PER INCH OF MOISTURE?

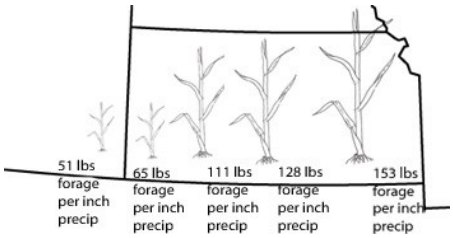
Information from the NRCS Web Soil Survey was used to develop graphic summaries of changes in peak standing herbage along west-east transects through Texas, Colorado-Kansas, and Wyoming-South Dakota. The amount of herbage produced per inch of precipitation increases as average annual precipitation increases on all 3 transects.

Eastward increases in yield response also correspond to lower elevations, longer growing seasons, and higher soil fertility. On rangeland in high ecological condition, about twice as much herbage is produced per inch of rain when annual precipitation doubles in the southern and central Great Plains.

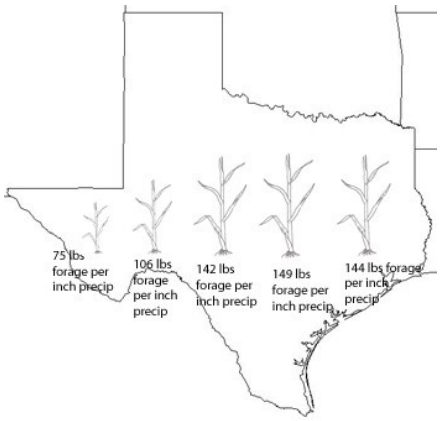
Average yield per inch of annual precipitation increases from about 74 to 144 lb/in through Texas, from about 58 to 153 lb/in from eastern Colorado through Kansas, and from 85 to 124 lb/in from eastern Wyoming through South Dakota.



Herbage production per inch of precipitation on loam soils near Bill WY, Edgemont SD, White River SD, and Winner SD.



Herbage production per inch of precipitation on silt loam soils near Bent County CO, Hartland KS, Windhorst KS, Hutchinson KS, and Moran KS.



Herbage production per inch of precipitation on clay loam soils near Pecos TX, Big Lake TX, San Angelo TX, Goldthwaite TX, and Gatesville TX.

The National Resources Conservation Service (NRCS) provides plant growth-curve information for many range sites on websoilsurvey.nrcs.usda.gov. The information may be limited to range sites in good to excellent condition (historical climax plant communities (hcpc)). Check with local NRCS and university range management advisory personnel for additional information. Site specific precipitation and temperature records including long-term and monthly data are available at regional climate centers.

SAMPLE CRITICAL DATES

NORTHERN/CENTRAL GREAT PLAINS

END OF JUNE + THROUGH-OUT SEASON	In the northern and central Great Plains, annual herbage production on good-condition loamy and silty sites dominated by mixtures of shortgrasses and midgrasses is correlated with total precipitation during May and June. Periodic monitoring will still be necessary.

CENTRAL GREAT PLAINS

JANUARY 1	On good-condition semiarid Sandhills rangelands in the central Great Plains, total annual precipitation for the two preceding years is a good indicator of herbage production during May and June (Dahl 1963).
MID APRIL	Depth of moist soil in mid April in these ecosystems correlates highly with peak standing herbage in early August. Depth of moist sand is easily measured when replacing fence posts in the spring. When there are 3 feet or more of wet soil in mid April, there will be enough herbage to support moderate stocking through the grazing season in at least 8 out of 10 years.
JUNE 1	Most cool-season grasses are in the reproductive stage of growth and warm-season grasses are in a vegetative growth stage. Height and production of the cool-season grasses has some correlation with the potential production of warm-season grasses.
LATE JUNE & LATE JULY	Near average or better precipitation during June and July would remove all concern of forage deficits.

SOUTHERN GREAT PLAINS

MARCH, JUNE, OCTOBER	Forage resources must be monitored throughout the year. In a Uvalde, Texas, example for rangeland, Larry White recommended conducting forage surveys in March, June, and October (critical dates) to determine if current forage supplies will last until additional plant growth is expected. Southern Great Plains range management advisors also emphasize the need to leave enough non-grazed herbage to support hydrological condition.

MONITORING PLAN AND SCHEDULE

It is important to monitor key resources on your critical dates, if not more frequently, so that you have the information you need to make decisions. Maintaining precipitation and grazing records for every pasture are the most critical rangeland monitoring activities every year. Scouting for indicator species and assessing hydrologic condition of rangeland should also be done annually. Below are some examples of key resources that may need to be monitored. Go to drought.unl.edu/ranchplan/inventorymonitor to see techniques for monitoring ranch resources.

You can create your own monitoring plan and schedule using Worksheet 5.

What to Monitor	When	Target Condition
Precipitation	On critical dates, prior to forage rapid growth, or monthly	Normal or percent of normal
Forage Availability	On critical dates or as needed when rotational grazing	Meet AUM needs
Residual (Remaining) Forage	After moving animals out of pasture	Meet hydrologic needs
Range Condition	Every few years	Meet ranch objectives
Livestock Grazing Records	Throughout grazing season as animals moved	Meet ranch objectives
Livestock Gain	Beginning and end of grazing season	Meet ranch objectives
Body Condition	Critical intervals in production cycle	Meet ranch objectives
Financial Health	Annually	Meet ranch objectives
Markets	As needed	Meet ranch objectives
Water Resources	Annually	Meet water quantity and quality needs

EVALUATE DROUGHT MANAGEMENT STRATEGIES

Drought is only one of the management challenges that ranchers need to plan for. It is important that the decisions you make before, during, and after drought fit into your overall plan. The decisions you make before, during, and after drought should help move you closer to the vision or goals that you have for your ranch.

As you think through best management practices to implement before, during, and after drought, you may want to consider:

Does it move you toward your vision or goals? Drought planning is just one piece of your overall ranch vision and goals, but can help you achieve your goals if you keep them in mind.

Is it feasible? Reflecting back on your inventory of your ranch resources, and the strengths, weaknesses, opportunities, and threats you identified, is this strategy something you can realistically do?

Will it make an impact? To explore what other producers and advisors have identified as being effective strategies to prepare for drought, seek out examples such as the Managing Drought Risk on the Ranch website (http://drought.unl.edu/ranchplan) or local resources.

Do the benefits outweigh costs? Financial decision making tools may help you identify the costs and benefits of proposed projects, and help you see the larger financial implications of your decision. The next few pages present some issues to consider in making changes to your operation. *Worksheet 6 may also be useful for documenting your ideas.*

EVALUATE BEST MANAGEMENT PRACTICES THAT HELP YOU PREPARE FOR DROUGHT

There are many strategies that you could use to achieve your overall objectives, and to reduce the impacts experienced in drought. With a limited amount of money, time, and energy, you must determine what actions you can take now and in the future that are most appropriate for creating a drought resilient operation.

These important decisions are outside of the realm of this publication, except to say again that management strategies that maximize the health of range resources and make the most of flexibility in the operation will contribute to an operation that weathers drought relatively well. Avoid overgrazing. Leave adequate plant cover for hydrologic condition of pastures. Strive towards financial health. Establish communication habits within the family and ranch business. Be clear about objectives and long range vision.

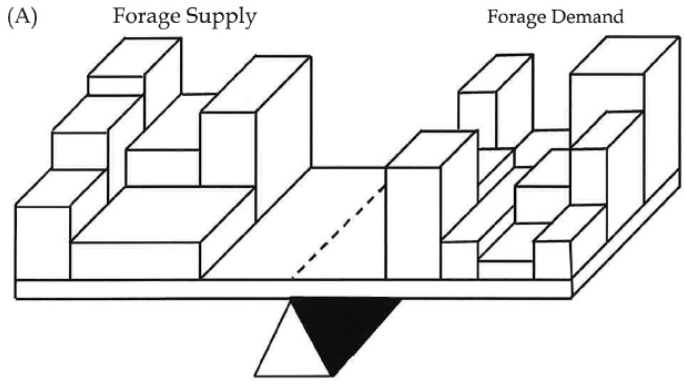
There are many excellent ranch management resources. Find more information at www.drought.unl.edu/ranchplan/beforedrought.

Some action will have to be considered and undertaken during and after drought, no matter how well you have designed your operation for drought resilience.

Use your ranch goals and strategic objectives to select action plans when managing forage demand. For example, if you have a registered or other specialized cow-calf enterprise, initially you may choose to manage forage supply more than forage demand. In contrast, commercial livestock producers should primarily focus on reducing forage demand with early sale of livestock subsets. Replacing grazing days with hay days dramatically increases cost of production. Complete liquidation of commercial cow herds may be a viable alternative to minimize loss of financial and ecological health.

Avoiding overgrazing then becomes a critical objective especially for native rangeland during drought. Herbage deficits can occur at different times of the year and the magnitude of these shortages differs among years. Consequently, drought plans need to identify prioritized subsets of livestock for sale or relocation. Sorting criteria should be based on ranch goals and objectives. They may include those listed in the figure below.

When action plans involve removing livestock, they need to be implemented quickly. When the likelihood of drought is relatively high, put the first-to-go livestock subsets in separate herds at turnout. Put a drought clause in every grazing lease and the necessary terms to make early removal of cattle efficient and equitable. Attach a copy of your drought plan to each grazing lease.



(B) Reducing Pre-drought Demand

Class	Sort By
• Stocker Steers	Ownership
• Stocker Heifers	Enterprise
• Breeding Heifers	Risk
• Heiferettes	Quality
• Cows	Age
• Bulls	Weight
	Pregnancy
	Weaning

Divide average weight by 1,000 lb = AU

Timely adjustments must be made in rangeland forage demand to minimize risk to carrying capacity and animal performance (A). Drought plans should identify livestock class and sorting criteria for specific target dates (B).

PARTIAL BUDGETING

Partial budgeting is a financial tool used to assess the costs and benefits associated with a specific change in an individual enterprise within the business operation.

1. IDENTIFY THE PROPOSED CHANGE(S)

Before starting partial budgeting, farm managers need to be clear in their minds about why they are considering making a change and to recognize the possible alternatives to the current practice that might help them meet their desired outcome. Since partial budgeting requires some effort, it is wise to choose among the best alternatives based on your initial assessment.

2. LIST THE KEY INFORMATION NECESSARY FOR ANALYSIS

This step is crucial and involves carefully gathering information pertinent to the costs and benefits associated with the proposed alternative(s). This process includes listing information about anything that would be different among the choices, such as costs, interest, yields, time, revenue, etc.

3. IDENTIFY THE POSITIVE AND NEGATIVE EFFECTS

Positive effects of the proposed change may result because of the elimination or reduction in cost of ceasing current activities and/or the generation of additional revenues by adoption of the new activities.

The negative effects of such a change could be generated by an increase in the cost by implementing the new activity and/or a reduction in the revenue from ceasing the current activity.

For example, in the case of a livestock enterprise, where buying replacement heifers is compared to raising replacement heifers from the ranch, the positive effect could be the reduction in the cost of feeding heifers limited range resources. Other cost savings may include labor, building, equipment, and management costs. The negative effects of this proposed change could be the cost of buying cows, the inclusion of inferior genetics (which results in reduced returns from the calves), or any other added cost or loss in revenue that can be attributed to buying versus raising cow replacements.

4. ESTIMATE THE NET EFFECT

Positive Effects	Negative Effects
1. Reduced Costs $ 2. Additional Returns $	1. Additional Costs $ 2. Reduced Returns $
Total Positive Effects $	Total Negative Effects $
Net Effects $	

In the final analysis, the difference between the positive and negative effects determines how the proposed alternative(s) compares with the current method of production. It is important to note that a partial budget decision is no better than the information that goes into it. The old adage “garbage in, garbage out” is very relevant. The table at left presents a simple format of partial budgeting.

Supply management includes options that increase the supply of forage and/or water by digging a well, trucking water to livestock, renting additional pasture, grazing alternative forages such as crop residue, and trucking livestock longer distances to obtain additional pasture.

Demand management options include decreasing the demand for inputs such as selling livestock, weaning calves early and moving them to a drylot or sale, and decreasing the grazing time in various pasture.

EVALUATING FEED OPTIONS DURING DROUGHT CONDITIONS

One of the most difficult parts of drought planning is determining viable feed options. Like many difficult things, the process can be better managed by reducing it to a series of steps.

1. ESTIMATE THE AMOUNT OF FEED YOU NEED TO CARRY ALL ANIMALS THROUGH THE FEEDING PERIOD.

This would be all animals, young stock, bulls, etc. It is import to be realistic and honest with yourself about the amount of feed it will really take.

2. ASSESS YOUR CURRENT FEED INVENTORIES; INCLUDE ALL FEED SOURCES THAT YOU HAVE CONTRACTED, BOUGHT, OR HAVE ACCESS TO.

It is important to consider the quality as well as the quantity.

The economic efficiency of supplements declines as the difference between livestock requirements and forage quality increases.

3. IDENTIFY ALL THE RELEVANT FEEDING OPTIONS AND EACH TOTAL COST.

This may include the purchase price, including transportation; harvesting cost if it is a standing crop, including losses; storage cost, including losses; feeding out cost, including losses; and dry matter and nutrient content.

What is key to remember here is that it really isn't what the feed cost, but rather the difference between the cost and revenue. That's what makes or breaks the bank. Two great tools for doing this are the Feedcost Cow-Q-Lator and the Partial Budgeting Work Sheet found at www.AgManagersTools.com. Don't forget any of the grazing management costs and make sure you include fencing and water, moving livestock, land rent, and wasted feed.

4. EVALUATE THE OPTIONS AVAILABLE WITH RESPECT TO YOUR GOALS AND BUSINESS PLANS, THE RANCH'S RESOURCES, OTHER RESOURCES YOU MAY HAVE ACCESS TO AND AVAILABLE FUNDS AND FINANCING.

Other sources of feed may be non-traditional in your area, such as crop residue. Having access to such extra resources may require thinking years in advance and developing those resources over time. Consider all the costs and benefits associated with buying feed from various different sources. Use partial budgeting to help you understand the economic implications of your decisions.

It is important to consider this option in different degrees and different ways considering both short-term and long-term costs. For example, a long-term benefit could be the opportunity to cull out the bottom of the herd and increase the productivity of each cow.

The basic idea when you consider reducing the herd size is to determine the potential loss of income from livestock (calves and cull animals) sales in the future as well as the reduced costs incurred for the care of fewer livestock numbers including all animal types. Timing of these sales is likely to differ from the normal operation, so include such things as the sale of animals sold earlier than normal.

The table below provides an example of how proper drought planning can lead to cost savings in a ranch operation.

Drought management strategy adopted at Gudmundsen Sandhills Ranch during 2002 drought and resulting cost-saving estimate.
Source: Nebraska Ranch Practicum 2009 Presentation by Dr. Don Adams, WCREC; Pasture rental rates for 2002 provided by Dr. Jerry Volesky, WCREC

Action taken during drought	**AUM savings**	**Cost savings (@ $25/aum in 2002 prices)**
Kept inventory current - 15 cull cow sold as identified	1.2 aum x 15 cows x 1 month = 18 aum	450
Identified 15 cows in May as culls and sold them as pairs in June instead of at weaning in October	1.5 aum x 15 cows x 5 months = 113 aum	2825
Weaned 300 March-born calves one month early in September	0.4 aum x 300 cows x 1 month = 120 aum	3000
Surplus 30 heifer calves sold 3 weeks after weaning (2 months early)	0.4 aum x 30 cows x 3 months = 24 aum	600
30 cows reduction (5% herd reduction) from September through May	1.2 aum x 30 cows x 9 months = 324 aum	8100
20 open cows sold in September (2 months early)	1.2 aum x 20 cows x 2 months = 48 aum	1200
110 cows to corn stalks in early November to late February	1.2 aum x 110 cows x 3.5 months = 462 aum	11550
25 pregnant June calving cows sold in January rather than in April as normal	1.2 aum x 25 cows x 2.5 months = 75 aum	1875
Total savings to drought management	**1184 AUM**	**29,600**

Source: Weathering Tough Times: Drought and Heat, UNL Extension

WORK TOGETHER AS A FAMILY

During crisis times, family and friends are the people who can help us see hope and a reason to look toward the future. Nurture relationships with family and friends. Avoid keeping secrets or purposefully withholding information from your spouse or partner. As problems arise, schedule time to deal with them. Weigh the costs and benefits and try to arrive at a mutually agreeable plan. Remember the value of each family member and remind each other how much they are needed and loved.

TAKE CARE OF YOURSELF

During these tough times it is even more important not to ignore basic self care and health habits.

FIND SOMEONE TO TALK TO

Our emotional and mental well-being is just as important as physical health. Family and friends usually provide emotional support. However, in times of severe stress, family and friends may not be able to offer the depth of help necessary. Mental health counselors, health workers, ministers, extension educators, and other professionals are trained to assist with problem issues and make appropriate referrals. Talking about problems doesn't make them go away, but it does help to voice concerns, deal with emotions, and examine various options.

DEVELOP A PLAN

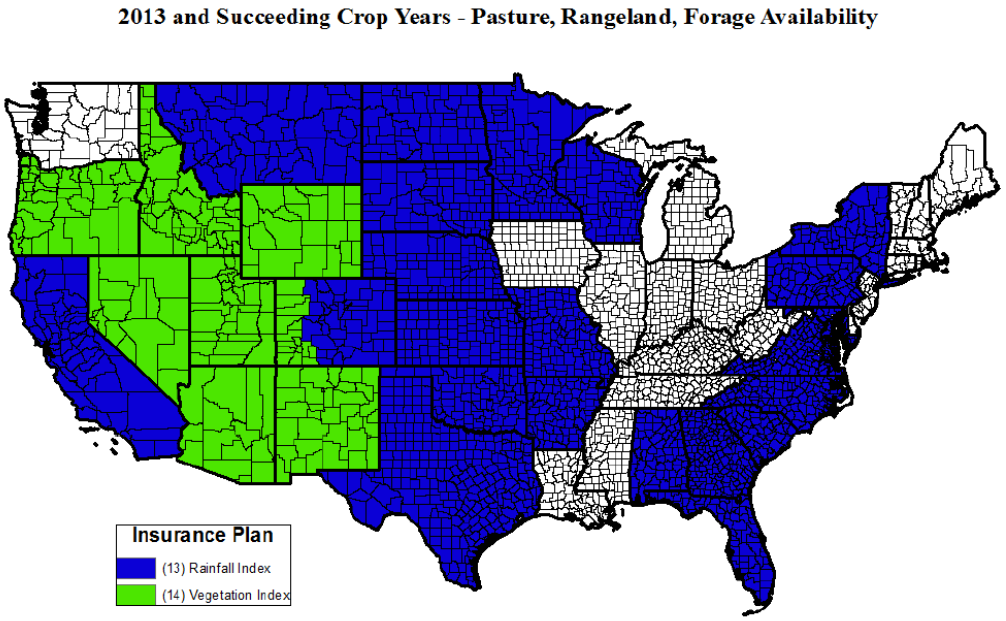
Extended drought causes many people to reevaluate their financial situation. It is human nature to think the worst without really taking an objective assessment of what resources might be available. It is easy to get stuck in the mindset that resources are strictly financial. Resources can mean many things. Identify the different types of assets at your disposal, looking beyond the obvious common financial resources. Resources include skills, interests, talents, past volunteer and work experiences, your physical location and environment, connections to other people, and, of course, family and friends, just to name a few. From that inventory, start to develop a plan based on several "what if" scenarios. Think about short-term and long-term needs, both from a family and business perspective. Be honest with yourself and your family. Working through this process will give you a clearer picture of your situation and possibly open up some options.

TAKE A BREAK!

Once you have decided upon a course of action and followed your plan, it’s time to get your mind off of the drought. Give yourself permission to take a break from the busyness of your life. Entertainment can come in small and inexpensive packages but still give a boost to your day.

PROGRAM OVERVIEW

- AREA plan only
- Losses cover an area called a grid
- No individual coverage
- Does NOT measure actual individual production
- Index – based on deviation from normal/historical
- No loss adjustments, records, etc.
- Timely payments
- Does not reward poor management practices
- Producer cannot influence outcome/ losses



INTENDED USE

- Grazingland
- Established acreage of perennial forage
- Intended for grazing by livestock
- Acreage must be suitable for grazing
- Hayland
- Established acreage of perennial forage
- Intended for haying
- Acreage must be suitable for haying

Learn more about how the program might work for you with the Pasture Rangeland Forage Decision Tool—http://agforceusa.com/rma/ri/prf/maps.

HOW IT WORKS

- Not required to insure 100% of acreage
- Forage utilized in the annual grazing or hay cycle can be insured without insuring all acreage
- All acres within a property may not be productive, e.g., rocky areas, submerged areas
- Provides additional flexibility for the insured to design the coverage to their specific needs
- Because the program is an area program, there is no opportunity to 'move' production

Learn more at http://www.rma.usda.gov/policies/pasturerangeforage/

EVALUATE STRATEGIES FOR DROUGHT RECOVERY

The length of the drought, the severity of the drought, market conditions, and other factors have a great impact on drought recovery options. Complacency in the aftermath of any scale of drought is hazardous. Cumulative effects of excessive grazing and intermittent drought can change species composition enough to cause measurable long-term declines in herbage production. When drought ends, vegetation recovery should become a primary management objective.

Priorities after drought breaks:

1. Restore hydrologic condition of rangelands
2. Restore plant vigor
3. Animal production objectives

In general:

- Do not graze weed infested pastures.
- Restock based on the recovery of mid- and tall-grasses by looking at the cover and height of preferred species.
- Delay entry of summer pastures by 1-2 weeks.
- Restoration of hydrological condition requires a reduction in spring and summer stocking rates.
- Rest pastures when air temperatures and soil moisture are simultaneously favorable for relatively rapid plant growth of preferred species.

HOW LONG WILL DROUGHT RECOVERY TAKE?

Factors that will shorten recovery time: relatively high pre-drought plant vigor and ecological condition; higher average annual precipitation (eastern Great Plains); and higher yield per inch of average annual precipitation (northern Great Plains).

Factors that will lengthen recovery time: excessive grazing pressure during drought, regardless of pre-drought condition; lower average annual precipitation (western part of Great Plains); and lower yield per inch of precipitation (southern part of Great Plains).

Attempting to increase yield responses to precipitation with fertilizer or other agricultural chemicals is likely to be ecologically disastrous.

RE-EVALUATE AFTER DROUGHT

After a drought period is a good time to reflect and assess the performance of your response to drought conditions. This evaluation will help you understand how to prepare and plan for the next drought. The recovery strategy is just as critical as the drought response plan.

WHICH PART(S) OF YOUR OPERATION TO KEEP?

With the end of the drought comes the opportunity to look at your enterprise mix and evaluate how each part has either contributed to, or hindered, drought mitigation, and to determine how these enterprises might aid or hinder in the recovery process. As you identify weak and strong links in your business, you can make the necessary changes in your enterprise mix to strengthen your operation. You may decide to add or remove parts or whole enterprises.

ARE YOU GETTING A READ ON THE FINANCIAL HEALTH OF YOUR RANCH AFTER A DROUGHT?

Your financial analysis will help you pinpoint areas of your operation you need to improve on, and those that are adding to your success. Indicators of financial health such as cash flow, debt to equity ratio, and net worth are helpful in this regard. Whole farm and enterprise budgets can be used to assess profitability associated with the different operations in your ranch.

CAN EXTERNAL FORCES ALTER YOUR DROUGHT RECOVERY PLAN?

The market situation is probably the single most important variable you will need to consider. Market outlook for both inputs and outputs will guide you on what kind of ranch operations will be most profitable.

DO YOU NEED AN INVENTORY REASSESSMENT? HAS YOUR RESOURCE ENDOWMENT CHANGED? USE YOUR RESOURCE ASSESSMENT AS PART OF YOUR RECOVERY PLAN.

You need to take account of how the drought has affected your resource base. Depending on your financial health and the current state of the market, decisions can be made to use the resources wisely. It is important to keep a close eye on your natural resources, since they are what drive the cow-calf business. Overused resources are likely to have hidden costs and be less productive than well-managed ones.

NOTES:

IMPLEMENT AND MONITOR YOUR PLAN

As you implement your drought plan, ask yourself: Is it working for you? Is it moving you toward your goals? Are you satisfied with how you managed through a drought using your plan? Would you make any changes to it?

If you are doing ongoing monitoring of your finances, range, and livestock, you will have a much easier time answering these questions, as you will be able to see trends appearing.

One method of tracking your progress is called the “Balanced Scorecard”. This approach provides a simple "scorecard" method of tracking performance and goals.

Resource: Barry Dunn, Roger Gates, Jack Davis, and Argustin Arzeno (2006) Using the Balanced Scorecard for Ranching and Management, South Dakota State University and Texas A&M-Kingsville

NOTES:

WORKSHEET 1: RANCH VISION AND STRATEGIC OBJECTIVES

Date_____ Form Completed by _____

RANCH VISION:

STRATEGIC OBJECTIVES	GOAL	ACTUAL
NATURAL RESOURCES (Range Health, Water Resources) 1. 2. 3. 4.		
PRODUCTION 1. 2. 3. 4.		
FINANCIAL 1. 2. 3. 4.		
CUSTOMER 1. 2. 3. 4.		
RANCH LIFESTYLE, LEARNING, AND GROWTH 1. 2. 3. 4.		

Source: "Strategic and Scenario Planning in Ranching: Managing Risk in Dynamic Times" (Gates, Dunn et al 2007).

Date: _____ Inventory Completed by: _____

(attach additional pages as necessary)

CATEGORY	RANCH INVENTORY
PRECIPITATION • Historical Frequency of Drought • Range of Annual Precipitation Amounts • Average Precipitation and Timing	
RANGE & FORAGE RESOURCES • Range/Ecological Site • Range Condition • Forage Production Potential of Each Pasture • Other Feed Supplies	

WORKSHEET 2: INVENTORY OF RANCH RESOURCES – SHEET 2

CATEGORY	RANCH INVENTORY
HERD RESOURCES • Number and Class of Live-stock • AUs throughout the Year • Feed Needs (AUMs) • Current Stocking Rate	
WATER RESOURCES • Well Capacity and Ability to Pump • Flow Rate • Water Quality	
FINANCIAL RESOURCES • Cash Flow • Debt/Asset Ratio • Unit Cost of Production • Participation in Insurance Programs • Marketing Alternatives	
HUMAN AND PERSONNEL RESOURCES • Family members' interests and abilities • Hired labor resources	

Droughts may have direct consequences, such as reduced crop yields, livestock losses, or pond depletion. These direct impacts may then lead to secondary consequences such as physical and emotional stress, or financial insecurity. Some of the more common types of drought impacts are listed below.

Rate the following drought impacts according to how severe each impact has been for your operation during past droughts:

1 = not impacted 2 = slight impact 3 = moderate impact
4 = severe impact 5 = devastating impact

RANGE/PASTURE

Reduced productivity of rangeland	
Range fires	
Increased weeds	
Disrupted plant communities	
Decrease in desirable forage species	
Wind and water erosion of soils	
Other	

WATER

High cost/unavailability of water for livestock	
Reservoir or pond levels dropping	
Reduced flow from springs	
Water quality problems	
Other	

HERD

Forced reduction of foundation stock	
Decreased livestock gains	
Greater disease, pests, health issues	
High cost/unavailability of feed	
High livestock mortality rates	
Disruption of reproduction cycles	
Decreased stock weights	
Increased predation	
Other	

FINANCIAL

Inability to support ranch employees	
Inability to fulfill debt obligations	
Decrease in capital	
Increase in debt/asset ratio	
Borrowing value of land and stock drops	
Tax penalties from sell down	
Future price/income risks	
Watering and feed costs increase	
Other	

SOCIAL/FAMILY

Mental and physical stress (e.g., anxiety, depression, loss of security, domestic violence)	
Increased respiratory ailments	
Reduction or modification of recreational activities	
Off-farm/ranch employment required at higher levels	
Family Stress	
Other	

Based on the impacts you see on your operation, you can begin to plan the areas that will take priority in your drought plan.

WORKSHEET 4: CRITICAL DATES AND TARGET CONDITIONS

Date_____ Form Completed by _____

Critical dates are timely monitoring points in annual management cycles. Current and predicted forage resources are the primary focus of critical dates.

Each **critical date** should have an **action plan** that clearly states **target points** for initiating the plan.

Target points may be based on carrying capacity of current forage or a percentage of average precipitation, i.e., 75%.

See “Identify Critical Dates and Targets” at http://www.drought.unl.edu/ranchplan for suggested critical dates by region.

CRITICAL DATE	TARGET CONDITION

Date_____ Form Completed by _____

WHAT TO MONITOR	WHEN	TARGET CONDITION
PRECIPITATION	My Dates:	My Targets:
FORAGE AVAILABILITY	My Dates:	My Targets:
RESIDUAL (REMAINING) FORAGE	My Dates:	My Targets:
RANGE CONDITION	My Dates:	My Targets:
LIVESTOCK GRAZING RECORDS	My Dates:	My Targets:
LIVESTOCK GAIN	My Dates:	My Targets:
BODY CONDITION	My Dates:	My Targets:
FINANCIAL HEALTH	My Dates:	My Targets:
MARKETS	My Dates:	My Targets:
WATER RESOURCES	My Dates:	My Targets:

WORKSHEET 6: EVALUATE STRATEGIES TO IMPLEMENT BEFORE DROUGHT

Date_____ Form Completed by _____

STRATEGIES	IS IT FEASIBLE?	WILL IT MAKE AN IMPACT?	GREATER BENEFIT THAN COST?	TO DO?
IMPROVE FORAGE RESOURCES				
MODIFY HERD/ENTERPRISE MIX				
MODIFY GRAZING STRATEGY				
IMPROVE WATER/ INFRASTRUCTURE RESOURCES				
IMPROVE FINANCIAL RESOURCES				
OTHER				

WORKSHEET 7: EVALUATE MANAGEMENT STRATEGIES DURING DROUGHT

Date_____ Form Completed by _____

DROUGHT STRATEGIES	IS IT FEASIBLE?	WILL IT HAVE AN IMPACT?	WILL BENEFITS OUTWEIGH COSTS?	TO CONSIDER?
FORAGE SAVING STRATEGIES				
FINDING ALTERNATIVE FEEDS & FORAGES				
FINANCIAL STRATEGIES				
FAMILY & PEOPLE STRATEGIES				
OTHER				

WORKSHEET 8: EVALUATE DROUGHT RECOVERY STRATEGIES

Date_____ Form Completed by _____

DROUGHT RECOVERY STRATEGIES	IS IT FEASIBLE?	**WILL IT HAVE AN IMPACT?**	WILL BENEFITS OUTWEIGH COSTS?	**TO CONSIDER?**
STRATEGIES TO RESTORE HYDROLOGIC CONDITION OF RANGELAND				
STRATEGIES TO RESTORE PLANT VIGOR				
ANIMAL PRODUCTION STRATEGIES				
FINANCIAL STRATEGIES				
FAMILY AND PEOPLE STRATE-GIES AND OTHER				

South-Central Kansas

AVERAGE ANNUAL RAINFALL- 21 inches/year.
CRITICAL DATES- April 1, June 15, August 15, & Nov 1

This example includes critical dates, trigger points (percent of average precipitation), and management decisions. A document like this might be the result of your work on ranch vision/ objectives, inventory, monitoring, setting dates and triggers, and evaluating strategies that fit your operation.

April 1

- End of the winter dormant season and the beginning of the growing season for warm season grasses
- < 4" of moisture during the winter dormant season (killing frost or Nov 1 till April 1) No prescribed burns should be conducted.
- Plan to increase the length of rest periods earlier than usual.

June 15

- About half of the forage is produced by June 15
- 75%(15.75") of the annual average rainfall is received between Nov 1 & June 15
- If the rainfall is <80% (12.60") of the 75% (15.75") then the stocking rate should be decreased 30% by weight. (Finish culling herd C)
- If the rainfall is < 60%(6.30") of the 75%(15.75") then the stocking rate should be decreased 40-50% by weight (Cull herd B deep)
- The 3 weeks following June 15th is very critical. By July 15 the destocking should be completed.
- Rest periods should be as long as possible by June 1 if any indicator of a drought is present.
- Graze periods should be as long as possible to allow the other paddocks to rest for as long as possible.

August 15

- About 90% of the annual forage has been produced. Warm season grasses are preparing for next year growing season. Rest between now & frost will benefit next year's grass production.
- Length of grazing season-Based on the rainfall in July & August
- If rainfall is <70% (1.50") of the average 5" during July & August end herd C grazing by Sept 1(Cull Deep)

November 1

- End of the growing season and the beginning of the winter drought(drought season)
- < 80%(16.80") of the 21" average annual precipitation would indicate the beginning of a drought for the next growing season unless the winter is exceptionally wet

SDSU Extension

livestock

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SOUTH DAKOTA STATE UNIVERSITY®
ANIMAL SCIENCE DEPARTMENT

Drought Management Tips for Beef Cattle Producers

Ken Olson | Professor & SDSU Extension Beef Specialist
Adele Harty | SDSU Extension Cow/Calf Field Specialist

Dealing with drought is an ever-present issue. Even when drought is not occurring, producers are either recovering from one or should be planning for the next. Thus, these tips for drought management cover the spectrum of creation and execution of a drought management plan in good times and bad.

Big Picture

1. **Have a plan.** Having a written drought management plan is critical to proactive management before, during and after drought. A well-executed plan is key to minimizing the devastating effects during drought and speeding recovery after drought. However, to do that, the plan must be executed in non-drought times to position the land, livestock, and other resources for reduced impact when drought occurs. The drought plan should be written to ensure that it is well thought out and to reduce the chance that something is forgotten or misunderstood when in crisis mode. The following tips should be addressed in the drought management plan. For more information on drought management plans, see *Managing Drought Risk on the Ranch A Planning Guide for Great Plains Ranchers* (https://drought.unl.edu/archive/Documents/RanchPlan/ranch-plan-handbook-to-print-9.14.pdf)

Supply Management

The best management plan is to stock conservatively in good years to be prepared for drought years. This is true for both rangeland and tame pasture settings. Conservative stocking in normal precipitation years leaves a forage reserve that can forestall the need to reduce stocking because of drought. It is especially important to not overgraze both during and after a drought. Overgrazing after the drought will delay or prevent vegetation recovery. This can permanently impair the health and productivity of the land.

2. **Improve grazing distribution.** Even with good grazing management, there will almost always be areas of pastures that are underutilized. To take advantage of the forage in underutilized areas of a pasture, use management tools that improve grazing distribution such as strategic placement of supplements or water. Even though this might be old forage from previous years, it can be a valuable resource if supplements are provided to overcome nutrient deficiencies. For more information see: *Grazing Distribution* (http://www.ksre.ksu.edu/bookstore/pubs/mf515.pdf)

3. **Consider alternative sources of forage and their management considerations.** A wide variety of alternative forages often become available during droughts. For example, CRP is often released for grazing or hay production, and cereal or corn grain crops that won't produce adequate grain to harvest can be grazed or harvested as hay or silage. Additionally, cropland can be planted to cool-season or summer annual crops for the purpose of providing emergency forage during drought. All of these forage sources can have management concerns. These concerns include inadequate or unbalanced nutrient content, toxins such as nitrates and prussic acid, and grazing restrictions because of application of pesticides. A variety of additional informational resources include:
   - *Alternative Feeds for Ruminants* (https://www.ag.ndsu.edu/publications/livestock/alternative-feeds-for-ruminants/as1182.pdf)
   - *Using CRP Hay during Drought* (https://beef.unl.edu/using-crp-hay-during-drought)

- *Grazing Corn Stalk Residue* (http://beef.unl.edu/cattleproduction/grazing-corn-stalk-residue)

4. **Purchase winter feedstuffs early at lowest cost, before prices spike as the drought worsens.** Even in normal precipitation years, prices are typically lowest in summer when feedstuff demand is lowest and rise as winter demand escalates. Drought causes these price increases to be more dramatic and volatile. Starting early will allow producers to make wise purchasing decisions. Even as prices rise because of the impact of drought, a producer needs to resist the temptation to make rash decisions. During drought, it becomes very important to invest time in shopping for the best price possible for the nutrients needed. Alternative options should be compared on a cost per unit of nutrient basis rather than price per ton. For example, if forage needs to be purchased primarily for its energy content, calculate the cost per mega-calorie (Mcal) from each feed. For a tool to compare feeds on a cost of nutrient basis, see: *Feed Nutrient Calculator* (https://extension.sdstate.edu/feed-nutrient-calculator)

5. **Consider the economics and feasibility of feeding cows in a drylot.** Often, alternative sources of forage, as described in tip 3, are not locally available. Hay or silage from failed crops, CRP, and emergency crops of annual forages can be hauled to the location of the cows or vice versa, depending on which is less expensive. Sometimes it is best to put failed crops such as corn into silage rather than hay. In this case, hauling the cattle to the silage is required and placing them in drylot near the silo is the most efficient. In either case, moving the cattle from pasture to a drylot has at least two advantages: First, it makes feed management and delivery easier. Second, it provides total relief for the drought-stressed pasture. For a tool to compare hauling cattle vs. hauling feed, see: *Move the Cows or Move the Feed* (https://extension.sdstate.edu/move-cows-or-move-feed)

   If alternative sources of forage are not available at economic prices, consider limit-feeding a high-concentrate diet to cows in drylot. In this case, an energy-dense ration based on grain or byproduct feeds such as distillers' grains would be fed in limited quantity so that the cows receive adequate nutrition to maintain body condition, but not enough to get fat. Because the diet is essentially a finishing diet for feedlot cattle, careful management is needed to avoid nutritional disorders such as acidosis.

   For more information about drylot feeding of cows, see:
   - *Drylot Beef Cow-Calf Production* (https://www.ag.ndsu.edu/publications/livestock/drylot-beef-cow-calf-production/as974.pdf)
   - *Limit Feeding Concentrate Diets to Beef Cows as an Alternative to Feeding Hay* (http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2017/ANSI-3028web.pdf)

6. **Minimize Feed Waste.** Although waste should always be managed, it is most important when feedstuffs are expensive and in limited supply. For hay, using bale feeders is key. Additional features on round bale feeders that further reduce waste include sheet metal around the bottom, slanted bars, and an internal cone. Moving from feeding hay on the ground to a well-designed hay feeder can reduce waste by as much as 30%. Putting out a one-or two-day supply of hay rather than more will also reduce waste. In drylot settings, active reading of bunks and management of daily feed deliveries is key to not providing excess feed that will go to waste. Managing so bunks are clean (slick) or only contain crumbles immediately before daily feed delivery will not only reduce waste, but will likely contribute to improved feed conversion by the cattle. For more information see:
   - *Feeding Management to Minimize Hay Waste* (https://u.osu.edu/beef/2019/01/23/feeding-management-to-minimize-hay-waste/)
   - *Feed Bunk Management* (https://store.extension.iastate.edu/Product/Feed-Bunk-Management)

7. **Understand the role of creep feeding calves during drought.** Some have recommended providing creep feed to calves so the supplemental feed substitutes for grazed forage and stretches the drought-limited forage supply. While this may be true, early weaning is a better alternative for

reducing grazing pressure. Not only does it totally eliminate grazing by calves, it also reduces forage requirements by cows because they are not lactating (see tip 12). Additionally, management of the feedstuffs used as creep feed can be controlled better in a drylot setting with weaned calves. For more information see: *Creep Feeding Options: Will it Pay?* (https://extension.sdstate.edu/creep-feeding-options-will-it-pay)

8. **Be wary of poisonous plants.** Many poisonous plants have taproots that extend deep into the soil to extract moisture that grass cannot reach, and therefore they may be the only green vegetation in the pasture. While these poisonous plants are present during normal precipitation years, other green vegetation is available for cattle to select. Be able to identify poisonous plants that are common in your area so you can remove cattle from a pasture with poisonous plants that are highly apparent under drought conditions. For more information, see:
   - *Drought Increases Toxic and Poisonous Plant risk to Livestock* (https://beef.unl.edu/cattleproduction/toxic-poisonous-plant-risk)
   - *Poisonous Plants to Livestock in the Western States* (https://www.ars.usda.gov/is/np/PoisonousPlants/PoisonousPlants.pdf)

9. **Manage livestock water supplies.** Livestock water may run out before forage does. Producers need to be prepared to haul water. Planning and developing improved sources of water that are drought-proof is an important part of drought management during years of normal precipitation. Drilling wells and installing pipelines can provide water supplies with increased reliability. Springs and ponds can be improved by cleaning and developing them to increase capacity. Although we suggest that water developments should be planned and conducted during normal precipitation years, the best opportunity to rejuvenate ponds by dredging sediment is when they dry up during a drought. Planning before the drought is important to being prepared when the opportunity arises. For more information see: *Waterers and Watering Systems: A handbook for Livestock Producers and Landowners* (http://www.ksre.ksu.edu/bookstore/pubs/s147.pdf)

10. **Monitor water quality in both surface and ground water to avoid poor cow and calf performance and death loss.** Surface and ground water in many areas of the Great Plains are high in sulfate content. Sulfates in water cause cattle to reduce water intake, which in turn leads to decreased forage intake and depressed performance. At higher concentrations of sulfates, cattle develop polioencephalomalacia, a brain disorder that quickly progresses from lethargy to death. Sulfate concentration in water often increases under drought conditions, primarily because water depletion increases the concentration of sulfates in the remaining water. Increased vigilance to ensure that safe, low-sulfate water is available to cattle during drought is important to cattle performance and survival. Another water quality concern during drought is blue-green algae blooms. These blooms are most likely to occur during hot, calm weather conditions. For more information see:
    - *How Do Sulfates in Water Affect Livestock Health* (https://extension.sdstate.edu/how-do-sulfates-water-affect-livestock-health)
    - *Blue-Green Algae and Livestock* (https://extension.sdstate.edu/blue-green-algae-and-livestock)

Demand Management

Adjust stocking rates to match drought-induced reductions in forage yield to avoid long-term damage to the base forage resource. Selling productive livestock is always hard to do. However, strategic and timely reductions in specific classes of livestock can play a role in minimizing the overall magnitude of cow herd dispersal over a long-term drought. The longer a producer waits, the deeper he will have to cull when the forage is completely depleted (e.g. total herd dispersal in a worst-case scenario). For more information see: *Drought and Stocking Rate Effects on Forage Yield from Western South Dakota Rangelands* (https://openprairie.sdstate.edu/cgi/viewcontent.cgi?article=1068&context=extension_extra)

11. **Monitor cow body condition score (BCS).** Body condition scoring provides a measure of the nutritional status of an animal. Research has shown that BCS influences productivity, particularly in terms of reproductive performance. Body condition scoring can provide an objective measure of the

influence of drought-induced forage shortage on the ability of grazing cattle to meet their nutritional needs. Specific BCS targets can be set in drought management plans to trigger stocking rate reductions to ensure sustained performance of remaining cattle. For more information, see:

- *Effects of Cow Body Condition and Calving Date on Calf Performance* (https://openprairie.sdstate.edu/cgi/viewcontent.cgi?article=1013&context=sd_beefreport_1988)
- *3-Step Body Condition Scoring (BCS) Guide for Range Cattle: Implications for Grazing and Reproduction* (http://www.wyoextension.org/publications/html/B1294/#:~:text=Optimum%20BCS%20is%20a%205,BCS%20of%203%20or%20lower)

12. **Wean calves early.** Cows need significant nutrients to meet the requirements of lactation. Weaning calves eliminates the lactation requirement and substantially reduces forage consumed to meet the nutrient requirements of the cow. Additionally, as calves grow, their consumption of grazed forage increases. Early-weaning calves and removing them from pastures will reduce forage demand by as much as 36% (https://extension.sdstate.edu/early-weaning-drought-management-strategy). For more information see:
    - *Early Weaning Beef Calves* (https://www.ag.ndsu.edu/drought/feeds-and-feeding/early-weaning-beef-calves)
    - *Economic Considerations for Early Weaning* (https://extension.sdstate.edu/economic-considerations-early-weaning)

13. **Shorten the breeding season and pregnancy check all cows 25 days after breeding ends.** This requires pregnancy diagnosis with ultrasound. It is key that cows diagnosed as open are immediately culled and marketed to eliminate their forage demand. Shortening the breeding season to 45 days or less selects the most fertile cows that get pregnant early in the breeding season, ensuring that the retained cattle are the most productive. While the overall herd size may need to be reduced, this practice ensures that the impact on overall productivity is minimized by improving herd reproductive performance. Additionally, the culled cows will be marketed earlier than most, avoiding the market downturn that is typical when most herds are being downsized in the drought-stricken region. For more information, see
    - *Tightening up Calving Season* (https://extension.sdstate.edu/tightening-calving-season)
    - *Bunch the Cow Herd* (https://extension.sdstate.edu/bunch-cow-herd)
    - *Beef Management & Reproduction Report Card* (https://extension.sdstate.edu/sites/default/files/2020-02/P-00146.pdf)

14. **Manage the bull inventory. Because of their larger size, bulls demand substantially more forage than cows.** Thus, reducing the number of bulls will have a greater impact than eliminating an equal number of cows. Consider eliminating bulls and utilizing artificial insemination (AI). If natural service is used, consider shortening the breeding season (see tip 13) and selling bulls when breeding ends. As a bull ages and gets larger, he requires more forage than a young replacement bull. For example, a mature 2400 lb. bull consuming 2% of body weight will eat about 48 lbs. per day, while a yearling bull weighing 1200 lbs. will consume about 24 lbs. per day. Selling the bull battery at the end of breeding eliminates forage demand by bulls until replacements are purchased before the next breeding season.

15. **Make timely herd reduction decisions using cow performance records.** A drought management plan should have trigger dates when a set percentage of cows should be sold based on a measure of drought severity, possibly as indicated on the U.S. Drought Monitor (http://droughtmonitor.unl.edu/) or a specific deficit in precipitation. The plan should call for a series of small cuts that start early in drought. A small percentage of the poorest performing cows culled early may be key to saving forage to reduce the magnitude of later cuts, thus retaining more cows in the long run. The plan should specify how to choose which cows to sell. Comprehensive and up-to-date individual cow performance records can be invaluable to identifying the least productive cows. For example, if the plan specifies that 10% of the cows will be sold if precipitation is 50% of normal on May 1, a computerized performance

record program that can provide a ranked list of the cows that are least productive will support identifying the cows to sell. Selective culling can lessen the overall impact of herd reduction, much like culling the less fertile cows suggested in tip 13. For more information, see:

- *Production Records for Cow/Calf Producers* (https://www.asi.k-state.edu/research-and-extension/beef/research-and-extension/ProductionRecordsforCowJan2016.pdf)
- *Guidelines for Uniform Beef Improvement Programs* (https://beefimprovement.org/wp-content/uploads/2018/03/BIFGuidelinesFinal_updated0318.pdf)

16. **Diversify into a cow-calf plus yearling operation.** Yearlings are more liquid than cows. They can be sold whenever resources are too limited to support them. By having yearlings to sell when drought limits forage availability, the investment in genetics in the cows can be retained. A drought management plan should have a trigger mechanism to determine when yearlings should be marketed. In general, it is best to set this trigger early in drought to maximize forage savings for the cows. Additionally, it is usually easier to restock with yearlings after drought recovery rather than attempting to rebuild the genetics in a cow herd. For more information see
    - *A Systems Thinking Approach to Ranching: Finding Leverage to Mitigate Drought* (https://journals.uair.arizona.edu/index.php/rangelands/article/view/19710/19339)
    - *Increasing flexibility in rangeland management during drought* (http://www.ars.usda.gov/SP2UserFiles/person/1354/98.%20Kachergis%20et%20al%202014%20Ecosphere%20drought%20paper.pdf)

Marketing and Finances

Written marketing and financial plans should be in place that include contingencies for marketing cattle under drought conditions and managing the financial implications of drought-induced management decisions. The marketing contingencies should be tied to the triggers for reductions in cattle numbers or changes in timing of marketing, such as early sale of yearlings or disposition of early-weaned calves.

17. **Market drought-induced herd reductions.** Market timing is important. Tips 12 to 16 discussed managing herd inventory during drought. As indicated, herd reductions should be made early in drought to maximize forage savings for remaining inventory. Another reason to sell early is that local cattle markets generally decline during drought-induced runs of cattle. Selling before the run helps reduce market losses.

18. **Avoid selling lightweight, early-weaned calves.** Early-weaned calves have been shown to perform well in feedlot settings. Rather than sell early-weaned calves at less than their potential value because of their small size, consider retaining ownership into a feedlot in a region not influenced by drought. Custom feedyards exist to feed cattle owned by customers such as cow-calf producers that retain ownership. Ownership can be retained for varying lengths of time. One option would be to feed them to normal weaning age and weight. Another would be to retain ownership to slaughter. Custom yards provide valuable services as partners to add value to weaned calves. They will typically assist with calculating breakeven prices to determine the best option under a given set of circumstances. The cost of drought-diminished forage supply is a great enough economic hardship; taking a hit on income because of lightweight calves should be avoided. For more information see:
    - *Feeding Management for Backgrounders* (https://www.ag.ndsu.edu/pubs/ansci/beef/as1158.pdf)
    - *Early Weaning Beef Calves Sometimes Makes Cents* (https://beef.unl.edu/cattleproduction/earlyweaning)
    - *A Cow-calf Producer's Guide to Custom Feeding* (https://www.ag.ndsu.edu/publications/livestock/a-cow-calf-producers-guide-to-custom-feeding/as1162.pdf)

19. **Consider using risk management strategies (e.g., futures, options, and Livestock Risk Protection).** Market prices for both cattle and feed typically become more volatile during drought. This means protection from risk associated with market volatility becomes more important than usual. This can be particularly true if ownership is retained on early-weaned calves, as discussed in tip 18.

Custom feedyards typically include assistance with risk management among the services that they provide to customers. For more information, see:

- *Livestock Risk Protection for Cattle* (https://extension.sdstate.edu/livestock-risk-protection-cattle)
- *Self-Study Guide to Hedging with Livestock Futures and Options* (https://www.cmegroup.com/trading/agricultural/files/AC-215_SelfStuy_GuideNYMEX.pdf)

Forage insurance is another risk management tool to be considered as a contingency for drought. In essence, it is an insurance policy that pays when forage production is reduced due to natural causes such as drought. For more information, see: *Pasture, Rangeland, Forage Insurance is a Risk Management Tool for Producers* (https://beef.unl.edu/cattleproduction/prfinsurance)

20. **Utilize livestock indemnity and forage disaster programs.** The USDA Farm Service Agency administers these disaster assistance programs. They provide government-funded payments to overcome economic hardship caused by natural disasters such as drought. For more information see:
    - *Livestock Indemnity Program* (https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/livestock_indemnity_program_lip-fact_sheet.pdf)
    - *Livestock Forage Disaster Program* (https://www.fsa.usda.gov/Assets/USDA-FSA-Public/usdafiles/FactSheets/livestock_forage_program_lfp-fact_sheet.pdf)

21. **Communicate with your Management Team.** Maintain close communication with your lender, tax accountant, and other financial professionals to keep them abreast of your financial situation. They play key roles in managing the influence of drought-induced decisions on profit, cash flow, tax implications (e.g. capital gains on cow sales), and related issues.

Back to the Big Picture.

As was said at the beginning, a drought management plan that considers these tips will play a role in mitigating the negative effects of drought. Final considerations include:

22. **Think outside the box.** As you make your plan, realize that one cannot continue "business-as-usual" during drought. Opportunities to find the best alternative feeds, market into the best prices possible, and generally reduce the damage will be found through unusual opportunities. People that fare the best during trying times are those that are open minded to alternatives. For more information see: *Tips for Overcoming Paradigm Lockdown* (http://beefmagazine.com/blog/tips-overcoming-paradigm-lockdown)

23. **Plan ahead for drought recovery management.** It will rain someday. The key to range recovery is allowing the land to overcome the stress of drought. Much like we have suggested triggers to instigate decisions and actions during drought, a drought plan should have triggers for restocking and returning to normal management as drought recovery occurs. While rapid restocking may provide the fastest short-term recovery from the economic hardship, it may not be the best for long-term stability. For more information see: Where to start if you are recovering from drought (http://drought.unl.edu/ranchplan/AfterDrought/StartHereAfterDrought.aspx)

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A Self-Learning Resource From MSU Extension

MONTANA STATE UNIVERSITY EXTENSION

MontGuide

Nitrate Toxicity of Montana Forages

by Emily Glunk, *MSU Forage Extension specialist;* Kathrin Olson-Rutz, *MSU Research Scientist;* Marc King, *Sweet Grass County Extension agent;* Dave Wichman, *Superintendent, Central Agricultural Experiment Station;* Clain Jones, *MSU Soil Fertility Extension specialist*

This publication outlines strategies for avoiding nitrate toxicity, including proper management, monitoring forage nitrate levels, and appropriate feeding programs.

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FORAGE CROPS CAN ACCUMULATE TOXIC amounts of nitrate (NO_3). High nitrate has been reported in cereal grains (oats, rye, wheat, barley, triticale, spelt, etc.), bromegrass, orchardgrass, fescue, sorghum, sudangrass, millet, corn, sweet clover and alfalfa. Several weeds, such as kochia, lambsquarter, pigweed, quackgrass and Russian thistle, can also have high nitrate levels, especially when growing under adverse conditions.

Nitrate poisoning of livestock was reported as early as 1895. Livestock losses occurred for many years before elevated nitrate levels in forage were determined to be the cause of death. The term "oat hay poisoning" was the common explanation for livestock losses in the 1930s, because large acreages of oats were harvested for forage during drought years, and oat accumulates nitrate more than most other cereal forages (Westcott et al., 2012).

Nitrate toxicity

Nitrate itself is not toxic to animals, but at elevated levels, it can cause a noninfectious disease called nitrite poisoning. At normal levels, forage nitrate is broken down by rumen microbes to nitrite (NO_2), and then further to ammonia (NH_3). This ammonia is then converted to protein by the rumen microbes for use by both the host animal and resident rumen microbes.

When an animal consumes excessive levels of nitrate, nitrite accumulates faster than it can be converted to ammonia and microbial protein. The accumulated nitrite passes into the small intestine, where it is absorbed into the bloodstream. Hemoglobin, the oxygen carrying molecule in blood, is converted to methemoglobin by high levels of nitrite. Methemoglobin is unable to supply oxygen to the body.

This low oxygen supply causes many negative effects in the animal (listed below). The intensity of nitrite poisoning is affected by the amount and duration of exposure to high nitrate levels. Chronic toxicity is caused by an animal consuming small amounts of high-nitrate forages over long periods of time, whereas acute toxicity is caused by a large amount of high-nitrate forage being eaten over a short period of time.

Signs of nitrate poisoning

Signs of early or chronic toxicity:

- Watery eyes
- Reduced appetite
- Reduced milk production
- Rough hair, unthrifty appearance
- Weight loss or no weight gain
- Night blindness
- Abortion

Signs of acute toxicity:

- Accelerated pulse rate
- Labored breathing, shortness of breath
- Muscle tremors
- Weakness
- Staggering gait
- Cyanosis (membranes such as the tongue, mouth, vulva and the whites of eyes, turn blue)
- Death

Treatment of chronic nitrate poisoning

The effects of sub-lethal nitrate levels on livestock health and performance are not well-defined. In our region, chronic symptoms such as abortions and poor winter health are of concern because we rely on hay during pregnancy and lactation. Safe and unsafe levels of nitrate in livestock feed have been established. Despite these guidelines, the effects of nitrate vary among individual animals, condition and age of livestock, other feeds in the diet and weather. Chronic nitrate toxicity can only be treated by knowing the N levels of forages and avoiding or diluting the affected feeds.

Treatment of acute nitrate poisoning

Acute nitrate toxicity can occur very rapidly, sometimes within minutes of observing the first signs. Oxygen transport in the blood is sharply reduced, causing the venous blood to become chocolate brown in color.

In these cases, the only way to save an affected animal is an immediate intravenous dose of methylene blue by a veterinarian. Due to the risk and speed of nitrate poisoning, relying on this treatment is not the best management practice to prevent nitrate toxicity death. Rather, producers should be aware of nitrate accumulating species and growing conditions, and use management strategies presented under "Guidelines for feeding livestock" to reduce potential nitrate toxicity.

Nitrate levels in plants

Nitrogen from the soil is taken up by plant roots in the form of nitrate. Plants convert nitrate to nitrite which in turn is converted to ammonia and then to amino acids, the building blocks of protein. Plant tissue accumulates nitrate during the night when photosynthesis is inactive, peaking in the morning. During the day, nitrate is quickly converted to protein when adequate sunlight

TABLE 1. Nitrate accumulation varies among crops, varieties, plant maturity, with forage treatment and nitrogen fertilization management.

Generality	Example NO_3 (ppm)		
Plant species and varieties vary in nitrate accumulation	Oats contained 1.5 times the nitrate as the average of oat, barley, spelt, spring wheat and triticale. Westford barley accumulated more nitrates than Haybet barley. [1]		
Nitrates decrease as plants mature	Oat at:	Heading	5047
		Flowering	4726
		Soft dough	3027
Plant parts vary in nitrates	Oat with 100 lb N/acre:	Stems[2]	8000
		Leaves	4200
		Heads	1000
Nitrates increase with high N fertilization	Oat stems at boot stage with:	50lb N/acre[2]	6000
		100lb N/acre	8000
		150lb N/acre	12500
Ensiling tends to decrease nitrates once fermentation is complete	Corn with 200 lb N/acre as:	green forage[3]	2319
		Silage	1468

[1] Westcott et al., 2012; [2] Crawford et al., 1961; [3] Vough et al., 2006

energy is available. Under normal growing conditions, there is little nitrate buildup; however, in some cases the roots accumulate nitrate faster than the plant can convert nitrate to protein. Nitrate accumulation varies among crop species and varieties, crop management, soil fertility, plant parts and plant maturity (Table 1).

When do toxic levels occur?

Abnormal, or "stressful", growing conditions such as drought, frost, unseasonable or prolonged cool temperatures, hail, shade, disease, insects, high levels of soil nitrate, soil mineral deficiencies or herbicide damage can cause high nitrate accumulation in forages. Crops grown under "stressed" conditions or on soils that have received high applications of manure or nitrogen fertilizer are especially suspect (Table 1). Mineral deficiencies, phosphorous and potassium in particular, may cause excessive accumulation of nitrates in the plant material. Adequate Sulfur may also help to convert nitrate to plant protein, thus decreasing nitrate buildup. It is always important to fertilize according to soil test recommendations to ensure adequate soil and plant nutrient balances. Split nitrogen applications and weed control during the growing season can help manage excessive nitrogen in forages.

Preventative Forage Management to Avoid Nitrogen Toxicity

- Soil test and apply nitrogen fertilizer in split applications during the growing season
- Control weeds, especially kochia, lambsquarter, and pigweed
- Plant dryland alternative cereal forages with high water use efficiencies, e.g. winter wheat, spring grains, etc.
- Cool-season cereal forages mature earlier and can be harvested prior to hail season, drought or frost.

Harvest Management

Take precautionary measures prior to harvesting or feeding forage if you suspect high nitrate concentrations. Even under ideal conditions, nitrate accumulation is unpredictable. Elevated nitrate levels are particularly suspect following environmental events such as drought, rain, hail, wind (lodging), frost, etc. Nitrate concentrations can vary among areas of a single field, haystack or silo. Therefore, nitrate testing is advised in many situations. Most MSU Extension Agents can provide the "Nitrate QuikTest," which is a rapid, qualitative test for high nitrate levels (Cash et al., 2005).

Avoid cutting or grazing when nitrate concentrations are at peak levels. Since peak nitrate levels occur in the morning, delay haying or grazing until the afternoon of a sunny day. In high soil nitrate environments or with nitrate-accumulating varieties, consider delaying harvest and raise the cutter head to avoid stalk bases. Nitrate concentrations will be highest in the lower third of the plant stalk, and so avoiding this area of the plant material will decrease risk of nitrate toxicity. If high nitrates are found or suspected in cereal forages, delaying harvest from flowering to soft dough stage can significantly decrease nitrate levels (Table 1). Also, toxic levels of nitrate can accumulate in forages immediately after a drought-ending rain or irrigation. If possible, wait about a week before harvesting or grazing after drought-ending moisture (Fjell et al., 1991).

Anticipate and test for nitrates following an environmental event such as rain, hail, wind, disease or insect infestation, drought, overcast weather, etc.

If possible, harvest forage immediately after an environmental event and prior to shoot regrowth which is high in nitrogen.

Crimp hay to accelerate dry down and volatize nitrogen (denitrification)

Nitrate toxicity is most likely to occur when livestock are pastured or fed green-chop, followed by hay. Silage is the least hazardous feed. Ensiling forage usually lowers the nitrate level 10 to 60 percent, as the fermenting microbes are able to consume the nitrates present in the forage. The nitrate level in hay usually remains constant or declines slightly in storage; however, this should not be expected.

Producers should never assume their forage levels are safe if they know a crop was exposed to any adverse growing conditions that increase nitrate accumulation.

Sampling plants or feeds for nitrate

Prior to harvest, sample standing crops that you suspect may have elevated nitrate levels. Collect 20 stems randomly by traversing in a zigzag pattern across an entire field. Clip the plants at ground level and test them with an Extension Agent trained in nitrate testing. If nitrate is detected using the qualitative test and growing conditions are normal, delay harvest for several days, which will usually reduce nitrate levels rapidly. Periodic testing may be necessary to assure that the nitrate level has declined. Use the qualitative test as a preliminary screening measure, and submit forages suspected of having elevated levels of nitrate for quantitative laboratory analysis.

Sampling hay or haylage (low moisture silage) for nitrate requires collection and testing of appropriate samples. An accurate measurement of forage nitrate is not possible unless the sample analyzed in the laboratory is representative of the forage lot in question. Poor sampling techniques or an inadequate number of subsamples are the main sources of error in analysis. Hay or haylage from different 'lots', that is harvested at different times (more than 48 hours apart) or from different fields, should each make up their own sample to be analyzed. Each 'lot' sample should be a composite of random subsamples taken from 20 bales or representing 10 percent for the stored forage.

At least one pound of forage is necessary for an adequate sample. Keep silage samples frozen until analysis to prevent nitrogen losses from volatilization or chemical changes. Seal hay and silage samples in plastic bags and ship to the laboratory in dry ice or insulated container for testing as soon as possible. See your Extension Agent for a list of laboratories that provide forage nitrate testing.

TABLE 2. Converting one form of nitrate to another.

Generality	Example NO_3 (ppm)	
	To convert reported data to one of these multiply by:	
Reported as	**NO_3 - N**	**NO_3**
Nitrate-nitrogen (NO_3-N)	(1)	4.4
Nitrate (NO_3)	0.23	(1)

Examples: 0.1% NO_3- N = 0.44% NO_3 (0.1 x 4.4);
0.44% NO_3 = 0.1% NO_3-N (0.44 x 0.23)
0.1% = 1000 ppm (move decimal point four places to the right)
750 ppm = 0.075% (move decimal point four places to the left)

Nitrate laboratory reports

Results of nitrate analysis may be confusing because of the variation in reporting methods. Further confusion and questions exist because of varying guidelines on what levels of nitrate can be fed safely. In the chemical analysis for nitrate, the actual element determined is the oxidized nitrogen. However, values may be reported as percent nitrate or nitrate-nitrogen (NO_3-N). Efforts have been made to have nitrate analysis and tolerances for safety uniformly reported as nitrate-nitrogen on a 100 percent dry matter basis. However, at present, reports may be given as nitrate or nitrate-nitrogen reported as either percent or as parts per million (Table 2).

Nitrate in water

In addition to forages and other feeds, drinking water can significantly contribute to nitrate toxicity. Nitrate in water can pose a greater risk than forage nitrate (Hibbard et al. 1998). Therefore, threshold hazard levels are lower for water than those for feeds (Table 3).

Nitrate applied to or produced in the soil may leach into groundwater or run-off into surface water. It is more concentrated below or near areas of animal and human fecal accumulation or disposal (e.g. feedlots, septic tank drain fields). High nitrate is more likely to be found in groundwater under low areas and waterways. Water from shallow, dug, bored and driven wells more frequently contains high nitrate than water from deep drilled wells. Test water from wells immediately following a wet period when levels tend to be highest (Undersander et al., 1999).

TABLE 3. Guidelines for use of drinking water with known nitrate content[1].

NO_3-N (ppm)	NO_3 (ppm)	Comment
< 10	< 44	Generally regarded as safe for all animals and humans.
10-20	44-88	Questionable or risky for humans, especially young children and pregnant women. Safe for livestock unless feed also has high levels. Animals drinking 10 pounds of water per 100 pounds of body weight would have intake of less than 0.1 gram NO_3-N per hundred pounds of weight if water contains 20 ppm NO_3-N.
20-40	88-176	Considered unsafe for humans; may cause problems for livestock. If ration contains more than 1000 ppm NO_3-N and the water contains over 20 ppm, the total NO_3-N is likely to exceed safe levels.
40-100	176-440	Unsafe for humans and risky for livestock. Be sure that feed is low in nitrate and a well-balanced ration is fed. Fortify ration with extra vitamin A.
100-200	440-880	Dangerous and should not be used. General or non-specific symptoms such as poor appetite are likely to develop. Water may also be contaminated with other foreign substances. When allowed free choice to cows on a good ration, acute toxicity not likely.
> 200	> 800	**DO NOT USE.** Acute toxicity and some death losses might occur in swine. Probably too much total intake for ruminants on usual feeds.

[1] Source: Undersander et al., 1999.

Portable meters are available to field test water nitrate levels before turning stock onto a pasture. If the water quality is questionable, get the water tested by a laboratory; your Extension agent or county health department can help with this.

Nitrates in forages and feed

Nitrate risk is generally characterized as the concentration of nitrate in a forage or feed. Feeding suggestions for forages with different nitrate concentrations have been developed based on numerous research trials (Table 4).

Guidelines for feeding livestock

Due to the variations in plants, water sources, and livestock, it is difficult to develop specific guidelines that fit all conditions. If there is a potential nitrate problem, growers should first have an accurate laboratory analysis of the suspect forage nitrate concentration. The nitrate concentrations and risks listed in Table 3 assume that high-nitrate forages comprise the entire diet, rather than a portion of the ration, and do not account for differences in animal size. For example, a 500-pound steer may have nitrate toxicity after consuming 15 pounds (3% of body weight) of barley hay that contains 8,000 ppm nitrate. However, if the steer weighs 1000 pounds or hay intake is limited to six pounds per day, no problems may occur. Therefore, the potential nitrate risk is better expressed as total nitrate consumption on a bodyweight basis (Table 5).

The following guidelines were developed conservatively to help assure animal safety. Reasonable animal health, feeding and care is assumed. Safe levels of nitrate are not specifically known for all various livestock feeding conditions.

TABLE 4. Effect of nitrate concentration on livestock[1]. These guidelines are more conservative than some others published.

Reported on 100% dry matter basis[2] as:		
NO_3 - N (ppm)	**NO_3 (ppm)**	**Comment**
<350	<1,500	Generally safe for all conditions and livestock
350-1,130	1,500-5,000	Generally safe for nonpregnant livestock. Potential early-term abortions or reduced breeding performance. Limit use to bred animals to 50% of the total ration.
1,130-2,260	5,000-10,000	Limit feed to 25-50% of ration for nonpregnant livestock. **DO NOT FEED TO PREGNANT ANIMALS** - may cause abortions, weak calves and reduced milk production.
>2,260	>10,000	**DO NOT FEED.** Acute symptoms and death.

[1] Source: Hibbard et al., 1998; [2] If nitrate content of a feed is reported on an "as is" basis, convert to 100% dry matter basis to compare it to levels in this table. For example, silage at 40% moisture that contains 600 ppm NO_3-N on an "as is" basis contains 600 ppm/0.6 = 1000 ppm on 100% dry basis; thus it fits the second group in this table.

TABLE 5. Determining feed and water nitrate uptake per pound of animal weight.

Nitrate from feed (mg/lb body weight) = [concentration of NO_3-N (ppm) x dry forage consumed per day (lb)]/body weight (lb)
Using 3% dry matter intake (DMI), this equation simplifies to: concentration of NO_3-N(ppm) x 0.03
Nitrate from water (mg/lb body weight) = [concentration of NO_3-N (ppm) x gallons consumed per day x 8.3 (lb/gallon)]/body weight (lb)
Total nitrate intake (mg/lb body weight) = nitrate from feed + nitrate from water

Toxicity of total daily nitrate intake in milligrams (mg) per pound of body weight[1].		
NO_3-N	**NO_3**	**Comment**
< 5*	< 20	Generally safe for all conditions and livestock.
5–14	20–60	Generally safe for nonpregnant livestock. Potential early-term abortions or reduced breeding performance. Limit use to bred animals and to 50 percent of the total ration.
14–28	60–120	Limit feed to 25–50 percent of ration for nonpregnant livestock. **DO NOT FEED TO PREGNANT ANIMALS** – may cause abortions, weak calves and reduced milk production.
>28	>120	**DO NOT FEED.** Acute symptoms and death.

[1] Hibbard et al. 1998

Forages with sub-lethal nitrate levels can be fed to healthy livestock with appropriate precautions:

- feed hungry livestock tested dry hay prior to exposure to decrease likelihood of rapid overconsumption,
- graze or cut forages in the afternoon when nitrate levels are lowest
- stock lightly so animals can select leaves, the lowest nitrate-containing portion of plants
- adapt livestock gradually to increasing levels of the suspect forage, see Strickland et al., 2003, for details
- feed grain with the hay to stimulate rumen microbes to convert nitrate to nontoxic amino acids and proteins at a faster rate, and
- blend with low-nitrate feeds.

Never turn hungry animals onto pasture with heavy dew or after irrigation.

High-nitrate feeds can be diluted with low-nitrate feeds to reduce the nitrate hazard of the ration using the following equation:

WL = (WH) (%H - %B) / (%B - %L), where
WL = weight of safe, low-nitrate hay required,
WH = weight of high-nitrate hay,
%H = nitrate concentration of high-nitrate hay,
%B = nitrate concentration desired in final blend,
%L = nitrate concentration of low-nitrate hay required for blending.

For example, a producer with 10 tons of hay tested at 0.6 percent (6000 ppm) nitrate, could blend 15 tons of hay tested at 0.1 percent (1000 ppm) to produce 25 tons of feed with 0.3 percent (3000 ppm) nitrate. The two hay lots should be processed and mixed thoroughly in a tub grinder to provide the proper dilution. The contribution of nitrates in drinking water towards total nitrate intake must be considered when calculating 'safe' feed blends. Also, if urea supplement is available in addition to high nitrate feed, it can exacerbate the rumen's high nitrate induced ammonia imbalance and lead to additional neurotoxic symptoms (urea toxicity) caused by excessive ammonia.

Boluses or feed additives containing the rumen bacteria Propionibacterium acidipropionici strain P5 (the active ingredient in Bova-Pro®) reduce the probability of nitrate toxicity. Boluses should be fed once, 10 days before exposure to high-nitrate feed, while the feed additive needs to be fed daily for 10 days prior to feeding high-nitrate feed (Highfill, 2011). The additive must also be ingested daily in order to ensure microbial survival and effectiveness. This supplement does not provide instant protection or heal affected animals and should be used in combination with other preventive measures.

In addition to the variations in plant and environmental factors that contribute to nitrate toxicity, there can be extreme variability among livestock for predisposal to nitrate toxicity. In feeding trials where toxic doses of nitrate were administered to a uniform group of beef cattle, there were three-fold differences among animals in the rate of blood methemoglobin formation (Hibbard et al., 1998). Diet and the rumen environment can significantly impact nitrate tolerance by individuals. Livestock that are thin or suffer from respiratory infections are more prone to nitrate toxicity.

Consult with your local Extension Agent for specific questions regarding sampling of forage suspected of containing dangerous levels of nitrate and your veterinarian about nitrate poisoning.

Summary:

- There are many factors that can increase nitrate levels in forage.
- Soil test and apply appropriate nutrients.
- Select forage types and crop rotations to avoid toxic nitrogen buildup.
- Control high nitrogen accumulator weeds within forage stands.
- Time harvest and grazing to minimize risk of nitrate toxicity.
- Monitor crop nitrate levels, especially immediately prior to harvest.
- Test your forages and water if there is potential for nitrate toxicity.
- Dilute any high-nitrate forages with low-nitrate forages to create a safe ration for livestock.

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A Self-Learning Resource From MSU Extension

Grazing Leases

by Kate Binzen Fuller, Assistant Professor/Extension Specialist, Dept. of Agricultural Economics and Economics; and Jeff Mosley, Professor/Extension Range Management Specialist, Dept. of Animal and Range Sciences

MONTANA STATE UNIVERSITY EXTENSION MontGuide

This MontGuide is a modified and updated version of Montana State University Extension Bulletin 120, *Pasture Leases and Beef Cattle Share Arrangements,* by Kent Williams, John Lacey, Dave Phillips, and John Ranney

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"WHAT IS THE VALUE OF MY PASTURE IF I LEASE it out to someone else?" and "How much should I pay to run my cattle on someone else's land?" are very common questions, but the answers are not always straightforward. Often, deciding whether to lease land is the easy part. With so many different types of leases available, decisions regarding the choice of lease and all its details can be tricky. Leases can be fixed or flexible, paid as a flat cash fee or based on this year's production or prices. Agricultural leases can be for land only, but can also include buildings, improvements, and machinery. In this bulletin, we discuss general guidelines for developing grazing (sometimes called pasture) leases.

What is a grazing lease?

A grazing lease is an agreement in which a landowner allows a tenant (the person who leases from the landowner) to graze livestock on the landowner's property. Typically, the tenant will pay the landowner some cash amount in exchange for the use of the land and the forage it provides. That cash amount can be determined in a variety of ways and may not be the same from one year to the next.

Estimating Grazing Lease Rates

Grazing lease rates can be estimated in a variety of ways, including:

- Comparing the grazable forage resource with the rates that others are charging (i.e., market value approach)
- Calculating anticipated income by comparing expected costs and returns (i.e., anticipated income approach)
- Considering the cost of alternative feeds (i.e., alternative feed approach) or
- A combination of these methods

The **market value approach** requires knowledge of local rental rates for grazing. Local rental rate information should be modified to fit each specific set of conditions. For example, local rental rates might be adjusted upward or downward for a particular grazing lease to reflect differences in forage quality, availability of stock water, presence of poisonous plants, responsibility for maintaining improvements, acreage, and length of lease agreement. Average county-wide cash rental rates on a per-acre basis, and for Montana as a whole on a per-head, per-cow/calf pair, and per animal unit month (AUM) basis for non-irrigated grazing lands are computed by the National Agricultural Statistics Service (NASS), and can be found using the NASS Quickstats website (http://quickstats.nass.usda.gov/) or the Montana State University Extension Ag Lease website (msuextension.org/aglease).

The **anticipated income approach** considers the expected returns of both the landlord and tenant. Landlords often seek a grazing rental rate that will cover their property taxes, their opportunity cost on the value of the land (that is, what the land might have earned for them if put to another use), the depreciation of improvements, and operating costs. Tenants often want to be assured a reasonable economic return from the grazing rental, taking into consideration livestock production costs and expected prices of livestock. Both parties will benefit from the development of cost and return budgets for the resources that they would contribute to a lease. The landlord should calculate the costs and returns associated with the grazing resource and associated improvements. The tenant should budget the costs and returns to livestock with grazing rental costs included.

The **alternative feed approach** estimates the value of grazing land forage by comparing it to the current feed value of an alternative feed source, such as grass hay or

stubble aftermath. This approach is easier when both feed sources have similar nutritive values. Average prices for several types of hay in Montana are available from NASS Quickstats: http://quickstats.nass.usda.gov/. The Montana Hay Hotline (http://services.agr.mt.gov/Hay_List/) is another source of current, local information, and the USDA Agricultural Marketing Service (http://www.ams.usda.gov/mnreports/bl_gr310.txt) gives current statewide averages for hay sales.

Basis for Expressing Lease Rates

Livestock grazing lease rates can be expressed in a variety of ways – per acre, per whole tract, per AUM, per head, share of gain, or variable basis. The basis on which the lease rate is expressed should best fit the needs of all parties to the lease. The basis of expressing the lease rate is often influenced by local tradition, but it can have important implications for both parties. The way in which lease rates are expressed can also determine whether the landowner is playing an active or passive role, which can be important in self-employment tax calculations. If the landowner is sharing in profit (and risk) in the operation, which is more common in share of gain or variable rate leases, that landowner can be subject to self-employment tax.

Per acre lease rates differ with the productivity of the grazing resource and lease conditions. The landlord usually receives the same rental rate each year for the duration specified in the lease. The tenant assumes the risk of annual fluctuations in forage production due to weather.

Per whole tract lease arrangements refer to leasing a block of land or ranch for a specified annual fee. This type of lease is normally used when leasing an entire ranch for a period of years or when a mixture of land types (rangeland, seeded pasture, crop aftermath, forest) are in the unit leased.

Per animal unit month (AUM) lease charges provide flexibility in allowing for different kinds and classes of livestock by using the AUM as a common denominator. However, the definition of an AUM can vary, so it is important that both parties understand the definition being used, and this definition can be included in the lease itself.

Per head or per pair lease rates, charged per month or season, vary with the type of livestock. Because even one species of animal can consume drastically different quantities of forage, depending on its age, weight, and other factors, utilizing AUMs as a common denominator may be preferable.

Share of gain applies to seasonally-grazed, weight-gaining animals such as stocker cattle, replacement heifers, and lambs. These charges may consist of a pre-established charge per pound of gain or a share of the total weight gain for the grazing period. The economic charge should be justified on the relative contribution to production costs by tenant and landlord, and current or futures prices can be used to determine an appropriate charge for pound of gain. In the following example, animals are weighed before and after grazing, and the landlord charges the owner of livestock 50¢ per pound of steer gain.

Example: Steers grazing from June 1 to August 30:
final weight (August) 900 lbs.
initial weight (June) 600 lbs.
total gain and price *300 lbs. x 0.50 =$150/steer*

Variable leases use a base rate that is fixed for the term of the lease and a variable rate that allows the lease rate to vary annually with livestock prices. The base rate should be established by considering the relative contribution of both parties to total production costs. The variable rate is formulated by considering prices from a livestock market and developing a price index.

For example, consider a base lease rate of $5 per acre adjusted at weaning using the October futures price relative to a rolling ten-year average calf price. Suppose the ten-year average is $1.50 per pound, and the October futures price is $2.00 per pound[1]. The indexed lease rate would be $5 x (2.00/1.50) = $6.67 per acre.

Regardless of how the lease rate is expressed, a grazing lease should always clearly specify the number and kind of animals allowed and the dates that these animals will be allowed to graze the leased land, and what will happen if the animals need to be removed early in the case of drought or fire. In some cases, it may be simplest to write a grazing lease on a per-acre basis and then stipulate in the lease the number and kind of livestock allowed. This approach eliminates potential confusion about the definition of an AUM, and maps can be used to definitively determine the number of acres included in the lease. However, specifying the definition of AUM in the lease will address many of these issues.

Terms of a Grazing Lease

Lease terms should be fully understood by both parties. To avoid misunderstandings and ambiguity in lease terms, leases should be written agreements. An unwritten lease can be very difficult to enforce, and leases over one year in duration must be in writing in Montana[2]. Lease agreements should be signed and dated by both landlord and tenant. Signatures should be notarized, and both

1. Ten year averages can be computed from livestock prices available at http://quickstats.nass.usda.gov/; feeder cattle futures prices are available at www.cmegroup.com/trading/agricultural/livestock/feeder-cattle.html.

2. See MCA 70-20-101 (http://leg.mt.gov/bills/mca/70/20/70-20-101.htm).

landlord and tenant should consider filing the signed lease with the local County Clerk and Recorder. Qualified legal advice is advised in developing the final version of the lease.

Leases must be developed to fit the specific situation. Consideration should be given to the following terms:

Grazing Management Considerations

Maintenance and Improvements. Provisions can be specified in a lease for maintenance necessary to prevent deterioration of fences, corrals, water developments, and other structures. In addition, range improvement practices (e.g., weed control, seeding, fertilization, new fence construction, etc.) may also be incorporated into the lease agreement as part of the fee or a condition of lease renewal. The lease should also specify how and if the tenant will be compensated for costs incurred by the tenant for improvements.

Stocking Rate. A stocking rate guide can be used to help set the allowable stocking rate for a lease. Table 1 provides suggested stocking rates for livestock grazing in Montana during spring, summer, or fall. If livestock grazing occurs only in winter, the stocking rates in Table 1 can likely be increased 20 percent. Your local Montana State University Extension (MSU Extension) office or local office of the USDA Natural Resources Conservation Service (NRCS) can also suggest appropriate stocking rates.

Recordkeeping and Monitoring. It is advisable that a grazing lease require the tenant to keep records of actual turn-on and turn-off dates and the number of livestock grazed. The tenant should also be required to submit these records to the landlord at the end of the grazing season each year. Some leases also require the tenant to further document grazing use with photos taken of the land immediately before and after the grazing season each year. Your local MSU Extension or NRCS office can help establish photo monitoring procedures.

TABLE 1. Livestock stocking rate guidelines for Montana rangelands, pastures, and forests.

Forage Type	Annual Precipitation (inches)			
	11-14 inches		15-19 inches	
Native Rangeland	Acres/AUM[1]	AUMs/acre	Acres/AUM	AUMs/acre
Run-in Sites (i.e., sites where water collects)				
Excellent Condition	0.9	1.1	0.8	1.2
Good Condition	1.2	0.8	1.1	0.9
Fair Condition	2.0	0.5	1.7	0.6
Poor Condition	4.0	0.25	3.3	0.3
Normal Sites				
Excellent Condition	2.5	0.4	1.7	0.59
Good Condition	3.3	0.3	2.2	0.45
Fair Condition	5.0	0.2	3.3	0.3
Poor Condition	10.0	0.1	6.7	0.15
Run-off Sites (i.e., sites where water runs off)				
Excellent Condition	4.0	0.25	2.5	0.4
Good Condition	5.0	0.2	3.3	0.3
Fair Condition	10.0	0.1	5.0	0.2
Poor Condition	20.0	0.05	10.0	0.1
Dryland Seeded Pasture	0.8–2.0	0.5–1.25	0.5–1.0	1.0–2.0
Dryland Hay Aftermath	2.5	0.4	2.0	0.5
Irrigated/Subirrigated Seeded Pasture	0.2–0.5	2.0–5.0	0.2–0.5	2.0–5.0
Irrigated Hay Aftermath	1.0	1.0	1.0	1.0
Grain Crop Aftermath	5.0	0.2	3.3	0.3
Dry Coniferous Forests				
20 percent Tree Canopy Cover	N/A	N/A	3.0	0.33
40 percent Tree Canopy Cover	N/A	N/A	6.0	0.17
60 percent Tree Canopy Cover	N/A	N/A	12.0	0.08

1. AUM = Annual Unit Month, the amount of forage needed by one 1,000-lb cow or its equivalent for one month

General Terms

A lease should include the names of the involved parties; number of acres involved; legal description of the leased land; number and kind or class of livestock; type of lease – annual, seasonal or continuing; starting and ending dates; and the method and conditions of payment. Lease agreements should also include the home addresses, mailing addresses, and emergency phone numbers of the landlord and tenant.

Lease Conditions

The length of the lease, as well as when rent is due, should be specified. Whether insurance is required is also an important consideration. It is recommended that a grazing lease stipulates that the tenant must carry liability insurance for the livestock that graze the leased property. Rights and conditions of renewal should be delineated, along with considerations regarding whether subleasing is allowed, and what will occur if the landlord or tenant dies. The right to terminate the lease, if it is breached or otherwise, must be specified.

Special Clauses

A grazing lease should address procedures to modify or terminate the lease in case of fire, drought, flood, and other emergencies. Prohibited activities or restrictions such as hunting or fishing privileges and logging should be stated in the lease. Grazing leases commonly specify that the tenant's vehicles (trucks, pickups, ATVs, etc.) travel only on established roads or trails, although exceptions are commonly allowed if needed to enable weed control or in case of emergency.

Landlord Services and Tenant Agreement

If the landlord has responsibilities for the tenant's livestock, those should be spelled out within the lease. Landlord services offered as part of a grazing lease vary from no more than collecting the lease payments to taking complete care of the livestock. For example, responsibilities vary among landlords and tenants for treating sick animals, checking water, providing salt and mineral supplements, herding or moving livestock between pastures, and maintaining fences. Guidelines governing the tenant's responsibilities for repairing facilities should also be specified. The landlord's right to inspect the property, and/or how it will be monitored in the landlord's absence should also be clearly defined.

Other

Qualified legal assistance should be consulted to set up the terms of your lease and make sure liabilities are addressed.

Useful resources

Montana State University Agricultural Land Leasing.
msuextension.org/aglease

Disclaimer

This publication is not intended to be a substitute for legal advice. Consultation with a lawyer is advised.

Acknowledgement

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Water Quality for Livestock

by Megan Van Emon, Extension Beef Cattle Specialist, Montana State University
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Fresh, clean water is a daily requirement of all classes of livestock. In fact, water is the most essential nutrient for livestock health and production. Animals need water to help them regulate their body temperature, digest their food, lubricate their joints, grow muscle, and to carry out almost every other biological process in their bodies.

Water quality may be impaired by contaminants such as salts, excessive nutrients, or bacteria, which can become more concentrated during drought as water sources dry up. Most contaminants will cause animals to drink less water, which, causes them to eat less, negatively impacting health and production. However, if livestock water (or food) contains a high amount of salt, animals may drink more water because salty water doesn't fully quench thirst. This is why testing to know what is in your animals' drinking water is extremely important for livestock production.

Water samples can be sent to commercial labs to analyze for parameters such as: total dissolved solids (TDS), sodium, calcium, magnesium, chloride, nitrate-nitrogen, pH, iron, copper, and conductivity. TDS is a common concern for livestock producers as it is a measure of the minerals, salts, metals, and other ions dissolved in water. Increased concentrations of TDS can cause aversion to the water source and/or illness, but TDS does not indicate the specific dissolved solid that may cause additional issues.

Concentrations of TDS may change throughout the year. Figure 1 below demonstrates the fluctuations in TDS levels in three water sources in southeastern Montana. Based on these results, water source Number One would not provide suitable livestock drinking water during most of the summer and fall. The variability of the results throughout the summer and fall also illustrates the importance of testing water sources immediately before and during livestock use. TDS can be estimated in the field using a simple meter that measures specific conductance. These meters can be purchased for as little as $15. More complex meters are also available for purchase at an increased cost. Table 1 lists the effects of increasing TDS concentrations in livestock drinking water.

Water with high TDS may also have high concentrations of sulfates or nitrates. High sulfate water tastes bitter and livestock may drink less water than they need to remain healthy. High sulfate concentrations in water can also lead to polioencephalomalacia (polio). Livestock owners should be especially aware of water sulfate concentrations when feeding high-sulfur feedstuffs, such as distillers grains or corn gluten feed, because the combination of sulfates in the water and sulfates in the feed can be toxic to livestock, similar to high levels of nitrates in water and feed sources (refer to BSSA Fall 2014 for more information on nitrate toxicity). High-sulfate water is also a concern when livestock are consuming feeds that contain high concentrations of the trace mineral molybdenum. It may be necessary to supplement cattle with copper when they are consuming feed high in molybdenum and sulfur and drinking water high in sulfates. Currently, MSU Extension faculty in Custer, Fallon and Carter counties can test water samples in their

offices to estimate sulfate concentration. Table 2 provides recommendations for safe sulfate levels in livestock drinking water.

Finally, bacteria are another common water contaminant that can depress livestock health. High bacteria concentrations in livestock drinking water can cause infertility, foot rot, and low milk production. Manure getting into stagnant water sources is a common source of bacteria and can also contribute to blue-green algae problems which can be toxic to livestock. Blue-green algae will bloom during hot weather and the winds are calm. The only prevention of poisoning by blue-green algae is to remove the livestock from consuming the contaminated water source. Blue-green algae blooms form on the surface of the water and is not able to be picked out and removed from the water source like a typical green-algae. Additionally, leptospirosis and fusobacterium can contaminate water and mud. Leptospirosis is spread through the urine and can rapidly spread through the herd. Fusobacterium causes foot rot, which is spread on hooves, which can lead to contamination of other sources of ground water they enter. For these reasons, minimizing manure reaching water sources will improve livestock health.

In summary, water quality is crucial to maintaining livestock production and health. Water quality differs throughout the year even from the same source and is greatly impacted by weather events, such as drought or heavy rainfall. Information gained from periodic water tests for TDS, sulfates, nitrates, and bacteria can help livestock owners to be good livestock stewards. Contact your local MSU county or reservation Extension office for water quality tests available in-house and testing laboratory contact information.

Table 1. Recommended use of livestock drinking water that contains total dissolved solids (TDS).

TDS Content (ppm)	**Recommendations**
<1,000	Low levels, excellent source of water for livestock.
1,000 to 2,999	Satisfactory for all livestock; may cause mild diarrhea in livestock; no effect on health or performance.
3,000 to 4,999	Satisfactory for livestock; may cause temporary diarrhea; may be refused by livestock not accustomed to it.
5,000 to 6,999	Reasonably safe for livestock; avoid using with pregnant or lactating animals.
7,000 to 10,000	Not safe for pregnant or lactating cows, horses, and sheep; not safe for young animals or animals with increased heat stress or water loss; use should be avoided; older livestock may consume if under low stress.
>10,000	HIGH RISK; DO NOT USE UNDER ANY CONDITIONS

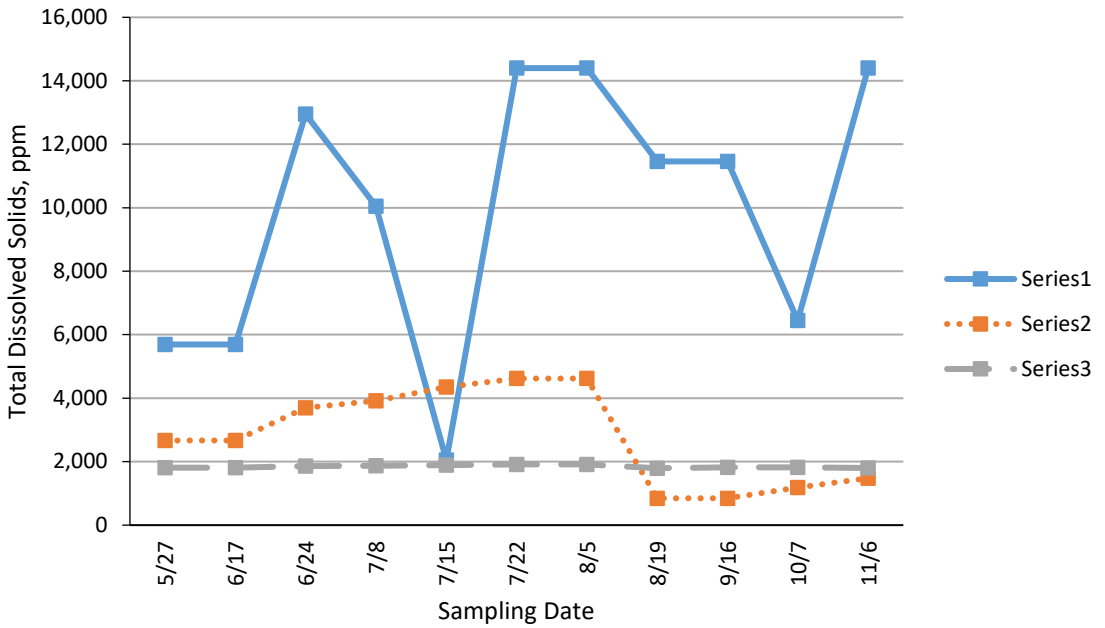

Figure 1. Total dissolved solids (TDS) at three water sources in southeastern Montana during summer-fall 2014.

Table 2. Recommended use of livestock drinking water that contains sulfates.	
Sulfate Content (ppm)	**Recommendations**
< 1500	No harmful effects. May be temporary refusal of water close to upper limits
1500 to 2500	May have temporary diarrhea. May contribute significantly to total sulfur intake and cause a reduction in copper availability.
2500 to 3500	Laxative effects, diarrhea will usual disappear after a few weeks. May have sporadic cases of sulfur-associated polio. Can cause a significant reduction in copper availability.
3500 to 4500	Laxative effects. Do not use for pregnant or lactating ruminants or horses, or ruminants fed in confinement. Sporadic cases of sulfur-associated polio are likely. Significant reduction in copper availability.
> 4500	Do not use for livestock under any conditions.

Table 3. Recommended use of livestock drinking water that contains nitrate.	
Nitrate Content (ppm)	**Recommendations**
< 100	Safe for livestock.
100 to 300	Water is safe for livestock. However, if hays, forages, or silages have high nitrate concentrations, water may contribute significantly to nitrate problem.
> 300	Water could cause nitrate toxicity in cattle, sheep, or horses. Do NOT use for livestock.