MP530

DROUGHT MANAGEMENT AND RECOVERY FOR LIVESTOCK SYSTEMS

DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

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Chapter 1

Climate of Arkansas

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The Random House Dictionary defines climate as “the composite or generally prevailing weather conditions of a region, such as temperature, air pressure, humidity, precipitation, sunshine and winds, throughout the year, averaged over a series of years.” Weather refers to conditions of the atmosphere over a short period of time. Climate is also concerned with the variability and probability of weather events.

The climate of Arkansas is classified as “humid subtropical.” Generally, there is a significant amount of precipitation in every month, and temperatures tend to be mild compared with the northern part of the country. Both temperatures and precipitation decrease from south to north. The Ouachita and Ouachita mountains also modify the weather and climate. Generally, temperatures are lower in the mountains, and precipitation is higher, especially on windward slopes. The lowest temperatures are often found at the bottom of valleys where cold air drains from mountaintops.

Temperature

The significance of temperature is often better defined by variability, extremes and trends than averages. Note Figure 1 below shows that there is only a slight increase in temperature per century. Yet there is considerable year to year variability. For the period 1895 through 2013, the statewide average annual temperature in Arkansas varies from 58°F to 63.6°F. The 119-year average is 60.5°F.

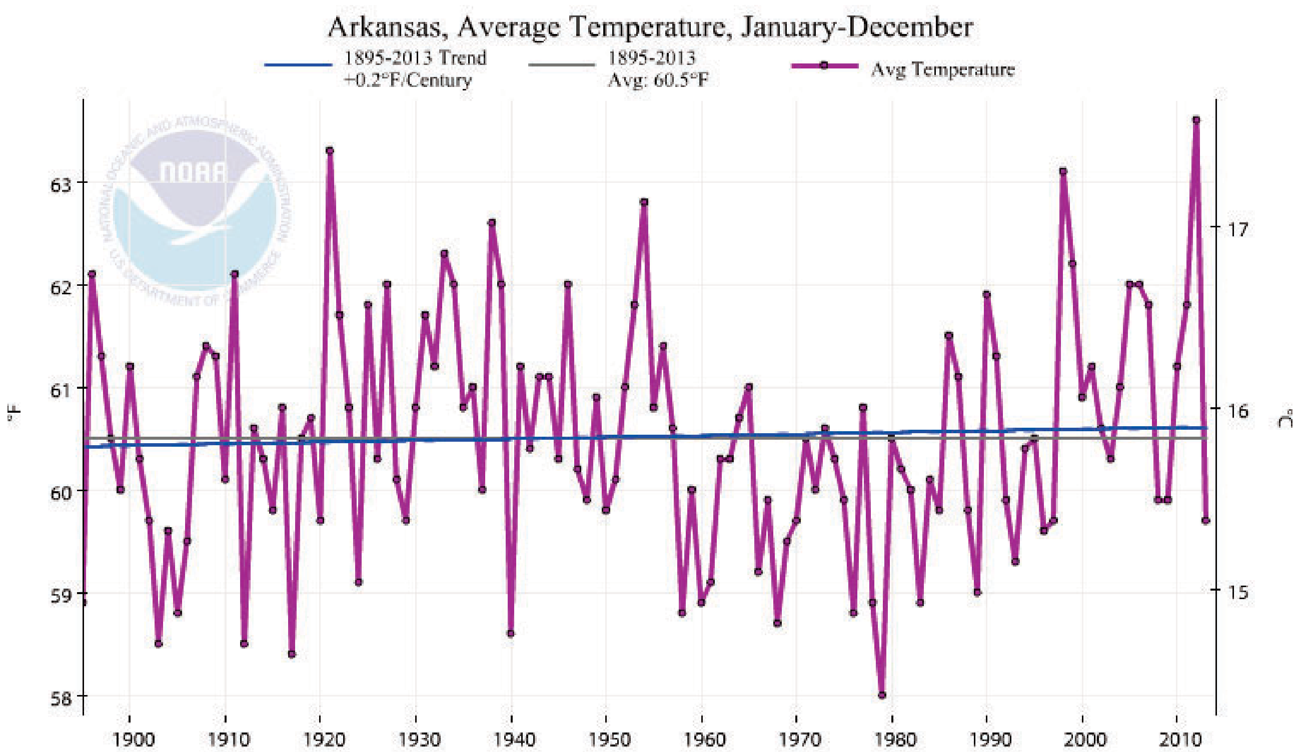


Figure 1. Arkansas average temperatures, 1895-2013.

Statewide, the coldest month is January, with an average low temperature of 29.3°F. July is the hottest, with an average high of 92.6°F. Monthly and annual averages are shown in Table 1.

There is a noticeable upward trend in temperature from 1973 through 2013 of 4.7°F per century. See Figure 2 below. The trend is virtually identical for the summer, while the winter trend is for an increase of 8.5°F. Fall and spring are increases of 3.2 and 3.1°F.

Temperature and precipitation averages are often termed "normal." Every 10 years the National Climatic Data Center, or NCDC, computes 30-year climate normal. The current "normals" are for the period 1981 through 2010. The long-term averages vary from zero to 1.0 degree with the 30-year normals.

For more in-depth comparison across the state, the Fayetteville Cooperative Observer Program (COOP) Experiment Station and the Pine Bluff COOP Station are compared. Table 2 illustrates the frequency for occurrence for both high and low temperatures. It is not surprising that there are more days with below freezing temperatures in northwest Arkansas than the southeast, or that days exceeding 90° are more numerous in the southeast. And while the average number of days exceeding 100°F is small, the years with the most days exceeding 100°F is dangerously high. In fact, since 1895 there are five years in Pine Bluff with more than 40 100°F days (Table 2).

Table 1. Arkansas average monthly and annual temperatures, 1895-2013 (degrees Fahrenheit).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum	49.5°	53.6°	62.8°	72.3°	80.0°	87.7°	91.6°	91.1°	84.9°	74.5°	61.4°	51.6°	71.8°
Minimum	29.3°	32.3°	40.0°	49.1°	57.6°	65.6°	69.1°	67.9°	61.0°	49.0°	38.7°	31.5°	49.3°
Average	39.4°	42.9°	51.4°	60.7°	68.8°	76.7°	80.3°	79.5°	72.9°	61.7°	50.1°	41.5°	60.5°

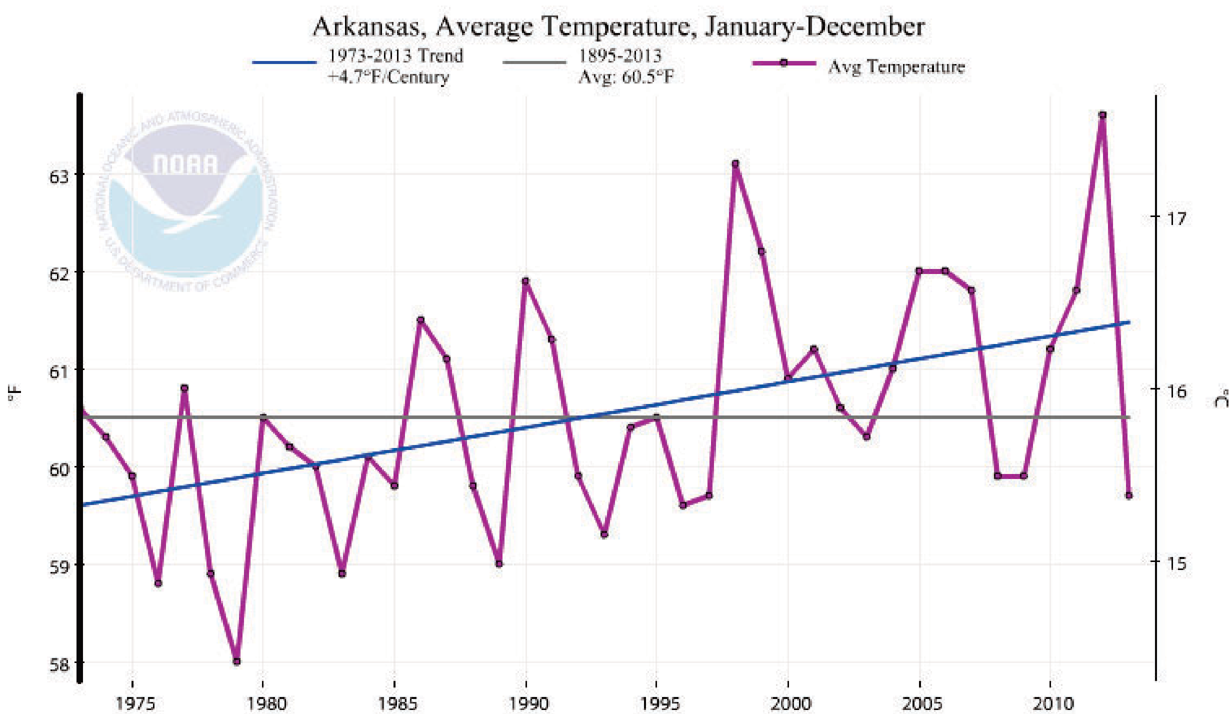


Figure 2. Average monthly temperature and trend for 1973-2013.

Table 2. Extreme temperature comparisons for 1901-2013*, Fayetteville COOP Experiment Station and Pine Bluff COOP Station.

	Fayetteville		Pine Bluff	
	Number	Year	Number	Year
Average number of days exceeding 90°F	47.4		83.8	
Most days exceeding 90°F	99	1954	124	1925
Average number of days exceeding 100°F	4.2		9.4	
Most days exceeding 100°F	40	1954	56	1954
Average number of days below 32°F	84.2		49.3	
Most days below 32°F	114	1960	84	1903
Average number of days below 10°F	6.5		0.9	
Most days below 10°F	20	1979	8	1983

* Exceeding and below also include "equal to."

The highest statewide summer average maximum temperature was 96.9°F in 1954, followed by 96.2°F in 1934, 95.7°F in 1936 and 94.8°F in 1943 and 2011. The lowest statewide winter average temperature was 24.2°F in 1918, followed by 24.6°F in 1978, 24.9°F in 1905, 25.0°F in 1977 and 25.5°F in 1899.

The record for the lowest temperature in Arkansas is -29°F at Pond in 1905, in northeast Arkansas. The highest temperature was 120°F at Ozark in 1936.

Growing season usually means the days between last and first frost, or approximately the last and first occurrence of 32°F. In the case of the Fayetteville Experiment Station, the average growing season is 194 days. The range over the period 1895 through 2003 is 159 to 237 days. The earliest frost-free date is March 10, which occurred in 1905, 1995, 2003 and 2012. The earliest frost date in the fall was on Nov. 23 in 2003. While there is a 90 percent probability of the frost-free period exceeding 174 days, there is only a 10 percent chance of exceeding 215 days.

Precipitation

Precipitation results from one or more sources: 1) middle latitude cyclones (lows), with warm, cold and other frontal situations, 2) tropical lows from the Gulf of Mexico, 3) thunderstorms, or 4) orographic uplift caused by hills and mountains. Middle latitude cyclones form at the boundary between cold air masses from the north and warm air masses from the south. While they can occur in any season, they are most common during the fall, winter and spring. They often produce widespread precipitation that does not vary substantially over small areas.

Thunderstorms are more of a warm season phenomena. They can produce intense showers over small areas. Tropical lows are associated with tropical cyclones (storms or hurricanes) that track overland from the gulf. As air rises over hill and mountains, the lowering of air temperature can trigger condensation and/or instability.

Over the period from 1895 through 1913, the precipitation in Arkansas has averaged 49.56 inches per year. The driest year was 1963, when the total precipitation averaged only 32.80 inches statewide. Other top five dry years were 34.74 inches, 1936; 34.76 inches, 1943; 35.61 inches, 1901; and 35.75 inches, 2005. The wettest year was 72.20 inches in 2009, followed by 71.78 inches in 1957, 70.01 inches in 1973, 67.86 inches in 1945 and 66.91 inches in 1990. Some may recognize significant flooding events in these years. For example, the Halloween and Christmas Eve flooding in parts of central Arkansas in 2009, flooding along the Mississippi River in 1973, flooding in Clinton in 1957 and flooding on the Arkansas River in 1990. The single year state record was set in 2009 when Leola in Grant County recorded 101.05 inches of precipitation. The highest average annual precipitation of 60.37 inches is at Big Fork in Polk County.

Figure 3 below shows statewide annual precipitation amounts from 1895 through 2013. Note the sloping blue line that indicates an increase in precipitation of 3.11 inches per century, or approximately one-third inch per decade.

Summer is the driest season and, together with high temperatures and evaporation, produces more severe drought conditions. The driest summer over the 1985-2013 period was in 1930 (3.97 inches), followed by 4.43 inches (1954), 4.49 inches (1980), 5.07 inches (1943) and 6.17 inches (1896). 1954 and 1980 were both hot and dry. Overall, summer precipitation shows a slight downward trend, but only 1.2 inches per century.

Evaporation

Evaporation is measured using fluctuation of water levels in an evaporation pan. The National Weather Service, NWS, has never maintained many evaporation stations. Only five at Blue Mountain Dam, Blakely Dam, Millwood Dam, Narrows Dam and Keiser are still in operation. Other stations that have been discontinued include Stuttgart, Russellville, Nimrod, Gillham, Hope, Norfork and Mountain Home.

Evaporation and evapotranspiration offset precipitation, which may lead to serious water shortages, whether for water bodies such as lakes or soil moisture for plant growth. Examples of a severe water shortage occurred in the summers of 1954 and 1980. For the entire summer, June through July, the Stuttgart 9 ESE COOP weather station measured only 3.99 inches and 2.04 inches of precipitation, respectively. The evaporation pans recorded 24.12 inches and 29.81 inches of evaporation. The average annual precipitation and evaporation for these summer months at Stuttgart is 10.15 inches and 22.23 inches, respectively. So even in an "average" precipitation and evaporation year, evaporation can far exceed precipitation.

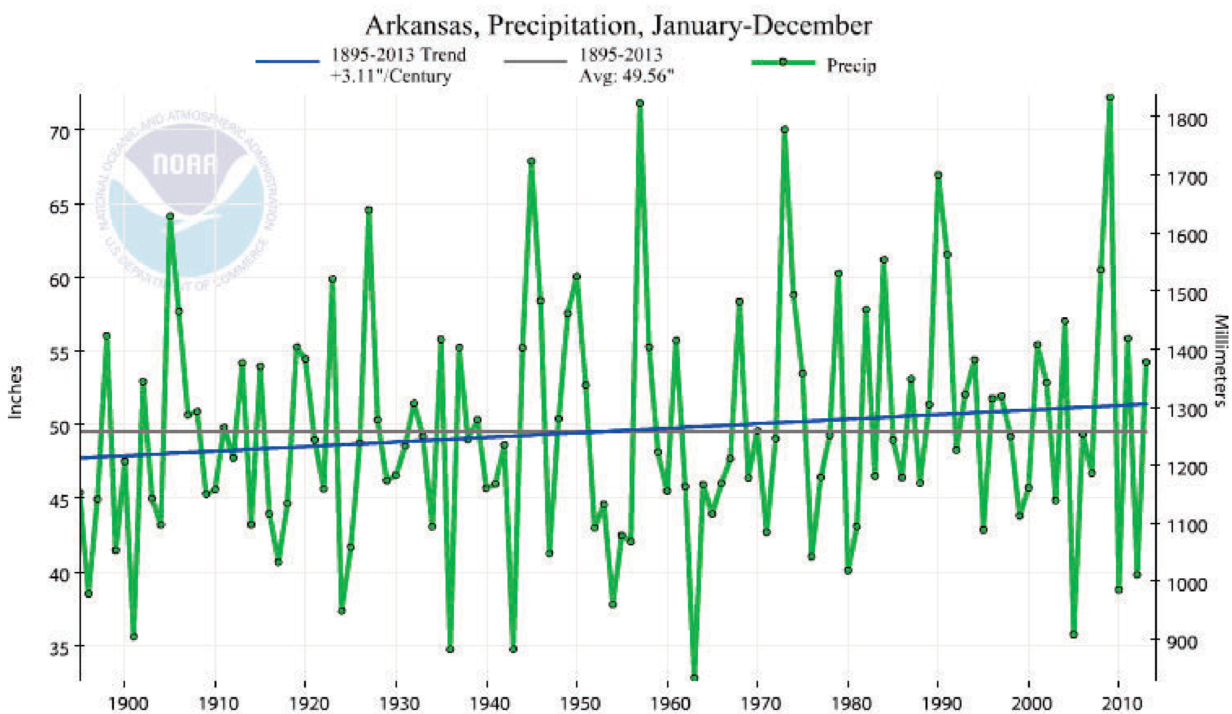


Figure 3. Average monthly precipitation and trend, 1895-2013.

Table 3. Arkansas average monthly and annual precipitation, 1895-2013 (inches).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation	4.06	3.69	4.78	4.93	5.15	3.99	3.76	3.36	3.63	3.58	4.25	4.37	49.56

Drought

The Palmer Drought Severity Index (PDSI), devised in 1965, was the first drought indicator to assess moisture status comprehensively. It uses temperature and precipitation data to cal - culate water supply and demand, incorporates soil moisture and is considered most effective for unirrigated cropland. It primarily reflects long-term drought and has been used extensively to initiate drought relief.

One way to compare historic droughts in Arkansas is to compare the PDSI for past years. Negative PDSI indicates drought conditions. While there are several periods of drought over the past 100-plus years, some droughts persisted over a number of years. Individual years with the highest negative drought index were 1952, 1954, 1955, 1956 and 1963. The drought of 1952-56 was the most intense over a 5-year period. The 1929-1944 period was interrupted by minor wet years in 1935 and 1937. More recently, drought episodes from 2005-2007 and 2010-2011 were interrupted by a wet year, including the record-setting year of 2009.

Droughts can develop quickly, as occurred in 2011. Most of the state experienced heavy

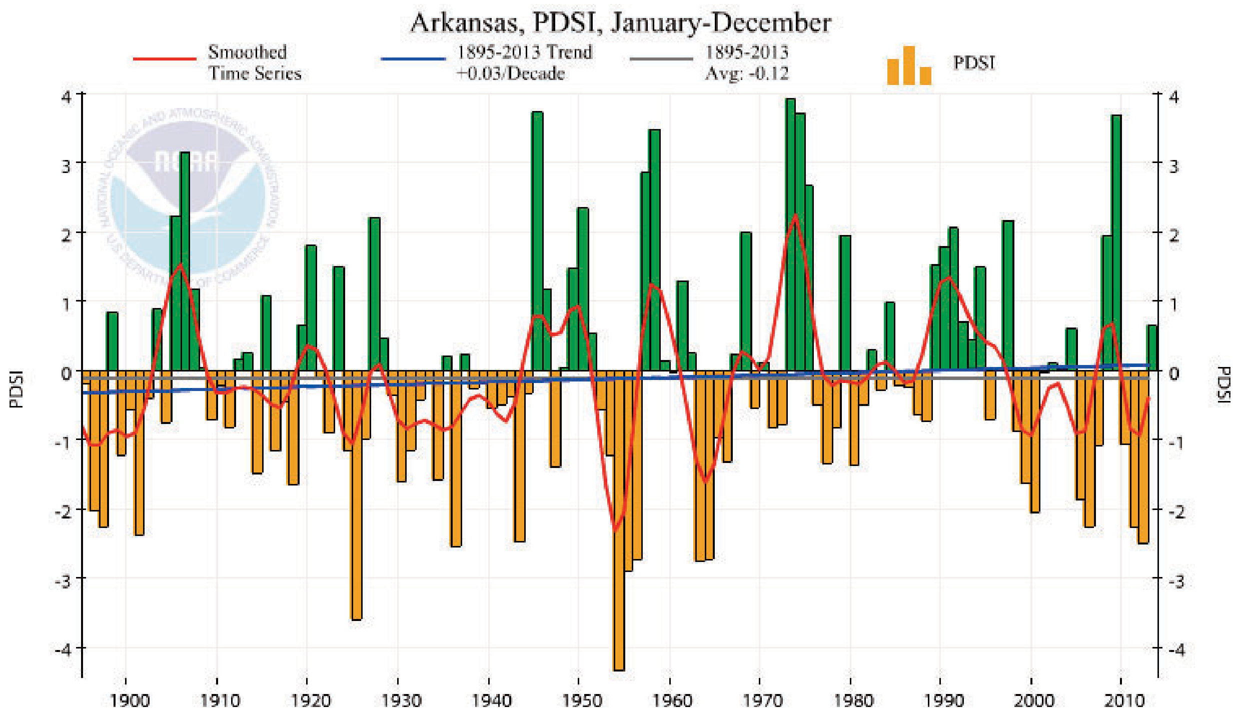


Figure 4. Historical Palmer Drought Severity Index.

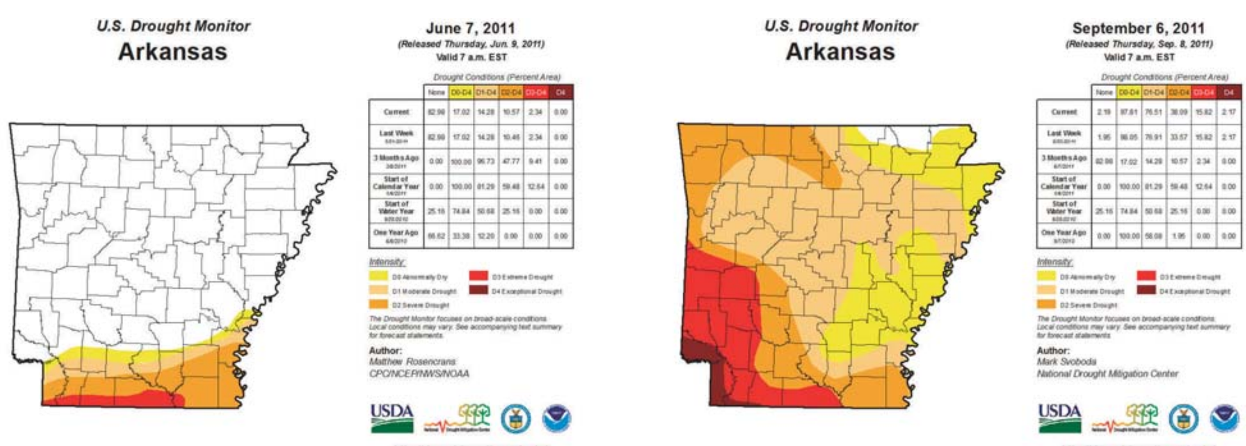


Figure 5. Drought Monitor for June and September, 2011.

rains and flooding in April and May. The north-central climate division recorded an average of nearly 33.5 inches of rainfall during those months. Drought conditions followed from June through October.

Snowfall

Snowfall helps recharge soil moisture, groundwater and streams during the winter. In the northern part of the state, there are areas that have annual snowfall averages between 10 and 15 inches. Record one-day totals are between 25 and 30 inches. Typically, a foot of snow has approximately 1 inch of water, so snowfall is not a major contributor to the water balance.

Severe Weather

Arkansas is frequented by severe weather, especially during the spring. Severe weather event often take the form of ice storms, severe thunderstorms, high winds, hail, lightning, heavy rainfall and tornadoes. Over the period 1950-2013, 1,714 (26-plus per year) tornadoes have caused 386 fatalities and $1,766 billion in damages. Tornadoes generally track from southwest to northeast.

Climate Prediction

Through the Climate Prediction Center, the National Oceanographic and Atmospheric Administration tries to predict the weather at time frames from six days to three months. The prediction or outlook is for temperature, precipitation, hazards and droughts. In the case of temperature and precipitation, the outlook is characterized as the probability that these weather elements will be either below or above the "normal" for that time period. As individual weather systems approach, forecasters can begin to give more details concerning the actual temperatures and precipitation amounts and type.

One of the factors used in predicting weather is the El Niño – La Niña phenomena. Most attention is given to the more studied El Niño. El Niño occurs when the Equatorial Pacific Ocean temperatures exceed normal conditions over several months. This results in heavy rainfall, including flooding, along the coast of Peru and Ecuador.

During winter, El Niño episodes (Figure 6, top map) feature a strong jet stream and storm track across the southern part of the United States and less storminess and milder-than-average conditions across the North. La Niña episodes (bottom map) feature a very wave-like jet stream flow over the United States and Canada, with colder and stormier than average conditions across the North and warmer and less stormy conditions across the South.

In Arkansas, the El Niño effect produces the most effect during the cooler half of the year. Historically, moderate to strong El Niño episodes in November-December have featured an increased frequency of near normal or above-normal precipitation over the northern two-thirds of the state and above-normal precipitation over the southern third. For January to March, El Niños result in near normal precipitation statewide.

El Niños vary in strength and effect on the weather. For 10 El Niño events from 1915 to 1992, during November-December, climate divisions in Arkansas averaged 119 to 135 percent of normal precipitation. January-March averages ranged from 87 to 103 percent of normal. The 1982-83 El Niño illustrates the

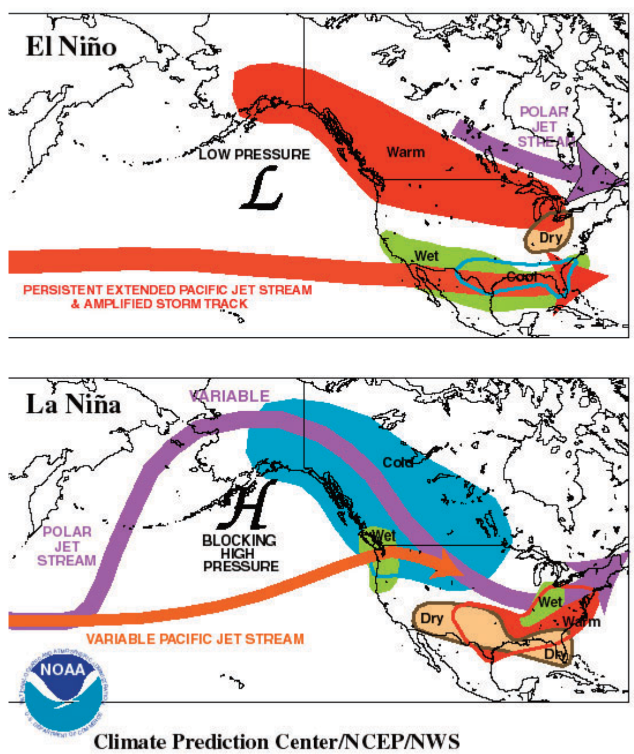


Figure 6. Typical January-March weather anomalies and atmospheric circulation during moderate to strong El Niño and La Niña.

more extreme potential impact on Arkansas. For the November-December timeframe, precipitation ranged from 194 to 248 percent of normal; for January-March, precipitation ranged from 45 to 84 percent of normal.

Other factors such as the Arctic Oscillation, or AO, can influence weather in Arkansas. The Arctic Oscillation refers to an atmospheric circulation pattern over the mid-to-high latitudes of the Northern Hemisphere. The most obvious reflection of the phase of this oscillation is the north-to-south location of the storm-steering, mid-latitude jet stream.

The AO's positive phase is characterized by lower-than-average air pressure over the Arctic paired with higher-than-average pressure over the northern Pacific and Atlantic Oceans. The jet stream is farther north than average under these conditions and storms can be shifted northward of their usual paths. Thus, the mid-latitudes generally see fewer cold air outbreaks than usual during the positive phase of the AO.

Conversely, AO's negative phase has higher-than-average air pressure over the Arctic region and lower-than-average pressure over the northern Pacific and Atlantic Oceans. The jet stream shifts toward the equator under these conditions, so the globe-encircling river of air is south of its average position. Consequently, locations in the mid-latitudes are more likely to experience outbreaks of frigid, polar air during winters when the AO is negative.

AO episodes typically last only a few weeks and are difficult to predict more than a week or two in advance. A strong negative AO in mid-January, 2014 was reflected in average January temperatures in Arkansas that were 3 to 6 degrees below normal.

Climate Change

As noted earlier, since the 1970's average annual temperatures have been increasing, with considerable year-to-year variability. Annual precipitation shows a very small increase over those decades. The National Climate Assessment, or NCA, and other studies indicate trends in the climate through the end of this century. Some of the predictions are already taking place.

- Since 1970, average annual temperatures have increased approximately 4.5°F. In the southeastern U.S., temperatures are expected to increase another 5 to 10°F at inland locations.
- The number of days with maximum temperatures exceeding 90°F is expected to increase. That number is expected to increase to up to 150 days. Heat indices are also on the rise.
- Precipitation is expected to increase slightly, but it will be offset by higher evapotranspiration rates.
- There are expected to be fewer below freezing days and a longer growing season.
- There are expected to be a greater frequency of both intense rainfall (flooding) events and more prolonged heat waves and drought episodes.

Scientists attribute much of the climate change to increases in carbon emissions over the past decades. If their projections are correct, the effects will be widespread, affecting public health, agriculture, water availability and forestry.

Resources

Information for this climate section was obtained or computed from the following sources, available on the Internet:

- NOAA National Climate Center "Climate at a Glance"
- NOAA Pacific Marine Environmental Laboratory
- Southern Regional Climate Center, CLIMOD
- Tornado History Project
- U.S. Drought Monitor
- Cool Weather (records)

Additional resources include:

- **Office of the Arkansas State Climatologist.** The Office of the Arkansas State Climatologist is located at the Arkansas Natural Resources Commission (ANRC) in Little Rock. For climate data and information, contact the ANRC at 501-682-1611.

- **Arkansas State Plant Board Weather Web.** As of 2014, the Arkansas State Plant Board operates 51 weather stations throughout the State. Data includes temperature, wind direction, wind speed, relative humidity, dew point, precipitation and solar radiation. Data is both real time and archived at 5-minute intervals.
- **Community Cooperative Rain, Hail and Snow Network (COCORAHS).** Arkansas is a participant in a nationwide network of volunteers who report precipitation daily over the Internet. As of 2014, there were more than 800 volunteers. In addition to reporting precipitation, they can also submit reports on severe weather, drought conditions, hail and snowfall. Various federal agencies use these reports, for example, in flood forecasting, drought evaluation and wildfire prediction.

Chapter 2

Managing the Cowherd as Drought Persists

Shane Gadberry, Associate Professor - Ruminant Nutrition, and Tom Troxel, Professor and Associate Department Head - Animal Science

When it comes to managing a beef cow herd through a drought, there is no plan or answer that fits all situations. Drought is a slow process that progresses over time and one never knows when a drought will end. Cash flow, off-farm income, owning a poultry farm, overhead debt and type of cattle enterprise are examples of why drought management isn't the same for everyone. There are some general rules of thumb that are rather simple but often overlooked during times of drought. They include:

- No rain means no plant growth.
- Drought should never be a surprise – it progresses slowly over time.
- Drought management is the balancing of forage and water supply with forage and water demand.
- The sooner the situation is identified the more management options are available
- The sooner proper management decisions are implemented the less negative impact the drought will have on the operation.

Drought often becomes an economic question of supply and demand in which the demand for forage and/or water exceeds the supply. The painful choice becomes increasing the supply of forage through the purchase of hay or other feedstuffs or decreasing the demand for forages and/or water through the reduction of livestock dependent on those resources. Granted that question would be a lot easier to answer if the length of the drought was known, but it's never known until it is over.

When it comes to making decisions regarding managing through a drought, make decisions on logic, not emotions. Oftentimes that is easier said than done, but it is the logical decisions that will help secure the long term sustainability of the operation, not the emotional decisions. Many will try to "hang on" in the hopes it will rain before initiating a destock plan. The longer one waits before initiating a destocking plan, the more depleted the forage becomes, which will delay pasture recovery when the rains return.

Culling Cows

If the cow herd is a spring-calving herd going into a summer drought, all cows should have a calf at their side. The first culls should be any cows not with a calf at side. All fall-calving cows should be pregnant; therefore, cull all fall-calving cows not pregnant. When feed becomes limited, open cows become a luxury one cannot afford.

Inspect all cows carefully for physical impairments. This would include teeth, feet, legs, bad temperament, extreme size (too large or too small), udders and undesirable calf-at-side. Short and broken-mouth cows should be culled first because they will not have acceptable productivity under drought conditions. Consult any production or herd records during this process to prevent overlooking cows with marginal production history. If records are not available, a visual assessment of calf-at-side will have to suffice. Although forced culling is never a pleasant management option, the result may be a smaller herd but the herd may become a uniform, genetically superior herd of beef cows. This smaller but superior group of cows will be the nucleus for a genetically superior cattle herd for the future.

Early Weaning

Weaning calves from their dams at 6 to 8 months of age is an industry norm. However, situations arise when weaning according to the industry norm may not be the best management practice.

During drought, cow-calf producers can explore the feasibility of early weaning. The first question that often arises is "How early is too early?" Dairy calves are separated from their dam within a day or two after birth. This is not a recommendation for beef calves but puts the idea of "early weaning" into perspective.

One important aspect of how early is too early is rumen development. Calves are not born with a fully functional rumen. The stomach of a very young calf functions more like simple-stomached animals. The functionality of the rumen develops over time and can be hastened with grain feeding (this allows dairy calves to be weaned from the bottle by 1 month of age). Early weaning beef calves between 120 days of age to normal weaning age is most practical. Rumen development will be far enough along by this age to support digestion of high quality forages as well as concentrate feeds.

Additional feed management considerations must be taken if weaning calves at 30 to 60 days of age. Forage is often the limiting factor during drought. If the intention is to retain ownership of early weaned calves, these calves will need to be fed a total mixed ration that is balanced for protein, energy, minerals, vitamins and effective fiber (fiber that promotes good rumen health). Some cow-calf producers choose to introduce calves to their diet before fully weaning. Calves can be introduced to the diet using creep feeders or feed bunks with electric fence that is high enough for calves to walk under but too low for cows to access the bunk.

Early-weaned calves must be vaccinated to prevent common clostridial and respiratory diseases, dewormed and the feed lot well maintained (feed and water troughs kept clean). The benefit to early weaning is a cow's energy requirement decreases by approximately 40 percent when she no longer needs to produce milk for a nursing calf. Therefore, a cow can more easily maintain body condition on a restricted diet (quantity and(or) quality).

Body Condition Scoring

Body condition score should be assessed frequently, and the body condition of cows will dictate culling and feeding management decisions. The idea body condition score of cows is 5 to 6. The easy way to determine if cows are body condition 5 to 6 is to visualize body condition scores 4 and 7. The hind ribs of body condition score 4 females are easy to see, and body condition 7 cows will have a very smooth appearance with fat pones at the rear of the tail head. It is common to find body condition score 3 (all ribs visible) and 4 cows during long-term drought, and unfortunately nutritional intervention is not sought until a high percentage of the herd is in thin condition.

Allowing cows that are initially in moderate body condition (BCS 5) to lose one to two body condition scores during drought is usually based on finances; however, there are negative economic consequences associated with allowing cows to become too thin. First, thin cows are less likely to breed back until body condition is restored and second, if cattle must be liquidated, thin cows will be discounted because of their lower dressing percentage, plus thin cows are marketed at a lighter weight. Extension publication MP373 discusses feeding beef cows based on body condition score.

Figure 1. Beef cow, moderately-thin body condition.

Grouping Cows

Regardless of drought, herds are easier to manage if grouped according to similar type, and the most common groups are based on age (growing replacements versus mature cows) or calving season (spring versus fall). Another level of grouping can be based on body condition score.

The objective for grouping cows based on body condition score is to minimize feed cost. Additional feed resources will be needed for thin cows compared to cows in moderate and good condition. Information on grouping cows for feeding is available through fact sheet FSA3033. This fact sheet is entitled *Winter Feeding,* but the same concepts apply to feeding during drought.

Substituting Grains and Byproduct Feeds for Forage

When pastures and hay supplies are diminishing, cattle producers can consider using grains and byproducts as sources of nutrients. These feeds are usually limit-fed, but formulation may take two approaches. The most common approach is to blend or purchase a mixed feed that is formulated to meet the nutrient requirements of the group. The blend will usually contain a higher proportion of cottonseed hulls or other low energy/high fiber feedstuff to moderate the feed energy while providing a source of fiber that supports good rumen health. These feeds are often formulated to be 12 percent crude protein and 60 percent total digestible nutrients (dry matter basis) and substituted for pasture or hay as needed. During the 2011 and 2012 drought, some companies that sell commodity blend feeds were marketing this type of feed as "pasture stretcher" or "forage stretcher."

Another method of substitution is called programmed feeding. In contrast to the previous method, diets that are program-fed are nutrient dense (75 to 85 percent TDN, dry matter basis) and are limit-fed to meet protein and energy requirements. These feeds only contain 15 to 20 percent roughage and are fed at 50 to 60 percent of normal intake. Special attention to nutrient requirements and change in body condition is important to programmed feeding. Programmed feeding is best accomplished using a total mixed ration, which most likely will require an on-farm mixer.

Due to short hay supplies in 2012-13, research was conducted at the Livestock and Forestry Research Station near Batesville, Arkansas, to examine programmed feeding using the approach of limiting the number of hours of access to hay along with feeding a high rate of soybean hulls. Estimated hay intake in that study was high despite the limited access time. This suggests that the total mixed ration is the better approach to programmed feeding. For more information regarding substitution feeding, read fact sheet FSA3036, *Substituting Grain for Hay in Beef Cow Diets*.

Feeding Grain and Oilseed Crop Residual Plant Material

During extreme drought, producers will often look to nontraditional forage/roughage sources for beef cattle. Common crop harvest residual used include corn stover (also called stubble or stalks), grain sorghum stover, rice straw, peanut stover and cotton gin trash. Before using crop harvest residual as feed, consider what chemicals were applied to those crops and the potential feed restrictions they impose.

Once the crop is considered safe to feed from a chemical residue perspective, the next step is to analyze these feeds for nutrient composition and nitrates. Corn stover can test positive for dangerously high levels of nitrates. Of the samples tested during the 2011 and 2012 drought, 16 percent of corn stover samples tested >1,400 ppm nitrate-nitrogen; whereas, 3 percent of grain sorghum stover samples tested >1,400 ppm nitrate-nitrogen.

The protein and energy composition of these crop residues can be quite variable. Many producers who utilized these for feed reported a negative experience. Rice straw is high in silica and poorly digested, which results in a negative experience as cows tend to refuse rice straw. To improve the nutritive value of rice straw, some producers reported raising the mower height or waiting for grasses or rice regrowth before mowing and baling. Unlike many grasses, rice leaf can be poorly digested as well.

Peanut stubble is probably the most palatable among crop residual options, but harvest requires experience to minimize leaf loss and dirt contamination. Gary Hill, Department of Animal Science, Georgia, indicated baling immediately following peanut harvest results in the best quality and palatability of peanut crop residue.

Compared to corn stover, sorghum stover tended to test higher in total digestible nutrients, which may be associated with leaf-to-stalk ratio. Table 1 is a summary of analysis results for harvested crop stover submitted to the University of Arkansas, Agricultural Diagnostics Laboratory during the 2011 and 2012 drought.

Crop residues such as corn and grain sorghum are often fed to allow cows to waste stalks and maximize leaf intake. This should improve nutrient intake and reduce nitrate risk. The ratio of TDN to protein of corn and sorghum stover suggests supplemental protein is warranted. Processing stalks into a total mixed ration is the most effective way of using total plant material, reducing the cost of feed waste.

The digestibility of crop fiber can be improved by 15 percent or greater through chemical treatment with anhydrous ammonia, calcium oxide (quicklime), calcium hydroxide (hydrated lime or slaked lime) or sodium hydroxide (caustic soda). Treatment is applied at the point of storage. Anhydrous ammonia is applied to sealed stacks; whereas, the other chemical treatments are applied during forage chopping and hydration. Treated forage is stored for approximately 20 to 30 days before feeding. Safety precautions and equipment cleanup procedures should be established before implementing chemical treatment as these chemicals have hazardous and corrosive properties.

Popular press during the 2011 and 2012 drought regarding treating forages with calcium oxide or calcium hydroxide resulted in some cattle producers believing treating hay with limestone (calcium carbonate) would improve forage digestibility. Limestone does not have the effect of calcium oxide or calcium hydroxide. In addition, do not ammoniate moderate to high quality forages. Visit with your local county Extension office to obtain specific detail on chemical treatment of crop residues.

Feeding Broiler Litter

Feeding poultry bedding waste (litter) is common during drought in areas where litter is easily accessible. A common question to feeding litter is "Is it legal?" Feeding litter has remained legal as long as the feed fed to the flocks did not contain rendered mammalian proteins. Some cattle buyers will not purchase cattle fed poultry litter; therefore, this should be considered. In addition, poultry are sometimes treated with antibiotics; therefore, at least a 14-day withdrawal between feeding litter and marketing cattle should be implemented. This is important to consider during drought management because

Table 1. Summary of crop residue sample submissions for 2011-2012.

	Samples	Average	Standard Deviation	Minimum	Maximum
Corn Stover					
CP	32	5.8	1.6	3.3	8.4
TDN	32	51.5	7.5	37.4	63.0
Nitrate-Nitrogen	147	737	885	76	5,400
Gin Trash					
CP	19	13.5	3.7	8.4	20.8
TDN	19	27.7	9.5	18.2	57.0
Peanut Stover					
CP	12	10.2	2.1	5.7	13.9
TDN	12	56.4	7.2	44.6	67.7
Rice Stover					
CP	32	7.9	6.1	3.5	36.0
TDN	32	51.2	6.4	39.3	69.2
Nitrate-Nitrogen	9	371	213	124	724
Sorghum Stover					
CP	92	6.8	2.7	1.7	16.5
TDN	92	58.3	8.7	26.2	78.1
Nitrate-Nitrogen	218	598	634	120	6,000

All values reported on a dry matter basis herds are sometimes forced into liquidation when feed and water supplies or finances dwindle.

Two common concerns with a litter-based diet include hardware disease and milk fever. A common mistake with feeding litter is not adding supplemental energy. A common statement is "I don't remember dad or granddad mixing feed with litter." Selection of beef cattle over time for growth, mature size and milk production is a good reason to not feed cows the same today as someone may have fed them 30 or more years ago.

Gestating and lactating cows will need 20 percent and 30 percent, respectively, corn, soybean hulls or hominy added to the litter to balance energy needs. Salt and vitamin A supplementation must be addressed. If using injectable vitamin A, pay attention to withdrawal time on the label. Once again, herds are sometimes forced into liquidation during drought, and during severe drought, many of these cows will be purchased for slaughter instead of replacements.

As a final note, reducing litter intake by 50 percent, beginning 30 days prior to calving, is recommended to minimize chances of milk fever. For more details on feeding litter, read fact sheet FSA 3016, *Feeding Broiler Litter*.

Tax Considerations

During times of drought, some livestock producers may reduce their herd size through larger than normal sales of livestock. For example, because of a lack of forage, a cow-calf producer may cull heavily and sell more cows than usual. Other animals may have been sold earlier than they normally would have been sold. For example, a producer whose normal business practice is to carry calves through winter and sell them as yearlings may, because of a shortage of forage, have sold the calves at weaning. In any case, weather-related conditions could cause producers to have higher than normal taxable incomes in the drought year and lower than normal taxable incomes in the subsequent year(s).

Income tax law allows farmers affected by weather-related conditions to defer reporting of this income to even out their income and avoid potentially higher taxes. Farm income averaging, which was enacted after the weather-related provisions, is another alternative which could result in lower income taxes for producers in some situations. Effective tax management involves consideration of several tax years rather than minimizing this year's tax bill.

Weather-Related Sales of Livestock

There are two provisions in tax law which attempt to cushion producers from the consequences of the weather-related sales of livestock. Livestock held for draft, breeding or dairy purposes and sold because of weather-related conditions are provided a two-year reinvestment period under the first provision (this replacement period can be extended if drought conditions persist).

The second provision, which applies to all livestock (other than poultry), allows cash basis taxpayers whose primary trade or business is farming a deferral of receipts from sales in excess of normal business practice because of weather-related conditions resulting in a disaster area declaration. Both provisions apply only to those sales which are in excess of the normal business practice of the producer.

Sale With Replacement

The gain on the weather-forced sale of livestock held for draft, breeding or dairy (not sporting) purposes does not need to be reported as income if the proceeds are used to buy replacement livestock within two years after the end of the tax year of the year of sale. Although declaration of the area as a disaster area is not necessary, a producer must be able to show that weather-related conditions forced the sale of more livestock than would normally be sold.

For example, a beef producer who normally sells five cows per year may sell 20 cows in the drought year because of limited forage and feed supplies. Gains from the sale of the extra 15 cows would not be reported as income if the producer purchased at least 15 replacement animals before the end of two years of selling the 20 cows. The new livestock must be used for the same purpose as the livestock which was sold. Thus, beef cows must be replaced with beef cows.

To make the election under Section 1033(e) to defer recognition of gain, a producer does not report the gain and attaches a statement to the current year's tax return. The statement shows the following:

(1) Evidence of weather-related conditions which forced the sale of the livestock.

(2) Computation of the amount of gain realized on the sale.

(3) The number and kind of livestock sold.

(4) The number and kind of livestock that would have been sold as normal business practice without the weather-related sales.

Sale Without Replacement

Producers who are forced to sell livestock because of weather-related conditions may be eligible for an exception to the rule the livestock-sale proceeds must be reported as income in the year they are received. This exception allows producers whose principal business is farming to postpone reporting these receipts as income for one year for both income and self-employment tax purposes. Although the livestock does not need to be located in a declared disaster area, there must be a relationship between the livestock and an area declared a disaster area. The animals can have been sold before or after the disaster area declaration. However, only the livestock sales in excess of a producer's normal business practice qualify for deferral. A declaration must be attached to the tax return for the year in which the weather-related sale occurred. To make the election the statement should include the following:

(1) A declaration that the election is being made under Section 451(e).

(2) Evidence of the weather conditions which forced the early sale on the livestock and when the area was declared a disaster area.

(3) A statement explaining the relationship between the disaster area and early sale.

(4) The total number of animals sold in each of the three preceding years.

(5) The number of animals that would have been sold as normal business practice if the weather-related condition had not occurred.

(6) Total number of animals sold and the number sold because of the weather-related event during the tax year.

(7) Computation of the amount of income to be deferred for each classification of livestock.

Further Information

For additional information on these tax provisions and details of the elections, see IRS Publication 225, *The Farmer's Tax Guide*. This publication is available on the IRS website at *www.irs.gov*. Search under Publication 225 in the publication search menu. For specific tax questions or concerns, consult your tax consultant.

Source: George Patrick and Michael Langemeier, Department of Agricultural Economics, Purdue University

Chapter 3

Feeding Horses During a Drought

Dr. Mark Russell, Assistant Professor - Equine

Drought can propose challenges to horse owners even when they foresee the conditions and have a plan in place. The rule of thumb to follow in this particular region is one adult horse per two acres or one acre for a yearling or two year old. One of the most important factors in feeding a horse is to keep any changes in feed gradual – this includes both forages and concentrates (grains, pellets, oats, etc). Horses do not accept a change in forage very well, and the shortage of hay and increase in the expense of concentrates has caused many horse owners to evaluate current feeding programs and seek alternatives. Here are some facts and helpful suggestions for feeding horses during a drought or during dry season conditions:

Roughage is the most important facet of a horse's diet. The owner should strive for approximately 50 percent of the horse's daily intake to be forage based (should be 1 to 2 percent of total body weight).

- ***Essential Sources.*** Roughages provide essential sources of digestible energy, protein and some vitamins and minerals.

Figure 1. Square hay bale.

- ***Employ rotational grazing.*** During months when there is more rain, use a fencing system that will allow for sections of the pasture to be ungrazed.
- ***Plant winter annuals.*** These can be rye, ryegrass or wheat. While the initial cost may be high, this option could possibly by less expensive than hay purchases over the course of a winter and early spring.

Roughage can be planted as early as late August. The typical timing for planting on a tilled seedbed begins in early September through early November. The typical planting period for sod-seeding either by no-till or broadcast methods begins in late September through early November. Early-planted ryegrass (September) can provide grazing in late fall. Late-planted ryegrass (November) will not provide significant grazing until late winter (March) except during warm winters such as in 2011-12. (For more information on winter grazing, consult with Dr. John Jennings, University of Arkansas forage specialist, or see U of A fact sheets FSA3051, *Baled Silage for Livestock*; FSA3064, *Using Cool-Season Annual Grasses for Grazing Livestock*; and FSA3063, *Using Cool-Season Annual Grasses for Hay and Silage*.

Tips to keep in mind:

Figure 2. Cool-season forages for grazing.

- Only feed hay when the previous feeding has been "cleaned up" completely.
- Weigh each feeding to prevent over-distribution. A fish scale commonly found in sporting goods or department stores is sufficient.
- Foaling mares should be kept away from fescue because of concerns over foal death at time of birth and the complete absence of milk production in some mares that have access to fescue.

Figure 3. Scales to weigh feed.

- Horse owners who have access to round bales (or the equipment to handle them) can save costs over the course of a dry season.
  a. Keep the bale covered and made inaccessible to horses.
  b. Limit each feeding by:
     – Limiting access to the bale to 2 hours each day
     – Use a pitchfork to pull each daily feeding off the bale and keep bale of hay away from the reach of horses.

The loss of crude fiber in **not** feeding hay can be found in other sources. Some common feedstuffs that can replace a **portion** of the roughage portion of the diet or can be given in a supplement form (crude fiber = 11 to 15 percent, usually approximately 1 cup per feeding is sufficient – starting with a small handful on the first feeding):

1. Rice bran (high in fat and phosphorus; may need to supplement calcium if not balanced by manufacturer).
2. Wheat bran (high in phosphorus; may need to supplement calcium if not balanced by manufacturer).
3. Oats (considered safe to feed, contains more fiber than other grains). Can be mixed with other concentrates in a higher volume than others listed above. **Crimped oats are more easily digested.**

Rice Bran **Wheat Bran** **Oats**

Figure 4. Readily digestible feedstuffs.

Some common alternative roughage that can be a replacement or a **partial** replacement for hay (high fiber feeds, > 15% crude fiber):

- Other hay sources:
  – Alfalfa
  – Oat hay
  – Straw (Oat straw is more palatable than wheat or barley straw and should serve as last resort.)
- Alfalfa cubes (May require soaking to make more palatable.)
- Alfalfa pellets
- Beet pulp (May also require soaking to make more palatable.)

It is tempting during a drought to increase what is most available, and many times that is concentrates (grains, oats, pellets, etc.).

Alfalfa Pellets **Wheat Bran** **Beet Pulp**

Figure 5. Hay substitutes.

These types of increases should be limited or avoided completely. However, if they are increased, keep in mind:

1. Feed smaller meals more frequently (for example, once in the morning, noon and late evening).
2. Concentrates should consist between 0.5 to 1 percent of body weight (A 1,000-pound horse would receive between 5 and 10 pounds of concentrate per day). This amount should be divided up into three equal feedings per day.
3. When increasing concentrates, it becomes more and more important to check feed for insects.
4. Feed concentrates by weight not volume. Weigh the feed and determine amount to be fed by weight of the horse.
5. Concentrates should not exceed 50 percent of the horse's total diet.

Other items to consider:

Although parts of Arkansas are in a drought, there may be hay available in other parts of the state or in neighboring states. Group up with other horse owners to split the costs of having the hay transported by someone else or go and purchase hay as a group to reduce costs. Also, if your horse is chewing on trees, fence posts or eating weeds, this may be an indication you are not meeting your horse's nutritional needs.

Sources: Clemson University, Colorado State University, University of Arkansas and Texas A&M University. Dr. Paul Siciliano, Dr. Lori Warren (2010), Dr. John Jennings (2012) and Dr. Pete Gibbs (2006).

Chapter 4

Sheep and Goats

Steve Jones, Retired Associate Professor - Animal Science

Drought is a recurrent phenomenon that seriously affects the productivity of sheep and goats. A number of feeding and other management strategies can be applied to reduce the negative effects of drought on sheep and goat performance. These revolve around balancing animal numbers with available feed resources and include reducing animal numbers through culling of poor producers, strategic supplementation of vulnerable groups of animals, adjusting grazing strategies during drought and efficient utilization of feed resources. The specific strategy or combination of strategies to apply will depend on assessment of each situation.

During drought, it is important that you constantly assess and revise your situation, and it is imperative that you make production decisions in light of both your long-term and short-term objectives.

Small Ruminant Nutrition

Feed is the single largest cost associated with raising small ruminants, typically accounting for 60 percent or more of total production costs. It goes without saying that nutrition exerts a very large influence on flock reproduction, milk production and lamb and kid growth. Late-gestation and lactation are the most critical periods for ewe and doe nutrition, with lactation placing the highest nutritional demands on ewes/does. Nutrition level largely determines growth rate in lambs and kids. Lambs and kids with higher growth potential have higher nutritional needs, especially with regard to protein. Animals receiving inadequate diets are more prone to disease and will fail to reach their genetic potential.

Small ruminants require energy, protein, vitamins, minerals, fiber and water. Energy – calories – is usually the most limiting nutrient, whereas protein is the most expensive. Deficiencies, excesses and imbalances of vitamins and minerals can limit animal performance and lead to various health problems. Fiber, or bulk, is necessary to maintain a healthy rumen environment and prevent digestive upsets. Water is the cheapest feed ingredient, yet often the most neglected.

Many factors affect the nutritional requirements of small ruminants: maintenance, growth, pregnancy, lactation, fiber production, activity and environment. As a general rule of thumb, sheep and goats will consume 2 to 4 percent of their body weight on a dry matter basis in feed. The exact percentage varies according to the size (weight) of the animal, with smaller animals needing a higher intake (percentages) to maintain their weight. Maintenance requirements increase as the level of the animals' activity increases. For example, a sheep or goat that has to travel a farther distance for feed and water will have higher maintenance requirements than animals in a feedlot. Environmental conditions also affect maintenance requirements. In cold and severe weather, sheep and goats require more feed to maintain body heat. The added stresses of pregnancy, lactation and growth further increase nutrient requirements.

A sheep or goat's nutritional requirements can be met by feeding a variety of feedstuffs. Feed ingredients can substitute for one another so long as the animals' nutritional requirements are being met. Small ruminant feeding programs should take into account animal requirements, feed availability and costs of nutrients.

Pasture, forbs and browse are usually the primary and most economical source of nutrients for sheep and goats, and in some cases, pasture is all small ruminants need to meet their nutritional requirements. Pasture tends to be high in energy and protein when it is in a vegetative state. However, it can have a high moisture content, and sometimes it may be difficult for high-producing animals to eat enough grass to meet their nutrient requirements. As pasture plants mature, palatability and digestibility decline, thus it is important to rotate pastures to keep plants in a vegetative state. During the early part of the grazing season, browse such as woody plants, vines and brush and forbs (weeds) tend to be higher in protein and energy than ordinary pasture. Sheep are excellent weed eaters. Goats are natural browsers and have the unique ability to select plants when they are at their most nutritious state. Sheep and goats that browse have fewer problems with internal parasites.

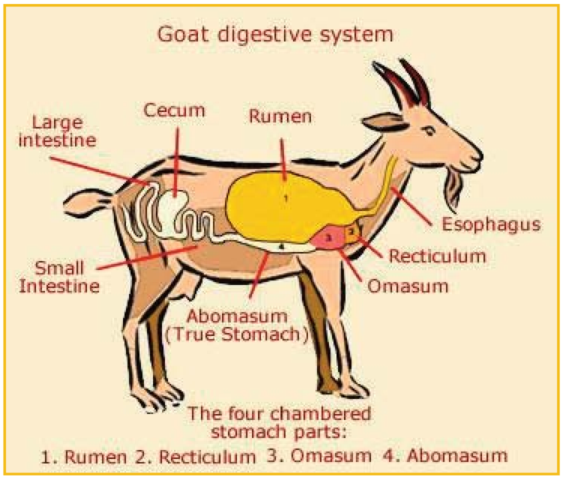


Figure 1. Goat digestive system.

Digestive System

Hay is the primary source of nutrients for small ruminants during the winter or non-grazing season. Hay varies tremendously in quality, and the only way to know the nutritional content is to have the hay analyzed by a forage testing laboratory. Hay tends to be a moderate source of protein and energy for sheep and goats. Legume hays – alfalfa, clover, lespedeza – tend to be higher in protein, vitamins and minerals, especially calcium, than grass hays. The energy, as well as protein content of hay depends upon the maturity of the forage when it was harvested for forage. Proper curing and storage is also necessary to maintain nutritional quality of hay.

It is sometimes necessary to feed concentrates to provide the nutrients that forage alone cannot provide. This is particularly true in the case of high-producing animals. There are also times and situations where concentrates are a more economical source of nutrients. Many feed companies offer “complete” sheep and/or goat feeds – pelleted or textured – which are balanced for the needs of the animals in a particular production class. Pelleted rations have an advantage in that the animals cannot sort feed ingredients. While complete sheep feeds have been available for many years, it has only been in recent years that meat goat rations have been introduced to the market place. Complete feeds come in 50- or 100-pound sacks and tend to be much more expensive than homemade concentrate rations.

Many minerals are required by small ruminants. The most important are salt, calcium and phosphorus. The ratio of calcium to phosphorus should be kept around 2:1 to prevent urinary calculi. Vitamins are needed in small amounts. Small ruminants require vitamins A, D and E, whereas vitamin K and all the B vitamins are manufactured in the rumen. A free choice salt-vitamin-mineral premix should be made available to small ruminants at all times, unless a premix has been incorporated into the grain ration or TIM (total mixed ration). In the very least, ewes and does should be fed pre-choice mineral during late gestation and lactation. Either a loose mineral or mineral block may be offered. Force-feeding minerals and vitamins is actually better than offering it free choice since animals will not consume minerals according to their needs.

Small ruminants should have access to clean, fresh water at all times. A mature animal will consume between 0.75 to 1.5 gallons of water per day. Water requirements and intake increase greatly during late gestation and during lactation. Water requirements increase substantially when environmental temperatures rise above 70 degrees F and decline with very cold environmental temperatures. An animal’s nutrient requirements will increase if it has to consume cold water during cold weather. Rain, dew and snowfall may dramatically decrease free water intake. Inadequate water intake can cause various health problems. In addition water and feed intake are positively correlated.

Body Condition Scoring

Body condition score, or BCS, has been shown to be an important practical tool in assessing the body condition of cattle, sheep and goats because BCS is the best simple indicator of available fat reserves which can be used by the animal in periods of high energy demand, stress, or suboptimal nutrition.

Goats

Scoring is performed in goats using a BCS ranging from 1.0 to 5.0, with 0.5 increments. A BCS of 1.0 is an extremely thin goat with no fat reserves and a BCS of 5.0 is a very over-conditioned (obese) goat. In most cases, healthy goats should have a BCS of 2.5 to 4.0. A BCS of 1.0, 1.5 or 2.0 indicates a management or health problem. A BCS of 4.5 or 5 is almost never observed in goats under normal management conditions; however, these BCS can sometimes be observed in show goats.

It is important to note that BCS cannot be assigned by simply looking at an animal.

Instead, the animal must be touched and felt. The first body area to feel in determining BCS is the lumbar area, which is the area of the back behind the ribs containing the loin. Scoring in this area is based on determining the amount of muscle and fat over and around the vertebrae. Lumbar vertebrae have a vertical protrusion (spinous process) and two horizontal protrusions (transverse process). Both processes are used in determining BCS. You should run your hand over this area and try to grasp these processes with your fingertips and hand. The second body area to feel is the fat covering on the sternum (breastbone). Scoring in this area is based upon the amount of fat that can be pinched. A third area is the rib cage and fat cover on the ribs and intercostal (between ribs) spaces.

BCS 1.0 – Visual aspect of the goat: Emaciated and weak animal, the backbone is highly visible and forms a continuous ridge. The flank is hollow. Ribs are clearly visible. There is no fat cover, and fingers easily penetrate into intercostal spaces (between ribs). The spinous process of the lumbar vertebrae can be grasped easily between the thumb and forefinger; the spinous process is rough, prominent and distinct, giving a saw-tooth appearance. Very little muscle and no fat can be felt between the skin and bone.



BCS 2.0 – Visual aspect of the goat: Slightly raw-boned, the backbone is still visible with a continuous ridge. Some ribs can be seen, and there is a small amount of fat cover. Ribs are still felt. Intercostal spaces are smooth but can still be penetrated.



BCS 3.0 – Visual aspect of the goat: The backbone is not prominent. Ribs are barely discernible; an even layer of fat covers them. Intercostal spaces are felt using pressure.



BCS 4.0 – Visual aspect of the goat: The backbone cannot be seen. Ribs are not seen. The side of the animal is sleek in appearance. It is impossible to grasp the spinous process of the lumbar vertebrae, which is wrapped in a thick layer of muscle and fat.



BCS 5.0 – Visual aspect of the goat: The backbone is buried in fat. Ribs are not visible. The rib cage is covered with excessive fat. The thickness of the muscle and fat is so great that reference marks on the spinous process are lost.



Sheep

While it is easy to see the body condition of a sheep when it is freshly shorn, it becomes impossible to do that by sight as the wool/hair grows. A woolly sheep can easily look in a lot better condition than it actually is. Many ranchers are shocked at the poor condition of their sheep when they are shorn. Therefore, it is necessary to palpate, or feel, each individual for accurate assessment of body condition. The animal should be standing in a relaxed position. It should not be tense, crushed by other animals or held in a crush. If the animal is tense, it is not possible to feel the short ribs and get an accurate condition score. Place your thumb on the backbone just behind the last long rib and your fingers against the stubby ends of the short ribs.

A body condition score estimates condition of muscling and fat development. Scoring is based on feeling the level of muscling and fat deposition over and around the vertebrae in the loin region. In addition to the central spinal column, loin vertebrae have a vertical bone protrusion (spinous process) and a short horizontal protrusion on each side (transverse process). Both of these protrusions are felt and used to assess an individual body condition score (Figure 2.) The system used most widely in the United States is based on a scale of 1 to 5. The five scores are shown in Figure 3 at right.

Body condition scoring is a subjective way of measuring the level of muscle and body fat

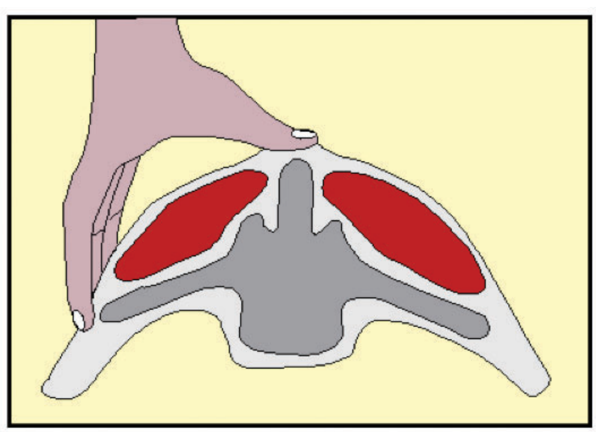


Figure 2. Palpating spinous and transverse processes.

Condition 1 (Emaciated):

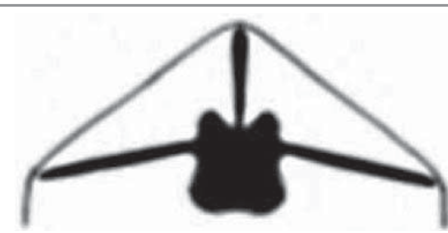
Spinous processes are sharp and prominent. Loin eye muscle is shallow with no fat cover. Transverse processes are sharp; one can pass fingers under ends. It is possible to feel between each process.

Condition 2 (Thin):

Spinous processes are sharp and prominent. Loin eye muscle has little fat cover but is full. Transverse processes are smooth and slightly rounded. It is possible to pass fingers under the ends of the transverse processes with a little pressure.

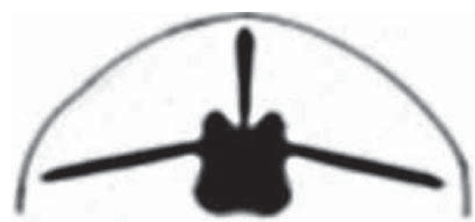
Condition 3 (Average):

Spinous processes are smooth and rounded and one can feel individual processes only with pressure. Transverse processes are smooth and well covered, and firm pressure is needed to feel over the ends. Loin eye muscle is full with some fat cover.



Condition 4 (Fat):

Spinous processes can be detected only with pressure as a hard line. Transverse processes cannot be felt. Loin eye muscle is full with a thick fat cover.



Condition 5 (Obese):

Spinous processes cannot be detected. There is a depression between fat where spine would normally be felt. Transverse processes cannot be detected. Loin eye muscle is very full with a very thick fat cover.

Figure 3. Muscle and fat around spine and transverse processes for condition score 1 to 5.

carried on your sheep. BCS can give you a good indication of the health, nutritional state and potential reproductive success of your flock in a single easy measurement. Despite its subjectivity, BCS are very reliable indicators when conducted by a trained scorer (Figure 4, page 26). Most sheep on most farms will have a BCS of between 2 and 4. Age, pregnancy status and wool coat are a few of the variables that can affect the outcome or interpretation of your ewes' BCS.

Nutrition in Drought

Extended periods of dry weather or drought generally shorten the season small ruminants can graze on available forage. This reduces the forage quality greatly, and consequently, there is a need for supplemental feeding. Animals require energy, protein, vitamins and minerals, but these nutrients need not come strictly from hay and some type of grain. Producers may need to look at some nontraditional or alternate feeds. Feed availability, quality and relative cost per unit of feed value should determine which feeds are used.

In years when grazing forages are limited, particular attention should be given to the amount animals are consuming on a daily basis. If a ewe or doe's nutritional requirements to produce muscle and fiber are not met, then she will not produce at a satisfactory level. Likewise, a ewe/doe, when overfed, wastes limited feed resources. In certain stages of the production

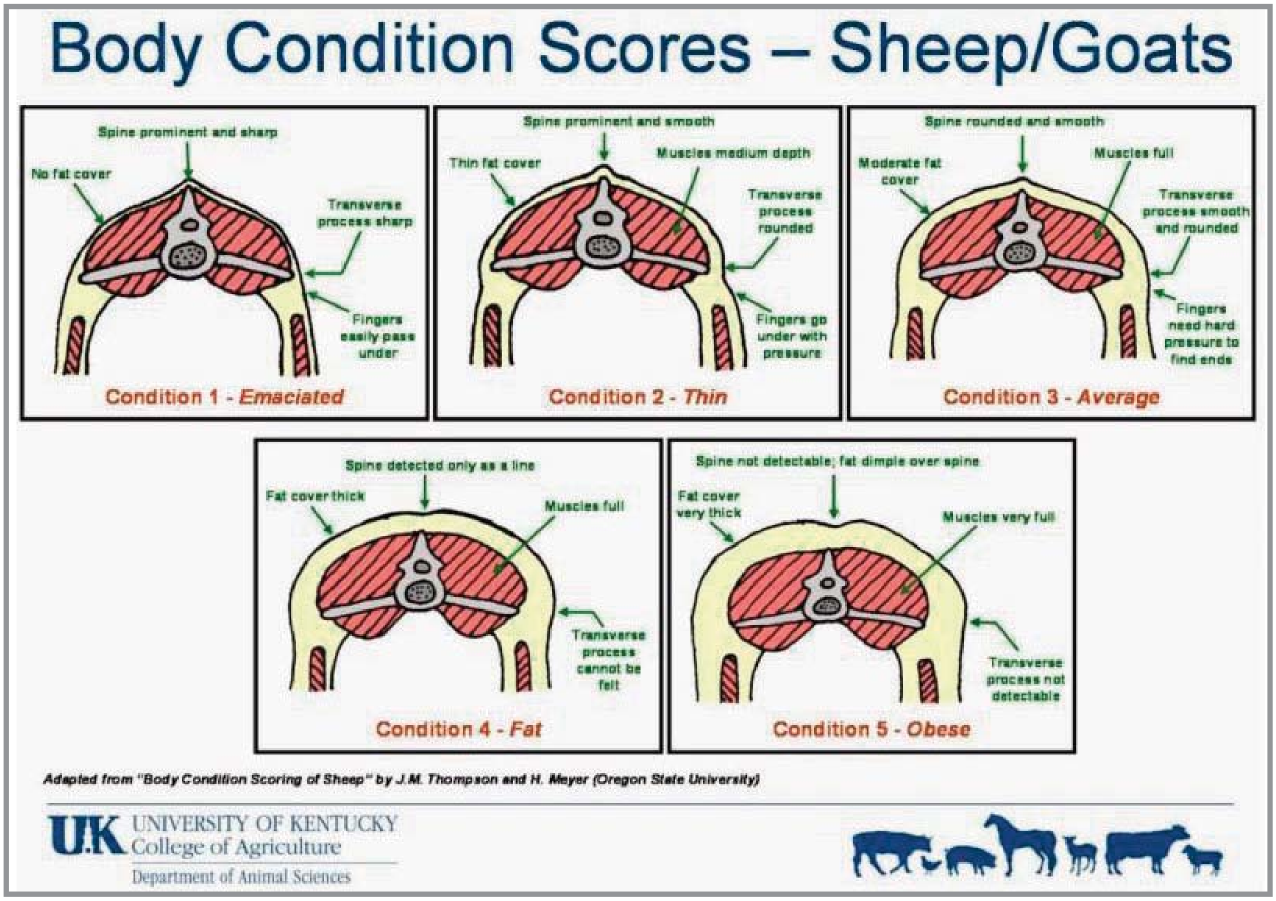


Figure 4. Body condition score of sheep and goats.

cycle, it may be advantageous to restrict intake of nutrients. Producers must first know the animal's nutrient requirements and the nutrient contents of the feeds that the sheep are consuming before a balanced feeding program can be calculated.

Price comparisons should be carefully considered when contemplating a supplementation or feeding program. One should particularly note that hays, especially late cut hays, are low in total digestible nutrients, or TDN. Straw, likewise, has a low TDN value. Feeds which are below 52 percent TDN will not meet energy requirements, even for maintenance, and should not be used as the sole source of energy even when they appear to be quite inexpensive. Addition of other energy and/or protein supplement, however, can make these useful alternatives to supplement ewes/does.

In Arkansas, forage brassicas have proven to be a viable option for quick establishment (45 to 60 days) and sufficient quality to meet animal requirements. Forage brassicas can extend the grazing season in fall when other forages are less productive, therefore reducing the dependence on stored or purchased feed. Brassica varieties can yield 1,100 to 3,800 pounds of dry matter per acre, depending on variety, degree of soil disturbance and fertilization. The crude protein and TDN will exceed the nutritional requirements for all classes of livestock, with CP ranging from 18 to 33 percent and TDN ranging from 72 to 89 percent.

Reproduction During Drought

The nutritional status of a herd is the most important factor influencing reproduction. It is also the factor over which the producer has the most control by either increasing or reducing nutrient consumption. The body condition of a ewe or doe strongly affects the following:

- The time at which puberty starts.
- The conception rate at first estrus in ewe lambs and doelings.
- The length of the postpartum interval.
- The health and vigor of newborn lambs and kids.

The practice of increasing nutrient intake and body condition prior to and during breeding is called flushing. Its purpose is to increase the rate of ovulation and, thus, lambing/kidding rate. Flushing is especially beneficial for thin females that have not recovered from previous nutritional stresses such as poor forage quality, parasite infection, lactation or disease. Flushing can be accomplished by providing ewes or does with high quality pasture, supplemental harvested forage, or grain, depending on environmental stress, availability of forage and body condition of the ewe. During drought, nutrition and stress from heat may limit breeding in late summer and early autumn. At this time, a high-nutrition diet needs to be fed. Increasing nutrients should start two to three weeks prior to turning the bucks in with the females. This should be continued at least two to four weeks into the breeding season. Bucks and rams should also be evaluated for proper body condition.

Small Ruminant Health

A sound management program to keep animals healthy is fundamental to the production of both sheep and goats. Producers must observe animals closely to keep individual animals and the whole herd or flock healthy and productive. If the health status of a herd is compromised, that operation will not be as efficient as possible. There are some human health risks when dealing with diseased animals. While most diseases affecting sheep and goats do not pose any human health risks, some are zoonotic, and it is important to protect not only caretakers but anyone else who may come in contact with diseased animals. To recognize clinical signs of diseases common to sheep and goats, it is important to be familiar with what is normal. Producers should assess the herd or flock's general health on a regular basis, including vital signs and body condition.

Table 1. Normal range for goat and sheep physiological parameters.

	Goat	Sheep
Temperature, rectal	101.5-103.5 degrees F	101.5-103.5 degrees F
Heart Rate	70-80 beats per minute	70-80 beats per minute
Respiration	12-25 per minute	15-30 per minute
Rumen movement	1-2 per minute	1-2 per minute
Estrous	18-21 days	14-20 days
Estrus	48-72 hours	24-48 hours
Gestation	145-155	144-151 days

The most common procedures done by producers are listed below with a brief explanation of correct methods.

Taking Temperature – Rectally

The first procedure usually performed on an animal suspected to be ill is to take its temperature. In goats, this is performed rectally. Either a digital or mercury thermometer can be used. Plastic digital thermometers do not break and may be considered as safer to use than a mercury thermometer. A small amount of lubricant may be put on the thermometer and it should be inserted with a twisting motion.

Respiration Rate

Respiration is detected by watching movement of the flank or chest. A normal range is 12 to 20 per minute.

Rumen Movements

Adequate rumen function is essential for a goat's health. One sign of adequate function is regular ruminal movement. This can be detected by placing the hand on the left flank of the animal. If the rumen feels soft and water-filled, this should be noted and reported to your veterinarian. Rumen contractions should be easily felt and should occur one to two times per minute.

Checking Mucous Membranes

Paleness of the mucous membranes in the mouth (gums), vagina and prepuce can be an indicator that the animal is in hypovolemic shock, meaning that there is a decrease in the blood volume circulating in the animal. The color of the conjunctiva around the eyes can be an indicator of anemia that could be caused by a heavy internal parasite burden. Roll down the lower eyelid to look at the color. A pale, whitish color indicates anemia. This color can be scored using the FAMACHA diagnostic system. Remember that irritation of any type causes membranes to turn red.

Animals should exhibit a healthy hair coat or fleece, while maintaining a body condition score appropriate to their production stage. Both coat and body condition score are good indications of nutritional adequacy and overall health. Signs of an unhealthy animal include isolation from the rest of the herd/flock, abnormal eating habits, depression, scouring or diarrhea, abnormal vocalization, teeth grinding or any other abnormal behavior.

Conclusion

To summarize managing small ruminants during drought conditions, the following strategies may be considered:

1. **Wean lambs/kids.** The ewe/doe nursing offspring has energy and protein requirements 200 to 300 percent that of dry ewes/does. Lambs/kids older than 60 days of age are not receiving significant nutrition from a lactating female, particularly when nutrition is limited. Lambs/kids can be removed from pasture and placed on feed in a drylot facility or sold. Removing the lambs and kids from pasture also serves to decrease the grazing pressure on pastures and allows for existing forages to be used for maintenance of the breeding flock/herd. The decision to sell or feed lambs/kids to heavier weights will be based on market prices, weight and condition of the animals and cost of additional gain. In most cases, the cost of additional gain through grain supplementation is economically beneficial.
2. If pastures become short enough that supplemental feed is necessary for the flock or herd, consider feeding other energy supplements. Feeding 0.5 to 1.0 pound per head per day will help "stretch" pastures and decrease the dependence on limited pasture forages as the sole nutrient source. Prior to breeding, additional energy through grain supplementation also has the added benefit of flushing the ewes/does, which has a favorable impact on number of offspring born.
3. In some situations, pastures may become so depleted such that the flock must be provided their entire diet through supplemental feed. In these situations, remove the flock from pastures to allow forages to recover once moisture is received. Since the nutritional requirements are low (assuming ewes/does are dry), utilizing poor to average quality hays is an option. A 175-pound ewe would require 3.5 pounds of hay (50 percent TDN, 9 percent crude protein) to meet her maintenance requirements for energy and protein. Limit feed hay to prevent consumption above requirements and to minimize wastage. If hay supplies are short, supplementing with grain will help limit the amount of hay needed. Supplementing grain will be most economical if hay needs to be purchased. However, ewes and does need to consume 1 percent of their body weight as roughage to maintain rumen function.
4. Be sure to follow a strategic deworming program, even during dry conditions. Excessive worm loads will cause additional stress on the flock, and short pastures are conducive to parasitism.
5. Provide a complete mineral formulated for sheep or goats to the herd at all times.
6. Evaluate the productivity of the flock or herd. Cull poor-performing ewes and does.

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Chapter 5

Water Quality and Quantity for Livestock During a Drought

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Major Points to Remember

- Water needs for livestock may increase substantially during a drought caused by above-average daytime temperatures and low-quality feedstuffs.
- Backup watering plans should be in place before a drought, as ponds and streams may dry up during prolonged drought periods.
- Water quality may quickly deteriorate in ponds and tanks with low levels of water and nutrient and feces contamination.
- Diversity of water sources – wells, ponds, access to city water lines – is the best protection against shortages of water during a drought.

Water Quantity

Water is the most abundant constituent of the body fluids, accounting for 60 to 70 percent of the total livestock body weight. Functions of water within the body include being solvent for chemicals and maintaining cell osmotic pressure. The physical characteristics of water such as relatively high specific heat and the dipolarity of the water molecule make it ideal as a body temperature regulator and transport medium.

Because of the high importance to metabolic functions, failure to provide enough water will reduce animal performance more quickly and severely than any other nutrient. Access to sufficient quantities of clean water will result in increased dry matter, or DM, intake and thus increased animal performance. Some studies suggested a reduction in nutrient digestibility if water is limited to cattle. Other negative effects may include decreased rates of respiration and rumination and increased concentrations of urea and potassium in blood serum. Several authors have suggested that a low drinking water temperature may be more beneficial for animal temperature regulation than large quantities alone.

The amount of water needed on a daily basis depends on several factors, including the air temperature, age of animal, moisture content of feed and forage and the distance the animal must travel to the water source. Previous research indicated various quantities, but a conservative estimate is to provide 1 gallon of water per pound of DM consumed. Table 1 provides an overview of quantities recommended during hot days in comparison with cool days.

Table 1. General watering needs for various classes of livestock depending on air temperature.

Livestock	Water needs per animal (50°F day)	Water needs per animal (90°F day)
Dry beef cows	8-12 gallons	20-30 gallons
Lactating beef cows	12-20 gallons	25-35 gallons
Lactating dairy cows	20-30 gallons	30-40 gallons
600-lbs weaned calves	6-9 gallons	10-15 gallons
Horses	8-12 gallons	20-25 gallons
Sheep and goats	2-3 gallons	3-4 gallons

Different water requirements under different conditions reflect the need of the animal to maintain water balance within the body. Approximately 20 percent of the body weight is considered extra-cellular water from which emergency water can be drawn to avoid dehydration. Mature animals have about 10 times more reserve water available than calves; therefore, young animals are much more sensitive to distress from diarrhea than older animals. Water requirement can vary widely based on the current condition of the animal or goals of production. For example, twice the water is required for lactating cows compared with nonlactating cows. Table 2 offers suggestions regarding the minimum water requirements at different ages of the animal.

Table 2. Minimum water requirements for cattle according to their age.

Category	Age (Months)	Requirement (gallons/ animal/day)
Calves	<1	0.25
Calves	1-2	1
Calves	2-4	2
Growing cattle	4-5	2.6
Growing cattle	6-12	4
Growing cattle	>13	>5.25
Cows	mature	9
Bulls	mature	10

Compared with other classes of livestock such as cattle and horses, sheep are more able to withstand lack of water. Sheep can endure dehydration up to 30 percent of their body weight. Additionally, sheep can drink almost 2 percent of their body weight in water at one time without detrimental effects.

Water Quality

Besides the required water quantities, water quality is of importance for keeping livestock healthy and productive. This is especially important during a drought and the recovery afterwards. A water quality assessment can be based on a variety of parameters, including physical properties, physiochemical properties, nutrient content, toxic compounds and microbiological agents.

The physical properties of water refer to the effects of temperature on water and consumption by cattle. Cattle prefer drinking water in the range between 40 degrees and 65 degrees Fahrenheit. Above 80 degrees F, water and DM intake usually decline, thereby affecting livestock productivity. During times such as a drought, water may get excessively hot from direct sunlight and uptake of heat by water lines and equipment. For these instances, it has been recommended to build small shade structures over the water tanks and troughs to reduce the water temperature. In some areas, producers use freezeproof water supply devices. The insulation in these devices should help keep the water relatively cool. Normally, such type of equipment is connected to water lines that run underground; therefore, heating of pipes may be substantially reduced, even during prolonged, droughty summers.

Physiochemical properties refer to pH, hardness and salinity. Salinity refers to the quantity of dissolved constituents, such as sodium chloride, that cause the water to be "saline," but salinity can also be cause by sulfates, magnesium or calcium. Salinity is measured by assessing total dissolved solids or electric conductivity. High levels of salinity lead to reduced feed intake and gains. Research indicated that cattle adjust to small changes in salinity, but large amounts of dissolved salts can cause harm. This is especially the case during a drought, when salinity levels of water in ponds or tanks may be elevated due to increased evaporation rates and stress levels for cattle are higher than normal. Table 3 indicates salinity guidelines.

Table 3. Salt concentrations and effects on cattle.
(Adopted from Higgins and Agouridis, University of Kentucky)

<1,000 mg/L	No health problems expected.
1,000-2,999 mg/L	Safe to drink, but may cause mild diarrhea (Even slight health impacts may not be acceptable in a drought situation where water and fresh forage are scarce).
3,000-4,999 mg/L	Water intake is lowered and cattle may initially refuse drinking. May cause diarrhea.
5,000-6,999 mg/L	Avoid offering to pregnant animals; may be still acceptable for other animals.
7,000-10,000 mg/L	Consumption will likely result in health problems.
>10,000 mg/L	Unsafe to drink; do not use.

Water hardness refers to the concentration of divalent metallic cations dissolved in water and is expressed as equivalents of calcium carbonate. Some other elements such as iron and manganese can also contribute to hardness. High iron concentrations (>0.3 mg/L) have been shown to affect cattle health and thus performance. In addition, high calcium concentrations (>12.5 g/kg in the diet) can reduce selenium uptake. Water in karst regions such the Ozarks may be high in calcium, and producers need to be aware of potential elevated concentrations in surface and well waters.

The pH indicates the acidity or alkalinity of water. Cattle prefer water between pH 5 and 9. Normally, the pH of water in ponds or tanks stays in this range, unless these values are drastically skewed – for example, due to an accidental fertilizer spill.

Among nutrients, nitrate in livestock drinking water is possibly the most severe problem in the southern U.S. Nitrate itself is not poisonous to cattle, but nitrite, to which nitrate is converted in the digestive tract, impedes the oxygen transport in blood. Excessive nitrate levels result in lethargic animals and sudden death. Although animals may adapt to high levels of nitrate, chronic exposure in water or feed will lead to adverse health effects including abortions, depressed growth rates and reduced feed intake. Table 4 indicates levels of nitrates and their acceptability. During a drought, nitrate problems can be greatly exacerbated due to increased concentrations in surface waters. Overgrazed pastures are common during droughts with loss of canopy cover. Increased runoff may then occur that potentially collects fertilizer and minerals attached to soil particles.

Table 4. Levels of nitrate compounds in water and their potential risks for cattle. *(Adopted from Higgins and Agouridis, University of Kentucky)*

NO_3 (mg/L)	NO_3-N (mg/L)	Comments
0-44	0-10	Safe for consumption.
45-132	11-20	Safe with low-nitrate feeds.
133-220	21-40	Potential harmful if consumed over long periods.
221-660	41-100	Risk of death.
>661	>101	Unsafe for consumption.

Sulfate occurs as salt it forms with iron, sodium calcium and magnesium. Elevated levels of sulfates can make water ill-tasting and thus being refused by cattle. High concentrations of sulfates in water cause diarrhea and, in some instances, copper deficiencies. Sulfate poisoning is characterized by weakness, lethargy, paralysis and even death. As with other potentially harmful compounds, of concern during prolonged droughts are increased concentrations in normally acceptable water sources, such as ponds. With increased evaporation rates and stressed animals, normally low levels of sulfates can pass a threshold that is harmful to cattle.

Toxic compounds such as arsenic and heavy metals are always of concern, as even small amounts can be a health hazard. A list of compounds and upper limit guidelines are listed in the University of Arkansas Cooperative Extension Service fact sheet FSA3012, *Water for Beef Cattle*.

Microbial agents of concern are fecal coliforms and cyanobacteria. Pathogens stemming from fecal matter may become a severe problem during drought periods if cattle have only access to streams or inappropriately managed ponds. The development of mud puddles in both streams and ponds with increased coliform counts is likely during a drought. Producers can prevent infections in the long term by establishing alternative clean water sources and access points as part of the overall grazing management plan.

Cyanobacteria (blue-green algae) may particularly develop during drought periods when solar radiation is high, waters are stagnant and concentrations of nutrients in surface waters and water troughs increase. There are cases in which cattle have become sick and even died from drinking infested waters by ingesting microcystins, which are the toxic compounds released by blue-green algae. Water contaminated with these algae has a moldy and musty odor. Even under normal nondroughty conditions, small ponds and streams can have high enough concentrations of algae in late summer to be harmful. Eliminating the source of the nutrient intake is the best method to control algae. There are several good designs available for pond water access points so cattle do not loaf in the entire pond and contaminate the water. Stock tanks or troughs can be cleaned with either copper sulfate or household bleach. When using copper sulfate, maximum tolerable levels for sheep are 2.7 pounds of copper sulfate/acre-foot of water, and for cattle 6.8 pounds/acre-feet. It is important not to exceed these levels – sheep are very sensitive to high copper concentrations. Bleach can be used at a rate of 2 ounces/50 gallons of water as long-term tank treatment. If infestation is severe, tanks should be emptied and scrubbed with bleach.

Water Sampling Collection

If in doubt regarding the suitability of a livestock water source, producers should take samples and submit them to a commercial or university laboratory for analysis. The sampling protocols should be followed strictly to get meaningful test results. Water samples for microbial testing should be analyzed within 24 hours. Sampling containers and detailed instructions are usually supplied by the respective laboratory.

Maintaining Water Quality During a Drought Event

The same basic principles that apply to livestock watering during normal nondroughty conditions apply during a drought as well. Water quality is not just a matter of protecting surface waters for the public good, but more so to provide cattle and other livestock with fresh, clean water to maintain health and productivity. Therefore, the setup and building of watering devices fed either by city waterlines, wells or ponds should be part of the overall long-term grazing management plan.

During a drought, it is likely that dry lots or sacrifice pastures are excessively used for keeping animals. Runoff will become a critical issue there once precipitation sets in again. Therefore, it is important to keep the damage to buffer strips or riparian zones, if there are any, to a minimum during a drought because these are the last line of defense if runoff occurs. Riparian zones and buffer strips can be grazed in an emergency, but enough time for recovery should be allotted.

For the different kinds of watering devices and water access points used on a farm, some specifics apply in the case of drought:

Ponds. They should be fenced off even under normal circumstances and a floating fence installed or an access point that limits loafing of animals. During a drought, water levels may be very low and ponds get muddied and contaminated very quickly with unrestricted cattle access. This will put animals at risk from a health perspective and will make repair of the pond afterwards difficult. Salts and other impurities that otherwise pose no problem may concentrate to toxic levels in ponds with low quantities of water.

Streams. In many cases, these are the only available water sources on many farms, but streams can dry up during severe droughts. Precautions should be taken to avoid damage to stream banks because this will make the recovery of vegetation in these areas difficult. If the property borders to larger streams or even a river, then off-stream watering devices should be installed over time as part of the grazing management plan. While creeks may dry up, larger streams and rivers may carry enough water during a drought so water can still be drawn. Base flow levels of streams may be judged from historic data. Intermittent streams are not recommended for usage as those will not carry water during a drought.

Wells. Wells provide a safe and reliable water source, but drilling is expensive and the location of the well should be evaluated carefully. Wells have to be deep enough to prevent contamination from leaching of agrochemicals and nitrates. The available water volume should be assessed as precisely as possible before drilling. Wells cannot be drilled during a drought assuming quick relief. They should rather be part of a long-term water management plan and installed based on thoughtful assessment of farm resources.

Water tanks connected to city lines. These devices may include tire tanks, freeze-proof tanks or a simple stock tank which is connected to a water outlet near the house or barn. These devices will provide safe and drinkable water during a drought because in the southern U.S., drought events get rarely severe enough that public water access will be limited. Therefore, it is recommended that producers have equipment such as smaller stock tanks in place during times of drought.

Summary

During a drought with above-normal daytime temperatures, watering needs for livestock can increase substantially compared with normal conditions. Therefore, it is important to keep watering devices in excellent working order at all times. As watering devices and access points are part of the overall grazing management plan, ideally, farms should be equipped with a diversity of sources that provide backups in a time of drought. On many farms, ponds and streams are used for livestock watering as the sole source of water. These can dry up during prolonged hot and droughty periods. Alternatives should be developed in advance that may include watering devices connected to city water lines, well access and floating pond fences among others. The latter is particularly helpful, because with increased drought and evaporation, pond waters become muddy quickly if cattle are allowed unrestricted access. For emergency purposes, stock tanks provide a way to water livestock close to working facilities or barns.

Chapter 6

Livestock Health Considerations During Drought

Jeremy Powell, DVM, Professor and Extension Veterinarian

Blackleg

Drought conditions force cattle to graze on shorter and shorter forage, increasing the risk of picking up the soil-borne pathogens that cause blackleg. Blackleg is a disease that affects cattle worldwide and is caused by the infectious bacteria *Clostridium chauvoei*. Cattle may become exposed to blackleg from bacterial endospores in the soil. Although blackleg can occur in very young calves, the disease typically affects animals between six months and two years of age. Rarely, losses may also be seen in adult cattle.

Blackleg usually affects calves that are in good condition and rapidly growing. Animals infected with this disease typically die rapidly without any outward signs of illness. However, clinical signs that may be noted very early in the disease include lameness, loss of appetite, fever and depression.

Postmortem lesions associated with blackleg include characteristic swelling at the area of the affected muscle tissue (legs, neck, hip, chest, shoulder, back or elsewhere). The swelling is due to fluid accumulation as well as gas buildup, which are produced by the bacteria. When pressure is applied to the affected areas, gas can often be felt moving while producing a crackling sound under the skin. Affected muscle tissue will contain dark areas of dead tissue, hence the name blackleg. This affected tissue may also have a foul odor (usually described as rancid butter).

It is virtually impossible to prevent contact with the infectious agent, so vaccination becomes the only way of effectively controlling this disease. It is generally recommended to vaccinate calves between two and three months of age. Before this period, calves should be protected through passive transfer of antibodies in the dam's colostrum. A regular vaccination protocol should be followed around weaning. Blackleg vaccine should be administered subcutaneously (under the skin) in the neck area. The common blackleg vaccines are referred to as "7-way" because they protect against other clostridial diseases such as malignant edema, black disease, enterotoxemia, etc.

If an outbreak of disease has occurred, a producer should contact his or her veterinarian for accurate diagnosis and management recommendations. The veterinarian will probably recommend that all animals receive immediate vaccination and followup boosters. Further losses may occur for a two-week period until the animals develop ample immunity against the disease. Carcass disposal should be done carefully after an outbreak of disease occurs. If possible, bury carcasses deeply where they lie, so they will not be dragged across the pastures, contaminating more ground.

Toxic Plants

During drought conditions, dry, hot weather can leave pastures thin and short. Occasionally, this may entice cattle to browse on weeds they wouldn't typically eat with adequate forage available. Some weeds can be very toxic to cattle and other livestock. It never hurts to assess your pasture for toxic plants and realize they can have a detrimental effect on your livestock.

Perilla mint weed (a.k.a. purple mint) is very common in our part of the country and is found in semi-shady areas of the pasture. Cattle don't typically prefer to eat mint weed, but when very little valuable forage is left in a pasture due to drought, cattle may be tempted to nibble on this toxic plant. Mint weed contains a ketone toxin that leads to severe respiratory problems in cattle. This toxin causes the affected animal's lungs to fill with fluid, leaving them unable to breathe. Affected cattle show signs of respiratory distress such as breathing with their mouth open and neck extended, frothy salivation, grunting when breathing and generalized weakness. Death often occurs within one to two days after onset of illness. Treatment for the perilla mint toxin is very limited. Often, the stress of handling the affected animal for treatment is enough to exhaust their already weakened state. The best medicine is to prevent the consumption of the plant.

Figure 1. Mintweed.

Figure 2. Johnsongrass.

Considered good forage by some producers and a weed by others, Johnsongrass can also lead to toxicity problems in cattle. Johnsongrass, sudangrass and other sorghum-sudan hybrids can accumulate nitrates (see Table 1) and also be a source of prussic acid (cyanide) in its leaves and stems. Young plants that have been stressed by drought, frost or recent application of herbicide contain dangerous levels of free cyanide in their leaves. It is especially common in Johnsongrass that is less than 18 inches tall and has started to regrow after a shower following a long dry spell. Cyanide prevents the body's ability to use oxygen. Therefore, affected cattle may show respiratory signs, but sudden death is a very common occurrence. Prussic acid will dissipate when Johnsongrass is cut and cured for hay. Johnsongrass is very common throughout our state. Dry summer pastures can turn deadly when cattle graze on forages that are poisonous. Usually, the best method of controlling plant toxicity is to limit exposure to the poisonous plant before a toxic level is ingested.

Nitrate Toxicity

Many different plants can be involved with nitrate toxicity in cattle. During drought situations, cattle eat weeds that are more commonly associated with nitrate poisoning since many normal forages are absent. Common weeds associated with nitrate toxicity are pigweed, jimsonweed, nightshade, thistle and dock. Plants tend to have abnormal nitrate levels during periods of stress, making toxicity more likely times of drought. However, other stressors, such as soil conditions (acidity, sulfur/phosphorus/molybdenum deficiency), disease, fertilizer or herbicide use, can increase the level of nitrate accumulation.

Cattle, sheep and goats are susceptible to this condition because microbes in the digestive tract of ruminant animals favor the conversion of nitrates to nitrites. It is the accumulation of these nitrites in the rumen and then the blood that actually lead to the poisoning of the animal. Nitrites are approximately 10 times more toxic than nitrates to the animal, although the syndrome is generally referred to as nitrate poisoning. Once high levels of nitrites begin to accumulate in the rumen, they are picked up into the blood stream. The nitrites combine with the hemoglobin in red blood cells, converting hemoglobin to methemoglobin. Methemoglobin is extremely inefficient at transporting and exchanging oxygen in the blood. Consequently, affected animals suffer from oxygen starvation and die due to tissue asphyxiation (suffocation).

Due to poor tissue oxygenation, nitrate poisoning can lead to several clinical signs in the affected animal. Signs associated with nitrate toxicity include shallow and rapid respiration, weakness, opened mouth breathing, blue mucous membranes, staggering, collapse and death. Hypersalivation, bloat and muscle tremors may also be noted. Since the signs may progress very quickly, death may occur before any illness is noted with the animal. In some cases that are not affected enough to cause death, other symptoms such as abortion may occur.

A field test, known as the diphenylamine (DPA) test, can be performed to detect the presence of nitrates in forage. The reagent for this test can be produced by mixing 0.5 grams of diphenylamine into 20 milliliters of water. Carefully add enough sulfuric acid to the solution to make 100 milliliters. This solution should be kept cool and stored in a brown bottle. To test suspect forages, place a drop of the test solution onto the cut surface of the plant stalk. A color change noted on the plant from green to blue indicates a positive reaction. A positive test identifies the need for a more quantitative laboratory procedure to be run on the forage before animals are allowed to graze.

Laboratory procedures can be done to identify dangerous levels of nitrites in hay, water or forage. In Arkansas, nitrate analysis can be performed at the University of Arkansas Agricultural Diagnostic Laboratory in Fayette - ville and at the Arkansas Livestock and Poultry Commission Veterinary Diagnostic Laboratory located in Little Rock. Reporting of nitrate levels can differ depending on the type of techniques used by the lab. Nitrates levels are typically reported out as nitrate-nitrogen (NO_3-N), nitrate (NO_3-) or potassium nitrate (KNO_3). Table 1 notes the guidelines for interpretation of laboratory results with each of these commonly reported expressions.

Another additive effect that can occur is if animals are consuming water from a source that has high levels of nitrates. Nitrates may reach dangerous levels in ponds that collect drainage from fertilized fields. Table 2 identifies significant levels of nitrates in water.

Postmortem diagnosis can be performed on animals that are suspected nitrate poisoning cases. Ocular fluid, blood and rumen contents can be collected from a dead animal. Ocular fluid especially accumulates high levels of nitrites when poisoning occurs. These samples can be tested by a veterinary diagnostic lab to determine if the animal actually died from nitrite toxicity.

Table 1.* Forage nitrate interpretation.

NO_3-N	NO_3-	KNO_3	Toxic Significance
<700 ppm	<3100 ppm	<5000 ppm	Considered safe to feed.
700-1400 ppm	3100-6200 ppm	5000-10,100 ppm	Generally safe, but limit to <50% of total dry matter in pregnant animals. Be sure H_2O is safe.
1400-2100 ppm	6200-9200 ppm	10,100-15,100 ppm	Do not feed to pregnant animals, and limit to <50% of total dry matter to non-pregnant animals.
>2100 ppm	>9200 ppm	>15,100 ppm	Potentially toxic.

*Levels shown on dry matter basis

Table 2. Water nitrate interpretation.

NO_3-N	NO_3-	KNO_3	Toxic Significance
<100 ppm	<440 ppm	<720 ppm	Considered safe.
100-300 ppm	440-1300 ppm	720-2200 ppm	Caution. Consider additive effect.
>300 ppm	>1300 ppm	>2200 ppm	Potentially toxic.

Chapter 7

Rebuilding the Cowherd Following the Drought

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Chapter 2 addressed managing the cowherd as drought persists. Culling the herd so as to have fewer mouths to feed is one of the management tools. If the drought is severe enough and long enough, the entire herd may be liquidated. Once the drought subsides, most, if not all, of the resources are still in place on the farm, making cowherd rebuilding a logical choice. For this reason, rebuilding the cowherd following drought is a different economic question than a typical herd expansion analysis. Here we can ignore input factors such as land, labor and capital since these resources were sufficient before the drought for a herd larger than the one in existence following the drought. In this chapter we can focus on various methods to acquire the breeding stock for a larger herd. It is also important to remember, however, that the excess land, labor and capital available once the drought subsides may have economic uses other than cow/calf production.

Beef cattle inventory in the U.S. and Arkansas from 2005 to 2014 is displayed in Table 1. While the number of beef cattle in Arkansas has been up and down over this 10-year period, the data show a decline from 2010 to 2013, followed by an increase in 2014. Much of Arkansas was in a drought during

Table 1. Cattle and calves, beef cows, and beef replacement heifers in inventory on January 1 in the U.S. and Arkansas.

Year	All Cattle and Calves		Beef Cows		Beef Replacement Heifers		Replacement Heifers as % of Cows	
	U.S.	Ark.	U.S.	Ark.	U.S.	Ark.	U.S.	Ark.
	Thousands							
2005	95,848	1,860	32,915	964	5,691	170	17%	18%
2006	96,702	1,710	32,994	899	5,904	175	18%	19%
2007	97,003	1,750	32,891	921	5,877	140	18%	15%
2008	96,035	1,810	32,435	943	5,647	150	17%	16%
2009	94,521	1,810	31,712	906	5,531	165	17%	18%
2010	93,881	1,910	31,371	937	5,451	179	17%	19%
2011	92,682	1,720	30,850	928	5,139	136	17%	15%
2012	90,769	1,670	30,158	909	5,262	115	17%	13%
2013	89,300	1,600	29,297	851	5,361	129	18%	15%
2014	87,730	1,660	29,042	882	5,471	137	19%	16%

2011. Whether or not and how to build herd size is thus at the forefront of decisions many commercial beef cow/calf operators have to make.

Spaulding et al. (1986) examined the economics of retaining beef heifers for expansion of cow-calf herds in Arkansas. They concluded that the decision to retain a heifer for herd expansion is strongly affected by the availability of pasture. When pasture was available at no cost, retaining the heifer yielded a positive net present value under their assumptions. As the cost of pasture increased, the net present value of the retained heifer decreased and, for some of their scenarios, was negative.

Doye et al. (2013) analyzed the expected financial impacts of herd rebuilding strategies on U.S. Southern Plains producers following the 2011 drought. The authors conclude that "regardless of land tenure, pasture type or rebuilding strategy, rebuilding appears to be financially feasible" (Doye, 2013). The results showed that a slow rebuilding scenario moderates debt financing of replacement females, and producers are projected to cash flow their cow herd rebuilding under this scenario. Herd rebuilding was most economical for those producers who own native pasture due to the low cost of forage production and few alternative uses for the land. Also, a combination of ways to utilize excess forage after the drought, like incorporating stocker cattle and some retained heifers along with buying a few pairs along the way, improved liquidity and cash flow as opposed to a one time investment in a large number of breeding stock.

Methodology

The analysis in this chapter utilizes a modified version of the Forage and Cattle Planner (FORCAP) decision support software using Microsoft Excel. "The Forage and Cattle Planner was designed to provide Arkansas Cow-Calf producers with a planning tool that would allow operation-specific analyses of varying production processes as they relate to both cattle and pasture management" (Daniel Keeton). Its ultimate goal is to estimate a whole farm budget for a cow-calf enterprise based on information provided by the user for a cow-calf operation that is neither growing nor declining in herd size. This decision aid is quite extensive, utilizing input data on almost all aspects of a farm. The large amount of input data required makes the model useful for comparing a vast number of management decisions, as it provides the expected change in returns from each option. Default values suggested by experts are entered in every data field, allowing the user to focus on changing only those variables most important to the decision at hand.

To investigate the economic considerations when rebuilding a cow herd after a drought, a representative farm is first described. The farm in our example consists of 180 acres of pasture and 60 acres of hay. The pasture receives no fertilizer, only lime as needed. The hay meadows receive a total of 154 pounds of N, 80 pounds of P and 120 pounds of K that are in part applied as two tons of poultry litter per acre each year with the remainder from urea. The pastures are 25 percent bermudagrass, 65 percent fescue and

Table 2. Physical attributes of a farm as it expands from 15 cows to 30 cows by retaining heifers using 180 acres of pasture and 60 acres of hay.

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
No. of cows	15	15	18	22	28	30
No. of heifers for replacement	3	6	7	9	7	5
No. of calves sold	9	6	7	9	17	19
Total live weight sold (lbs)	8,741	7,181	7,736	8,846	15,845	16,885
Pasture Forage Growth (lbs/acre)	3,095	3,095	3,095	3,095	3,095	3,095
Actual Grazing Efficiency[a]	25%	26%	29%	33%	37%	38%
Stocking Rate (pasture acres/cow)	12	12	10	8.2	6.4	6.0
Hay Forage Growth (lbs/acre)	7,076	7,076	7,076	7,076	7,076	7,076
Hay Sold (No. of 800 lb bales)	395	386	280	238	168	155

[a]Forage consumed by cattle as a percentage of available forage growth. Includes potential of forage transfer for as long as one month and effects of harvesting excess forage as hay.

Table 3. 2004-2013 Average Arkansas beef cattle prices deflated using a CPI Index to 2013 dollars.

Type of Animal		Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Year Round[b]
Steers[a]	4-500 lb	171.86	179.03	178.35	174.83	173.28	170.92	168.86	171.83	166.50	167.94	169.80	171.93	173.36
	5-600 lb	156.69	164.13	164.13	161.66	161.02	160.03	158.57	158.90	153.26	152.68	152.99	155.70	159.09
	6-700 lb	144.40	150.66	150.07	149.48	150.50	151.76	151.62	151.41	145.78	143.42	143.05	144.77	147.82
	7-800 lb	137.22	139.78	136.89	138.89	140.31	144.32	145.40	146.25	140.71	139.06	138.06	139.25	139.38
Heifers	4-500 lb	149.73	157.26	157.20	155.75	156.63	154.79	153.43	154.49	147.66	145.72	146.07	149.16	152.72
	5-600 lb	139.28	146.19	145.89	145.67	147.34	147.52	146.99	147.12	140.64	137.12	136.35	139.28	143.01
	6-700 lb	132.28	136.95	135.80	136.60	139.19	140.19	141.39	140.95	135.66	132.04	130.48	132.82	135.41
	7-800 lb	127.11	129.55	126.68	127.65	131.48	133.97	134.98	135.67	130.85	128.03	126.62	127.07	128.92
Cows	Breaking Utility and Commercial (75-80% Lean)	68.31	73.86	72.49	73.65	74.66	74.13	73.70	72.24	68.98	66.71	65.34	66.90	70.89
Bulls	Yield Grade 1-2	84.43	89.37	88.54	89.61	92.32	92.71	92.47	91.40	86.51	83.05	81.82	82.47	87.39

Source: USDA AMS, Little Rock, Arkansas.

[a]Steer and heifer prices are for medium and large frame calves with a muscle score of 1.
[b]Weighted average to reflect sales of calves year round using a typical calving distribution.

10 percent clover by area. The hay meadows are 50 percent bermudagrass, 45 percent fescue and 5 percent clover. Twenty acres of a winter annual are planted each year to provide forage during winter months. The farmer employs continuous grazing and a year-round calving season. Annual sales include 555-pound steers, 520-pound heifers, cull cows and excess hay. Before the drought, the farmer kept 30 cows on a routine basis. During the drought, half the herd was sold, but all the land, machinery and facilities are still in place.

The default values in the model were used for all input and output prices. Cattle output prices are the average of the previous 10 years inflated to 2013 dollars. Fertilizer prices are also the 10-year average in 2013 dollars. Ten-year averages were chosen to remove the effect of cyclical changes in prices that typically play a significant role in the herd rebuilding decision. Since current prices are cyclically high, the eventual culling of animals at expected lower prices in the not-too-distant future would likely lower returns to beef production as reported within. Since these cyclical price movements are quite unpredictable, we chose to analyze the decision removing this factor and used 10-year average prices as shown in Table 3.

With the representative farm described, the analysis for this chapter involves modeling three scenarios for rebuilding the cow herd from 15 head to 30 head. The first scenario consists of retaining all heifer calves each year until the 30-head desired herd size is reached. In this scenario the typical amount of culling of old cows still occurs. Scenario 2 consists of buying 15 bred heifers the first year to reach the desired herd size. Scenario 3 consists of buying 15 bred cows the first year.

A key element to the economics of expanding the herd comes from the hay produced and harvested. This study assumes that once the drought is over, the farmer returns to a typical fertilizer and hay production strategy that existed pre-drought when the farm had 30 cows. Therefore, fertilizer costs and hay machinery costs remain constant in each year in each scenario, regardless of herd size. In scenarios when the cows do not eat all the hay, the excess hay is sold for $30 per 800-pound roll. Excess pasture forage (when a yield of at least half a roll per acre can be harvested) is also baled and sold. This is possible as FORCAP models cattle and forage production on a monthly time step. The modified version of FORCAP also allows modifying the herd size in a particular year by increasing or decreasing the number of replacement heifers and/or modifying the mix of young cows (with first calf at foot) vs. mature cows.

Results

Scenario 1: Retaining Heifers

The first scenario consists of retaining heifers until the herd size returns to 30 cows. The base year represents the first year after the drought. Rainfall has returned to normal and the farm has returned to its typical fertility and forage production routine, including the utilization of winter annuals. Any excess forage is baled for hay and any excess hay is sold.

Changes in the physical makeup of the farm are displayed in Table 2. The variables related to forage production, such as acreage, fertility and forage growth, remain unchanged over the five years. In the early years, less forage is consumed by cattle and more is baled. In the later years, the opposite occurs. Total live weight sold goes down initially as heifers are retained and then increases as more steers are produced and ultimately, in year 5, the 30-cow herd is back to equilibrium selling steers, heifers and cull cows. The stocking rate increases from half the desired rate with a 30-cow herd and steadily increases as more replacements are retained to rebuild the herd. As the stocking rate increases over time, the number of hay bales sold is reduced considerably.

Changes in the economic situation of the farm for Scenario 1 are displayed in Table 4. Total receipts go down in the first three years of the expansion as heifers are retained rather than sold and as less excess hay is available for sale. By year four and five, total receipts exceed those of the base year. Direct costs increase over time, but there are some tradeoffs as expenses related to baling hay decline and those associated with feed, veterinary services and marketing increase.

Notice that in year five, when the herd is back to its pre-drought size, the returns above direct costs are only $1,091 greater than they were in the base year. This occurs because selling hay is almost as profitable as selling calves. In Arkansas, with average annual rainfall of 50 inches, we have the option to produce hay rather than cows as long as the hay market remains strong.

This approach has two shortcomings. First, the nutritional value and dollar value of the hay is assumed to be constant whether it was

Table 4. Physical attributes of a farm as it expands from 15 cows to 30 cows by retaining heifers using 180 acres of pasture and 60 acres of hay.

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
Gross Receipts						
Steer Calves	$5,332	$5,332	$6,220	$7,998	$10,663	$10,663
Heifer Calves	$2,301	$0	$0	$0	$3,835	$5,369
Cull Cows	$2,409	$2,409	$2,409	$2,409	$4,016	$4,016
Cull Bulls	$442	$442	$442	$442	$883	$883
Excess Hay	$11,910	$11,580	$8,400	$7,110	$5,040	$4,650
Total Receipts	$22,394	$19,763	$17,471	$17,958	$24,437	$25,581
Direct Costs						
Fertilizer	$8,371	$8,371	$8,371	$8,371	$8,371	$8,371
Feeding and Operating	$1,377	$1,439	$1,553	$1,786	$2,185	$2,256
Marketing	$476	$387	$421	$488	$816	$875
Miscellaneous	$10,107	$10,113	$10,094	$10,177	$10,822	$10,863
Total Direct Costs	$20,330	$20,309	$20,438	$20,823	$22,193	$22,365
Operating Interest	$610	$609	$613	$625	$666	$671
Returns above Direct Costs	$1,454	$-1,156	$-3,580	$-3,489	$1,578	$2,545
Ownership Charge for Equipment, Fencing and Buildings	$11,000	$11,000	$11,000	$11,000	$11,000	$11,000
Ownership Charge of Breeding Livestock	$888	$1,023	$1,203	$1,470	$1,743	$1,738

produced on the fertilized hay meadow or the unfertilized pasture. Second, the hay equipment is assumed to depreciate at a constant rate per year regardless of the number of hours it is used. Thus, if these two shortcomings were addressed, the base year would be less profitable than depicted in Table 4 because a large quantity of lesser quality hay is being fed while the quality hay is being sold, and likely greater repair and maintenance on the hay equipment would be required.

Scenario 2: Buying Bred Heifers

The second scenario consists of buying 15 bred heifers in year 1 to go with the 13 mature cows and two replacement heifers from the previous year. So in year one, the farm consists of 13 mature cows and 17 first calf heifers. Then, in year two and following, the herd returns to its pre-drought equilibrium of a 30-head mix of mature cows and replacement heifers.

Changes in the economic situation of the farm for Scenario 2 are displayed in Table 5. Returns above direct costs increase instantly and stay there. Ownership charges for breeding .livestock also goes up instantly and remains. The investment in 15 bred heifers is estimated to be $15,000. Ownership charges, or the opportunity cost of not employing the extra $15,000 investment in another investment, is estimated at an average of $868 per year.

Scenario 3: Buying Bred Cows

The third scenario consists of buying 12 bred cows and three bred heifers in year one to go with the 13 mature cows and two replacement heifers from the previous year. So in year one the herd returns to its pre-drought equilibrium of a 30-head mix of mature cows and replacement heifers.

Changes in the economic situation of the farm for Scenario 3 are displayed in Table 6. Returns above direct costs increase instantly and stay there. The opportunity cost of breeding livestock also goes up instantly and remains. The investment in 15 bred animals is estimated to be $13,200. The opportunity cost of the extra $13,200 investment averages $850 per year.

Table 5. Cost and returns of a farm as it expands from 15 cows to 30 cows by buying 15 bred heifers in year 1.

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
Gross Receipts						
Steer Calves	$5,332	$10,663	$10,663	$10,663	$10,663	$10,663
Heifer Calves	$2,301	$5,369	$5,369	$5,369	$5,369	$5,369
Cull Cows	$2,409	$4,016	$4,016	$4,016	$4,016	$4,016
Cull Bulls	$442	$883	$883	$883	$883	$883
Excess Hay	$11,910	$4,650	$4,650	$4,650	$4,650	$4,650
Total Receipts	$22,394	$25,581	$25,581	$25,581	$25,581	$25,581
Direct Costs						
Fertilizer	$8,371	$8,371	$8,371	$8,371	$8,371	$8,371
Feeding and Operating	$1,377	$2,232	$2,256	$2,256	$2,256	$2,256
Marketing	$476	$875	$875	$875	$875	$875
Miscellaneous	$10,107	$10,863	$10,863	$10,863	$10,863	$10,863
Total Direct Costs	$20,330	$22,341	$22,365	$22,365	$22,365	$22,365
Operating Interest	$610	$670	$671	$671	$671	$671
Returns Above Direct Costs	$1,454	$2,570	$2,545	$2,545	$2,545	$2,545
Ownership Charge for Equipment, Fencing and Buildings	$11,000	$11,000	$11,000	$11,000	$11,000	$11,000
Ownership Charge of Breeding Livestock	$888	$1,828	$1,738	$1,738	$1,738	$1,738

Table 6. Cost and returns of a farm as it expands from 15 cows to 30 cows by buying 12 bred cows and 3 bred heifers in year 1.

	Base Year	Year 1	Year 2	Year 3	Year 4	Year 5
Gross Receipts						
Steer Calves	$5,332	$10,663	$10,663	$10,663	$10,663	$10,663
Heifer Calves	$2,301	$5,369	$5,369	$5,369	$5,369	$5,369
Cull Cows	$2,409	$4,016	$4,016	$4,016	$4,016	$4,016
Cull Bulls	$442	$883	$883	$883	$883	$883
Excess Hay	$11,910	$4,650	$4,650	$4,650	$4,650	$4,650
Total Receipts	$22,394	$25,581	$25,581	$25,581	$25,581	$25,581
Direct Costs						
Fertilizer	$8,371	$8,371	$8,371	$8,371	$8,371	$8,371
Feeding and Operating	$1,377	$2,256	$2,256	$2,256	$2,256	$2,256
Marketing	$476	$875	$875	$875	$875	$875
Miscellaneous	$10,107	$10,863	$10,863	$10,863	$10,863	$10,863
Total Direct Costs	$20,330	$22,365	$22,365	$22,365	$22,365	$22,365
Operating Interest	$610	$671	$671	$671	$671	$671
Returns Above Direct Costs	$1,454	$2,545	$2,545	$2,545	$2,545	$2,545
Ownership Charge for Equipment, Fencing and Buildings	$11,000	$11,000	$11,000	$11,000	$11,000	$11,000
Ownership Charge of Breeding Livestock	$888	$1,828	$1,738	$1,738	$1,738	$1,738

Conclusions

Retaining heifers is a viable way to move the farm away from selling hay and toward selling more calves. In our example, the farm went from a positive return over direct costs of $1,454 per year to negative returns during the first three years of the expansion before returning to positive returns in years four and five, ultimately exceeding the pre-expansion returns.

Buying bred heifers increases returns over direct costs immediately and returns the herd to its pre-drought equilibrium in just two years. In our example, a $15,000 investment netted an extra $1,091 in most years. Thus, the payback period on this investment is in excess of 13 years. This is much too long to be economically attractive. Again, the fact that the farm could have sold excess hay with no extra investment makes herd expansion much less economical.

Buying a mix of bred cows and bred heifers to match the long run equilibrium mix of young and old cows increases returns over direct costs immediately and returns the herd to its pre-drought equilibrium in the first year. In our example, a $13,200 investment netted an extra $1,091 each year. Thus, the payback period on this investment is approximately 12 years.

Because selling hay is an economically viable alternative to cattle production, even at the mediocre selling price of $30 per bale, as we have assumed in our example, herd expansion was less than desirable in any of three scenarios examined here. Perhaps the best approach is to retain heifers, but at a slower rate than depicted in Scenario 1. Retaining only one or two extra heifers each year, rather than three, four or six as depicted in Table 2, might allow the herd to expand without creating negative returns above direct costs. This retention rate decision could also fluctuate with hay prices. If hay prices are high, retain fewer heifers; if hay prices are low, grow the herd more aggressively.

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Chapter 8

Drought Management for Forages

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Dry weather occurs at some point nearly every summer. Drought, however, is defined as an extended period of abnormally low rainfall. Drought symptoms such as wilted and dried grass are common during hot summer weather, but drought is more severe than typical summer dry spells and can have long-lasting consequences.

Unlike severe storms, drought does not occur suddenly. Drought can occur during any season and causes stress and lower forage productivity. Dry winters can cause delayed and reduced growth of spring pastures, and hot temperatures accelerate drought stress during summer.

Poorly distributed rainfall can cause "drought stress" of forage even though the cumulative monthly rainfall may be near normal. A heavy rain on July 1 followed by a heavy rain on July 31 could be summarized as statistically normal rainfall, but the month in between with no rain and hot summer temperatures causes extreme stress on forage. Pastures should be scouted closely for signs of drought stress any time when temperatures are high and when no significant rainfall has occurred within 7 to 10 days.

There is an old saying that during summertime, we are only "two weeks away from a drought." This refers to the low moisture-holding capacity of most soils and the associated high evapotranspiration demands of growing forage and other vegetation.

Drought stress can accelerate quickly when surface and subsoils become dry from extended low rainfall periods. Sandy and light-textured soils have lower moisture-holding capacity than heavy-textured silty or clay soils. Sandy soils warm up more quickly, as well as cause forages to exhibit moisture stress sooner, than on heavier soils.

Slope aspect is also important. Forages growing on south- and west-facing slopes often show drought stress sooner than on north and east slopes, because as soil temperatures increase, evapotranspiration and water loss increase.

Maintaining good forage cover over the soil maintains cooler soil temperatures and reduces water loss. When forages begin to show drought stress, management must respond quickly to preserve as much potential grazing as possible. That makes each of these points important for maintaining grazing during dry weather.

Failure to take preventative action and to plan ahead at early signs of drought often results in overgrazing damage to pastures, excessive feeding and herd liquidation. Although drought cannot be avoided entirely, a good forage management plan will lessen the impact on forages and hasten pasture recovery when growing conditions return. Planning ahead for forage requirements will help to maintain a herd through the drought crisis.

Drought management for pastures includes three primary categories:

1. Develop a balanced seasonal forage system to avoid drought
2. Manage forage for efficient utilization during drought
3. Manage pastures for recovery after drought

Develop a Balanced Seasonal Forage System to Avoid Drought

A balanced forage program and good pasture grazing plan greatly reduce the impact of a drought and help extend the grazing season. Extending the grazing season has a strong positive impact on profitability of livestock operations. Many farms already have an adequate forage base to produce enough forage for the livestock, but management is often focused on producing hay for a long hay-feeding season instead of producing more lower-cost grazing days.

The most important part of a balanced forage system is the planning and strategy used with the existing forages. Longer grazing seasons can usually be achieved by simply changing forage management. Planning a longer grazing season requires a seasonal approach to forage production and management. Spring, summer and fall seasons are managed as 100 days each, leaving a 65-day winter season.

Forage management plans should be made at least one season in advance to ensure timeliness of implementation and to allow options in case of unexpected growing conditions such as drought. Plans for spring pasture are made in fall and winter; plans for summer are made in winter and spring; and so on. Various forages can be used to fill out a grazing program (Figure 1). More details on developing a longer grazing season are found in FSA3139, *Arkansas 300 Day Grazing System – Getting Started*.

Figure 1 below shows typical grazing periods for different forages.

Diversity of seasonal forage species on the farm improves forage production throughout the year. Both cool-season and warm-season forages should be included.

In north Arkansas, the ratio of cool-season to warm-season forage should be about two-thirds cool-season and one third warm-season forage. In south Arkansas, this ratio may be reversed due to a longer growing season.

Cool-season forages like fescue, clover or ryegrass should be managed for spring and fall grazing. Fescue can be stockpiled for winter grazing. Cooler temperatures favor growth of cool-season forages such as ryegrass, fescue, orchardgrass and clovers but not warm-season grasses like bermudagrass. Fescue and ryegrass grow best at temperatures between 68^0 and 77^0 Fahrenheit and growth stops at temperatures above 86^0F and below 40^0F.

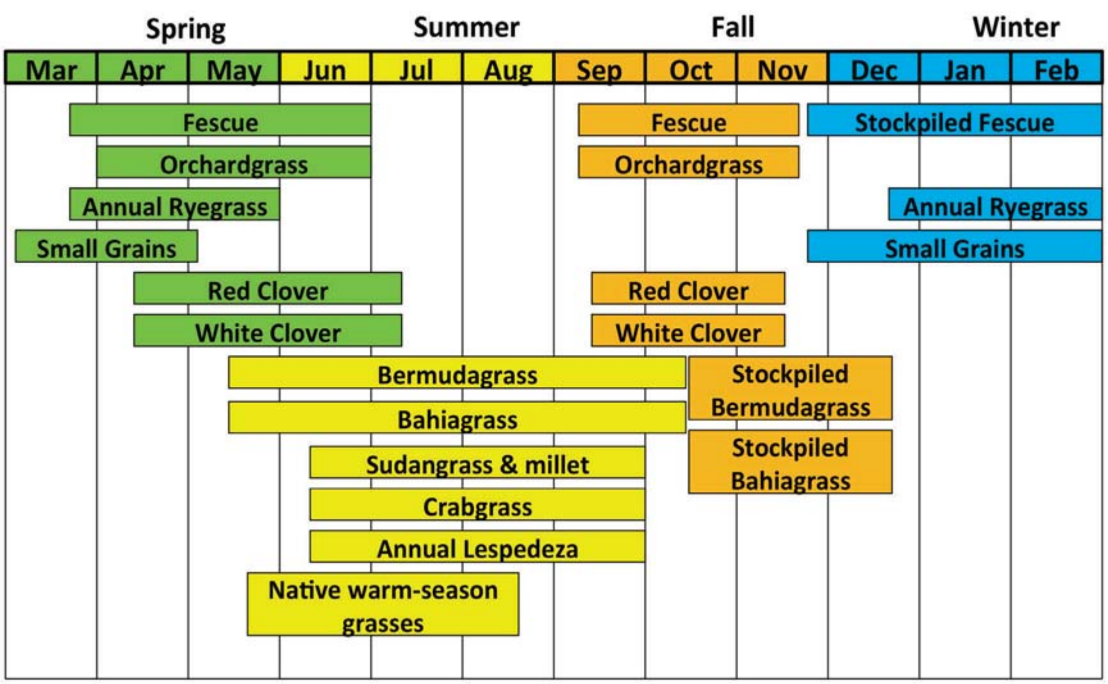


Figure 1. Seasonal grazing periods for commonly grown forages in Arkansas.

Warm-season forages like bermudagrass should be managed for summer grazing through early fall. Bermudagrass grows best between temperatures of 85^0F and 95^0F. In spring or fall, growth of warm-season grasses stops when night temperatures cool to 50^0F. No forage grows well when temperatures exceed 100^0F.

A combination of warm- and cool-season forage species in different pastures across the farm is desirable to improve forage availability during weather extremes. A very simple balanced forage system may include tall fescue and bermudagrass or annual ryegrass and bermudagrass. Individual pastures can be single perennial forage species or simple mixtures that have similar growing seasons.

It is not necessary to have complex forage mixtures in each pasture. In fact, complex multi-seasonal perennial forage mixtures within individual pastures are not desirable for all pastures because it complicates management. Plant perennial cool-season forages like fescue and clover together in separate pastures from perennial warm-season forages like bermudagrass or bahiagrass. This separation simplifies management practices such as fertilization, weed management, and planning seasonal grazing or hay harvest. The transition of grazing cool-season forages to warm-season forages can be accomplished more easily. However, annual cool-season forages such as ryegrass are compatible in perennial warm-season pastures like bermudagrass since each species grows at a different time of year. Further, the annual ryegrass dies in summer and does not compete with the warm-season forage.

Figure 2. A balanced forage program includes cool-season forages and warm-season forages to fill out the grazing season.

Manage Forage for Efficient Utilization During Drought

It always rains after a drought, so careful pasture management is important during a drought to ensure good forage recovery when the drought ends. Management decisions should be made quickly during early stages of drought to maintain enough forage to feed the herd. Culling poor performing animals is one choice to reduce the amount of forage needed, but improving pasture management is also effective. Producers who plan forage and grazing practices ahead get themselves into a position to take advantage of better growing conditions when those conditions eventually return. When pastures become grazed short and producers are forced to feed hay, management strategies must focus on pasture recovery after drought. Main points to consider for managing forages during dry weather include the following:

- Avoid continued overgrazing before pastures become grazed short. Overgrazing weakens plants and leads to shortened root systems causing them to respond more slowly to rain and fertilizer. Overgrazing causes higher soil temperatures because it removes residue that shades the soil surface. During the 2011 drought in Oklahoma, soil temperatures in bare, overgrazed pastures reached as much as 150 degrees.

Figure 3. Overgrazing during drought weakens forages and increases soil temperatures which further delays pasture recovery.

- Protect any remaining standing forage by shutting pasture gates or by using temporary electric fencing. Manage any remaining forage as if it were standing hay and allocate it in strips or paddocks large enough for 2-3 days grazing. Larger paddocks and longer grazing intervals may be used but utilization will be reduced leading to fewer total grazing days.

- Temporary electric fence is a good investment and is a great tool for subdividing pastures and for strip grazing pasture. A solar or battery-powered electric fence energizer and single strand of temporary electric polywire can be installed in a matter of minutes to subdivide pastures as needed. Properly installed electric fence systems with modern low-impedance energizers will not start pasture fires.

Figure 4. A temporary single-strand electric fence can be installed quickly and easily to control access to limited forage.

- Although all forages produce lower yield when drought occurs, some species including bermudagrass and KY-31 tall fescue can tolerate heavy grazing pressure and still persist while others are eliminated from the stand. Manage grazing pressure carefully during prolonged dry weather to prevent loss of high quality forage species such as novel endophyte fescue, clover, orchardgrass and native warm-season grasses.

- Scout for toxic plants on rented land, new pastures or ungrazed areas. Hungry cattle or cattle brought to a new field or farm will often eat plants they would normally avoid. Perilla mint and poison hemlock are two extremely toxic plants that are common in pastures. Johnsongrass is responsible for several cattle deaths each summer. Prussic acid poisoning potential is very high for johnsongrass forage that is short (less than 18" tall), wilted forage or for a new flush of growth soon after a rainfall.

- Forage sorghum, sorghum-sudan crosses and sudangrass all can develop prussic acid toxicity under the same conditions as johnsongrass. The same precautions should be used for these forages as for johnsongrass to prevent animal deaths. Wild cherry trees also have high prussic acid potential. Prussic acid dissipates when the forage dries, so well-cured hay is safe. Reliable field or routine laboratory tests are not available for measuring prussic acid levels in forage.

Figure 5. Avoid grazing drought-stressed and wilted johnsongrass during drought to prevent prussic acid poisoning in cattle.

- Nitrates can accumulate to toxic levels in some plant species especially during drought stress. Plants known for accumulating nitrate include johnsongrass, sorghums (forage sorghum, sorghum-sudan and sudangrass), corn and pigweed. High nitrate levels do not dissipate when hay is cut and remain high even in dry hay. High nitrates usually occur when forages have been heavily fertilized with nitrogen fertilizer, but can also occur after poultry litter application or in fields with a history of manure application. Laboratory and field tests can be conducted on fresh forage and on hay for nitrate content.

- Irrigation is gaining interest but requires more water volume than a home well or farm pond can produce. It takes 27,154 gallons of water to apply one inch of water per acre. Irrigating a 40-acre pasture with 1 inch of water would require more than 1 million gallons of water. During intense drought, weekly irrigation of 2 inches or more is often required to maintain forage production.

- Where adequate irrigation is available, consider planting a summer annual crop such as pearl millet or sorghum/sudan hybrid. If planted by late July, these forages have the potential to produce a hay crop by mid-September if properly irrigated. Agreements between livestock and crop farmers could be considered for this option. Under strict dryland conditions, this may not be a consideration without good rainfall.

- Consider the possibility of renting unused pasture from neighboring landowners. Pasture rent can be much less expensive than buying hay and feed. Landowners renting pasture should work with renters to make a fair written agreement that protects both parties. The landowner certainly does not want overgrazed, degraded pastures and the renter should be a good steward to have the option of renting again if necessary.

- Scout for insect pests such as armyworms and grasshoppers. Armyworm infestation is highly likely on the first fields to green up after rainfall since the moths key in on green tender growth for egg laying. Forages need leaf area for regrowth. Fields damaged by insect pests such as armyworms and grasshoppers during drought recover more slowly. Insecticide is an added expense, but protecting good quality green forage is cheaper than buying hay.

- Feeding hay and limit grazing during dry weather can stretch available forage on drought-stressed pastures. If all pastures are already grazed short and no regrowth is being produced then cattle can be shut in a single "sacrifice pasture" pasture and fed hay until better growing conditions arrive. This practice limits overgrazing damage to one pasture and helps protect forage in other pastures that will needed for later grazing.

- Protect hay from weather damage during storage. Many people do not have adequate storage for large amounts of hay. Hay can be stacked outside, but make sure it is up off the ground and covered. It can be stacked on pallets, poles, large crushed rock, or even used tires. Cover it with a good quality hay tarp. The cheap blue tarps are not UV protected and will fall apart when exposed to wind and direct sunshine.

- Hay prices and value increase sharply during drought. Protect hay when feeding to reduce waste. Feed hay in rings to reduce hay waste. Unrolling hay increases hay waste unless it is done on a limit-feeding basis. Consider limiting the time cattle have access to hay to five-six hours per day. Limiting time access should only be considered for high quality hay. Most hay consumption occurs during the first few hours of feeding and longer access increases waste. Hay tests are very important when considering this option. Limiting intake on poor quality hay will reduce body condition of animals quickly.

- When feeding hay during drought, consider using a temporary electric wire fence wire to reduce waste from trampling. Unroll the bale, then string up an electrified polywire down the length of the line of hay. Place the wire about 30 inches high over the hay. Cattle will line up as if eating at a feed bunk. This method is effective to reduce waste and increases utilization of the hay.

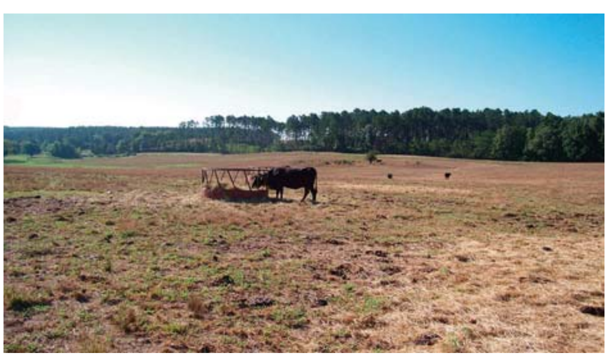


Figure 6. Confining livestock and feeding hay in a sacrifice pasture during drought protects other pastures from overgrazing damage.

Figure 7. Using a temporary electric polywire to reduce trampling and waste of hay.

- Empty hay barns make good commodity feed sheds, so as hay is fed consider alternative uses of empty barn space for storage of other feeds.
- Crop residues will often be harvested during drought and sold for hay. Always check the history of crop chemicals used on the crop during the growing season. Many chemicals prohibit use of treated crops for livestock feed. Test approved crop residues for nitrate level and for feed value. Corn stalks often have higher incidence of dangerous levels of nitrate than milo stalks, but both have shown a considerable range below and above dangerous levels. Feed value of all crop residues should be assumed to be low. Lab tests will help when developing a feeding strategy using crop residues.
- Producers trying to purchase enough hay to feed their herds need to estimate hay needs. A general rule of thumb is that a dry cow will eat about 2 percent of her body weight per day in forage dry matter. So a 1,000-pound nonlactating cow will consume 20 pounds dry forage per day. But when the moisture content of the hay and hay waste during feeding are considered, more hay is required. For example, if the hay moisture content is 12 percent and 20 percent is wasted during storage and feeding, the daily amount of hay for that 1,000-pound cow is closer to 29 pounds.

  How many bales to purchase is an important question. Bale weights vary considerably with bale size, forage type, moisture content, baler and operator. Based on many farm demonstrations, the average weight for a typical 4x5 large round bale is approximately 750 pounds. Weights of 1,000 pounds for 4x5 round bales are uncommon.

  In many hay weighing demonstrations, the estimates of hay weight by producers almost always exceed actual weights. A 5x6 round bale has 1.8 times more volume than a 4x5 round bale and can reach a weight over 1,300 pounds.

  Tables 1 and 2 contain a set of guidelines for the estimated daily and monthly amount of hay needed for various weights and herd sizes for nonlactating cows. These values assume that hay quality is sufficient to maintain cows in good body condition. Feeding more poor quality hay will not overcome the nutrient deficiency because a cow cannot eat more low quality hay. These same values could be used to estimate hay need for horses as well. Hay need for a mature horse is similar to that for a similar size cow and is approximately 2 percent of body weight per day. Amounts may be adjusted for superior quality hay or when supplemental feed or grazing are added to the ration.

Table 1. Amount of hay (lbs)* needed per day for feeding different size cow herds.

Number of cows	Cow body weight (nonlactating cow)		
	1,000 lbs.	1,200 lbs.	1,400 lbs.
	Amount of hay per day (lbs.)		
25	710	853	995
50	1.420	1,705	1,990
100	2,840	3,410	3,980

*Assumes hay at 12% moisture and 20% waste during storage and feeding.

Table 2. Number of 4x5* round bales of hay needed per month for feeding different size cow herds.

Number of cows	Cow body weight (nonlactating cow)		
	1,000 lbs.	1,200 lbs.	1,400 lbs.
	Number of bales per month		
25	29	34	40
50	58	68	80
100	116	136	160

*Assumes 750 lb bale weight, 12% moisture, and 20% waste during storage and feeding.

Manage Pastures for Recovery After Drought

Damage Assessment

Some pasture forages will be killed or severely thinned by drought. Evaluate pastures and determine which fields will recover, which fields need overseeding and which fields need complete renovation. Good assessment of actual forage damage and weed pressure will be critical. Soil tests for all pastures will be extremely helpful.

In many cases, particularly with fescue and white clover, seed produced in summer will germinate in fall and can fill in thin fields if grazing pressure is limited. Not all pastures will show the same level of drought damage so improvement strategies need not be the same across the farm. Some pastures may fully recover with time and management while others may need complete renovation.

A simple 5x5 wire frame grid (25 squares) made from concrete reinforcement wire or a cattle panel is a good tool for assessing drought damage. Drop the wire frame in random spots across the pasture and count the number of squares with live forage, the number of squares with bare ground or no forage, and the number of squares with undesirable weeds. Count "1" for any square that contains all or part of a plant. Add the number of squares for each four frames counted (100 total squares) to get a percent stand. For example if a fescue pasture was being assessed for damage and fescue was counted in 10 squares in Frame 1, eight squares in Frame 2, 16 squares in Frame 3, and 20 squares in Frame 4, then the stand percent or "frequency rate" is 54 percent (10+8+16+20=54). If wooly croton was counted as 4, 8, 10, and 3 for the four frames then the weed "frequency" is 25 percent. It is recommended to count at least 16 frames per pasture (or multiples of four) to get a good assessment.

Drought damage to perennial pastures can be separated into three classes:

- **Fully functional** = stand frequency greater than 70 percent. Fully functional pastures should recover quickly with weed control, proper soil fertility, and deferred grazing or harvest once satisfactory growing conditions return. Complete recovery in these pastures may require one to two months of uninterrupted growth.
- **Moderately damaged** = stand frequency between 40 and 70 percent. Pastures with this level of damage should fully recover with weed control, proper soil fertility, and deferred grazing or harvest. Past management practices likely have contributed to the pasture response to drought. Tillers and volunteer seed from some species will aid in stand recovery. Some overseeding may be necessary. Complete recovery in these pastures may require two to three months or more of uninterrupted growth.
- **Severely damaged** = stand frequency less than 40 percent. Severely damaged stands will require patience and precipitation for adequate recovery. Similar to the other drought-damaged pastures, these could also fully recover with weed control, proper soil fertility, and deferred grazing or harvest, but it may take a year or longer for full recovery. Tillers and volunteer seed from some species will aid in stand recovery. Pastures in this category should be the first considered for stand renovation if a forage species change would help with developing a balanced seasonal forage system.

Figure 8. A simple wire 5x5 grid can be used to assess drought damage, determine percent stand, weed percentage, and to assess volunteer reseeding of desirable forage species.

Figure 9. Seedling fescue that germinated in late fall after a severe summer drought.

Figure 10. Some drought-damaged pastures can recover from germinating volunteer seed under careful management (left: fescue pasture during drought of 2012; right: same pasture in May 2013).

After assessing the drought's damage to pastures, producers should seriously think about possible changes and improvements. Not all farms have the perfect forage or livestock system in place. When assessing the drought damage consider options for improving the forage management program. Changes in fencing, pasture subdivision, livestock water placement, and forage species can all be considered. The following four options outline strategies for specific drought damage situations.

Options:

1. Manage to let the surviving forages regrow without reseeding
2. Try to thicken the thin pastures with more of the same species
3. Add legumes, winter annuals, or forage brassica to thin fields
4. Renovate damaged pastures by converting to other forages

Option 1 – Manage to let the surviving forages regrow without reseeding. Success with this option will be dependent on severity of drought damage, the existing forage species, and willingness of the operator to nurse the field back to health. Drought-damaged pastures should be treated like newly seeded fields when recovery begins. Prolonged grazing during drought reduces plant populations. Tall fescue fields are resilient and often produce enough seed in summer to repopulate a drought-thinned stand in the fall. Clovers often die out during severe drought. White clover is a prolific reseeder and that seed should germinate in fall. Common bermudagrass produces seed and surviving rhizomes of hybrid or common bermudagrass will regrow. Thin pastures will eventually fill in, but this may take a year or more depending on level of damage. Orchardgrass and clovers, other than white clover, will likely need to be reseeded. Careful field observation after rainfall in fall and early spring will reveal how much reseeding took place.

When rainfall occurs and pastures begin to green up, defer grazing to allow top growth and roots to regrow. Grazing stressed pastures immediately after green up will further weaken plants and will lead to more pasture thinning especially over winter. Fertilization will speed pasture recovery. Soil tests are important for making fertilizer decisions. Phosphorus is important for root growth and can help plants with weak root systems to recover. During and after recovery, graze the best pastures last. This practice will help ensure the best pastures continue to be the best pastures. Grazing too soon before adequate recovery will cause stand thinning, weed encroachment, and decline of pasture condition.

Scout pastures closely for weeds. Some weeds such as wooly croton are avoided by livestock and populations can build unnoticed. Winter annual weeds will germinate in fall at the same time as volunteer clover or cool-season grasses. Weeds can take over a weakened pasture quickly when rainfall occurs, preventing forage regrowth and sharply reducing volunteer reseeding of desirable forages. Use concentrated grazing pressure, mowing, or herbicide as appropriate to control specific weed species.

Figure 11. Uncontrolled weeds can take over a pasture reducing forage recovery and eliminating germination of volunteer fall cool-season forages such as ryegrass, fescue or clover.

Option 2 – Try to thicken pastures with the same species. If a pasture did not produce a seed crop, adding seed to fill in thin areas can prove beneficial. But the pasture should be managed like a new seeding. Make sure any forage or weed canopy is removed before planting. Fall rains stimulate a lot of weed growth that can hinder seedling forage establishment. Guessing at a seeding rate based on percent damage is difficult. It is best to use a full seeding rate (recommended rate per acre) and plant it properly in the affected areas to make this option effective. Simply spreading a little seed over a weedy field hoping something good will happen has a high chance of failure. Fescue and orchardgrass should be planted in fall. A good option is to mix wheat or cereal rye with fescue or orchardgrass to provide spring grazing. Do not plant annual ryegrass with fescue and orchardgrass seed. Ryegrass will crowd out most other forages. Plant bermudagrass in spring.

Option 3 – Add legumes, winter annuals or forage brassica to thin fields. Thin pastures provide a great opportunity to interseed legumes or other complementary forages. Typically hay supplies and pasture availability are both very low following drought so winter annual forages make good emergency forage crops. Legumes improve forage quality, reduce N fertilizer need, and help fill in thin grass pastures. Soil tests are very important to make sure that soil fertility is adequate for legume survival. Clover and other legumes can be overseeded into grass pastures and hayfields during fall or late winter. Fall or late winter seeding is recommended for fescue pastures. Fall seeding of legumes is recommended when planting into bermudagrass and other warm-season grass pastures. White and red clovers are popular perennial clovers and arrowleaf and crimson clovers are popular annual clovers. Weed control prior to planting is important. Planting clover in fall before assessing the population of germinating winter annual weeds can lead to stand failure. In fields with known histories of winter annual weed problems, it may be best to spray seedling weeds in fall (November-December) with a herbicide having low soil residual such as 2,4-D and overseed the clover in February after the herbicide residual has dissipated.

Figure 12. Broadcast seeding clover into short fescue sod during winter.

Consider planting winter annual forages or forages brassica in fields with the greatest damage to provide fall and winter grazing. Work with local dealers to find a seed source and reserve the amount needed early. Winter annuals such as wheat, cereal rye, triticale, oats, and annual ryegrass are all good options. Forage brassicas such as forage turnips and rape make excellent forage and can provide earlier fall grazing than small grains. Mixtures of forage brassica and ryegrass have been very effective for emergency forage.

Figure 13. Forage brassicas can produce high yielding quality forage quickly in fall.

Cool-season annual grasses are high quality forages that are often used for backgrounding stocker calves. Winter annuals also make a good replacement for hay and feed for brood cows.

Research at the University of Arkansas System Division of Agriculture's Southwest Research and Extension Center has shown that planting winter annuals at the rate of one-half acre per cow can provide excellent supplementation to hay for wintering beef cows. The crude protein is often in excess of 30 percent of dry matter in the fall and does not generally decline below 20 percent of dry matter until the late spring when the annuals begin to mature. Energy content (measured as total digestible nutrients or TDN) can be nearly as high as corn or other feed grains in the fall and early spring and is far greater than the cow's requirements at any stage of her production.

Figure 14 below indicates the TDN of cool-season annual grass pasture in relation to the TDN requirements of a brood cow in months post-calving. The cow's peak nutrient demand is in the first three months after calving, then nutrient requirements decline rapidly as cow's milk production slows down in later stages of lactation. After a calf is weaned the nutrient demand is even lower, reaching the lowest level when cows are dry in late gestation.

From November to early April, cool-season annual pastures contain over 85 percent TDN. Although the TDN declines rapidly when forages start to mature in the late spring, TDN of cool-season annuals is in excess of the cow's nutrient requirements until late May or early June.

A concern with cool-season annuals is that cows may become too fat for optimal calving and rebreeding performance if allowed unlimited intake of these forages. This may be managed by increasing stocking rates to reduce individual cow intake or by limit-grazing (limiting cow access time to annuals).

Limit-grazing of winter annuals is a practical method for using the benefits of these forages for cows while minimizing the area that needs to be planted to annuals. Under limit-grazing, cows are routinely pastured on dormant pasture or fed hay in a dry-lot but are allowed to eat their fill from a limited-access winter annual pasture several times per week.

At the SWREC, limit-grazing of beef cows and calves on a mixture of wheat/rye/ryegrass (planted at 0.2 acre of per head) for two days per week produced the same cow, calf, and rebreeding performance as cows fed unlimited hay plus a supplement. Limit-grazed cows also consumed 30 percent less hay during the winter feeding period. Winter annuals can also be used as creep pastures for calves, a method that maximizes the benefits of the high-quality forage for promoting calf performance. In creep grazing

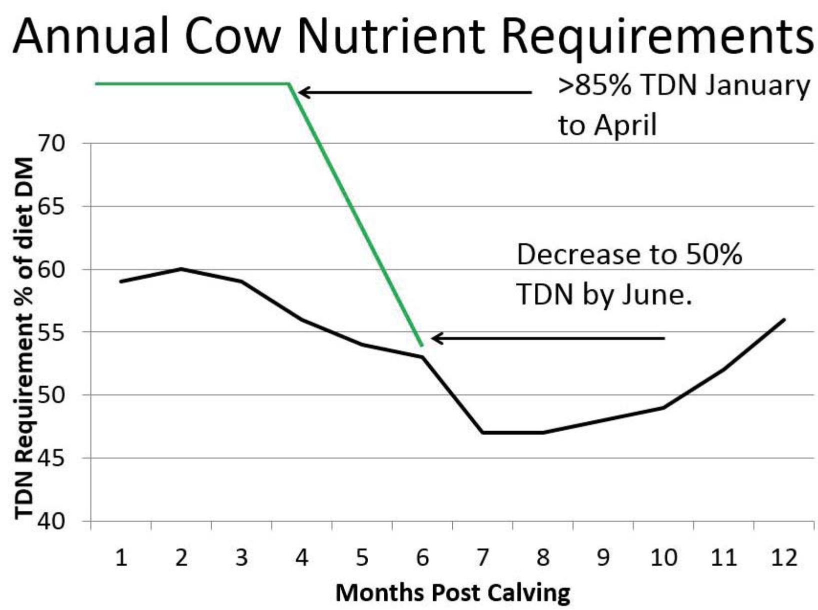


Figure 14. Total Digestible Nutrient content of cool-season annual grasses compared with the TDN requirement of spring-calving brood cows by month post-calving.

systems, calves are allowed unlimited access to excellent pasture via creep gates or a single electric wire set high enough so that they can walk under it but cows cannot.

Interseeding Into Warm-Season Pastures. Interseeding cool-season annuals into a warm-season grass sod can provide some advantages and disadvantages to the operation. High quality forage can be grown on a site that will not be used until the following summer, and cool-season forages interseeded into warm-season grass sod will have reduced bogging by livestock during wet conditions compared with conventionally tilled pastures in crop fields. Pastures can be established using a no-till drill to cut through the sod and place the seed into the soil, or by lightly disking the pasture to disturb the sod and spreading the seed with a conventional fertilizer spreader and then harrowing to cover the seed. The disadvantages of the no-till drilling method are the requirement of the specialized drill. The disk and spread method has the disadvantages of the lack of ideal seed placement and of disrupting the sod, which may cause fields to be rough and uneven.

Cool-season annual pastures are typically planted in the fall as early as local conditions allow. Planting date has a large impact on fall forage production. In clean-tilled or no-tilled crop fields, planting of these pastures for fall pasture is recommended to be done by the first week of September. Calves may be stocked at 1 to 1.5 calves per acre by the first of November in well managed small grain fields. When interseeded into a warm-season grass sod, they must be planted later to decrease competition from the existing warm-season grasses with the cool-season annual seedlings. Because of the later planting date, fall growth of cool-season annuals interseeded into bermudagrass sod is less than in tilled crop fields, but moderate levels of grazing may still be attained at reduced stocking rates.

Warm-season pastures should be prepared by grazing or haying to a 3- to 4-inch stubble height. Plant 100 to 120 pounds per acre of small grain and 20 pounds per acre annual ryegrass when the warm-season grass growth slows. This is usually early October in northern Arkansas and mid-October in southern October. If temperatures are not cool enough to slow growth of bermudagrass or other warm-season grasses, then rains that cause seedling cool-season grasses to emerge will also stimulate warm-season grasses to grow and compete with the seedlings.

Competition from warm-season sods that have not yet gone dormant is the most serious problem for early sod-seeding of winter annuals in Arkansas. Warm-season grass sods must be controlled in some way prior to early-planting of winter annuals. Bermudagrass pastures can be sprayed with a low rate of Roundup or generic glyphosate (1 pint of 41 percent glyphosate/acre) to force bermudagrass into dormancy. This will allow seeding of cool-season annuals in early to mid-September, with little risk of competition from the warm-season grasses. During the drought in southern Arkansas in 2011, bermudagrass pastures were dormant in late summer and had very little forage accumulation. Since warm-season grass was already dormant, wheat and ryegrass seed was no-tilled in mid-September with no additional management to suppress the sod. “Dusting” in the small grains and ryegrass, by broadcasting seed on sod and dragging the pasture, increases risk of stand failure if rains do not occur due to shallow seed placement and predation of seed by insects or birds.

Often producers are hesitant to plant cool-season annual pastures in dry conditions and wait for “ideal” conditions. But delayed planting often leads to delayed forage growth. A good example of this occurred in 2011. Figure 15 on the next page shows small grain and ryegrass forage yield from November through March of dedicated crop fields planted in dry conditions in early September (green line); interseeded small grains planted in sod during dry conditions in mid-September (black line); interseeded small grains planted in sod in ideal conditions in early November (red line); and interseeded ryegrass planted in sod in early November (blue line). Forage accumulation of 1,000 to 1,200 pounds per acre is the minimum amount necessary for initiation of grazing. Accumulation of forage in dedicated crop fields was adequate for grazing in late October or early November, whereas interseeded small grains were not ready for grazing until late November to early December, even though planting was delayed by only two weeks. The two-week delay caused a month delay in grazing! When planting was delayed until early November, after fall rains occurred, small grain forage accumulation was not adequate for grazing until mid-January. Forage accumulation of ryegrass was not adequate for grazing until mid-February.

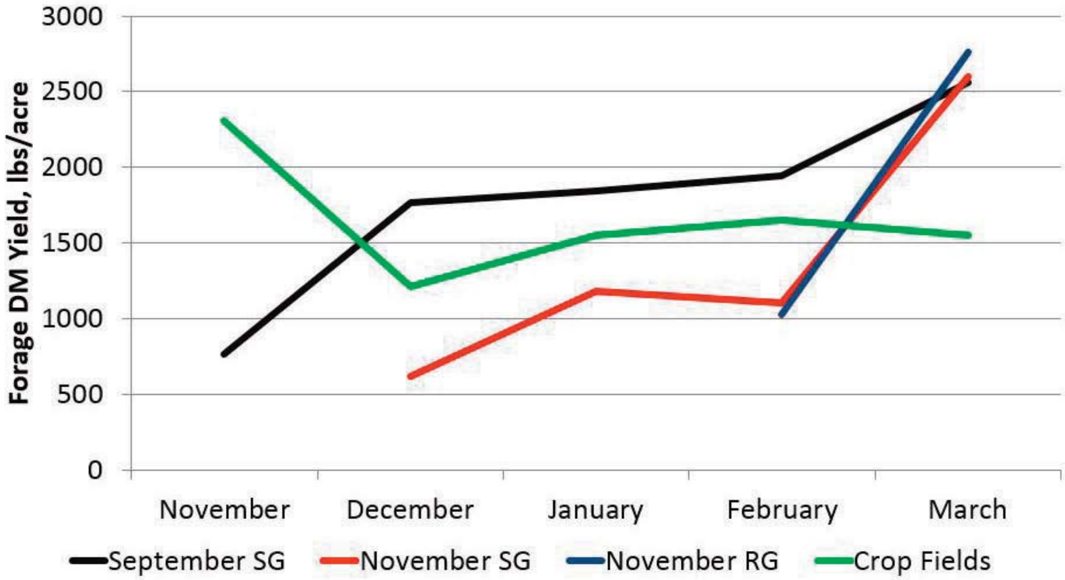


Figure 15. Forage dry matter yield by month for small grain (SG) planted in dedicated crop fields or interseeded into bermudagrass sod and ryegrass (RG) interseeded into bermudagrass sod.

For spring-calving cow-calf systems, the delay in forage availability caused by late planting may not be a big concern. Since the nutrient requirements of beef cows is quite low until calving, spring calving cows do not need the high quality forage supplied by winter annual grasses until calving begins in January or February (which closely matches the availability of late planted cool season annual grasses). When cows are on cool-season annual grass pastures full time, hay consumption will decrease to a very low level (< 10 pounds per day) even if supplied free choice.

Figure 16. Heifer with newborn calf on cool-season annual grasses. Cattle with high nutrient requirements, like first calf heifers, can graze cool-season annuals to increase body condition and body weight while reducing hay needs.

Cows in early lactation can gain more than 2 pounds per day and will gain in body condition (an increase of 1 BCS per month is common). Even first calf heifers will gain body weight and body condition after calving, increasing the chances of rebreeding. At the SWREC during 2011, rebreeding rate of cows raising their first calf was over 90 percent when grazing cool-season annuals following calving.

Option 4 – Renovate severely damaged pastures and convert to other forages. Does the field need to be reseeded, and if so, does it need to be the same forage species or variety? Could the grazing and hay systems be improved to avoid severe effects from the next drought? Converting damaged fields to different forage species can help extend the grazing season, improve forage quality, or reduce fescue toxicity. Make sure the new forage fits the operation because renovation is an expensive and time-consuming process. Select new forages based on seasonal forage need. For example, warm-season grasses should be considered in fescue-dominant systems. Cool-season grasses should be selected in bermudgrass- or bahiagrass-dominant systems.

Specific Renovation Scenarios

Renovating KY-31 Toxic Fescue to Novel Endophyte Fescue

Situation: Tall fescue is the most common perennial cool-season grass in Arkansas. Most of the fescue is the variety KY-31, and it is infected with the toxic endophyte that causes fescue toxicosis in livestock. In cases where fescue toxicosis and fescue foot have occurred in the past, consider renovating drought-damaged KY-31 pastures and converting to a non-toxic novel endophyte fescue.

Renovation Strategy: This is a chance to convert damaged toxic KY-31 pastures to other nontoxic forages. Thin and weakened fescue will be easier to kill than healthy, robust stands. Use the spray-smother-spray technique to finish off the old stand.

Tillage by itself will not kill all the old fescue. The "spray-smother-spray" (S-M-S) method has been a reliable method for renovating toxic fescue pastures and can begin in the fall or spring.

If starting renovation in fall, apply a nonselective herbicide (e.g., glyphosate) to the actively growing fescue during fall (September to late October) and no-till drill a small grain for winter/spring forage. Do not plant annual ryegrass because natural reseeding from ryegrass will cause severe competition later when novel endophyte fescue is planted. Follow the harvest of the small grain forage in late spring with a second herbicide application. Continue the renovation process by no-till drilling a summer annual such as pearl millet. The summer annual forage provides heavy shade and competition for any remaining fescue plants and can be harvested for hay or grazed. In fall, after harvest of the summer annual, apply herbicide again to kill any remaining KY-31 fescue and the summer annual forage. No-till drill the novel-endophyte fescue.

For spring renovation start in late April to early May when fescue is actively growing and before any new seed is produced. Clip or graze the fescue to a height of 4 to 6 inches and apply a nonselective herbicide such as glyphosate. After the fescue top growth dies down, no-till plant a summer-annual forage, such as pearl millet or sorghum-sudan. After the final harvest of the annual forage in late summer, follow up with a second herbicide application. The field can be planted with NE+ fescue or other cool-season grass in the fall. Several proven NE+ fescue variety/endophytes are on the market and many have been grown successfully in Arkansas.

Cows grazing pearl millet being grown as a summer "smother" crop during the renovation process of eliminating toxic KY-31 fescue to replant non-toxic novel endophyte fescue.

Figure 17. Cows grazing pearl millet being grown as a summer "smother" crop during the renovation process of eliminating toxic KY-31 fescue to replant non-toxic novel endophyte fescue.

Renovating KY-31 Toxic Fescue to Warm-Season Grass

Situation: Most fescue is the variety KY-31, and it is infected with the toxic endophyte. Fescue-dominant forage systems can often benefit from addition of warm-season grasses to improve seasonal grazing and to give livestock a break for toxic fescue during summer. Bermuda - grass, crabgrass, or native warm-season grasses are options to consider.

Renovation Strategy: Use the spray-smother-spray technique previously described to finish off the old fescue stand. Tillage by itself will not kill all the old fescue.

If starting renovation in fall, apply a nonselective herbicide (e.g., glyphosate) to the actively growing fescue during fall (September to late October) and no-till drill a small grain or ryegrass for winter/spring forage. In May, graze the winter annual forage to 3 to 4 inches and apply a second herbicide application. Wait two weeks for weed seed to germinate and apply another herbicide application. At that point, a warm-season grass such as bermudagrass or even native warm-season grass can be no-till planted if desired.

If a winter annual forage is not planted in fall, herbicide application can be delayed until March to kill fescue and winter annual weeds. A second herbicide application can be made in late April to kill emerging weeds and any remaining fescue prior to planting the warm-season grass. Late-germinating weeds are a main disadvantage when converting old fescue pastures. Be sure to allow enough time between herbicide applications in spring for weed germination to occur before the final herbicide application. In some cases, a third herbicide application may be necessary to kill germinating weeds before planting the warm-season forage.

Renovating Bermuda or Bahia to Cool-Season Grass

Situation: Bermudagrass can be severely damaged by drought on many farms. On farms with dominant warm-season grass pastures, consider planting a novel-endophyte fescue to improve seasonal grazing in spring and fall. Fescue can produce more fall forage than winter annuals and at a lower cost. Novel-endophyte fescue helps extend the grazing season and does not cause fescue toxicosis like Ky-31 fescue.

Renovation Strategy: Tillage by itself will not kill all the old bermudagrass or bahiagrass. Use the spray-smother-spray technique to finish off the old bermudagrass stand. Bermudagrass is not tolerant of heavy shade so maintaining a tall canopy of other forages helps eliminate the bermuda stand.

If starting renovation in fall, apply a nonselective herbicide (e.g., glyphosate) and no-till drill a small grain for winter/spring forage. Do not plant annual ryegrass because natural reseeding from ryegrass will cause severe competition later when novel endophyte fescue is planted. Follow the harvest of the small grain forage in late spring with a second herbicide application. Continue the renovation process by no-till drilling a summer annual such as pearl millet. The summer annual forage provides heavy shade and competition for any remaining bermuda plants and can be harvested for hay or grazed. In fall, after harvest of the summer annual, apply herbicide again to kill any remaining bermuda and the summer annual forage. No-till drill the novel-endophyte fescue.

For spring renovation start in late April to early May when the bermudagrass begins growing and before any new seed is produced. Clip or graze the pasture to a height of 4 to 6 inches and apply a nonselective herbicide such as glyphosate. Wait two to three weeks and apply a second herbicide application to kill any remaining bermudagrass and germinating seedlings. After the top growth dies down, no-till plant a summer-annual forage, such as pearl millet or sorghum-sudan. After the final harvest of the annual forage in late summer, follow up with a herbicide application to kill the summer annual forage and weeds. The field can be planted with NE+ fescue or other cool-season grass in the fall.

Chapter 9

Forage Insects

Kelly Loftin, Associate Professor - Entomology

During drought conditions, pests are especially important because of their direct competition with livestock for a limited resource, forage. Pest species such as fall armyworms and grasshoppers may be more abundant because pathogens can be less effective during dry conditions. The economic damage caused by the bermudagrass stem maggot can be more apparent because of the slow growth and stress.

Armyworms

Armyworms are of particular importance during drought situations because they can quickly defoliate a field when forage is already in short supply. Scouting and early detection of armyworm infestation is vital in preventing significant yield loss. Several insecticides are available to control armyworms. In addition, cutting for hay is an option, especially if the grass is mature enough to cut.

Two species of armyworms can be significant pests of Arkansas forage and pasture production. (Figures 1a and 1b). Both species are in the family Noctuidae along with other garden and agronomic pests such as cutworms, bollworms and budworms. In Arkansas, the "true" armyworm (*Pseudaletia unipuncta*) is more of a spring pest of cool season grasses and tall fescue. The fall armyworm, or FAW (*Spodoptera frugiperda*), is a summer/fall pest primarily of bermudagrass, but it can also damage fall-seeded, newly established winter annuals, fescue and orchardgrass.

In southern Arkansas, we can expect to see fall armyworm damage in bermudagrass as early as June. True armyworms are more of an issue in northern and central Arkansas primarily on fescue (and fescue grown for seed) but will also damage other grasses and small grains. True armyworms may not reach pest status every year partially as a result of mortality from natural predators and pathogens. In contrast, we can expect to have fall armyworm damage in south Arkansas forage almost every year. In recent years, we have also witnessed significant fall armyworm damage in central and north Arkansas. Other armyworms such as the yellow striped armyworm (*Spodoptera ornithogalli*) and beet armyworm (*Spodoptera exigua*) may attack forages but seldom reach pest status on Arkansas forage.

Damage from true armyworms and fall armyworms can seem to appear overnight. Although the damage might appear overnight, larvae have likely been feeding for a week or more before they or their damage appear. This is because when the worms are small (early instars) they do not eat much. It is not until the

Figure 1a. True armyworm. Note the mottled head.

Figure 1b. Fall armyworm. Note the inverted Y on head.

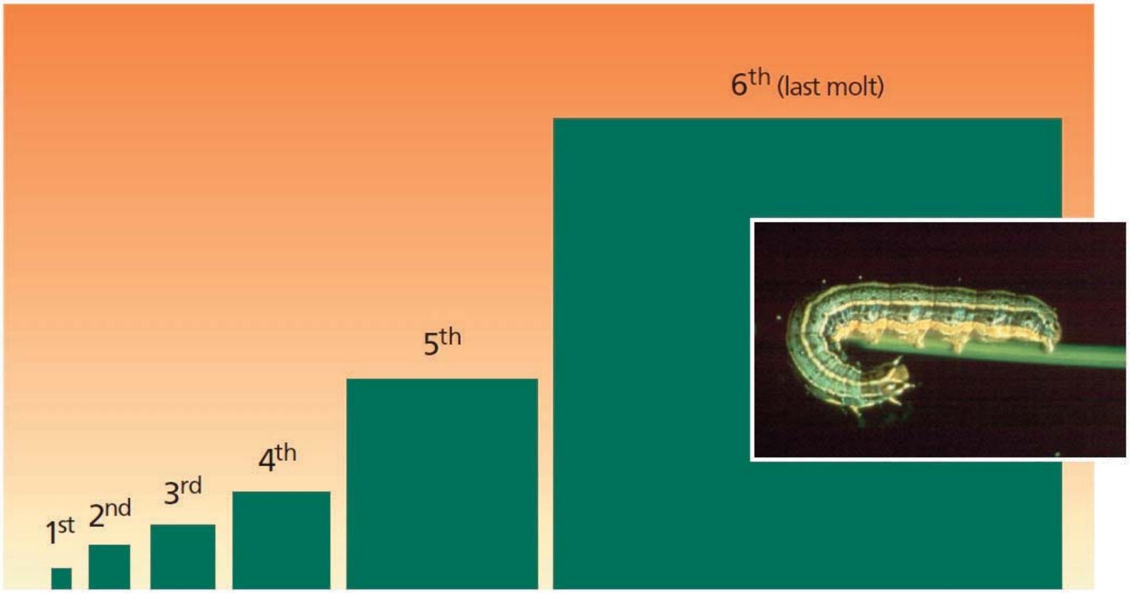


Figure 2. Relative amounts of food eaten by a fall armyworm caterpillar during each growth stage. *Image by Kathy Flanders, Auburn University.*

5th and 6th instar that the caterpillars begin consuming large amounts of forage (Figure 2). In addition, large armyworms may move into an uninfested field (or area of a field) that is adjacent to a field that was just defoliated. Because armyworms are so destructive and compete with livestock for forage, diligent scouting in susceptible fields should begin in April for the true armyworm and mid-June or July fall armyworms.

Fall armyworms do not overwinter in Arkansas instead the adult moths catch wind currents and gradually move into the state from the south and lay eggs. About 30 days are required for a fall armyworm egg to develop into an adult moth. The forage feeding stage – as caterpillars -- is about two weeks. At the end of feeding, the fully mature caterpillar is about1.5 inches long. Fully mature caterpillars pupate on or in the soil. After about nine days as a pupa, an adult moth will emerge. The newly emerged female moth will mate and begin laying eggs about three days after they emerge. Fall armyworm caterpillars can feed any time of day but may be concealed during the hottest, brightest part of the day. Fall armyworm infestations can be expected from as early as mid-June through September. Outbreaks are more likely during periods of drought because some of their natural enemies are less active during droughts. In Arkansas, fall armyworm outbreaks often occur as the grass grows following rainfall that had broken a prolonged dry period.

In contrast to fall armyworms, true armyworms can overwinter in Arkansas. The true armyworm life cycle is very similar to that of the fall armyworm except that it takes about 40 days for a true armyworm egg to develop into an adult during the warmer temperatures of the spring. During colder temperatures the generation period may be extended to 60 days. Another major difference is that the true armyworm caterpillar is a nocturnal feeder.

Armyworm control decisions should be based on treatment thresholds derived from sampling the field (Figure 3). In general, insecticide treatment is warranted if three or more half-grown armyworms per square foot are present. The best way to conduct sampling is to make at least 10 random samples across the field. Also remember that moths often lay eggs in the lushest part of the field, so include a few samples from these areas. A sampling device constructed of half- or three-quarter

Figure 3. Fall armyworm larvae.

inch PVC pipe that covers one square foot makes the sampling much easier (Figure 4). Also, early signs of armyworm damage by small caterpillars include leaves that are chewed on the underside only and fields with a slight "frosted" appearance. Another sign that fall armyworms may be present are birds feeding in the pasture or hayfield.

Figure 4. Fall armyworm sampling device.

Factors such as the size of the caterpillars and maturity of the hay crop should be considered before making an insecticide application. For example, if a field is heavily infested and the grass is ready to harvest, consider cutting and baling as soon as possible rather than making an insecticide application. In contrast, if the field is not ready to cut and you have about three or four very small (from one-eighth to one-quarter of an inch) fall armyworm caterpillars per square foot, continue scouting and if their abundance does not decline below threshold by the time they reach a half-inch, then treat with an insecticide. Don't wait until the armyworms are 1.5 inches long because they are about to pupate and have likely already caused most of the damage that they will do and large worms are more difficult to kill. Additional information on armyworms can be found in FSA7083, *Managing Armyworms in Pastures and Hayfields*, and is available at http://www.uaex.uada.edu/publications/PDF/FSA-7083.pdf.

Per-acre insecticide cost will vary from as low as about $2.50 up to well over $10.00. When calculating cost, always consider the cost per acre and not the cost per gallon of product. Also consider residual activity of the product, especially if you are seeing an overlapping population (all sizes of armyworm caterpillars) and heavy armyworm pressure. Remember, pyrethroid insecticides such as Karate® (lambda-cyhalothrin), Mustang Max® (zeta-cypermethrin) and Baythroid XL (beta-cyfluthrin) have shorter-duration residual activity. In contrast, other products such as Prevathon® (chlorantraniliprole), Besiege® (chlorantraniliprole and lambda-cyhalothrin) and Intrepid® (methoxyfenozide)) do have longer-duration residual activity and can reduce the number of applications necessary to produce a hay crop.

For additional information of insecticides labeled for use against armyworms in pastures and hayfields, check out the Forages section of the current MP144, *Insecticide Recommendations for Arkansas*, available at http://www.uaex.uada.edu/publications/pdf/mp144/c-forages.pdf.

Grasshoppers

Grasshoppers can consume up to 50 percent of their body weight in forage each day. In contrast, cattle consume up to about 2.5 percent of their body weight in forage per day. In other words, 50 pounds of grasshoppers would eat about as much as a full-grown cow. To make matters worse, grasshoppers compete directly with livestock because they preferentially feed on the most desirable forage plants.

Several species of grasshoppers occur in Arkansas. Some of the most common grasshopper species include the differential (*Melanoplus differentialis*) (Figure 5a), red-legged (*Melanoplus femurrubrum*) (Figure 5b) and two-striped (*Melanoplus bivattus*) (Figure 5c). In past years, more calls were about differential and red-legged grasshoppers.

Figure 5a. Differential grasshopper. *Photo by David Riley, University of Georgia, Bugwood.org.*

Figure 5b. Red-legged grasshopper. *Photo by Clemson University, Bugwood.org.*

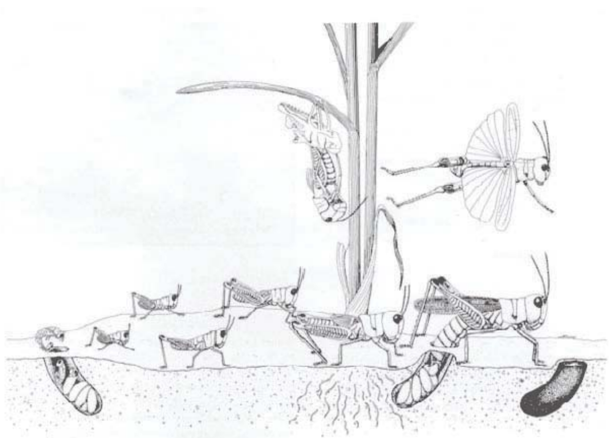
Figure 5c. Two-striped grasshopper. *Photo by Whitney Cranshaw, Colorado State University, Bugwood.org.*

Grasshopper abundance varies with location and is sometimes spotty. The local grasshopper abundance is often related to dry/hot weather conditions and early spring/mild winter. This is because naturally occurring fungal pathogens of grasshoppers that help lower grasshopper populations are suppressed in hot and dry conditions.

Grasshoppers have a one-year life cycle and survive winter in the egg stage. The adult female lays several egg masses in soft soil at depths of one-half to 1.5 inches. Development to adult takes about 30 to 60 days. Grasshoppers go through five or six nymphal stages before becoming fully mature, winged adults. Instead of developed wings, nymphs have wing pads. Generally, adults are most active during the summer while nymphs are active in the spring. Grasshoppers are polyphagous herbivores, eating both grasses and forbs.

Grasshoppers are difficult to control, especially large ones. In addition, grasshoppers will fly a considerable distance in search for suitable food. In some situations, insecticide application can be a viable option. However, it can be difficult to judge whether control is economically warranted. Before treating a pasture or hayfield for grasshoppers, producers should weigh the value of the field as hay or forage against the cost of an insecticide application. In general, broadcast insecticide application is not economically feasible if less than 10 grasshoppers per square yard are found. Another option to consider is spot treating areas where a large number of grasshopper nymphs (small wingless grasshoppers) are observed. This technique can reduce grasshopper numbers in local areas because newly hatched nymphs remain concentrated in the hatching areas for some time. Later, as wings develop, grasshoppers are capable of flying from the hatching area in search of suitable forage.

Two of the most important factors to consider when choosing an insecticide to apply to a pasture are the size of the grasshopper and grazing restriction. If the grasshoppers are larger than one-half inch, they are more likely to survive treatment with an IGR product (such as Dimilin 2 L (diflubenzuron)). In other words, if grasshoppers are large, use the higher labeled rate of conventional products such as the pyrethroids or newer products containing chlorantraniliprole rather than an IGR treatment. Producers should also adhere to grazing and harvest restrictions. Fortunately, many of the products available today have no grazing restriction and only minimal harvest restriction. Diflubenzuron and the pyrethroids such as lambda-cyhalothrin, beta-cyfluthrin and zeta-cypermethrin have a zero day grazing restriction when applied to grass. In contrast, hay harvest restrictions vary. For example, producers need to wait at least seven days before harvesting hay from a grass field treated with lambda-cyhalothrin and one day from a grass field treated with diflubenzuron. Another important change in grasshopper control is that Sevin (carbaryl) formulations are no longer labeled for grasshopper control on grass forage or hay. See the pasture section of the current Insecticide Recommendations for Arkansas (MP 144) (http://www.uaex.uada.edu/publications/pdf/mp144/c-forages.pdf) for product names, rates and grazing/harvest restrictions.



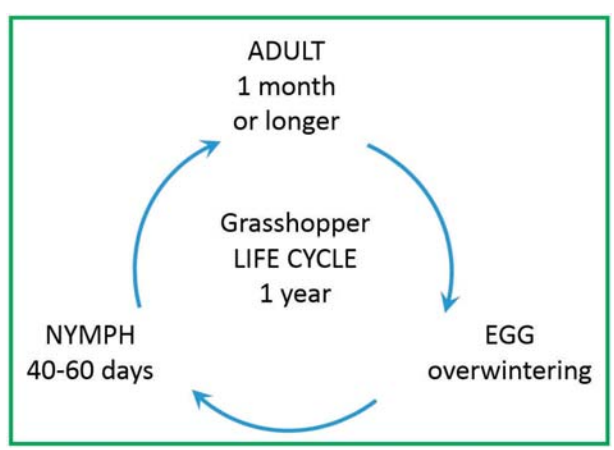


Figure 6. Typical grasshopper life cycle.

Bermudagrass Stem Maggots

In late July 2013, the bermudagrass stem maggot, *Atherigona reversura* (Family Muscidae), was identified from a bermudagrass field near Magnolia, Arkansas. Shortly after this initial confirmation, it was identified in many more Arkansas counties – from extreme northern to extreme southern Arkansas. These findings indicate that this fly is likely found throughout Arkansas. In the U.S., it was first discovered in Georgia in 2010 and is currently found in other southeastern states as well as Oklahoma and Texas. Information on its biology, the damage it causes and control methods is very limited. To date, economic thresholds and yield loss data have not been established for this pest.

Damage caused by the bermudagrass stem maggot results from larval stages (maggots) feeding in the shoot, causing the top two or three leaves to die (Figure 7). Lower leaves remain alive and unaffected by the maggot's feeding. Because of the death of the top couple of leaves, the plant (and field, if heavily infested) may exhibit a frosted appearance (Figure 8). The life cycle from egg to adult requires about three weeks. The adult female fly will lay eggs on the bermudagrass stem near a node. The maggot will hatch from the egg, crawl up to toward the last plant node (where the leaf blade emerges from the stem) and burrow into the shoot and begin feeding. Usually, by the time the top leaves have died, the maggots have exited the stem and pupated on the ground. With such a short generation period, multiple generations occur and populations tend to increase later in the season, causing an accumulation of damage.

Figure 7. Typical damage caused by the bermudagrass stem maggot. Note the dead upper leaves.

Figure 8. Bermudagrass stem maggot damage.

The adult fly is small (approximately ⅛ inch long) and yellow colored with four prominent black spots on the abdomen (Figure 9). The maggot (larva) is also yellowish colored and about one-eighth of an inch in length when fully mature (Figure 10).

Figure 9. Bermudagrass stem maggot adult. Note the four black spots on its abdomen.

Figure 10. Bermudagrass stem maggot larvae.

Although yield data and economic threshold data is very limited, experiences in other states provide basic guidelines to consider. In general, this pest is less of a problem in coarse-stemmed bermudagrass varieties (Tifton 85 and others), bermudagrass that is grazed or bermudagrass that is baled for cattle hay. In grazed pastures, cattle eat the fly eggs and maggots along with the grass, lessening population buildup. Bermudagrass stem maggots may become an economic pest in finer-stemmed varieties (common, Coastal, Alicia and others) that are baled for horse hay, especially later in the season after the population builds. The issue with horse hay is that the dead top leaves cause an unsightly appearance to some in the horse hay market, resulting in rejected hay.

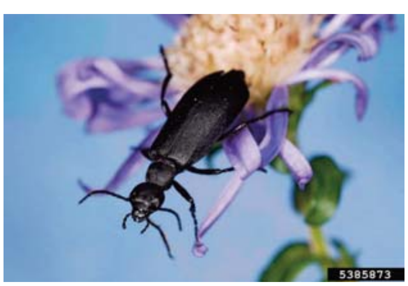
Growing conditions appear to influence the amount of damage caused by the bermudagrass stem maggot. Impact on yield is lessened when soil and moisture conditions allow for normal rapid growth. In this situation, loss of a few upper leaves would have little impact on yield. In situations where growth is limited by poor soil conditions or lack of moisture, yield losses are more likely to occur. Researchers believe this is because the slow growth rate allows egg laying and maggot development to occur earlier and more often in the grass growth cycle. Also, in heavy infestations, regrowth after cutting will be slowed substantially when a greater percentage of stems are damaged.

Management options for the bermudagrass stem maggot include harvesting and, in some cases, insecticide application. Cutting for hay is usually recommended if significant damage is identified within one week of normal harvest. When damage occurs from one to three weeks after harvest and is substantial, yield may be compromised. In this situation, harvest may be necessary to prevent further stunting and significant yield loss. Pyrethroid insecticides labeled for use in hay fields appear to be the least expensive and most effective insecticide. These insecticide treatments should be applied from seven to 10 days after cutting. This treatment interval is important because the grass has resprouted, and adults emerging from larvae that pupated at the time of cutting should have emerged and are ready to lay eggs. The pyrethroid insecticide application is aimed at the egg-laying adults and is less effective once the bermudagrass is thick because it cannot penetrate the canopy to reach where adults are often found. So far, insecticide applications aimed at maggots developing in the stem have not been effective.

Blister Beetles

Blister beetles belong to the family Meloidae and get their common name because they discharge cantharidin when crushed or held tightly, resulting in a painful blister. Although all life stages of the blister beetle contain cantharidin, we are most concerned about the adult stage because this stage is more likely to result in blistering if we handle one or poison horses if they eat enough of the beetles. Blister beetles in the genus *Epicauta* are the group we are most concerned about because they are more likely to cause cantharidin poisoning (Figure 11). Even within this genus, cantharidin levels vary. The amount of catharidin per beetle determines the approximate number of blister beetles that would be required to cause cantharidin toxicosis in horses. Blister beetles are considered an important pest of alfalfa and do not feed on grasses but can be found feeding on broadleaf weeds in grass pastures and fields.

Most blister beetle species have only one generation per year. Adult beetles lay eggs in the soil. Eggs will hatch into blister beetle larvae that can molt several times before transforming into pupa (the overwintering stage). The main prey of blister beetle larvae in the genus *Epicauta* is subterranean grasshopper eggs. An abundance of grasshoppers may lead to an abundance of blister beetles. Adults emerge from the soil throughout the growing season;



Black Blister beetle (*Epicauta pennsylvanica*). *Photo by Joseph Berger, Bugwood.org.*

Striped Blister Beetle (*Epicauta occidentalis*). *Photo by University of Tennsssee.*

Threestriped blister beetle (*Epicauta vittata*). *Photo by Clemson University, Bugwood.org.*

Figure 11. Blister beetles of the genus *Epicauta*.

however, the period of peak emergence varies with the species. We began seeing an abundance of striped blister beetles beginning in late May and June. Adults feed on alfalfa flowers and foliage as well as soybeans, clover, peanuts, peas and several weeds (goldenrod, pigweed, goat-head and puncturevine). Blister beetles are gregarious and often congregate in large swarms within alfalfa fields and on other host plants listed above.

The main concern of cantharidin toxicosis is from horses that consume hay contaminated with adult blister beetles. Cantharidin is very stable and remains toxic in beetles long after the beetles are dead, meaning they are toxic – dead or alive. Alfalfa hay is more likely to contain blister beetles than grass hay. It would be less likely for horses to consume enough blister beetles while grazing to cause significant problems when compared to consuming blister beetle-contaminated hay. Remember, live beetles will emit cantharidin when crushed or handled, which would result in a painful blister that should help deter live beetle consumption. Using Table 1, we see a rough estimate of the number of beetles it would take to kill a horse. As you see from the table, cantharidin levels vary widely and the actual number of beetles in the hay is very important. Depending upon the species, it can take tens to hundreds of beetles to cause toxicosis in horses. The two species that pose the most risk for livestock poisoning are the three-striped blister beetle (*Epicauta vittata*) and the striped blister beetle (*Epicauta occidentalis*). Another very important factor that leads to blister beetle-contaminated hay is the tendency of blister beetles to congregate. For example, if during harvest large numbers of beetles congregated around a plant and were killed by the crimper or a conditioner, lethal numbers of blister beetles could occur in a single flake of alfalfa hay.

In summary, the major concern is blister beetle-contaminated hay. Contamination of hay usually occurs when beetles are crushed during the crimping process or if beetles are crushed by equipment wheels prior to baling. Once contaminated, the hay does NOT lose toxicity because cantharidin remains stable in dead beetles and does not degrade with heat or drying.

Concerns about blister beetle contamination of alfalfa hay cannot be totally eliminated. However, specific harvesting practices can reduce the potential for blister beetle contamination. These practices include:

1. Cut hay without using crimpers (additional drying time might be required).
2. Use a sickle mower without a conditioner (usually slower and can allow time for beetles to get out of the way).
3. Avoid driving equipment on cut hay (helps prevent crushing beetles into the hay).
4. Cut hay prior to 10 percent bloom (hay cut in the early bloom stage minimizes beetle attraction to the flowers).
5. Match the cutting with the market (normally, first cutting alfalfa in May and late September alfalfa are before and after the major blister beetle season and are the best cuttings to target for horse owner buyers).
6. Recognize blister beetles and understand their biology and behavior.
7. Effectively manage broadleaf weeds because blister beetles are attracted to blooms.
8. Thoroughly inspect and scout fields just before and during harvest to detect blister beetle presence.

Additional blister beetle information is available at http://www.uaex.uada.edu/publications/PDF/FSA-7054.pdf. A listing of insecticides labeled for use against blister beetles in alfalfa check is available in the Forages section of the current MP144, *Insecticide Recommendations for Arkansas*, http://www.uaex.edu/publications/pdf/mp144/c-forages.pdf.

Table 1. Estimated number of beetles for a lethal (1 mg/kg bw) dose of cantharidin.

	Horse Weight (lbs)			
	250	500	800	1,200
Cantharidin (mg / beetle)	**Number of Blister Beetles**			
0.5 (other blister beetles)	227	450	719	1,090
5.0 (striped blister beetles)	23	45	72	109

Adapted from: L.H. Townsend, University of Kentucky.

Baled Hay and Imported Fire Ants

Severe drought can result in tremendous hay and forage shortages and may lead to the importation of baled hay from areas outside the normal hay market area. For example, in the drought of 2012-2013, baled hay was abundant in areas infested with imported fire ants (red imported fire ant (*Solenopsis invicta)*, black imported fire and (*Solenopsis richteri*) and their hybrid) such as Louisiana, Mississippi, Alabama, some parts of Texas and other states. Unfortunately, baled hay, stored in contact with the soil and originating from fire ant-infested areas, could potentially harbor imported fire ant colonies or newly mated queens. Importing either imported fire ant colonies or newly mated queens into non-fire ant-infested (nonquarantined) areas of Arkansas could easily result in the establishment of imported fire ants in areas currently free of fire ants. Some have suggested that winter temperatures in north Arkansas are too cold to support imported fire ants. Fire ant expansion models suggest otherwise. In addition, we have seen fire ant colonies in North Arkansas survive and develop into mature colonies. Fortunately, these colonies (from accidental human-aided introductions) were identified and controlled before populations expanded.

Below are a few of the more commonly asked questions related to fire ants and baled hay.

1. How does the imported fire ant quarantine affect hay movement?

Baled hay that has been stored improperly in direct contact with the soil and from fire ant-infested (quarantined) areas cannot be shipped to noninfested (nonquarantined) areas. Although roughly half of Arkansas is included in the federal imported fire ant quarantine, 41 Arkansas counties are not quarantined (noninfested) and many of these nonquarantined counties are cattle producing. This means that only properly stored hay should be transported into non-fire ant infested (nonquarantined) areas if the hay originated from fire ant-infested (quarantined) areas. The rationale for this restriction is to simply limit the artificial (human-aided) spread of imported fire ants into noninfested areas.

2. What hay is at risk of imported fire ant infestation?

Baled hay from infested areas that has been stored in contact with the soil is at risk of harboring imported fire ants, imported fire ant

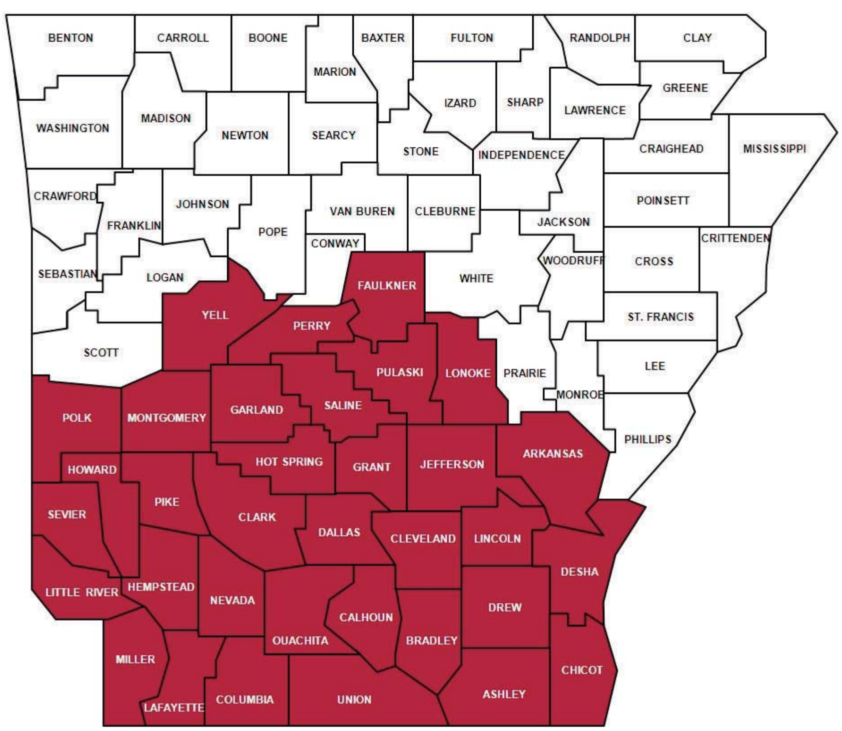


Figure 12. Fire ant quarantine areas (red) in Arkansas (as of August 2014).

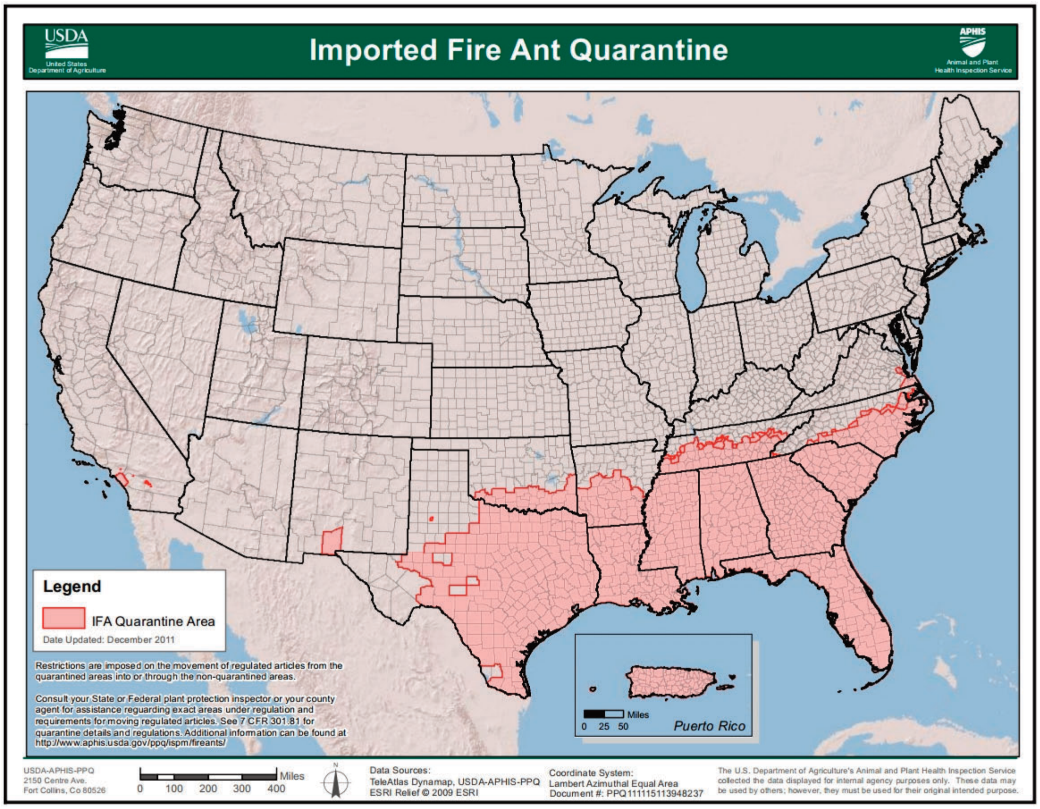


Figure 13. USDA imported fire ant quarantine map for U.S.

colonies or imported fire ant queens. Fire ant transport risk can be reduced by applying fire ant bait (insecticide) around the outside of hay storage areas; storing hay on asphalt, concrete or hard pan; elevating hay in the field onto a pallet or tire; placing hay on landscape cloth or thick plastic so it is not in direct contact with the ground; and shipping only hay that has been stored from the second tier or above. Hay purchasers can also request that a state inspector (where the hay originated) certify that the hay is free of fire ants.

3. Why do we have an imported fire ant quarantine?

Imported fire ants spread through natural mating flights and through the transport of infested sod, baled hay, soil (alone and with other material), nursery stock, other potted or balled plants excluding house plants and used earth-moving equipment. The rate of spread through natural mating flights is relatively slow in comparison to transport through these human-assisted means. In 1958, the USDA Animal and Plant Health Inspection Service, or APHIS, enacted a Federal Imported Fire Ant Quarantine (7CFR301) to slow and prevent the artificial spread of imported fire ants from fire ant-infested (quarantined) areas to noninfested (nonquarantined) areas. Either all or part of the following states are included in the quarantined area: Arkansas, California, Oklahoma, Texas, Louisiana, Mississippi, New Mexico, Tennessee, Alabama, Georgia, South Carolina, North Carolina, Virginia, Florida and Puerto Rico. Currently, within Arkansas, 34 counties are included in the federal quarantine. These counties are Ashley, Arkansas, Bradley, Calhoun, Chicot, Clark, Cleveland, Columbia, Dallas, Desha, Drew, Grant, Garland, Hempstead, Hot Spring, Howard, Jefferson, Lafayette, Lincoln, Little River, Lonoke, Miller, Montgomery, Nevada, Ouachita, Perry, Pike, Polk, Pulaski, Saline, Sevier, Union and Yell. Nonquarantined counties are periodically evaluated by the Arkansas State Plant Board to determine if new areas should be placed in the quarantine.

The Federal Imported Fire Ant Quarantine is a USDA APHIS regulation. Inspections and enforcement in Arkansas are carried out by the Arkansas State Plant Board. Additional imported fire ant quarantine information is available by selecting "Imported Fire Ants" under category

"Insects" from the following web address: http://www.aphis.usda.gov/planthealth/pests_and_diseases.

4. Where did imported fire ants originate and why are they important?

Imported fire ants were accidentally introduced into the United States from South America about 80 years ago. Actually, two species were introduced: the red imported fire ant, *Solenopsis invicta*, and the black imported, *Solenopsis richteri*. The more widespread is the red imported fire ant, which is well established in 14 states located in the South and as far west as California. The first documented sighting of the red imported fire ant in Arkansas was in El Dorado (Union County) in 1958. Now, more than 50 years later, they infest much of the southern half of Arkansas and are found in isolated areas in the northern half of the state.

Imported fire ants negatively impact the quality of life. Their painful stings pose a health threat and disrupt human activities. A single ant has the ability to produce numerous painful stings, which in a small percentage of susceptible individuals, can lead to severe allergic reactions. Fire ants are also a concern to cattle and poultry producers because of their aggressive swarming behavior as they forage or if their mounds are disturbed. Occasionally, fire ants swarm and kill newborn livestock and have been shown to be detrimental to wildlife such as quail chicks, etc. Sometimes these ants will short-circuit electrical equipment such as air conditioners, poultry house cooling fans, well pumps, electric paddle wheels used in commercial fish production and other electrical equipment. Also, fire ants often construct large mounds that can damage hay harvesting equipment during harvest. Economic losses in Arkansas are estimated at $128 million per year, and for the U.S. the estimate is roughly $6.3 billion.

5. What do imported fire ants look like and how do they behave?

Field identification of imported fire ants includes mound characteristics, worker size and coloration, aggressive demeanor when disturbed, burning sensation after being stung and pustule formation at the site of the sting. Fire ant mounds, or colonies, appear fluffy and worked, which is more pronounced following a rainfall. In addition, fire ant mounds DO NOT have a center opening. A volcano-like mound is characteristic of many native ant mounds encountered. This is because imported fire ants will enter and leave their nest through underground tunnels. Although imported fire ant mound size will vary with soil type and moisture, they range in size from a few inches in height in turfgrass to twenty-four inches or more in undisturbed areas (pastures and undeveloped areas).

Imported fire ant workers range in size from one-eighth to one-quarter of an inch in length. This variation in size within a colony is an important distinguishing feature because many other ant species are uniform in size. However, there are other characteristics which distinguish imported fire ants from other ant species. The aggressive nature of imported fire ants compared to other ant species is one such trait. If a mound is disturbed, usually hundreds of fire ant workers will swarm out and run up vertical surfaces to sting.

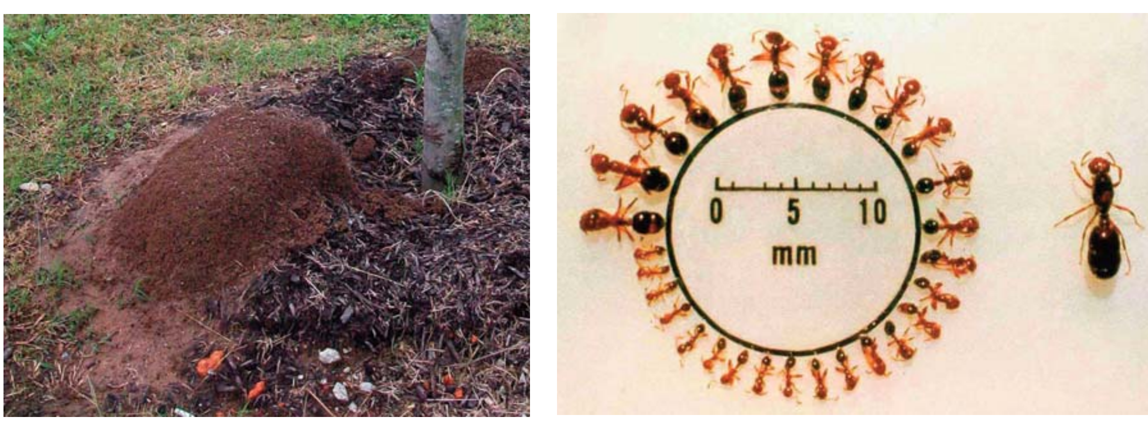


Figure 14. Imported fire ant identifiction: fire ant mound on left and on right an array of fire ants by size compared to a queen.

Residents of infested areas quickly recognize imported fire ants by the mounds they build or the stings they inflict. Ant workers bite with their chewing mouthparts to attach firmly to the skin allowing them the leverage to inject the stinger and venom. Unlike honey bees, fires ants can sting repeatedly without harm to themselves. Those stung by fire ants normally feel burning or stinging sensation at the sting site. About 12 hours later, the imported fire ant's unique venom forms a characteristic white fluid-filled pustule or blister at the sting site.

Key Points: Site Identification

1. Mound without external opening and fluffy appearance.
2. Mounds range from a few to 24 inches in height.
3. Aggressive demeanor when mound disturbed.
4. Workers range from one-eighth to one-quarter inch in length.
5. Sting causes burning sensation and produces a pustule about 12 hours following being stung.
6. Head and first antennae segment of red imported fire ants are reddish brown in color.

Morphological identification, which requires a dissecting microscope – Imported fire ants are either reddish brown (red imported fire ants) or brownish black (black imported fire ant or hybrid) in color. In addition, workers of both species and their hybrids range in size from one-eighth to one-quarter of an inch in length. Morphological identification is best accomplished using major (large) workers. The key morphological characteristics used to identify imported fire ants include:

1. Antenna consists of 10 segments
2. Antennal club consists of two segments
3. Antennal scape almost reaches the vertex of the head
4. Mandibles with four teeth
5. Possess a median clypeal tooth
6. Pedicel (waist) consists of two nodes

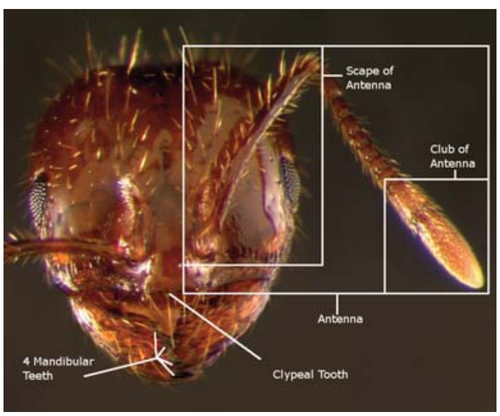


Photo by Ricky Corder.

Photo by University of Florida.

Figure 15. Morphological identification of imported fire ants.

Appendix

Livestock Weather Hazard Guide

Dry bulb temperature	Percent of relative humidity intervals																				COLOR KEY
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	SAFE
75									70	70	71	71	72	72	73	73	74	74	75	75	
76							70	70	70	71	72	72	72	73	74	74	74	75	76	76	
77						70	70	71	71	72	72	73	73	74	74	75	75	76	76	77	
78					70	70	71	71	72	72	73	74	74	75	75	76	76	77	78	78	
79				70	70	71	72	72	73	73	74	74	75	75	76	77	77	78	78	79	
80			70	70	71	72	72	73	73	74	74	75	76	76	77	78	78	79	79	80	
81		70	70	71	71	72	73	73	74	75	75	76	77	77	78	78	79	80	80	81	ALERT
82		70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82	
83	70	71	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	82	83	
84	70	71	72	72	73	74	75	75	76	77	78	78	79	80	80	81	82	83	83	84	
85	71	72	72	73	74	75	75	76	77	78	78	79	80	81	81	82	83	84	84	85	
86	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	86	
87	72	73	73	74	75	76	77	77	78	79	80	81	81	82	83	84	85	85	86	87	
88	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	85	86	87	88	DANGER
89	73	74	74	75	76	77	78	79	80	80	81	82	83	84	85	86	86	87	88	89	
90	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	87	87	88	89	90	
91	74	75	76	76	77	78	79	80	81	82	83	84	85	86	86	87	88	89	90	91	
92	74	75	76	77	78	79	80	81	82	83	84	84	85	86	87	88	89	90			
93	75	76	77	78	79	80	80	81	82	83	84	85	87	87	88	89	90				
94	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90					
95	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90						EMERGENCY
96	76	77	78	79	80	81	82	84	84	86	87	88	89	90	91						
97	77	78	79	80	81	82	83	84	85	86	87	88	90	91							
98	77	78	79	80	82	83	84	85	86	87	88	89	90								
99	78	79	80	81	82	83	84	86	87	88	88	90									
100	78	79	80	82	83	84	85	86	87	88	90	91									
105	80	82	83	84	86	87	89	90	91												

Source: University of Missouri Extension

Other Sources

University of Arkansas Cooperative Extension Service Fact Sheets

Alternative Feeds for Beef Cattle (FSA3047)
Beef Production in Arkansas (MP184)
Body Condition with Dairy Cattle (FSA4008)
Body Condition with Sheep (FSA9610)
Calibrating Drills and Broadcast Planter for Small-Seeded Forages (FSA3111)
Common Arkansas Plants Poisonous to Cattle (FSA3025)
Culling the Beef Cow Herd (FSA3092)
Feeding Beef Cows Based on Body Condition Scores (MP373)
Nitrate Poisoning in Cattle (FSA3024)
Rainfall Effects on Wilting Forages (FSA3090)
Prussic Acid (FSA3069)
Substituting Grain for Hay in Beef Cow Diets (FSA3036)
Test Hays for Nutrient Composition Before Feeding (FSA3114)
Tips for Feeding Horses During a Drought (FSA3136)
Water for Beef Cattle (FSA3021)

Note: All publications can be obtained at your local county Extension office or at www.uaex.uada.edu.

Arkansas Livestock and Poultry Commission
#1 Natural Resources Drive
Little Rock, AR 72205
(501) 907-2400 Main Office
(501) 907-2430 Lab
(501) 907-2410 Lab Fax
(501) 907-2425 Admin. Fax
email: info@alpc.ar.gov

Arkansas Agriculture Department
1 Natural Resources Drive
Little Rock, AR 72205
Phone: 501-683-4851
Fax: 501-683-4852

Arkansas Natural Resources Commission
101 East Capitol, Suite 350
Little Rock, AR 72201
(501) 682 - 1611
Fax (501) 682-3991

Farm Service Agency
Arkansas State Office
700 West Capitol Ave, Rm 3416
Little Rock, AR 72201-3225
501-301-3000

Feedstuff and Water Testing

Feedstuff Testing

The following list represents laboratories that producers have mentioned for their services and the list is not representative of all available laboratories and their respective services.

University of Arkansas, Agricultural Diagnostic Service Laboratory
Fayetteville, AR
479-575-3908
- Forages and crop residues for nutrient composition and nitrates
- Poultry litter for nutrient composition

(Samples can be submitted through the local county Extension office.)

Dairy One
Ithaca, NY
1-800-344-2697
www.dairyone.com
- Forages and crop residues for nutrient composition and nitrates
- Byproduct feedstuffs and total mixed rations for nutrient composition
- Silages for fermentation profiles
- Mycotoxin testing
- In vitro digestions of feedstuffs for digestibility evaluation

Dairyland Laboratories, Inc.
Arcadia, WI
608-323-2123
www.dairylandlabs.net
- Forages and crop residues for nutrient composition and nitrates
- Byproduct feedstuffs and total mixed rations for nutrient composition
- Silages for fermentation profiles
- Mycotoxin testing
- In vitro digestions of feedstuffs for digestibility evaluation

SDK Laboratries, Inc.
Hutchinson, KS
877-464-0623
www.sdklabs.com
- mycotoxin testing

Whitbeck Laboratories, Inc.
Springdale, AR
800-874-8195
www.whitbecklabs.com
- Mycotoxin testing

Water Testing

Water Quality Laboratory - Fayetteville
2435 N. Hatch Avenue
Fayetteville, AR 72704
479-575-7317
(Samples can be submitted through the local county Extension 0ffice.)

University of Arkansas, United States Department of Agriculture, and County Governments Cooperating

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