Utilizing Forages in Texas

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Forage and forage-based livestock production enterprises are big business in the US. Latest available USDA statistics (1998) indicate that hay harvested in the US was worth approximately $11.7 billion. This made hay third in overall value among agricultural crops grown in the US. Only corn ($19 billion) and soybeans ($14 billion) exceeded the value of hay (Table 1). The value of all cows and calves in 1999 was estimated at approximately $59 billion with the gross income from beef cattle during 1997 estimated at approximately $36 billion.

Table 1. Value of commodities produced in the US. Source: USDA National Agricultural Statistic Service.

Commodity	Value[1] ($)
Barley	663,773,000
Corn	19,092,590,000
Cotton	4,321,585,000
Cows and calves	36,414,317,000
Rice	1,617,984,000
Rye	29,879,000
Soybeans	14,659,646,000
Sugarbeets, sugarcane	2,050,286,000
Tobacco	2,808,636,000
Wheat	6,931,996,000

[1] All values are based on 1998 statistics except for cows and calves (1999) and sugarbeets and sugarcane (1997).

Approximately 36% of the total cowherd is contained in the 13 southern states (Table 2). Likewise, much of the hay produced also comes from these same states. It should be obvious, then, that forages play a major role in the economies of these states. While warm-season grasses provide the base on which most operations are based, cool-season forages also play a significant role in both cow-calf and stocker calf production systems. Below is a brief discussion of the main species adapted for use as hay crops or grazeable forages in the South.

Table 2. States comprising the US southern region, estimated number of cows and calves, and their estimated value. Source: USDA National Agricultural Statistic Service.

State	Number of head	Value ($)
Alabama	1,500,000	690,000,000
Arkansas	1,820,000	855,400,000
Florida	1,800,000	936,000,000
Georgia	1,300,000	676,000,000
Kentucky	2,420,000	1,185,800,000
Louisiana	900,000	468,000,000
Mississippi	1,160,000	533,600,000
North Carolina	980,000	470,400,000
Oklahoma	5,200,000	2,652,000,000
South Carolina	480,000	240,000,000
Tennessee	2,180,000	1,024,600,000
Texas	14,000,000	7,000,000,000
Virginia	1,700,000	816,000,000
US Total	98,521,500	58,560,210,000

Warm-season Forages

Bahiagrass: Bahiagrass (*Paspalum notatum*) is a warm-season perennial bunch grass native to South America. The first introduction to the US occurred in 1913 with common bahiagrass by the Florida Agricultural Experiment Station. In 1935, Escambia County Extension Agent Ed Finlayson found a more productive bahiagrass growing along the docks and railroad tracks at Pensacola, FL. This variety became known as 'Pensacola' and has been the most widely used of all the varieties to date. A more recent release from the USDA-ARS station at Tifton, GA, 'Tifton 9' has exhibited increased seedling vigor and usually higher dry matter production compared with Pensacola.

Bahiagrass has several characteristics that make it valuable as a pasture grass. Bahiagrass

grows on a wider range of soils than does bermudagrass or dallisgrass. Compared with hybrid bermudagrass, bahiagrass tends to green up earlier and remain green longer in the fall, but lacks the drought tolerance of the bermudagrass on deep sandy soils. Bahiagrass is resistant to weed encroachment due to an extremely thick thatch formed and tolerates close, continuous grazing better than most other grasses. The species also produces moderate levels of dry matter on soils of very low fertility and, finally, is established from seed.

Suitable soil types range from upland sandy sites (which may suffer during summer drought) to more poorly drained sandy areas. When establishing bahiagrass, seed should be broadcast onto a well-prepared seedbed at 12 to 15 lbs of pure live seed per acre, covered with no more than ½ inch of soil, and rolled to ensure good seed-soil contact. Higher seeding rates can help to quicken establishment. Establishment usually takes place in the spring after the last chance of a killing frost has occurred. Although the optimum temperature range for bahiagrass seed germination is 85 to 95°F, weed pressure is greater with later plantings and the relatively weak bahiagrass seedlings are at a competitive disadvantage. Apply any needed P and K and the least amount of N possible at planting. N will only serve to encourage weed competition. After the grass begins to cover, 40-60 lbs/ac of additional N may be used. Early weed management involves mowing or limited grazing. 2,4-D herbicide may be used only after the grass reaches 5-6" in height; use of phenoxy herbicides prior to this stage may kill or injure the grass seedling. Once bahiagrass reaches a thick, solid stand, weeds are seldom a problem. Ideally, bahiagrass should be fertilized according to soil test recommendations, although even minimal amounts of N, P, and K will serve to increase dry matter production and crude protein content.

Bahiagrass should primarily be used for pasture, although some is harvested and conserved as hay. Producers used to harvesting bermudagrass hay should realize bahiagrass should be cut at a much lower plant height (8-10") if high levels of forage nutritive value are desired. If bahiagrass is cut for hay, it is critical to apply appropriate N, P, and K based on soil test recommendations due to the removal of nutrients from the site. Given similar levels of fertility, hybrid bermudagrass will usually provide more dry matter production and higher levels of crude protein and digestibility (Table 3). Under low levels of fertility or no fertility, bahiagrass, however, can persist for many years in relatively pure stands. Forage nutritive value is usually adequate for mature beef animals, but growing animal performance will suffer if an appropriate supplement is not provided.

Table 3. Forage nutritive value of bahiagrass, bermudagrass, and mixed warm-season grass hay.[1]

Hay Type	Crude Protein	Total Digestible Nutrients	Acid Detergent Fiber
	----------% DM----------		
Bahiagrass	8.3	50.0	44.2
Bermudagrass	10.7	54.4	40.4
Mixed grass	9.3	50.7	43.1

[1] Louisiana State University

To maximize use of the pasture and to help reduce winter feeding costs, overseeding bahiagrass with a legume, cereal grain, or ryegrass may be advisable. In the past producers have perceived it difficult to establish cool-season pasture in bahiagrass. This is generally due to the thick thatch of rhizomes produced by bahiagrass. In order to reduce bahiagrass competition, the pasture should be grazed close and lightly disked. Clover or ryegrass seed should be broadcast sometime in mid October. If using a cereal grain, a drill should be used to place the seed deeper. Note that although bahiagrass can perform under low fertility programs, winter pasture species will not. Fertilizer should be applied at the recommended rate based on soil test.

Although bahiagrass has many positive characteristics as a pasture grass, it has its share of problems. Because the species can persist under lower fertility environments, many producers have witnessed an invasion of bahiagrass into their bermudagrass fields. This

is usually because fertility is less than optimum for the bermudagrass to prevent establishment of the bahiagrass. Once present, bahiagrass tends to remain and even become dominant in bermudagrass fields. Generally, 3/10 oz of the herbicide Ally is required to eliminate mature plants. Without a change in fertility or grazing management, bahiagrass generally will return from seed in the soil the following year.

Bahiagrass establishment is slow and the species responds poorly to N fertilizer rates above 100 lbs/ac. Lower dry matter production compared with hybrid bermudagrass can create a need to decrease stocking rate. Likewise, lower forage nutritive value decreases animal performance. These situations reduce the potential for profit for those attempting to maximize production per unit area of land.

To summarize, bahiagrass has a bad reputation, but only when compared with *well-managed* bermudagrass. Under more realistic circumstances of lower fertility and continuously stocked cowherds, bahiagrass may not be so bad as a pasture grass. Depending on the goals and objectives for your particular property, bahiagrass may deserve more respect than it has received in the past. Below are the most common bahiagrass varieties usually encountered.

Bermudagrass: Bermudagrass (*Cynodon dactylon*) probably originated in southeast Africa. The earliest mention of bermudagrass comes from the diary of Thomas Spalding, owner of Sapeloe Island, Georgia and a prominent antebellum agriculturalist. Found in his diary was the following entry: "*Bermudagrass was brought to Savannah in 1751 by Governor Henry Ellis*." He went on to say that "*If ever this becomes a grazing country it must be through the instrumentality of this grass*." Writers as early as 1807 referred to bermudagrass as one of the most important grasses in the South at the time. Thus, bermudagrass has been a part of southern agriculture for at least 250 years. Hybrid bermudagrass with improved productive capability and nutritive value has played an important role in livestock production across the southern US for nearly 60 years with the introduction of 'Coastal' in 1943.

Bermudagrass is a warm-season perennial grass that spreads mainly by rhizomes (underground stems) and stolons (horizontal aboveground stems). The grass tolerates a wide range of soil types and soil pH values, thus making it adapted to most of the southern US. Limited cold tolerance in early common and hybrid cultivars of bermudagrass led to the release of several cold-tolerant varieties, thus providing useful warm-season perennial grasses for the warm-season, cool-season transition areas of the US, including Oklahoma, Arkansas, Missouri, and Tennessee.

Bermudagrass is generally planted on a well-prepared seedbed with sprigs (stolons and rhizomes) of hybrid varieties at 25-40 bushels of sprigs per acre. Seeded varieties are generally seeded at 8-10 lbs seed per acre. An initial soil test will indicate whether P or lime is required. If so, these nutrients should be incorporated into the seedbed prior to planting.

Sprigs should be fresh and planted the same day they are dug. Sprigs should be planted 1-2" deep, while seed should be planted no more than ¼". Rolling helps to ensure good sprig- or seed-soil contact and good establishment. One quart of 2,4-D low volatile ester or 1-2 quarts of Weedmaster should be applied per acre the day of planting to minimize broadleaf weed problems.

When new growth is noticed, 40-50 lbs N/ac should be applied along with the recommended K. When stolons begin to develop, another 40-50 lbs N/ac plus ½ the recommended K should be applied.

Although capable of high production, bermudagrass must be well fertilized to reach its production capability (Table 4). Given adequate moisture, N is usually the most limiting factor to forage production, but appropriate levels of P and K are critical to yield and persistence. Adequate pH is also important in maintaining a vigorous stand of bermudagrass. Inadequate levels of N not only limit bermudagrass dry matter production, but also reduces crude protein levels. Less than optimum bermudagrass growth can also invite weed infestation, thus

Table 4. Coastal bermudagrass dry matter (DM) yield as affected by fertilizer and broiler litter application rate.[1]

Application rate (lbs/ac)	DM 1992 (lbs/ac)	DM 1993 (lbs/ac)
N-P_2O_5-K_2O (lbs/ac)		
0-0-0	4780	4050
100-33-67	7140	6450
200-67-134	8680	8290
400-134-268	9640	10460
Poultry litter (tons/ac)		
2 SPR + 2 SUM[2]	7580	6930
4 SPR	8320	7450
4 SPR + 4 SUM	8850	7840
8 SPR	9810	9270

[1] Evers, 1998

[2] SPR is late spring and SUM is mid-summer.

reducing carrying capacity and increasing input costs. Careful attention to soil fertility, beginning with an **annual soil test** to determine the soil nutrient status is necessary to ensure good bermudagrass growth, disease resistance, and cold tolerance.

Besides providing good nutrition for cows during the growing season, bermudagrass is harvested and conserved extensively as hay for livestock winter feeding programs. The use of hay is generally an expensive way to winter cattle. In fact, the average 1000-lb round bale of bermudagrass costs the producer approximately $35.00 to harvest, bale, haul, store, and haul again to the feeding area. Regardless of the cost involved, however, bermudagrass hay production is a popular practice across most of the South.

Hay production is severe service for both soil and grass since nutrients are continually mined from the soil. Many soils test low and very low in P and/or K. Typical fertilizer strategies may involve limited application of these nutrients, but generally nitrogen only is applied under the false impression that it is the only nutrient bermudagrass requires. Nothing could be further from the truth! It takes all of the nutrients in appropriate amounts for bermudagrass to produce the high yields it is known for.

Think of the hay harvest as a checkbook with a low account balance. If a check is written, but no deposit made to cover the check, the account will be overdrawn in short order. If, however, a deposit is made to cover each check written, the account balance will not decrease. In the same manner, each hay harvest represents a check written on an account that is already low in phosphorus and/or potassium. A typical 2-ton hay harvest from bermudagrass removes approximately 100 lbs N, 30 lbs P_2O_5, and 80-100 lbs K_2O. If the soil test for P and/or K is low or very low, consider returning this level of nutrients back to the hay field after each harvest. This helps to minimize continued mining of the soil at the site. Another option would be to rotate hay fields in and out of production and allow certain fields to be grazed for a few years before harvesting hay again. This practice would allow grazing animals to return P and K to the soil via urine and feces.

Non-traditional methods of bermudagrass use may also help reduce winter feeding costs. These uses include the use of standing or "stockpiled" bermudagrass for fall and early winter grazing and overseeding bermudagrass swards with cool-season annual forages such as small grains, ryegrass, and clover to provide late winter and spring grazing. The combined use of stockpiled bermudagrass and overseeded ryegrass can reduce winter feeding costs by $50-60 per cow per winter.

Warm-season perennial grasses such as bermudagrass generally have lower nutritive value compared to warm-season annuals or cool-season forages. With a sound fertility practice (Table 5), however, and careful attention to stage of maturity at harvest (Table 6), bermudagrass can provide forage of good to excellent nutritive value. Bermudagrass is the most important warm-season grass forage in the South and will likely continue to be throughout this century. Below is a short description of several popular bermudagrass varieties currently used in the South.

Alicia: Cecil Greer of Edna, Texas selected Alicia. It was reportedly selected from bermudagrass collected in Africa in 1955. Franchise growers sold cuttings of aboveground

material (tops) for the establishing of Alicia. It spreads primarily by stolons and has fewer rhizomes than Coastal and is usually not as productive as Coastal (Table 7). It is usually propagated by cuttings rather than by sprigs. Under moderate to heavy grazing and fairly severe winters it's recovery in the spring has been slow. The forage nutritive value of Alicia is lower than Coastal. Alicia is not as winter-hardy as Coastal and is susceptible to rust.

Table 5. Coastal bermudagrass crude protein (CP) content as affected by fertilizer and broiler litter application rate.[1]

	CP (% DM)									
	1992					1993				
Application rate (lbs/ac)	June 11	July 9	Aug 6	Sept 8	Oct 7	May 7	June 17	July 19	Aug 23	Sept 22
N-P_2O_5-K_2O (lbs/ac)										
0-0-0	11.2	9.4	9.8	10.0	8.9	11.5	9.4	6.6	8.9	8.1
100-33-67	13.2	10.1	13.1	11.8	9.0	19.8	8.5	9.3	9.5	9.3
200-67-134	14.2	11.2	15.0	14.6	11.5	20.3	9.8	11.7	10.0	10.3
400-134-268	16.8	13.1	16.9	16.4	14.3	21.8	14.3	12.8	11.1	12.9
Poultry litter (tons/ac)										
2 SPR + 2 SUM[2]	13.0	10.4	13.0	11.9	9.4	13.7	10.4	7.8	10.1	10.0
4 SPR	13.4	10.5	10.2	10.7	8.8	18.1	10.0	7.0	9.8	10.3
4 SPR + 4 SUM	13.8	11.3	15.5	14.2	9.6	17.0	11.7	10.1	10.9	11.8
8 SPR	15.9	13.8	13.1	12.5	10.1	22.3	14.3	9.5	9.5	10.6

[1] Evers, 1998
[2] SPR is late spring and SUM is mid-summer.

Callie: Callie was selected as an aberrant plant in an old plot of bermudagrass plant introductions at Mississippi State University in 1966 from a plant introduced from Africa. Callie is a robust grass with large stolons, wide leaves and a tall growth habit that establishes rapidly the first year. It produces dry matter yields about equal to Coastal and gives good animal gains when free of rust. Callie produces a ground cover consisting of an open type sod. Because of the open sod, spring recovery may be slower than Coastal. Callie is not as cold tolerant as Coastal and is extremely susceptible to rust, which reduces forage yield and nutritive value.

Cheyenne: Cheyenne is a cross between a bermudagrass from an old turf site in the Pacific Northwest and another plant from former Yugoslavia. Jacklin Seed Company and Pennington Seed developed and released this cultivar in 1989. Like common bermudagrass, Cheyenne is established using seed. Cheyenne has produced the least dry matter yield of the seeded bermudagrasses in a 3-year evaluation trial at Overton.

Table 6. Effect of clipping frequency on yield and nutritive value of 'Coastal' bermudagrass hay.[1]

Clipping Interval (wk)	DM Yield (tons/ac)	Leaf (%)	Crude Protein (%)	Lignin (%)
1	6.3	---	21.4	…
2	7.8	87.6	20.8	9.4
3	8.6	81.3	18.8	9.6
4	9.7	74.8	17.0	10.3
6	12.6	57.7	13.8	11.2
8	12.5	51.4	12.2	12.0

[1] Burton and Hanna, 1995

Common: A highly variable cultivar in appearance that responds favorably to good management in East Texas. Common may be found growing under almost every conceivable condition throughout the bermudagrass-growing region. It can be considered a forage grass, a turf grass or a noxious weed. Because of the long experience with common, it is often used as a standard for evaluating new material. Common dry matter yields are generally about

1/3 lower than Coastal with the forage nutritive value being about the same.

Table 7. Annual and average yield (lbs DM/ac) of selected bermudagrasses.[1]

	Variety			
Year	Coastal	Coastcross-1	Alicia	Common
1971	5985	8443	6309	2751
1972	16459	18808	19033	14015
1973	15121	18806	13290	11816
1974	12849	13805	12711	9316
1975	19320	15761	15540	13443
1976	15773	14809	12960	11591
1977	14839	9583	11317	9977
Average	**14335**	**14288**	**13023**	**10416**

[1] Eichhorn et al., Homer, LA. Annual fertilization = 500 lbs N, 150 lbs P_2O_5, 300 lbs K_2O.

Coastal: A hybrid between Tift bermudagrass, a vigorous growing bermudagrass found in an old field near Tifton, Georgia, and an introduction from South Africa. Coastal is a result of an extensive breeding program by Glen Burton, USDA-ARS, Georgia Coastal Plains Experiment Station at Tifton, GA, and was released as a variety by that station in 1943. Coastal is a highly productive bermudagrass producing both rhizomes and stolons and is adapted to a wide range of climatic conditions. It has exceptional longevity, readily responds to fertility and irrigation, and possesses better drought tolerance than common. Coastal is also tolerant of heavy grazing pressure or frequent and close defoliation. Coastal is the most widely planted bermudagrass in Texas.

Coastcross-1: Coastcross-1 was developed by crossing Coastal and a plant introduction from Kenya, Africa and released by the Georgia Coastal Plains Station in 1967 from the breeding program of Dr. Glen Burton. Coastcross-1 grows taller and has broader, softer leaves than Coastal. It is highly resistant foliage diseases. Coastcross-1 spreads rapidly from stolons, but produces few rhizomes. Coastcross-1 produces about the same dry matter yield as Coastal (Tables 7&8), but is 11-12% higher in digestibility. Although Coastcross-1 produces more fall growth, it does not have the winter tolerance of Coastal. Its lack of cold tolerance limits it to the lower bermudagrass growing region.

Texas Tough: Texas Tough is a mixture of seeded bermudagrass blended and sold by East Texas Seed Company of Tyler, TX. The blend consists of 1/3 Giant and 2/3 common bermudagrass, one-half of which is hulled and the other one-half unhulled. At Overton, a 3-year variety evaluation trial has indicated Texas Tough to be the most productive of the seeded varieties in the trial, averaging 6497 lbs DM/ac over the 3-year period.

Table 7. Annual average crude protein content (% DM) of selected bermudagrasses.[1]

	Variety			
Year	Coastal	Coastcross-1	Alicia	Common
1971	14.6	14.8	15.4	15.2
1972	13.3	13.0	12.8	13.4
1973	12.6	10.8	12.5	13.9
1974	13.2	13.5	12.9	14.3
1975	12.0	12.5	12.1	14.0
1976	13.8	16.2	14.4	15.4
1977	15.1	19.9	15.5	16.8
Average	**13.5**	**14.4**	**13.6**	**14.7**

[1] Eichhorn et al., Homer, LA. Annual fertilization = 500 lbs N, 150 lbs P_2O_5, 300 lbs K_2O.

Tierra Verde: Tierra Verde, like Texas Tough, is a mixture of Giant and common bermudagrass. The Tierra Verde blend is 50% hulled and unhulled Giant and 50% hulled and unhulled common. Data obtained from a 3-year variety evaluation trial at Overton indicates Tierra Verde has averaged 5341 lbs DM/ac, second only to Texas Tough among the seeded varieties (Table 9).

Table 8. Annual average in vitro digestible dry matter (IVDDM) of selected bermudagrasses.[1]

	Variety			
Year	Coastal	Coastcross-1	Alicia	Common
1971	56.4	60.6	55.0	58.7
1972	56.8	61.1	54.4	56.1
1973	53.3	55.1	50.4	53.1
1974	50.6	56.9	47.3	49.9
1975	52.4	56.2	48.2	51.2
1976	57.7	59.9	56.2	58.4
1977	55.9	58.2	54.3	56.7
Average	**54.7**	**58.3**	**52.2**	**54.8**

[1] Eichhorn et al., Homer, LA. Annual fertilization = 500 lbs N, 150 lbs P_2O_5, 300 lbs K_2O.

Tifton 44: Dr. G. W. Burton developed Tifton 44 at the Georgia Coastal Plains Experiment Station as a cross between of Coastal and a cold-hardy plant surviving in Berlin, Germany for 15 years. Tifton 44 dry matter yield and disease resistance is similar to Coastal, but Tifton 44 has

a slightly higher forage nutritive value and a greater cold tolerance than Coastal. Tifton 44 generally greens up a week to ten days earlier in the spring and remains green a week to ten days longer in the fall. Tifton 44 is slow to establish. Since Tifton 44 is slow to establish, it needs to be planted in soils that are relatively free of common bermudagrass, which can become a serious weed problem. Tifton 44 is used more in North and Northeast Texas because of its cold tolerance.

Table 9. Comparison of seeded bermudagrass varieties at Overton, TX.[1]

Variety	1997		1998	1999	AVG
	Grass	Weeds			
	----------DM (lbs/ac)----------				
Texas Tough	2480	523	5262	11749	6497
Tierra Verde	2085	159	4885	9054	5341
CS 90160	2737	141	3550	9696	5328
Ranchero Frio	1943	291	2912	8984	4613
KF CD194	1914	298	3664	7407	4328
Cheyenne	2408	268	3430	6640	4159

Tifton 78: The Georgia Ag Experiment Station and USDA-ARS released Tifton 78 in 1984. Tifton 78 is a hybrid between Tifton 44 and Callie bermudagrass. Compared to Coastal, Tifton 78 is taller, spreads faster, establishes easier, is higher yielding and more digestible. The higher digestibility allows for improved animal gains. Tifton 78 is also immune to rust. Tifton 78 has rhizomes but very poor cold tolerance. Tifton 78 plantings at the Overton Experiment Station were killed by hard freezes two years in a row, while Coastal plantings were not harmed. Tifton 78 appears to be adapted only to the most southern areas of the state.

Tifton 85: Tifton 85 was developed by the USDA-ARS in cooperation with the University of Georgia Coastal Plain Experiment Station, Tifton, GA in 1991. Tifton 85 is a hybrid between a plant introduction from South Africa and Tifton 68. Tifton 85 has large stems, long stolons and no rhizomes. Tifton 85 is established by either planting sprigs or tops. In a 3-year trial in GA, Tifton 85 produced 26% more dry matter and was 11% more digestible than Coastal. Animal gains are approximately 10% better than Coastal due to the higher digestibility. At Overton, Tifton 85 has greened up earlier and remained green longer than Coastal.

World Feeder: World Feeder bermudagrass was offered for sale in 1991 by Louis Gordon, president of Bethany-based Agricultural Enterprises Corporation at Bethany, Oklahoma. World Feeder bermudagrass has rhizomes and stolons and makes rapid growth. Data from both Oklahoma State University and Texas A&M University indicate World Feeder is less productive than most of the commonly used hybrid bermudagrasses, similar in forage nutritive value, and very expensive to establish.

Dallisgrass: Dallisgrass is native to South America, and the first noted specimen was apparently collected in Louisiana in 1842. The grass is a tufted, leafy, deep-rooted perennial. It is palatable and produces forage that is higher in nutritive value and palatability than bahiagrass and some bermudagrasses. It initiates growth earlier in the spring and grows later into the fall than most warm-season grasses. Dallisgrass can be an important pasture grass for the following reasons:

1. It produces forage of good nutritive value and can retain this nutritive value late into the summer
2. It grows well with bermudagrass, white clover, and annual ryegrass.
3. The forage is palatable to cattle.
4. It persists under heavy grazing.
5. Dallisgrass is well adapted to poorly drained loam and clay soils that can be common in parts of the South.

The down side to dallisgrass is its lower dry matter production compared to some bermudagrass varieties, it is difficult to establish, and is subject to ergot (*Claviceps* spp.) infection, which is toxic to cattle when the seedheads are consumed.

Dallisgrass responds to fertilization, but only up to approximately 150-200 lbs N/ac. Phosphorus and K should be applied based on soil test recommendation. No N should be used

if white clover is grown as a companion crop. This is a common practice with dallisgrass since both it and white clover tend to favor similar sites.

Pearlmillet and the Sorghums: These warm-season annual grasses are popular both as grazing and hay forages. Pearlmillet (*Pennisetum americanum*) and the various *Sorghum* spp. (sudangrass, forage sorghum, sorghum-sudan hybrids) have good heat and drought tolerance. Both types of grass, however, tend to accumulate nitrates to toxic levels when drought affects plant growth, especially in the presence of N fertilizer. Because the sorghum types can also produce toxic levels of prussic acid, their best use may be as hay crop since the prussic acid volatilizes out of the forage during the field curing process. Pearlmillet, which does not produce prussic acid, may be the better choice as a grazing grass, though nitrates toxicity can still be a problem.

Either pearlmillet or one of the sorghums is generally planted at approximately 25-30 lbs per acre. Increased seeding rate (up to 50 lbs per acre) may decrease stem diameter and improve curing time of sorghums planted for hay harvest. Smaller stem diameter also promotes quicker recovery from cutting or grazing.

There have been positive responses to N fertilizer up to 400 lbs N/ac. Most production systems, however, will use approximately 200 lbs/ac for hay production. Grazing systems may only use 50-75 lbs N/ac. Application rates greater than 100 lbs should be split applied to minimize loss due to leaching on sandy soils and to minimize nitrate accumulation. Phosphorus and K should be applied based on soil test recommendation and pH should be maintained between 6 and 7. Dry matter production of these forages can exceed 10 tons/ac if adequate moisture is received and the appropriate levels of fertility are used. Forage nutritive value can be good if the grasses are harvested at the right stage of maturity. To maximize regrowth, either for a hay crop or in a grazing pasture, plants should not be harvested lower than 8-10". This helps to stimulate increased growth from the terminal meristem. Plants harvested below about 6" may result in reduced regrowth or even plant death. Maximum dry matter yield for both types of grass appears to occur as the plants approach maturity or attain heights of 32-48". Most uniform grazing and the least amount of waste occur when plants are 20-28" tall.

Although these warm-season annual grasses can be very productive, producers who use them should be aware of the situations that can produce toxic levels of nitrate accumulation or prussic acid poisoning. Either malady can and does kill cattle with great certainty.

Cowpeas: Cowpeas (*Vigna unguiculata*) are annual viney plants with large leaves. The species is tolerant of drought, low fertility, and soil acidity. Cowpeas, however, do require adequate levels of phosphorus to be productive. Forage nutritive value is high and plants are easily established during May through June. Cowpeas are used as a warm-season planting for white-tailed deer to offset the negative effects of summer stress. Allowing growing animals to have creep access to cowpeas provides for enhanced animal performance during summer when forage nutritive value of other species is typically reduced. Cowpeas do not cause bloat in ruminants.

Cool-season Forages

Small grains and annual ryegrass: Limited forage growth during fall, winter, and early spring causes many livestock producers to feed hay, silage, or concentrates. This winter feeding program is generally expensive and reduces profitability. More cost-effective winter feeding programs generally utilize some form of cool-season pasture.

Although adapted cool-season perennial forage grasses could provide the least costly means of wintering livestock, with the exception of tall fescue, suitable cool-season perennial forage grasses have not been identified for all many portions of the South. Thus, cool-season annual forage grasses are the most commonly used forms of winter pasture.

This following is a brief discussion of those cool-season annual forage grasses that may be used for winter pasture programs in the South.

Barley: Barley (*Hordeum vulgare*), along with wheat, is thought to have originated in the Near East. This species is probably the least utilized of the cereal grains for pasture use; barley is generally grown for grain that is used in the brewing industry. Barley is less winter hardy than wheat and rye and winterkilling could be a problem during especially severe winters. Barley, however, can provide good winter pasture, although other cereal grains typically provide better alternatives. Of the cereal grains, barley is the most tolerant of saline and alkaline soils and, thus, may provide pasture on certain soils that may be less productive when other cereal grains are used. Barley does not grow well on very sandy soils.

Oat: Oat (*Avena sativa*) originated as a domesticated crop in Europe and has been used as both food for humans and feed for livestock. Oat also provides excellent cool-season pasture for livestock and is a popular planting for white-tailed deer and turkey. Oat has the least cold tolerance of the cereal grains and this limits its use to generally the southern half of the Gulf Coastal states. Oat grows better on wet soils than the other cereal grains. Oat is planted both during late summer/early fall and in late winter/early spring for either pasture or hay. If planted in late summer/early fall, oat is more susceptible to winterkill than with later plantings.

Rye: Rye (*Secale cereale*) also originated in Europe. Rye is the most winter-hardy of the cool-season annual grasses. Rye is also the most productive cool-season annual grass on soils that are low in fertility, well drained, and sandy in texture. Rye generally produces more fall forage than spring forage and matures earlier in the spring than most wheat varieties. Because of this aspect, a mixed-planting of rye and annual ryegrass provides good seasonal distribution of forage production since ryegrass makes most of its growth during spring. The most popular rye varieties have been developed by the NOBLE Foundation at Ardmore, OK. They are 'Elbon', 'Bonel', 'Oklon', 'Maton', and 'Bates'.

Ryegrass: Ryegrass (*Lolium multiflorum*) is indigenous to southern Europe and is a popular choice for winter feeding of livestock. Ryegrass grows on a wide range of soil types and grows better on wet soils than any cool-season annual grass. Ryegrass is generally later in maturity, thus extending the grazing season well into spring. Ryegrass establishes readily without any seedbed preparation and tolerates a high level of grazing pressure. With adequate moisture, ryegrass can produce large quantities of forage (mostly during the spring production phase) and is generally the most productive of all the cool-season annual grasses if appropriate levels of fertility and an adequate soil pH is provided.

Triticale: Triticale (*Triticum secale*) is a unique species that resulted from a cross of wheat and rye. Grain from triticale is used as a feed grain for the livestock industry. In Kansas, triticale has been shown to produce more forage than wheat or rye, be better adapted for early planting for fall forage production, provide a longer grazing period than wheat or rye, and have superior tolerance to drought, pests, and low pH when compared with wheat. In south-central Oklahoma trials, however, triticale generally did not produce as much fall forage as did rye. Production and distribution of forage is similar to most wheat varieties. Although often overlooked, triticale could be a good choice for annual winter pasture.

Wheat: Wheat (*Triticum aestivum*) is grown on several million acres of land in the US, in many cases as a dual-purpose (grain + pasture) crop. Most of the acres in the Southern Plains are planted to hard red winter wheat, but in the south most wheat planted is soft red wheat. Although wheat is an excellent forage crop, rye usually produces more total forage, more forage in the fall, has greater cold tolerance, and is better suited to the acid sandy soils encountered across much of the southern US.

Establishment

Cool-season annual forage grasses are well adapted to most regions of the South with soil texture generally the greatest limiting factor. The choice of species, therefore, is largely up to

the producer depending on his particular management philosophy and livestock production needs. Be aware that cool-season annual grasses can produce different levels of forage (Fig. 1). Regardless of species, it is important that cool-season annual forage grasses be established under a fairly narrow set of conditions to ensure maximum probability of success.

Maximum fall forage production is generally a function of moisture, planting date, and fertility. Adequate stored soil moisture can be critical to maximizing forage production; thus, many producers choose to leave cool-season annual pastures fallow during the warm months of the year to conserve soil moisture.

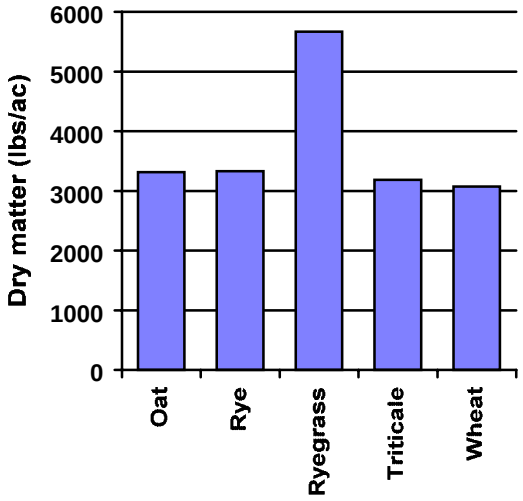

Figure 1. Three-year (1993-1996) dry matter production of various cool-season annual grasses at Ardmore, OK. NOBLE Foundation, 1996.

Where moisture is generally not limited, such as in eastern Oklahoma, the cool-season annual forages may be successfully sod-seeded into warm-season perennial grass swards. This practice is used to increase forage nutritive value and extend the grazing season. The warm-season grass, however, should be grazed or mowed short prior to establishment of cool-season annual grasses. The warm-season grass should also be near the onset of dormancy to minimize competition for sunlight, moisture, and other nutrients of emerging cool-season annual grass seedlings.

A soil sample should be obtained well before the time to establish the cool-season pasture. Adequate P and K (65 and 250, respectively, based on OSU Soil, Water, and Forage Analytical Laboratory indices) should be present and soil pH should be 5.5 or higher. If planting into a clean-tilled seedbed, necessary P, K, and lime should be incorporated into the soil well ahead of planting. Phosphorus can also be applied at planting in the seed furrow as 18-46-0. If sod seeding into a warm-season grass sod, P, K, and lime can be surface-applied with good results, and again, 18-46-0 can be applied in the seed furrow.

Nitrogen is second only to moisture as a limiting factor to plant production. Nitrogen fertilizer may be applied as anhydrous ammonia pre-plant in clean-tilled seedbeds, or as a topdress using dry forms of inorganic nitrogen fertilizer, such as ammonium nitrate or urea. Liquid formulations of nitrogen, such as Solution 28, may also be used to topdress. Nitrogen applications may be made at planting, or after germination and at levels designed to provide the quantity of forage desired.

Nitrogen application rates will vary with region of the state. In the eastern portion of Oklahoma, 100 to 150 lbs of actual nitrogen per acre may be utilized by the cool-season annual grass. As fields are planted farther west in the state, less nitrogen is applied due to reduced moisture availability.

Planting for fall pasture should be made as early as possible to allow maximum forage production prior to winter dormancy. Where possible, late-summer plantings (i.e., late August, early September) can capitalize on the bimodal precipitation pattern experienced in Oklahoma and provide pasture for grazing by late October or early November. Semi-dwarf wheat, however, may exhibit poor emergence due to higher soil temperatures experienced during late summer plantings. If forage is the only concern, taller, later maturing varieties may be a better choice for the livestock producer.

Seeding rate and planting depth can be critical elements in stand establishment. Tall varieties of wheat may be planted as deep as 2" in late August and produce good stands. This

aspect can be important during late summer plantings where producers attempt to plant to soil moisture. Semi-dwarf wheat, on the other hand, suffers from poor emergence if planted greater than 1" due to a much shorter coleoptile length. Rye should not be planted any deeper than 3/4". Ryegrass is generally not planted, but simply broadcast over a field, generally as part of a fertilizer application for a mixed-planting with rye or wheat.

Forage Legumes: Legumes may be used in much of the southern US as a means of extending the length of grazing season, increasing the nutritional plane of grazing livestock, and/or reducing the amount of nitrogen fertilizer required in a forage production program. Several forage legumes are widely adapted to and used in the southern US. Some of the important forage legumes are listed below.

Alfalfa: Alfalfa (*Medicago sativa*) is the most important perennial forage legume for hay production and is sometimes used for grazing. Proper soil fertility and pH along with well-drained soils are critical for high forage yields and long-lived stands.

Alfalfa is normally sown between mid-September and mid-October in the south without a companion crop. Companion crops may be useful, though, to help control wind erosion on sandy sites.

Alfalfa growth begins in March and continues until the onset of short days and cold temperatures or until drought induced dormancy. Haying at 28-to 35-day intervals or rotational grazing of one to 3 day grazing periods followed by three to 4 weeks of regrowth is normally the best way to maintain good stand life and high production. Continuous grazing may also be successful if six to eight inches of stem is maintained.

Bloat may be a problem when grazing alfalfa. Carefully read the section on bloat in this publication.

Annual lespedezas: The annual lespedezas [Common (*Kummerrowia striata*) and Korean (*Kummerrowia stipulacea*)] are tolerant of acidity and low phosphorus situations; thus, the species are well adapted to infertile sites and offer forage of high nutritive value during late summer under low-input production systems. Stocker cattle have been reported to gain better on a combination of lespedeza and bermudagrass than on bermudagrass alone. Seeds should be planted at 25 to 35 lbs/acre during March or April. Light grazing pressure will generally allow the plants to reseed. Yields are lower than other warm-season forages such as bermudagrass or the sudangrass types of annual grasses. As with cowpeas, growing animals perform well when allowed creep access to lespedeza.

Arrowleaf Clover: Arrowleaf clover (*Trifolium vesiculosum*) is a relatively late-production cool-season annual clover that produces most of its growth during April and May. Arrowleaf clover plants typically mature during late June through July. If conditions are favorable during early fall, some growth may be available for grazing in late fall or early winter.

Arrowleaf clover is not adapted to calcareous or wet soils and has some degree of drought tolerance. Arrowleaf clover is generally high in digestibility and superior to that of crimson clover at all stages of maturity. Bloat potential with arrowleaf clover is low and is a good choice for pasture mixes where adapted. When arrowleaf clover is kept grazed to a height of three to four inches during spring, livestock may continue to graze until early June or later. If a hay crop is desired, grazing should be terminated in early to mid May. This allows the clover a chance to regrow before cutting and may reduce some of the problems associated with making hay during the typically rainy May weather in the South.

With proper grazing management, arrowleaf clover is an excellent reseeding annual due to the high percentage (70-90%) of hard seed produced. If managed for reseeding, the arrowleaf clover stand may remain viable for many years.

Austrian Winter Peas: Austrian winter peas (*Pisum sativum*) may produce a moderate amount of dry matter used for grazing, as a hay crop, or as a green manure. Winter peas are often used as companion crops with cereal grains and are high in nutritive value. They

make good silage and are relished by cattle and white-tailed deer.

Winter peas are easily established on well-drained loam or sandy loam soils and should be planted during September or October at 20 to 30 lbs of seed/acre in mixed stands with cereal grains or ryegrass and 30-40 lbs/acre in pure stands. Austrian winter peas are intolerant of low pH soils.

Berseem clover: Berseem clover (*Trifolium alexandrinum*)resembles alfalfa and grows to a height of two feet or more. This annual clover is adapted to alkaline sites and is tolerant of wet soil conditions but performs best on fairly good sites and is not adapted to low fertility sites. Berseem clover may provide fall forage and produces peak forage levels during March through June. Grazing should keep plants between three and four inches in height to encourage new leaf production. Berseem clover is not a particularly good reseeding species but does not cause bloat problems.

Crimson Clover: Crimson clover (*Trifolium incarnatum*) is well adapted to the Gulf Coast region and is an early clover with peak production occurring in March through April. Crimson clover is similar to arrowleaf clover in areas of adaptation. It will not tolerate calcareous or poorly drained soils but is better suited to acidic soils than arrowleaf clover. Crimson clover may be successfully established into bermudagrass by drilling the seed into a pasture that has been grazed or mowed short. Though adapted only to the southeastern quarter of the state, crimson clover is easy to establish and provides excellent forage. Crimson clover is a relatively poor reseeder due to a lack of hard seed. Plants generally will germinate during the summer and die before fall.

Hairy Vetch: Hairy vetch (*Vicia villosa*) is a dependable, widely adapted cool-season annual legume used throughout the South. The plant has a large seed that allows seedlings to emerge through a thatch of three to four inches to reach sunlight. Hairy vetch is fairly tolerant of acid soils, but soils should be well drained.

Hairy vetch has a vine-like growth habit with a peak production period during March and April. Plants bloom in early May and will have mature seed by late May. If allowed to mature, hairy vetch has a good reseeding capability.

Dry matter production is normally less than that of other cool-season annual legumes, but the plant is a dependable producer. Hairy vetch can be grazed or harvested as a hay crop.

Cattle grazing pure stands of vetch have developed dermatitis (inflammation of the skin), similar to photosensitization. This has not been a problem when adequate grass was available.

Cattle may develop muscular problems when grazing vetch, especially when the seeds are forming. Moving cattle to a pasture without vetch is the only practical way to control this problem.

Red Clover: Red clover (*Trifolium pratense*) is a short-lived perennial with an upright growth habit that may be used as pasture or as a hay crop. Due to a long-growing season, red clover typically is the highest yielding clover in areas of adaptation. Red clover is typically planted during September through early October or February through March, at six to eight lbs/acre in drill rows or 12-15 lbs/acre broadcast. Soil pH should be above 5.5 for maximum production.

Red clover is not as long lived as is alfalfa; however, stands of red clover may be maintained for many years by reseeding with two lbs of seed/acre every two to four years.

Rose Clover: Rose clover (*Trifolium hirtum*) is a cool-season annual that is somewhat new to the South. Most varieties of rose clover that have been available in the past were earlier in maturity than either crimson and arrowleaf clover. Drought tolerance of rose clover, however, is typically greater than crimson or arrowleaf clover. Rose clover will not tolerate wet or poorly drained soils but is fairly tolerant of alkaline soils and soils of low fertility. If rose clover is allowed to produce seed the first year, a lower initial seeding rate may be used with a good stand becoming established in the second year.

Most rose clover varieties from California produce relatively low dry matter yields. A relatively new release from Texas, Overton R-18, has a higher yield potential and is

intermediate in maturity to crimson and arrowleaf clover.

Subterranean Clover: Subterranean (sub) clover (*Trifolium subterraneum*) is a dense, low-growing, annual legume of medium maturity that will withstand close grazing and continue to produce seed. Following pollination of the small white flowers, the flowers "peg down" and the seeds develop on or just under the soil surface.

Sub clover normally reaches no more than six or eight inches in height and is not as productive as arrowleaf or crimson clover. Sub clover is not suited for hay production.

Sub clover is more tolerant of acid soils than most clovers but does not tolerate a pH above 7.0. Sub clover is tolerant of close continuous grazing and is more tolerant of shade than other legumes but does not do as well as other clovers in grass sods.

Sweetclover: White (*Melilotus alba*) and yellow sweetclover (*Melilotus officinalis*) are biennial species that can produce two or more tons of forage/acre.

Sweetclover is very similar to alfalfa and has great value as a soil-improving and pasture crop and is best adapted to clay or loam soils at near-neutral or higher soil pH. Sweetclover is relatively drought tolerant and winter hardy and either of the species may be planted in spring or autumn at 10 to 15 lbs of seed/acre.

Coumarin, an aromatic compound found in sweetclover forage, reduces the palatability to livestock until they become accustomed to the bitter taste. Dicoumarol, a toxic substance that develops from coumarin during heating and spoiling of sweetclover hay, reduces the blood-clotting ability of animals and may result in their death. This problem has been overcome by the development of low-coumarin sweetclover varieties

White (Ladino) Clover: White clover (*Trifolium repens*) is a perennial legume common across most of the southern US. Common white clovers are of shorter stature and do not exhibit the larger leaf of the taller ladino varieties. White clover requires good soil moisture and is not productive under droughty conditions.

White clover is often planted at three to four lbs/acre into existing tall fescue or bermudagrass stands. Best production will be obtained on fertile, well-drained soils if rainfall is favorable. White clover will tolerate wet soil conditions better than most legumes. Because it is often found on wetter sites, white clover may survive a dry spell during the summer months better than other forage legumes.

White clover does not exhibit the same erect growth habit as red clover and mixed grass-clover stands should be grazed fairly close to prevent competition for sunlight from becoming a limiting factor in white clover production. While cattle are grazing pure stands of white clover, bloat potential may be reduced with free-choice access to grass hay. As with red clover, broadcasting one or two lbs of seed/acre in the fall or winter may be necessary to maintain a stand for several years.

Legume Fertility Requirements: In general, legumes are typically more sensitive to soil nutrient deficiencies than are forage grasses. However, because of the symbiotic relationship with *Rhizobia* bacteria, nitrogen fertilizer is generally not required. Phosphorus and potassium, however, are critical to maintaining a productive stand of legumes. An annual soil test should be used to determine the need for phosphorus and potassium and will also indicate if there is a deficiency in micronutrients, such as boron. Legumes are more sensitive to low soil pH than are most forage grasses and, based on soil test recommendations, lime should be applied when pH soil values fall below 6.0.

Legumes in Grass Pastures: Many legumes may be successfully established into grass pastures. One popular strategy is to sod seed (no till) cool-season annual legumes into bermudagrass pastures. The bermudagrass must be carefully managed to ensure that a minimum amount of residue remains at the time of establishment. If the bermudagrass canopy is not removed, emerging legume seedlings will not be able to compete for sunlight and become established. Forage canopies may be removed by grazing (recommended) or by mowing.

Proper use of a cool-season annual legume in bermudagrass will provide forage of high nutritive value during the late winter and early spring and the legume will serve as a source of nitrogen for early bermudagrass growth. This may help reduce the requirement and expense of nitrogen fertilizer.

Another popular strategy for utilizing legumes in a grass pasture is to mix red or white clover into a tall fescue or other cool-season grass pasture. The tall fescue has a negating effect on the bloating potential of legumes, and legumes may play a role in reducing the effects of fescue toxicity. A higher level of management is required for this type of program, but the effort may result in improved animal performance and reduce the need for nitrogen application.

Inoculation: When properly inoculated, legumes generally do not require nitrogen fertilizer because of a symbiotic relationship with *Rhizobia* bacteria. In the symbiotic relationship, bacteria extract atmospheric nitrogen and convert it to a plant-available form within root systems of legumes. Legumes, when properly inoculated, can fix significant amounts of nitrogen. The amount will vary between species, sites, and years but can range from as little as 30 up to 150 lbs/acre. While it is possible to establish without the nitrogen-fixing bacteria, nitrogen fertilizer must be applied and the economic advantage of using legumes is lost.

In pastures where legumes have been used in the past, the *Rhizobia* may persist for several years. However, when initially establishing legumes, the proper type of bacteria (inoculant) must be introduced into the forage system. This is known as **inoculation** (Table 10). Inoculation of seed occurs before planting and is accomplished by applying a sticking agent to the seed and then adding inoculant to the seed. The inoculant should be applied immediately prior to planting the seed.

Inoculated seed should not be stored in a location where the seed will be subjected to high temperatures for a lengthy period of time nor should the seed be mixed with fertilizer. Both practices can be lethal to the bacteria.

Once a field has a successful stand of a legume species, bacteria **may** remain viable in the soil for two to five years. If present in sufficient quantities, a subsequent planting of the same legume may not require that seed be inoculated at planting.

The most consistent method, however, is to inoculate legume seed with the proper *Rhizobia* each time the seed is planted regardless of the pasture history. *Rhizobia* bacteria are host specific and producers should be sure the strain of bacteria is appropriate for the legume being established. Commercial packages of inoculant list the legume species for which the package is effective.

Commercial sticking agents are available from those who provide the inoculant and generally these provide the most appropriate method for inoculating legume seed. A 10 to 50% solution of sugar/water or syrup/water may also be used to moisten the seed so that the inoculant will adhere.

Bloat: Certain legumes can create serious bloat problems in ruminants. Bloat is caused by the formation of a stable foam in the rumen. If not relieved, the pressure created by the entrapment of rumen fermentation gases in the foam can lead to death by suffocation in as little as one hour or less.

Environmental aspects may also play a contributing role in bloat. Cattle have been observed to stop foraging prior to passage of a weather front and gorge themselves following the inclement weather. Cattle may need to be moved or a bloat preventative may be required during such times. Frost can also increase the incidence of bloat by disrupting plant cell walls and increasing their rate of fermentation in the rumen. Delay grazing those legumes that are known to cause bloat for a few days following a hard frost.

Legume bloat usually occurs during the lush growth period associated with spring. When using a legume known to cause bloat, the number of problems can be minimized with proper management (Table 11).

Poloxalene, a bloat preventative, must be consumed by cattle daily, both prior to turning cattle onto legumes and thereafter, to be effective. Feed poloxalene at one to two grams/100 lbs of body weight per day. Cattle should be accustomed to consuming a mineral mixture, and a feeding strategy that results in cattle getting an effective amount of poloxalene should be used. This may mean hand feeding cattle one to two pounds of highly palatable supplement containing the desired amount of poloxalene.

There are reports that feeding either oat hay or sudangrass hay "effectively controlled" bloat of steers grazing young, lush regrowth of alfalfa. The amount of hay that cattle must consume to decrease bloat is large and in the range of four to six lbs/head/day for 400 to 60-lb cattle depending on how much of the bloat-causing forage they consume.

Table 11. Management strategies to minimize bloat potential in livestock.

- ⇒ Never turn hungry cattle into a lush legume pasture. Allow cattle to fill on grass hay first.
- ⇒ Provide a bloat preventative to livestock several days prior to and while grazing legumes of known bloat potential.
- ⇒ When first turned into lush legume pastures, watch cattle closely for several days for distended rumens indicating bloat.
- ⇒ If possible, fill cattle with hay or other roughage immediately before or after the passage of a weather front.
- ⇒ Delay grazing bloat-causing legumes for a few days following freeze damage.
- ⇒ Allow livestock to have free-choice access to grass hay while grazing lush legumes.

Table 10. Legume Summary

Legume species	Growth habit	Seeding rate[1] (lbs/acre)	Planting date	Production period[2]	Inoculum type
Alfalfa	Perennial	8-20	Sept-Oct	Mar-Nov	A
Arrowleaf clover	Annual	8-10	Sept-Oct	Mar-July	O
Austrian Winter Peas	Annual	30-40	Sept-Oct	Mar-April	C
Berseem clover	Annual	10-20	Sept	Nov-Dec, Mar-June	R
Cowpeas	Annual	40-100	May-June	June-Sept	EL
Crimson clover	Annual	20-30	Sept-Oct	Nov, Mar-April	R
Hairy vetch	Annual	20-25	Sept-Oct	Mar-May	C
Korean lespedeza	Annual	20-25	Mar-April	July-Sept	EL
Common lespedeza	Annual	20-25	Mar-April	July-Sept	EL
Red clover	Perennial	6-15	Sept-Oct, Feb-Mar	April-July	B
Rose clover	Annual	10-15	Sept-Oct	Mar-May	WR
Subterranean clover	Annual	10-20	Sept-Oct	Nov-Dec, Mar-May	WR
Sweetclover	Biennial	10-15	Sept-Oct, Mar-April	May-Aug	A
White (ladino) clover	Perennial	3-4	Sept-Oct, Mar-April	Mar-June, Oct-Nov	B

[1] Use the lower seeding rate when using drills that place seed in contact with the soil.
[2] Production period may be longer with high levels of precipitation during summer months.

Tall fescue: Tall fescue (*Festuca arundinacea*) is a cool-season, perennial bunchgrass that came to North America from Europe in the late 1800's. Since the discovery of a field of fescue in eastern Kentucky in 1931 and the subsequent release of the Kentucky 31 variety in 1943, tall fescue has become the dominant cool-season perennial grass in the southeastern United States. Most commonly referred to as "fescue", tall fescue is used for forage and erosion control.

The species has a range of adaptation that is centered in the Arkansas, Missouri, Tennessee, and Kentucky area. Tall fescue, however, is also found in abundance west into eastern Oklahoma and northeast Texas; south into northern Louisiana, Mississippi, Alabama, and Georgia; east into North and South Carolina, and Virginia; and north into West Virginia, southern Ohio, southern Indiana, and southern Illinois

Tall fescue grows on a wide variety of soil types, but it performs best when grown on loam or clay soils that have some water-holding capacity. Tall fescue will also grow well on

soils that are typically too wet for most other forage grasses but will not tolerate flooded conditions. Conversely, tall fescue should not be planted on extremely droughty sites or on deep sands. Many older, established stands that originated from KY-31 tall fescue have persisted under conditions of low fertility, low soil pH, and overgrazing.

For best results, plant 15 pounds of pure live seed per acre in a well-prepared seedbed that allows planting at a consistent depth of approximately one-half inch. Fertilize according to a soil test, and apply at least 50 pounds of actual nitrogen per acre. Fertilize during seedbed preparation to allow phosphorus and potassium to be incorporated.

Fertilizer use on fescue, or any other crop, should always be based on a reliable soil test. A soil test is the only way to determine how much phosphorus and potassium is required annually to maintain production and efficient use of the nitrogen applied.

The soil test will also indicate the pH level and how much lime to apply if the pH is too low. Fescue will tolerate a pH as low as 4.5, but legumes in a fescue pasture require a lime application if the pH is below 6.0.

The Endophyte Challenge: The term "endophyte" refers to a fungus, *Neotyphodium coenophialum* that is hidden within a plant and may be either parasitic or symbiotic in its relationship with the host plant.

The endophyte lives within the fescue plant itself and grows between the cell walls. The fungus obtains its nutrition from plant materials and since plant cells are not destroyed, it is impossible for a producer to determine infection simply by looking at the fescue plant. Laboratory tests must be conducted to accurately determine if a plant is infected with the fescue endophyte.

Both the endophyte and the fescue plant benefit from their relationship. The fescue plant provides the endophyte a source of nutrition, protection from the environmental elements, and a means of reproduction. The endophyte either produces a number of other alkaloids or is responsible for plant production of the alkaloids that provide the plant with resistance to insects, nematodes, and certain environmental stresses such as drought. The endophyte also enables the fescue plant to tolerate close, continuous grazing.

The removal of the endophyte from the fescue plant and the resulting removal of the alkaloids causes the fescue plant to be more susceptible to insects, certain plant diseases, drought, and close grazing. Some recent research has suggested that a new “novel” endophyte-infected tall fescue varieties may provide the positive benefits of the endophyte, but none of the negative. Research is currently being conducted to determine if this is so.

The alkaloid compounds produced as a result of the fescue-endophyte infection create a number of adverse effects in grazing livestock. The beef cattle industry alone experiences an estimated $600 million dollar annual loss due to endophyte-induced alkaloids. Bred mares grazing endophyte-infected tall fescue during the last trimester of pregnancy may experience several negative effects including abortion, stillborn foals, agalactia (reduce milk production), prolonged gestation, and thickened placentas.

There are two basic approaches to minimizing the negative effects of endophyte-infected tall fescue: learn to manage the grass properly, or renovate the existing fescue. Many producers have found tall fescue to be a valuable component of their pasture systems, if not the primary forage base for their livestock operations. Those who successfully utilize tall fescue have learned to dilute the toxic effects for cattle by interseeding clovers with the grass or by providing other forages such as dry hay or even grain to minimize the effects. These management strategies do not work in the case of horses. Producers also should not allow cattle to graze endophyte-infected tall fescue after about May 1. Alkaloid compounds in the plant are much higher during this time of year, while fall forage and early spring forage are relatively low in alkaloid compounds.