

FORAGES at KCA

Presented by

University of Kentucky
Kentucky Cattlemen's Association
Kentucky Forage & Grassland Council

Friday, January 14, 2011
Lexington Convention Center
Lexington, Kentucky

SPECIAL PUBLICATION – KFGC 2011-1

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F O R E W O R D

This marks the sixteenth consecutive year we have had a Forage Symposium at the Kentucky Cattlemen's Convention. We challenge you to consider the content of the proceedings and the discussions of the day in light of your overall beef-forage program. It is our hope you will go away with at least one idea or practice that you can implement to improve your overall forage-animal program.

On behalf of the program committee, I want to thank Mr. Dave Maples and all the fine folks at KCA for their support, assistance and encouragement. In addition, I want to thank the Kentucky Forage and Grassland Council for their continued support of Forages in Kentucky. My thanks to Ray Smith, Laurie Lawrence, Jeff Lehmkuhler and Byron Sleugh for their presentations and papers for the proceedings.

Special THANKS are extended to Mrs. Christi Forsythe for her extra effort in program planning and in preparing and editing the proceedings.

Let me close by extending a special invitation to attend the Heart of America Grazing Conference at the Holiday Inn Hurstbourne in Louisville on January 25-26 and the 31st Kentucky Alfalfa Conference at the Fayette County Extension Office on February 24. For more information on forages and forage-related events, see our website at <http://www.uky.edu/Ag/Forage>

Garry D. Lacefield
Program Chairman

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Forages: Back to Basics

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Over the past fifteen years, we have covered many forage-related topics ranging from the species we grow through marketing our final products. Through all of these themes, we have attempted to address the “basics” in a practical way. We will continue that theme today as we deal with some very important-practical topics.

As we begin, let’s first examine the four basic objectives of a successful forage program: establishment, production, harvesting and marketing. Within each there are many details that we must consider. There are also very specific goals for each objective including stand, yield, quality and profit.

Establish for STAND
Produce for YIELD
Harvest for QUALITY
Market for PROFIT

Our challenge is to “control the CONTROLLABLE” for the most efficient-economical forage-livestock program.

The following are fundamental “BASICS” of forage production that were probably first taught to all of us by parents and grandparents and have been refined by science and practiced on farms across Kentucky:

KNOW FORAGE OPTIONS AND ANIMAL NUTRITIONAL NEEDS. Forages vary as to adaptation, growth distribution, quality, yield, persistence, and potential uses. Also, various types and classes of animals have different nutritional needs. Good planting decisions require knowing forage options for the land resources and nutritional needs of the animals.

ESTABLISHMENT IS CRITICAL. Good forage production requires an adequate stand of plants. Mistakes during establishment often have long-term consequences. Use of high quality seed of proven varieties, timely planting, and attention to detail lead to establishment success.

SOIL TEST, THEN LIME AND FERTILIZE AS NEEDED. This practice, more than any other, affects the level and economic efficiency of forage production. Fertilizing and liming as needed help ensure good yields, improve forage quality, lengthen stand life, and reduce weed problems.

USE LEGUMES WHENEVER FEASIBLE. Legumes offer important advantages including improved forage quality and biological nitrogen fixation, whether grown alone or with grasses. Every producer should regularly consider on a field-by-field basis whether the introduction or enhancement of legumes would be beneficial and feasible. Once legumes have been established, proper management optimizes benefits.

EMPHASIZE FORAGE QUALITY. High animal gains, milk production, and reproductive efficiency require adequate nutrition. Producing high quality forage requires knowing the factors that affect forage quality and managing accordingly. Matching forage quality to animal nutritional needs greatly increases efficiency.

PREVENT OR MINIMIZE PESTS AND PLANT-RELATED DISORDERS. Diseases, insects, nematodes, and weeds are thieves that lower yields, reduce forage quality and stand persistence, and/or steal water, nutrients, light, and space from forage plants. Variety selection, cultural practices, scouting, use of pesticides, and other management techniques can minimize pest problems. Knowledge of potential animal disorders caused by plants can reduce or avoid losses.

STRIVE TO IMPROVE PASTURE UTILIZATION. The quantity and quality of pasture growth vary over time. Periodic adjustments in stocking rate or use of cross fencing to vary the type or amount of available forage can greatly affect animal performance and pasture species composition. Knowing the advantages and disadvantages of different grazing methods allows use of various approaches as needed to reach objectives. Matching stocking rates with forage production is also extremely important.

MINIMIZE STORED FEED REQUIREMENTS. Stored feed is one of the most expensive aspects of animal production, so lowering requirements reduces costs. Extending the grazing season with use of both cool season and warm season forages, stockpiling forage, and grazing crop residues are example of ways stored feed needs can be reduced.

REDUCE STORAGE AND FEEDING LOSSES. Wasting hay, silage, or other stored feed is costly! On many farms the average storage loss for round bales of hay stored outside exceeds 30%, and feeding losses can easily be as high or higher. Minimizing waste with good management, forage testing, and ration formulation enhances feeding efficiency, animal performance, and profits.

RESULTS REQUIRE INVESTMENTS. In human endeavors, results are usually highly correlated with investments in terms of thought, time, effort, and a certain amount of money. In particular, the best and most profitable forage programs have had the most thought put into them. Top producers strive to continue to improve their operations.

As we go through the Conference, I challenge each of you to think about each topic in reference to your farm with ideas and strategies for improvement and refinement to “Control the Controllable” as we capitalize and use “Forages” for profit.

Hay for Horses: Needs and Wants

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“Needs” and “Wants”?

Hay producers have to satisfy two types of clients, horses and humans. Horses need clean hay that has a nutritional value that is appropriate for the requirements of the horse. Clients want hay that is consistent, convenient and cost effective. So, in many cases the “needs” of the horse and “wants” of the human are not exactly the same.

How Much Hay Does A Horse Need?

The amount of hay a horse needs will be influenced by the nutrient requirements of the horse as well as the nutrient content of the hay, and any other feeds the horse is receiving. Most horses will consume 1.5 – 2.0 lbs of hay (or equivalent pasture) for each 100 lb of body weight (so 18 – 24 lb of hay for a 1200 lb horse). The more palatable the forage the higher the expected voluntary intake by horses. Lactating mares will consume higher amounts of forage than horses at maintenance. Elite performance horses and weanlings might receive somewhat lower levels of forage because they will be receiving significant amounts of concentrate. Restricting forage intake can lead to digestive disturbances and behavior problems, so the *minimum* hay (or pasture) intake for any horse should be about 1 lb of hay for each 100 lb of body weight. This amount of hay would not meet a horse’s nutrient requirements so additional feed would be necessary when a horse receives this limited amount of hay.

What Quality of Hay Does A Horse Need?

Hay quality can be evaluated in several ways, but cleanliness and nutritional value are important for horses.

Cleanliness: Hay that contains dust or mold can irritate the horse’s respiratory tract. Optimum athletic performance depends on a healthy respiratory

tract, therefore dusty/moldy hay should never be fed to horses used (or intended for) athletic events. A chronic respiratory disease commonly called “heaves” can be aggravated by moldy and dusty hay. Horses with heaves can have so much difficulty breathing that even mild exercise is impossible. In addition, moldy hay can contain toxins that can affect the horse if they are ingested.

Horse owners should not rely on the nutritional wisdom of horses to prevent problems associated with moldy hay. Horses will usually avoid small patches of moldy hay, but selectivity decreases as hunger increases.

Mold is usually found in hay that is baled at too high a moisture content; but dust can be found in hay that is baled under dry conditions. Dust and dirt can also irritate the horse’s respiratory tract, and care should be taken to avoid hay that has a lot of dirt and dust.

Hay that is clean is also free of weeds, especially ones that are potentially harmful to horses. Harmful weeds include poisonous plants, but also thistles, nettles and other plants that can cause physical injury. These types of weeds can influence the acceptability of the hay to horses and increase waste.

Nutritional Quality: There are usually two main factors that influence the nutritional quality of hay: stage of maturity at harvest and type of plant. Plants harvested in early maturity are usually higher in protein, more digestible and more palatable than plants harvested in late maturity. Legumes are usually higher in protein, more digestible and more palatable than grasses.

Grass hays harvested in late maturity usually have relatively low nutrient values. When hay has fewer nutrients per pound, it will be necessary to feed more pounds to achieve the same nutrient intakes, or it will be necessary to provide more supplemental concentrate. Lower quality hay is often lower in palatability. Hays that are lower in palatability will have higher rates of waste. In general, hays with low nutrient value are less desirable for horses. However, hays with low nutrient values may be suitable for horses with low nutrient requirements, especially if those horses tend to be inactive and overweight!

Legume or grass-legume mixed hays that were cut in early or mid-maturity are useful for horses with higher requirements (lactating mares, growing horses, horses in moderate or heavy exercise). Using high quality hay, horses will be able to obtain 50-70% of their nutrients from the hay, and the remainder from a grain-based concentrate. The amount and composition of the concentrate should be adjusted to complement the type and amount of hay that is being fed. In general, as hay quality increases, less concentrate/supplement will be needed to meet nutrient requirements.

Although horses exhibit preferences for certain types of hay, most types of hay can be used for horses. Common types of hay used for horses include alfalfa, red clover, timothy, orchardgrass and bromegrass. Bermudagrass is also used for horses. Recently we have investigated the acceptability of teff hay for horses. Teff is a summer annual that can produce reasonably good yields. We found that teff is most acceptable if it is harvested at a relatively early stage of maturity.

Although tall fescue can be used for horse hay; there are two general precautions. Generally tall fescue harvested in later maturity is relatively low in palatability, so waste can be high and overall feeding value might be low. Second, tall fescue can be infected with an endophytic fungus that produces compounds that are harmful to pregnant mares. Endophyte infected tall fescue can cause prolonged gestation, difficulty foaling and decreased milk production. Unless tall fescue hay is known to be free of the toxic endophyte, it should not be fed to pregnant mares.

Some horse owners have concerns about feeding alfalfa hay. Allowing horses unlimited access to very high quality alfalfa hay may result in some digestive upset (such as diarrhea). Horses that have restricted exercise and low nutrient needs can also get too fat if too much high quality alfalfa hay is fed. Therefore, it may be necessary to restrict the amount of very high quality alfalfa that is fed to some horses; especially those with lower nutrient requirements. High quality alfalfa is most useful for horses with high nutrient requirements such as weanlings. Mid and late bloom alfalfa hay as well as alfalfa-grass mixes can be fed to most classes of horses.

Recent research suggests that alfalfa can be more beneficial to the equine digestive tract than some other hays. Many performance horses develop stomach ulcers. No one understands exactly why horses get stomach ulcers, but stress and diet have been proposed as the two most likely causes. A study at Texas A&M University examined the stomachs of horses in training that were receiving diets of forage and grain. When alfalfa was used as the forage, the incidence and severity of the stomach ulcers was less than when grass hay was used as the forage. This study supported an earlier experiment in Tennessee that suggested that a high concentrate diet that contained alfalfa hay was healthier for the stomach than a diet that utilized grass hay. These researchers have suggested that alfalfa might buffer stomach acid more effectively than grass hay because it is higher in calcium, protein and potassium.

Horse owners should be aware that alfalfa hay has been associated with a few problems in horses. Alfalfa hay that may be contaminated with blister beetles should not be fed to horses. Blister beetles contain a toxin that can be fatal to horses. In some parts of the U.S., a small percentage of horses fed alfalfa hay have developed intestinal stones. These "enteroliths" are composed of

magnesium and other minerals that collect around some type of small object. If an enterolith becomes large enough it can block the gastrointestinal tract and cause colic, and potentially death. Although enteroliths can occur, their incidence is quite low.

Consistency, Convenience and Cost

Horse owners want hay that looks, smells and feels the same from bale to bale and load to load. When the hay is consistent, the remainder of the feeding program can also remain relatively consistent. Dietary changes are a risk factor for colic, so feeding a consistent diet is usually considered a good management practice.

Convenience is also important to horse owners, especially to those who feed their own horses. One of the major factors affecting convenience is bale size. Small square bales are still preferred by many horse owners because they are easier to handle. Bales that weigh 50-60 lb can be managed by most horse owners, whereas bales that weigh more than 100 lb may be difficult to move easily.

Large round bales can be a convenient means of feeding hay to horses that are kept in pastures. Large round bales that are mold-free and have been stored inside can be used for horses. Round bales can become moldy in the field if they are not consumed rapidly; therefore, it is best if round bales are used for relatively large groups of horses that consume the bale in just a few days. One of the disadvantages of using round bales is that waste may be quite high. In addition, the horse owner must have the proper equipment to move the round bales and also to clean up the wasted hay in the feeding area.

Because many small horse operations do not have the trucks or trailers to move large amounts of hay, delivery service is often a major convenience. Some horse owners are willing to pay a higher price for the convenience of someone else delivering and stacking their hay! Conversely, some horse owners have limited storage space and the ability to pick up small amounts of hay at a time is important to them.

Cost is always a primary consideration for horse owners. Hay should be purchased on an equivalent weight basis. Comparing prices by the ton is easy; comparing prices "by the bale" is very difficult. Many horse owners do not appreciate that a relatively small increase in bale weight can compensate for a higher price per bale. If a 60 lb bale costs \$4.50; the hay costs 7.5 cents per pound. If a 50 lb bale costs \$4.00, the hay costs 8 cents per pound. Another way to look at it is to calculate the cost per ton for each hay...the 60 lb bale that costs \$4.50 will cost \$150/ton; whereas the 50 lb bale that costs \$4.00 will cost

\$160/ton. Which-ever way you choose to look at it, in this example the “cheaper” bale is really more expensive!

Hay cost should also be considered in the context to the total feeding program. Hay with low nutrient value might cost less per pound, but it could actually increase the cost of the total feeding program because more supplementation will be needed.

Where Can I Get Additional Information?

Alfalfa Hay: The High Quality Hay for Horses. Accessed on 1/15/09. Available at <http://www.alfalfa.org/pdf/Alfalfa%20for%20Horses%20Revised.pdf>

The Nutrient Requirements of Horses. National Research Council. 2007. National Academy Press, Washington DC

Southern Forages. Ball, D.M., C.S. Hoveland and G.D. Lacefield. 2002. PPI. Norcross Georgia

Gastric ulcer syndrome in exercising horses fed different types of hay. Lybbert, T., P. Gibbs, N. Cohen and D. Sigler. 2007. Proc. Equine Science Symposium. Baltimore, MD.

And visit the website for the University of Kentucky College of Agriculture!
www.ca.uky.edu

Strategies for Reducing Losses to Forage Related Disorders

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Forage induced disorders are not uncommon. These may be the result of poor harvesting and storage, symbiotic relationships with other organism such as endophyte-infected tall fescue, or environmentally induced. Poisonous plants can also be problematic when they are present in areas where cattle actively graze or forage is harvested. Yet, in many instances, problems are rare and often limited not affecting the entire herd. A primary management strategy is to ensure forage availability is not limiting forcing cattle to consume poisonous plants. Additionally, farming involves a given amount of management in all daily activities and one cannot simply ignore the fact that forages need to be managed.

Bloat

During the spring of 2010, it appeared as if all the moons and stars aligned perfectly resulting in above average clover concentrations in many pastures across the state. News of cattle losses due to bloat were increasing in frequency coincidentally during the spring grazing school that was being held in Princeton. Unfortunately, cattle losses to legume bloat are not predictable. If they were, one could identify susceptible animals and apply selective preventative management. Preventative management strategies that can reduce the severity of bloat exist and are presented below.

- A.) The simplest and first line of defense is as simple as looking down your nose. Monitoring grazed pastures provides one the opportunity to establish the level of risk. Visually estimating the amount of legumes in the pasture sward can help determine if cattle may be at high or low risk. As the percentage of legumes increase above 50% in the stand, the risk to bloat increases as selective grazing can result in cattle grazing predominately legumes. This pasture monitoring provides you the opportunity to implement proactive prevention management strategies.
- B.) Promoting grass growth by nitrogen fertility in the spring will promote grass growth. In most pasture situations, nitrogen fertility will stimulate

grass growth. This will increase the competitiveness of the grass reducing legume growth.

- C.) Allowing forages to mature can decrease the incidence of bloat. This is especially true for alfalfa as the leaf:stem ratio will decrease with maturity. As the plant matures, the plant will also have a greater degree of lignification lowering the digestibility. Waiting to graze clover pastures until the maturity plants have flowered has been suggested as a method to reduce the risk of bloat.
- D.) Avoid grazing legumes while plants are wet. If possible, avoid moving cattle to fresh legume pastures during the rain or while dew is still on the plants. Move cattle in the afternoons.
- E.) Avoid moving cattle to pastures high in legumes when hungry. Under rotational grazing scenarios, move cattle earlier in the rotation rather than forcing cattle to graze paddocks close. Also, moving cattle in mid-day allows for cattle to finish their early morning grazing bout. If needed, provide hay before moving ensuring cattle are not hungry when moved to legume pastures.
- F.) Feeding hay has been shown to reduce the incidence of bloat for cattle consuming alfalfa as well as cattle grazing winter wheat. This is a practical management strategy and hay should not be high in crude protein. High protein hay will provide additional soluble protein. Palatable, high quality grass hay is ideal. Cattle will consume hay even when grazing.
- G.) The use of feed additives can also be implemented as a preventative strategy. Poloxalene is the most common, FDA approved bloat prevention feed additive. Research has shown that it works by reducing both foam formation and disrupts foam stability. Most will opt for using the 33 1/3 lb blocks containing this product. It is important to note that using feed additives as a method to prevent legume-induced bloat requires daily consumption at the target levels. Since these blocks are of a size that allows for only 1-2 animals to be actively consuming the product at the same time, it is important that ample blocks be placed out for groups of grazing cattle. Manufacturer tags indicate the number of blocks placed in the field should be at least one per 5 animals. Though no label claim has been approved for preventing or reducing the severity of bloat, monensin has been demonstrated to reduce the incidence and severity of bloat in grazing cattle by several researchers. One limitation is that the use of monensin has not been approved for use in free-choice feeds or

minerals for beef cows and must be mixed in at least one pound of grain or supplemental feed.

- H.) Wilting legumes rather than feeding green chop also has been shown to reduce the incidence of bloat. Though this may not be practical, in situations where bloat cannot be kept under control, it is one more option.
- I.) Monitor cattle closely, especially late morning as cattle have a large grazing bout near sunrise. A large amount of fermentation will occur following consuming this forage and 4-6 hours following sunrise one might expect to see mild cases of bloat. Some bloat is not a bad thing, but cattle showing signs of bloat should be noted and closely monitored. Below is a bloat scoring table that can be utilized to help in recording the severity of bloat (Table 1).

Table 1. Bloat scoring system.	
Score	Description
0	No bloat – No distension in left paralumbar fossa
1	Slight – Slight distension in left paralumbar fossa; “puffy”
2	Mild – Marked distension in left paralumbar fossa; well rounded out between hip and rib on left side; little to no distension on right side
3	Moderate – Well rounded out on left side, drumlike; full on right side; restless
4	Severe – Both sides badly distended; left hip nearly hidden; skin tight; defecation; urination; incoordination; protruding anus; mild respiratory distress
5	Terminal – Extreme abdominal distention; severe respiratory distress; cyanosis; prostration; death unless treated

Adapted from Johnson et al., 1958.

Nitrates

There are a variety of forages that can accumulate nitrates. Often nitrate issues occur with cultivated crops during drought situations. Nitrogen fertilization of corn, oats, barley, wheat, rye, sorghum, sudangrass and hybrids followed by drought conditions results in accumulation of nitrates in the base of the plant.

Other plants typically classified as weeds can also pose a risk to nitrate toxicity. Johnsongrass is likely the most typical one and others include dock, nightshade, Jimson, pigweed, thistle, lambsquarter and others. This can be of concern during the periods of drought as low forage availability may result in cattle consuming plants they normally would avoid.

Low to moderate concentrations of nitrates are not toxic to cattle. It is actually the conversion of nitrates to nitrites in the rumen that results in a problem. Nitrites inhibit the hemoglobin's ability to bind and transport oxygen. Cattle have the ability to utilize and detoxify moderate levels of nitrates, especially if allowed to adapt over time. However, sudden exposure to forage high in nitrates overwhelm the animal's ability to detoxify these levels resulting in complications. Pregnant females exposed to high nitrates often abort a few weeks later as a result of a lack of oxygen delivered to the fetus.

During dry years and periods of drought, suspect forages should be sampled and tested for nitrate/nitrite concentrations. This is especially true of forages chopped such as corn silage and sorghum, sudangrass and hybrids. Following precipitation, nitrates are mobilized from the base of the plant and the risk is greater immediately following a rain. Laboratory results are often expressed as parts per million (ppm) of nitrates. Guidelines for using forages are presented in Table 2.

Levels of Nitrates	Comments
0 to 4,400 ppm	Safe to growing cattle, non-pregnant females. Caution is warranted for pregnant females and young animals at the upper levels.
4,400 to 8,800 ppm	Generally safe when fed in a balanced diet for growing cattle and non-pregnant females. For pregnant females limit to not more than half the daily ration. Be sure water does not contain excessive levels of nitrates and do not utilize non-protein nitrogen as a source of protein in the diet. Be cautious when feeding to pregnant and young stock.
8,800 to 15,000 ppm	Limit to 1/4 th of the diet. Diet should be balanced and provide enough fermentable carbohydrates to make use of the nitrates and ammonia. May impact milk production and fertility.
15,000 ppm or more	Considered TOXIC and should not be fed.

Prussic Acid

Hydrocyanic acid (HCN) or prussic acid is poisonous to cattle and is another forage related disorder that is often associated with hot, dry conditions. During normal growing conditions that allow for actively growing forages, cyanogenic glucosides are compartmentalized and isolated from enzymes (emulsion). However, during stress from drought or following frost, these molecules come into contact yielding prussic acid (dhurrin). Also, the action of mastication or chewing and breakdown of the plant cell structures releases the dhurrin and the bacteria begin to act on it releasing cyanide. The cyanide is then absorbed into the bloodstream. The cyanide does not hinder the ability to transport blood, but it prevents the uptake of oxygen. Hence, the oxygen of affected animals will be bright red.

Plants that are most likely be problematic include sorghums, johnsongrass, sorghum-sudan hybrids and sudangrass. One challenge with this disorder is that the younger plants and newer or younger leaves of plants are higher in HCN. Cattle are typically drawn to younger, more succulent plants as they are often more palatable. Downed cherry trees following a storm can also produce HCN and result in cattle losses if cattle are not excluded from areas with downed cherry trees. Fortunately, the HCN is metabolized and inactivated with time. The typical recommendation is to avoid grazing these areas for 10-14 days after which time the leaves are likely to be safe.

Because young plants pose a greater risk, avoid grazing the above mentioned plants until they are at least 18-24 inches tall. As with nitrates, one should avoid grazing or harvesting forages known to pose a risk for at least four days following precipitation. Avoid grazing following a frost for at least 7-10 days. Just as with bloat, if grazing areas that were of risk, cattle should not be turned in hungry and should be fed hay prior to entry. Because these forages may tiller and regrow during the active growing season, it is recommended that sorghums and the like be rotationally or strip grazed to prevent grazing of the new young shoots which are higher in HCN.

Pasture management is essential for a successful forage-based beef enterprise. Environmental conditions can increase the need for management to reduce the risk of livestock disorders. Proactive management strategies can reduce the impact of many forage related issues, but it is important to realize that it likely will not completely eliminate the risks. Contact your local county Extension office for additional resources and have a great conference.

Endophyte in Tall Fescue: Impact on Horses and Cattle

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Tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh.] is an introduced cool-season perennial grass from Europe. Originally imported for regularly flooded pastures, tall fescue is now widespread across the United States due to its adaptability of a wide range of soils and climate. Kentucky 31 tall fescue is the ecotype discovered in 1931 by E.N. Fergus, which launched its popularity as a dependable, adaptable, and palatable pasture crop. In the mid-1970s, the negative effects caused by consuming tall fescue were termed fescue toxicosis. The source of fescue toxicosis was not identified until Charles Bacon first reported evidence of an endophytic fungus in tall fescue. The endophytic fungus, later identified as *Neotyphodium coenophialum*, has a symbiotic relationship with tall fescue. Tall fescue provides nutrients for the endophyte, while *Neotyphodium coenophialum* produces toxic alkaloids that protect the plant from herbivory, diseases, and gives the plant its tolerance of many environmental stresses, including drought. The three main classes of alkaloids that potentially cause fescue toxicosis are ergot, pyrrolizidine (lolines), and pyrrolopyrazine (peramine) alkaloids (Schultz). Ergot alkaloids are made up of three families: ergopeptines, ergolines, and clavines. **Ergovaline**, an ergopeptine, is the primary alkaloid toxin affecting grazing mammals. *Neotyphodium coenophialum* does not change the appearance of the plant. Therefore, the endophyte is only detected by laboratory analysis. Endophyte-infected tall fescue spreads solely by seed. Due to the vast acreage of tall fescue, fescue toxicosis is the top toxicity problem of large animals in the United States.

Tall Fescue and Cattle

In beef cattle, endophyte infected tall fescue consumption can cause the following disorders:

Fescue Foot – Fescue foot is a dry, gangrenous condition of the body extremities of cattle consuming “wild” endophyte fescue. Usually it causes lameness and/or the loss of the tips of the tails or ears, but may result in sloughing of hooves or feet. Animal gains also are reduced. Fescue foot is generally associated with cold weather.

Bovine Fat Necrosis – This condition of cattle is caused by the presence of masses or hard fat in the abdominal cavities that can cause digestive or

calving problems. It usually occurs only where essentially pure wild endophyte fescue pastures have been heavily fertilized with poultry litter or nitrogen fertilizer.

Fescue Toxicity – Signs of fescue toxicity can include: (1) reduced feed intake; (2) decreased weight gain; (3) lower milk production; (4) higher respiration rate; (5) elevated body temperature; (6) rough hair coat; (7) more time spent in water and/or shade; (8) less time spent grazing; (9) low blood serum prolactin concentration; (10) excessive salivation; and (11) lower reproductive performance. Some or all of these responses have been observed with beef cattle, dairy cattle, sheep, and deer consuming pasture, greenchop, hay and/or seed.

Effects of Endophyte on Grazing, Intake, Digestibility and Gain in Cattle

Grazing Time - Several studies have shown that as endophyte infection level (the percentage of fescue plants in a stand that are infected) increases, animals spend less time grazing during the day and more time grazing at night. In Maryland, grazing time was reduced by about 20% as compared to steers grazing EF fescue (Table 1).

Table 1. Percentage of time steers grazed during daylight or dark hours.		
	Endophyte Level	
	Low%	High %
Daylight	52	34
Dark	14	22

Bond, J., J.B. Powell. and B.T. Weinland. 1984. Behavior of steers grazing several varieties of tall fescue during summer conditions. *Agron.* 7,76:707.

In a Georgia study in which steers were switched from EI (95% infected) to EF (<1% infected) fescue, steers on EF fescue spent about 60% of the time between noon and 6:00 p.m. grazing, as compared to only about 5% by steers on EI fescue. Steers switched to EI fescue showed a reduction in grazing time within two days, and forage intake for this group was depressed within one week. Forage intake for the group switched to EF fescue remained lower for at least 10 days following the

switch, but was normal after 28 days. However, grazing time for those switched to EF fescue was still reduced one month later.

Intake and Digestibility - On-farm observations and research have provided evidence that cattle prefer EF and novel endophyte fescue. In Tennessee, steers had a preference for clover in EI pastures, but there were indications that they preferred fescue to clover in EF pastures. When heifers in Missouri were offered diets containing 60% fescue seed, either EF or 75% EI, 11 of 12 heifers avoided the EI diets. Much, but not all, of the reduction in livestock average daily gain (ADG) or gain per unit area of land an EI fescue is due to reduced feed intake.

Normally, physical factors such as high fiber content of forage are associated with poor intake, but they do not explain intake differences between EI and EF fescue. Further, the toxins do not appear to have a major effect on microbial digestion in the rumens of grazing animals. Forage digestibility and crude protein levels are similar in EI and EF fescue.

Effects on Beef Yearling Gains

Since the early reports of the association of the endophyte with fescue toxicity, many grazing and feeding trials with EI and EF fescue have been conducted. A summary of data (Table 2), illustrates that decreased gains of steers grazing EI forage are widespread, quite uniform, and not limited to certain geographic areas or management conditions.

Location	Endophyte ¹		Daily Gain		Feed	Reference
	Low E	High E	Low E lb/day	High E lb/day		
Alabama	2	>90	1.83	0.99	Pasture	Hoveland et al., 1983
Arkansas	0	81	1.57	1.21	Pasture	Goetsch et al., 1988
Kentucky	<1	61	1.54	0.99	Pasture	Boling, 1985
Missouri	3	83	1.37	0.46	Pasture	Crawford et al., 1989
Oklahoma	<1	76	1.87	1.37	Pasture	McMurphy et al., 1990
Tennessee	2	71	1.48	1.06	Pasture	Chestnut et al., 1991
Virginia	0	77	1.43	0.90	Pasture	Tulley et al., 1989

¹Number of infected tillers per 100 tillers.
²Not reported.

Fescue toxicity is sometimes referred to as "summer syndrome" or "summer slump" because visible signs are most pronounced during hot weather. However, poor weight gains on EI pastures can occur throughout the grazing season. In an Alabama study (Table 3), during November, December, and March there was a 50% decrease in ADG of steers grazing EI fescue, as compared to EF fescue. During the warmer months of April, May and June, the decrease was 59%.

Factors affecting animal reaction to fungus toxins include air temperature, humidity, presence of other forages, animal management, and time of year (toxin levels are higher in spring and summer than at other times during the year). Though several factors affect reaction to the toxins, steer ADG typically decreases about: 0.1 lb for each 10% increase in infection rate.

In Georgia, grazing behavior of steers on EI and EF fescue pastures was similar in March. However, higher temperatures during April and June resulted in steers on EI fescue spending less time grazing, more time standing in the shade

(heat stressed animals normally stand to maximize evaporative cooling), and consuming more water than steers on EF fescue.

If forced to exert themselves physically during hot weather, animals suffering from severe fescue toxicity are at risk for heat overload that can result in death.

Increased nitrogen (N) fertilization increases the incidence of bovine fat necrosis, but investigations have revealed that N fertilization does not affect steer ADG on EI fescue (except indirectly by increasing the competitiveness of fescue, thus increasing the amount of toxic fescue in an animal's diet). However, N fertilization of EI fescue can increase gain per acre because of higher stocking rates.

Months	Endophyte		ADG Decrease
	~5%	>94%	
Nov., Dec., Mar.	1.59	.79	50%
Apr., May, June	1.72	.71	59%

Hoveland, C.S., S.P. Schmidt, C.C. King, Jr. and E.M. Clark. 1984 Association of fungal endophyte with seasonal gains of beef steers grazing tall fescue pasture. In: H. Riley and A.D. Skelvag (Ed.) Proc. Eur. Grassl. Fed. p. 382-386.

Effects on Beef Cows and Calves

Most fescue pasture in the United States is used in commercial beef cow-calf operations. In several studies (Table 4), cows grazing EI fescue lost weight and had lower pregnancy rates, and their nursing calves had slower gains and reduced weaning weights, compared to those grazing EF pastures.

Cows				Calves				Reference
Daily gain		Pregnancy rate		Daily gain		205-day wean wt		
Low	High	Low	High	Low	High	Low	High	
E	E	E	E	E	E	E	E	
lb/ day		%	%	lb/day		lb	lb	
1.01	-0.51	-- ¹	--	2.56	1.87	520	434	Schmidt et al.1983
0.46	-0.11	95	55	1.72	1.37	474	410	Gay et al.1988
0.44	-0.15	87	58	1.63	1.30	489	419	Essig et al.1989
0.09	-0.24	89 ²	74	1.61	1.28	--	--	Tucker et al. 1986b
0.79	-0.46	78	49	2.25	1.90	529	461	McDonald, 1989

¹Not determined or not reported Low E fescue was 21% INF vs. 77% for High E.
²Low E fescue was 21% INF vs. 77% for High E.

A decline in body condition can affect reproduction, and cows that are thin before and at calving may have a long interval between calving and first estrus. Therefore, cows entering the breeding season in a poor or negative gaining condition because of EI fescue probably will have a prolonged post-partum interval regardless of later endophyte effects. In Kentucky and

Missouri, supplementary feed (in the form of either clover or grain) for cattle on EI fescue improved pregnancy rates, but not up to economically acceptable levels. Thus, it appears that factors other than nutrition are involved in the reduced pregnancy rates associated with EI fescue.

Effects on Beef Heifers

In an Alabama study, weaned beef heifers were assigned to pastures having low, medium, or high levels of infection (Table 5), and received hay of similar infection levels during winter.

Table 5. Effect of endophyte-infected fescue on gains, pregnancy rates and milk yield of heifers.						
Endophyte Level %	Initial weight lb	Daily gains			Post-calving	
		Grazing lb/day	Winter lb/day	Pregnant %	Pregnant %	Milk produced lb/12 hr
0-5	562	1.65	0.18	0.96	0.93	8.16
25-60	560	1.26	0.35	0.82	0.45	7.05
80-99	591	0.75	1.19	0.55	0.33	3.97

Danielson, D.A., S.P. Schmidt, C.C. King, L.A. Smith and W.B. Webster. 1986. Fescue toxicity and reproduction in beef heifers. *J. Anim. Sci.* 63 (Suppl.1): 296 (Abstr.).
 Schmidt, S.P., D.A. Danielson, J.A. Holliman, H.W. Grimes and W.B. Webster. 1986. Fescue fungus suppresses growth and reproduction in replacement beef heifers. *Alabama Agric. Exp. Stn. Highlights Agric. Res.* 33(4):15

Heifer ADG decreased as infection level increased. All heifers were observed in estrus prior to their first breeding, but pregnancy rates decreased as infection level increased. Following first calf births, pregnancy rates were further reduced in heifers grazing pastures with medium and high infections levels, but not in those grazing low-endophyte pastures.

Initiation of the estrous cycle in heifers grazing EI fescue is not delayed, and cessation of the estrous cycle in animals already cycling does not occur. Research in Alabama indicates that conception in cattle is not affected by the endophyte. Reduced calving percentages of cattle on EI fescue appears to be due to early embryonic death.

Brahman vs. British Breeds of Cattle

Brahman cattle are known for their heat tolerance and may be better adapted to resist or tolerate the hyperthermia (high body temperature) observed during hot weather. In breed comparisons, Angus and Brahman- Angus cross steers have exhibited decreased gains when grazing EI fescue, but the magnitude of the decrease is less for the Brahman-cross steers. Brahman-cross animals frequently gain better due to greater heterosis, so reduced endophyte effects, if any, are difficult to detect.

Feedlot Gains of steers that Previously Grazed Fescue

Because of their unthrifty appearance, steers that have grazed fescue often bring reduced prices, making it important to determine whether there are carryover effects on feedlot performance. Studies in Georgia, Arkansas, Oklahoma, and Tennessee indicate that when steers grazed on EI fescue arrived at a feedlot during cooler weather, they gained faster than steers that had grazed EF fescue, especially during the first 28 days.

Steers arriving during hot weather did not show increased *gains*, but their gains were not reduced as a result of previous exposure to EI fescue. However, in a Georgia experiment, steers grazing endophyte-free fescue continued to show the same gain advantage over EI fescue in the feedlot as they did a pasture.

Effects on Milk Production

Consumption of EI fescue reduced milk production by as much as 45% in beef cows and 50% in beef heifers in Alabama, and by 60% in dairy cows in Kentucky. Milk production of lactating dairy cows can be sharply reduced even when fescue has low infection levels. Milk production by dairy cows consuming EF fescue was similar to those grazing alfalfa-orchardgrass in Kentucky and annual ryegrass in Alabama. Differences in milk production caused by consumption of toxic fescue appear to be primarily due to differences in forage intake.

Effects on Thermoregulation

Cattle consuming EI fescue typically exhibit hyperthermia (abnormally high body temperature) during warm weather as shown by increased rectal temperature. Studies in Kentucky have shown that EI fescue has the most detrimental effect on cattle when the ambient temperature exceeds 88°F.

In Alabama, steers were fed non-infected or infected hay and seed in controlled environments at 70°F (cool) and 90°F (hot). Feed intake was reduced 36% by steers fed the EI diets in the cool environment, but rectal temperatures and respiration rates were not affected. In the hot environment, feed intake was reduced 60% in steers fed the EI diet, and rectal temperatures and respiration rates increased.

In the cool environment, steers fed the EI diet had reduced temperatures at the body extremities (ear tips, tail tips, hooves). This hypothermia (reduced temperatures) in animals consuming EI fescue is most likely a result of vasoconstriction (constriction of the blood vessels) caused by the fungus toxins, and the reduced blood flow results in the fescue foot syndrome.

In a study in Georgia, body temperature of steers grazing EI fescue was higher in summer and colder in winter than those of animals grazing either EF or novel endophyte fescue.

Thus, it is clear that the toxins in EI fescue result in abnormal function of the thermoregulatory center in many animals. In warmer weather animals have difficulty eliminating heat from their bodies (evidenced by standing in shade or water, panting, etc.). Cold temperature results in natural restriction of blood flow in body extremities to minimize heat loss, but additional restriction caused by the fungus toxins reduced blood flow too much and may cause gangrene. Furthermore, when animal's body temperature is such that it makes it uncomfortable (hot or cold), it spends less time grazing and forage intake is reduced.

Tall Fescue and Horses

The most evident effects of equine fescue toxicity are apparent in pregnant mares. Monroe was the first to find conclusive evidence concerning pregnant mare tall fescue toxicity and reported increased gestation length, agalactia, foal and mare mortality, tough and thickened placentas, retained placentas, weak and dysmature foals, reduced serum prolactin levels and reduced progesterone levels. Other symptoms include abortions, decreased conception, early embryonic mortality, and dystocia. Studies found a general lack of elevated body temperatures, unlike fescue toxicity in cattle, but some studies reported increased sweating in pregnant mares. Since horses possess more sweat glands than cattle, evaporative cooling from sweating more freely regulates body temperature. Research has shown that toxicity symptoms appear in pregnant mares at ergovaline levels greater than 300 parts per billion (ppb). However, most extension publications suggest a more conservative level of 150 ppb. Tables 6 and 7 summarize historical research studies on fescue toxicity symptoms at various ergovaline concentrations. During the last trimester of pregnancy, scientists generally recommend mares be removed from endophyte-infected pastures to avoid serious complications.

Table 6. Summary of ergovaline research on mares during conception and the first trimester of pregnancy (first 110 days).	
Concentration of Ergovaline (ppb)	Symptom
45	No negative pregnancy outcomes
160	No clear signs of fescue toxicosis
271	No negative pregnancy outcomes
308	Weight loss Suppressed serum prolactin No adverse effects on pregnancy through day 28
325	Signs of fescue toxicosis
867	Decreased progesterone concentration No effect on embryonic development No pregnancies lost
1171	Significantly prolonged luteal function Decreased 14 day viable pregnancy rate per cycle Increased early embryonic death rates

Table 7. Summary of ergovaline research on mares during late term pregnancy (last 60-90 days).	
Concentration of Ergovaline (ppb)	Symptom
390	Dystocia with foal survivability greatly reduced Prolonged gestation No evidence of udder development nor lactation prior to and during parturition
300-500	Failure to come into heat Early-term abortions Prolonged gestation Retained placentas Difficult births Poor udder development with little or no lactation Poor foal survival

Unlike pregnant mares, little is known concerning the effects of fescue toxicity on stallions and geldings. Areas of interest for male horses include ergovaline retention and elimination, fertility, body temperature, growth and development, and nutrient digestibility. Schultz reported no effects of ergovaline on body weight, rectal temperature, serum enzymes and prolactin, nutrient digestibility, or alkaloid retention. However, geldings exposed to tall fescue for 20 days compared to 4 days did excrete more fecal ergovaline. Fayer-Hosken reported ergot alkaloids decreased ejaculate volume, but with no effects on sperm motility, number morphology, and sperm morphology. Spermatozoa counts may counteract the reduction of ejaculate volume, but further research is

needed to determine this hypothesis. Thomson researched the effects of bromocriptine on prolactin concentrations and gel-free semen volumes. Bromocriptine is a synthetic alkaloid similar to ergot alkaloids found in endophyte-infected tall fescue. Bromocriptine decreased the prolactin concentrations and prevented the increase in gel-free semen volume caused by sexual stimulation, but did not affect volume of gelatinous material, sperm concentration, motility, pH of gel-free semen, number of spermatozoa per ejaculate and prolactin concentration in gel-free semen.

Minimizing Fescue Toxicity with Cattle and Horses

Producers can adopt pasture management practices to reduce fescue toxicity complications including removing endophyte-infected tall fescue, planting endophyte-free or novel endophyte-infected tall fescue seed, diluting endophyte-infected tall fescue pastures, strategic mowing, and stockpiling infected tall fescue. Endophyte-free tall fescue pastures can persist in cooler temperature locations, like in the Pacific Northwest states, but without proper management endophyte-free pastures will not persist in the southeastern United States. As a result, researchers have developed novel endophytes, non-ergot alkaloid-producing endophytes, to incorporate into endophyte-free tall fescue. The novel endophytes provide stress tolerance, including insect and disease resistance and drought tolerance, without producing harmful ergot alkaloids. Novel endophyte varieties have been researched and patented and are available for purchase. Herbicides are also commercially available to remove fescue in pastures. For instance, imazapic is a herbicide that kills tall fescue, but does not harm Kentucky bluegrass and orchardgrass. Another option is to dilute concentrations of toxic fescue in pastures by overseeding other grasses and legumes. Ergovaline concentrations are the highest within the seedheads of the endophyte-infected tall fescue. Therefore, strategic mowing of the infected pastures to prevent seed development can reduce the risk of a spike in toxicity levels.

For more detailed information on these topics and for a complete set of references refer to the publications listed below:

Tall Fescue Endophyte Concepts

Tall Fescue Toxicity for Horses: Literature Review and Kentucky's Successful Pasture Evaluation Program

These publications and others can be found on the University of Kentucky Forage website: <http://www.uky.edu/Ag/Forage/> by clicking on "Forage Publications" in the middle of the screen.

Controlling Weeds in Horse and Cattle Pastures

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Weed control is one of the most talked about concerns of forage-animal systems. Producers will sometimes pay more attention to some pests than others and more so in some crops than others. For example, a producer may have a very low threshold for weed infestation in their corn, soybean or tobacco field but will have a very high tolerance for weeds in their pastures. This is usually because the “direct” dollar value of the forage is not seen while we can “see” how a reduction in soybean or corn yield will affect the bottom line of our operation. Vegetation manipulation is the only practical way to increase forage for livestock and to improve wildlife habitat on some grasslands (Holechek et al., 2004) especially when land prices prohibit the acquisition of more acreage.

Horses tend to graze plants closer to the ground than cattle and this can leave openings for weeds to establish themselves. Horses also tend to re-graze an area or spot graze more so than cattle so care must be taken to manage the grazing of horses versus cattle in a pasture. When forage production is limited and animals are hungry, they will eat plants that they would not otherwise eat. Some weeds are more palatable at certain growth stages (young), after herbicide application, or if animals have access to wilted leaves (Ball et al. 2002); nevertheless, weeds tend to reduce the palatability, quality, quantity, and stand life of desirable forage crops (Green and Martin, 1998). Differences in intake due to palatability is important because it can be the difference in milk or meat yield from animals and could also be because other less desirable plants (weeds) are mixed in with the forage. Weedy plants, generally, are not high yielding and are not usually desirable by livestock or have high quality. Forage quality of weeds rapidly declines with maturity and weeds become completely unacceptable to livestock, thus leaving a visible weedy look to your pasture. Weeds are “passive opportunists” that will fill the gap left by dead or overgrazed forage plants (Barnes et al. 2003) but some species can be very aggressive and choke out your desired forage. Therefore, it is important to consider implementing **appropriate** weed control strategies when needed.

It has been well documented that forage yield can be significantly affected in pasture and rangeland (Grekul and Bork, 2004; Gylling and Arnold, 1983; Reece and Wilson, 1983; Sheeley et al, 2000) if steps are not taken to manage the weeds. Grekul and Bork (2004) found that for every 1 pound of Canada thistle, there is a correlation of approximately 1 pound loss of forage production

and you could lose approximately 4 pounds of forage per acre for every Canada thistle plant in a 10 ft² area. Controlling certain weeds can lead to substantial increased in forage production as demonstrated by Reece and Wilson (1983) who found forage production increased 110 to 314% during a three year period by controlling mixed stands of musk and Canada thistle. In Montana, Sheley et al. (2000) found that controlling spotted knapweed increased perennial grass biomass 280-750% compared to the untreated areas up to 3 years after application. Herbicide-treated plots had greater biomass 3 years after treatment and that grass competition may help explain the long term control of spotted weed. In addition to reducing forage yield, weeds can also impact livestock access to forages. Bull and musk thistle reduced the amount of forage utilized, 42 and 72%, respectively, in beef cattle, and sheep grazed hill country pastures in New Zealand (Seefeldt et al, 2005).

Weed Management Strategies: It is prudent to use a variety of measures to be most successful. University of Kentucky Extension Publication AGR-172 (Weed Management in Grass Pasture, Hayfields, and other Farmstead Sites) is an excellent resource to get more detailed information. Some examples of herbicides labeled for use in permanent grass pastures and the approximate cost as well as the cost of mowing is presented in Table 1 which is from AGR-172.

Biological Methods: Biological control is more effective on some weeds than others. If you choose this option you should expect a delay in control as the control agent gets established and multiplies. Contact your local extension offices for more information on bio control agents that are available in your area.

Cultural Methods: This includes the crop management decisions and practices that are employed in the production system. Examples include:

- **Variety selection:** Select certified, vigorous, adapted varieties that will grow quickly in the early season to provide competition against weeds.
- **Crop rotation:** In forage production systems, yearly rotations do not normally occur but we may notice different weed problems if you go from a grass hayfield or pasture to an alfalfa hayfield or pasture and vice versa.
- **Use weed free seed:** Cheap seed may not be so cheap after all. Use certified seed that is free of noxious and other weeds. The seed label will provide information about the content of weed seed. You can visit http://invader.dbs.umt.edu/Noxious_Weeds/default.htm to find out what weeds are considered noxious weeds in your state.

- **Changing planting and harvesting date:** In some instances, crops will be able to germinate and grow earlier in the season than many weeds will. This early planting date will give crops an early start on the weeds. Keep in mind however, that some weeds like chickweed and henbit are winter annuals and will be actively growing early in the spring if that is when you plan to plant your crop or if you did a fall planting.
- **Field scouting:** This can be done in conjunction with other activities such as moving animals or fences, while putting out feed or minerals or while mowing. Once a weed problem is identified, whatever treatment option you choose, **DO NOT DELAY TREATMENT**. Delaying will only worsen the weed problem as the weed will likely get to a reproductive stage and reproduce.

Mowing or clipping: This is more effective when used in conjunction with other methods of control. Keep in mind that mowing is not selective and you will be mowing your desirable forage as well as the weeds. When weeds are mowed frequently it can reduce seed production and deplete food reserves in the root because they will not have enough time to replenish them before they are cut again. Low root reserves lead to slow growth and forage crops can then out-compete weeds. Some weeds can alter their growth habit if mowed frequently. For example, upright growing spiny amaranth or pigweed can change to a creeping growth habit if mowed frequently.

Chemical methods: If your pastures are pure stands of grass, it is very easy to use a selective herbicide to control broadleaf weeds. However, when the situation in question involves legume-grass mixtures, you will not successfully control broadleaf weeds without significantly injuring or killing your legumes. Legumes can usually be inter-seeded into a pasture up to a year after the herbicide application depending on what herbicide you used. Any decision to use herbicides should be prefaced by first determining which weeds are present in the area to be treated and the best time/stage to treat them. Using the right herbicide at the right time, right rate and with a properly calibrated sprayer can save you time and money. Herbicides are usually selective only within certain rates, environmental conditions, and methods of application. Foliar-active herbicides are applied directly to the leaves or stems of plants where they are absorbed and translocated in the plant. For control of established weeds, including perennial plants, herbicides that are translocated within the plant prevent regrowth. These herbicides may or may not remain active once moved into the soil. Soil-active herbicides can provide control of germinating seed and may also be absorbed by the roots or inhibit root growth of established plants.

Plant response to herbicide treatment is typically dependent on the growth characteristics of the target plant (Sosebee, 1983). *Annual plants are best*

treated with herbicide when actively growing and before changing from the vegetative to reproductive stage. Biennials should be treated when in the rosette stage of development. Simple perennial plants and non-sprouting woody plants, perennial plants that reproduce solely by seed, are best treated during the late vegetative through flowering stages of development, but before fruit set. Creeping perennials, plants that reproduce both by seed and vegetative means, should be treated after flowering and fruiting are complete or when carbohydrates within storage organs below-ground are being replenished. Herbicide effectiveness declines when vegetative growth ceases and reproduction begins. Sprouting woody plants, arguably the most difficult class of plants to control should be treated when energy reserves in the roots are being replenished and the herbicide can be translocated below-ground.

Six tips for cost –effective weed control

- Identify the weed problem – you need to know what it is before you can plan a control strategy
- Use a calibrated sprayer – this prevents the under- or over-application of a herbicide and can reduce cost
- Spray at the right time, at the right rate, with the right herbicide
- Recognize that drought stressed or mature weeds will be more difficult to control
- **Read and follow all label directions for proper use including handling, mixing and applying the herbicide.**

Table 1. Herbicides labeled for use in permanent grass and approximate costs. **Note these costs reflect costs at the time of preparing this article and are not current.**

Herbicide	Rate	Estimated Cost/Acre*	Type of Weeds Controlled
Cimarron	0.1 to 0.4 oz/A	\$2.30 - \$9.20	Selected broadleaf weeds and certain woody plants. Temporary growth suppression of tall fescue or other pasture grasses may occur.
Cimarron MAX	Co-Pak	\$7.50 - \$15.00	Herbaceous broadleaf weeds. Temporary growth suppression of tall fescue or other pasture grasses may occur.
Crossbow	1 to 2 qt/A	\$15.00 - \$30.00	Woody brush and broadleaf weeds.
2,4-D Ester/Amine (3.8 lb ae/gal. formulations)	1 to 2 qt/A	\$3.75 - \$7.50	Herbaceous broadleaf weeds.
Dicamba (Banvel, Clarity, etc.)	0.5 to 2 pt/A	\$5.50 - \$22.00	Broadleaf weeds and woody brush.
ForeFront R&P	1.5 to 2.6 pt/A	\$10.50 - \$18.20	Herbaceous broadleaf weeds.
Milestone	3 to 7 fl. oz/A	\$8.25 - \$19.25	Herbaceous broadleaf weeds.
Overdrive	4 to 8 oz/A	\$12.50 - \$25.00	Herbaceous broadleaf weeds.
PastureGard	1.5 to 4 pt/A	\$10.50 - \$28.00	Woody brush and broadleaf weeds.
Redeem R&P	1.5 to 4 pt/A	\$20.60 - \$55.00	Herbaceous broadleaf weeds.
Weedmaster/Banvel + 2,4-D	2 to 4 pt/A	\$7.00 - \$14.00	Broadleaf weeds and woody brush.
MOWING		\$12.00 - \$18.00	Broadleaf weeds, weedy grasses, and small brush.

* The estimated cost (\$/A) does not represent the use of spray additives or the cost for application.

Source: AGR 172- University of Kentucky – Green et al. Weed Management in Grass Pasture, Hayfields, and other Farmstead Sites

Brush Management: Slowing the pace of brush encroachment into pastures is a challenge to land managers. A critical need is to determine what set of conditions or series of events are responsible for the invasion of pastures by woody species. Often the woody plant movement into pastures and subsequent expansion has been favored by overgrazing or neglect of a pasture. Overgrazing reduces vigor of forage species and decreases their ability to suppress encroaching woody species.

Before a brush management strategy can be developed it is important to **assess the means of regeneration or reproduction**. Woody species can be classified as those that reproduce only by seed and those that reproduce by seed and vegetative propagation from buds located on the root or crown of the parent plant. For example, when the main stem of honey locust is removed, buds located on the crown produce stems that enable the plant to persist. Thorny brush species like multiflora rose, honey locust, and blackberry can disrupt grazing patterns, and injure animals, landowners and workers as well as affect forage availability.

Brush Control Measures: As with herbaceous weeds, biological, mechanical, cultural, and chemical control measures are available to manage brush in pastures. Herbicides can be broadcast applied aerially, by ground equipment (tractors or ATV), or by backpack sprayer. Where the targeted brush stands are tall and/or dense aerial application may be most suitable. Use of application technology that reduces drift potential is important. Spray volumes should be no less than 5 gallons per acre. With ground spray equipment, keeping the spray

boom as low as possible without disrupting the desired spray pattern could reduce spray drift. Total spray delivery volume of 20 gallons per acre will also reduce drift potential and increase coverage of the targeted brush species.

Individual Plant Treatment (Spot Treatment) Techniques: Individual plant treatment can be an efficient, cost-effective alternative to broadcast applications to control brush, shrubs, or vines. Individual plant treatments include spot applied concentrate, high volume foliar, low volume basal, and cut-stump applications.

Summary

Integrating biological, cultural, mechanical, and chemical control methods in the proper sequence and combination will improve the efficiency and effectiveness of weed management. Your best weapon against weeds is a vigorous stand of productive forage. It is important to note that chemical weed control is a tool that should be used when the situation warrants and it is not as an answer for all situations. Whenever herbicides are used, ALWAYS read and follow all label directions for the product. Weaknesses in pasture management strategies must be identified before long-term improvements can be made following weed control. The cost of any potential treatment should be weighed against its potential success and effect on the forage system. While options like mowing may provide some control/suppression of weeds, the per acre cost compared to using chemicals is usually higher and total control is not as long-lasting.

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