Forage Systems for
Stocker Cattle

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Forages can be a relatively inexpensive feedstock for stocker development in the Southeast. With the luxury of a nearly year-round growing season, beef producers in this region have a competitive advantage over producers in other regions with a shorter grazing season and cattlemen who primarily use concentrate-based rations. However, it is critical to appropriately match the animal's nutritional needs to the forage base. This publication provides a guide to the various forage systems that could be used for stocker development and provides guidelines for managing grazing or hay harvests for optimum forage yield and quality.

Comparing Forage Systems

When evaluating or comparing forage systems for stocker development, a number of factors need to be considered. Many of these considerations are specific to the individual farm, situation, or management ability (e.g., the capability to plant, manage, and use annual forage crops; appropriateness of the site to the requirements of the forage system in question, etc.). With all other factors being equal, the primary basis for comparing forage systems includes:

1. **Average daily gain** - ADG; the expected average rate of gain per animal,
2. **Gain/acre** - the amount of gain expected to be produced per acre,
3. **Grazing period** - the expected number of days when the forage system can be grazed at a specified stocking rate, and
4. **Stocking rate** - the expected number of animals capable of being grazed on a given acre for the specified grazing period.

These factors individually influence the profitability of the forage system but they are also interrelated. The interrelationship between some of these factors can be seen in their definitions (e.g., stocking rate and grazing period) or their mathematical relationships (e.g., gain/acre = ADG x days in grazing period x stocking rate). To understand how these aspects interact, it is important to understand that the grazing pressure applied by different stocking rate levels can affect ADG and gain/acre.

In general, the goal is to maintain ADGs at least above 1.5 lbs/head/day so that the animal's weight stays appropriate to its age. However, this must be done while optimizing gain/acre, since this term is a primary determinant of profitability. Though one may think that gain/acre could be increased merely by increasing the stocking rate, this may be counter-productive. Certainly, increasing the stocking rate up to a certain level improves gain/acre (Figure 1). However, ADG generally decreases as stocking rate increases. As the stocking rate increases beyond an optimum, the lower ADG of the individuals can begin to cause gain/acre to decrease. The reason for this is that as stocking rate increases, an individual animal may not be able to select high quality forage and, ultimately, may not have enough forage available to meet its nutritional needs for high production.

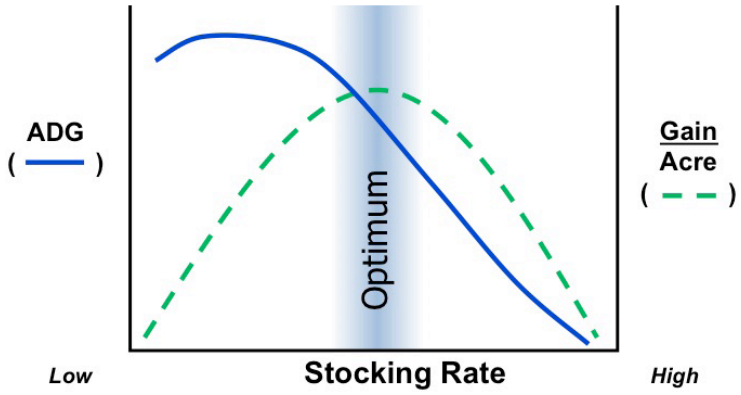

Figure 1. The general interrelationship between stocking rate, average daily gain (ADG), and gain/acre for a given grazing period.

Since these four key aspects are interrelated, it is important to consider them collectively when comparing forage systems. Like a jigsaw puzzle, the only way to see the whole is to simultaneously consider these four core pieces (Figure 2). In this publication, research results for a number of different forage systems for stocker development have been summarized using these four factors whenever possible. Unfortunately, not all of the research that has been done was performed in such a way as to provide all of these four factors.

It is also important to recognize that the provision of supplemental feed can influence or improve all four of these key factors. The results of research trials reported here are from trials where no supplemental feed was provided to the animals. This makes for a good comparison of the different forage species and indicates the species (or varieties) that would need to be supplemented more or less. Additional information about improving ADG, gain/acre, stocking rate, and grazing period with supplemental feed can be found in the Related Publications section at the end of this document.

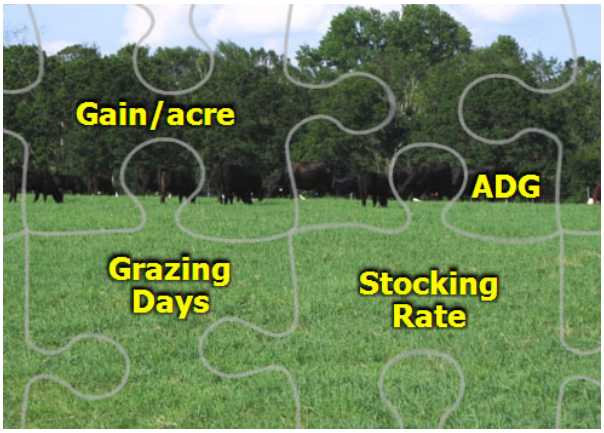

Figure 2. Gain/acre, average daily gain, the days in the grazing period, and stocking rate are interrelated and central to understanding how one forage system for stockering compares to another.

Forage Systems Overview

The Southeast's mild climate and high rainfall allow for excellent forage production conditions. More than 60 forage species are grown and used in Georgia. Of these forage crops, several are capable of producing the quality and quantity of forage necessary to support a stocker beef cattle production system. Table 1 presents a summary of the 12 forage crops that are most commonly used for stocker development in Georgia.

Table 1. Key characteristics of forage systems commonly used for pasture-based stocker development programs in Ga.

Forage	Type[†]	Yield[‡] (tons/a)	Quality[§]		Cost of[¶]		Ease of Use For[††]	
			CP (%)	TDN (%)	Establishment	Production	Grazing	Hay
Annual Ryegrass	CSAG	4-5	10-20	56-74	Medium	Medium	1	3
Oats	CSAG	3-4	8-17	55-70	Medium	Medium	2	2
Rye (cereal)	CSAG	2-3	8-17	52-70	Medium	Medium	2	4
Wheat	CSAG	3-4	8-17	50-70	Medium	Medium	2	2
Arrowleaf Clover	CSAL	1.5-2	14-24	56-75	Low	Low	1	4
Crimson Clover	CSAL	1.5-2	14-24	57-75	Low	Low	1	4
Tall Fescue	CSPG	4-5	10-16	58-62	Medium	Low	1	1
Crabgrass	WSAG	2-5	9-12	58-65	Low	Medium	1	3
Pearl Millet	WSAG	4-6	8-12	52-58	Medium	High	3	4
Sorghum-Sudangrass	WSAG	4-10	9-12	53-60	Medium	V. High	4	4
Bahiagrass	WSPG	3-5	9-12	50-56	High	Medium	1	1
Bermudagrass (hybrid)	WSPG	5-8	10-14	55-60	V. High	V. High	1	1

[†] Cool season annual grass (CSAG), cool season annual legume (CSAL), cool season perennial grass (CSPG), warm season annual grass (WSAG), and warm season perennial grass (WSPG).
[‡] Typical range in yields of recommended varieties, but highly dependent on growing season and conditions.
[§] Assumes harvest or grazing occurs at recommended stages of growth.
[¶] Based on 2010 seed, fertilizer, and fuel costs and assuming moderate soil fertility.
[††] Ratings are 1 – 4: 1 = relatively easy and 4 = quite difficult or requires high level of management.

Cool Season Annual Forage Programs

Mild weather and the ability to grow high quality forages during late winter and spring make the cool season annual forage program an excellent option for forage-based stocker systems. In general, cool season annuals are high in crude protein and very digestible (Table 1). Cool season annual forage grasses and legumes can maintain high quality through the spring if the forage is kept in a vegetative stage of growth by proper grazing

management. Research suggests that lightweight calves should gain an average of 1.8 to 2.3 pounds per day on productive, well-managed cool season annual pastures with little or no supplementation. The performance of cool season annual crops varies with location in the state, soil type, and management. However, it is generally useful to combine cool season annuals either individually in separate paddocks or as mixtures within a paddock. The primary reason for doing this is that the crops differ in when they are most productive and complement the forage quality of one another (Figure 3). Using two or more species, either in a mixture or in different areas, provides better distribution of forage production.

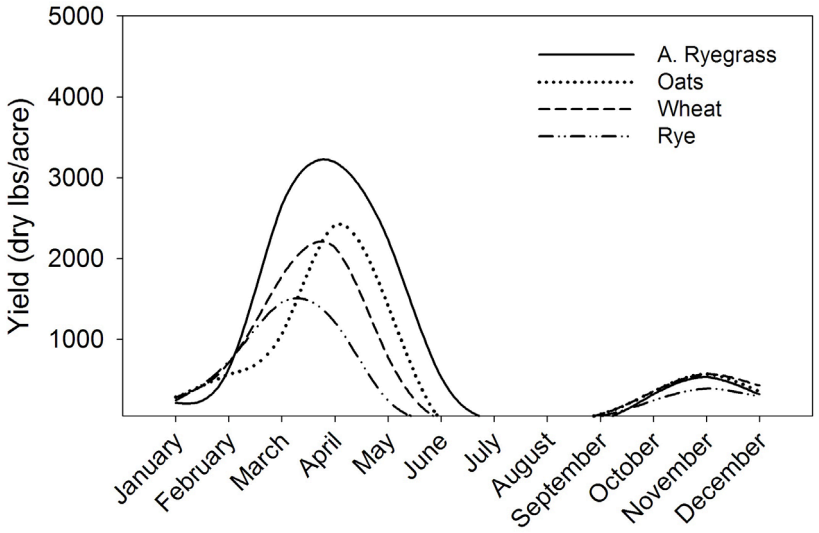

Figure 3. A typical seasonal yield distribution of selected cool season annual grasses in Georgia.

Cool Season Annual Forage Crops

Small Grains – Rye, wheat, and oats are widely used in stocker programs. Rye and wheat are more cold tolerant than oats and can be grown statewide. Oats are best adapted to south Georgia. Rye produces more forage in late fall and late winter than wheat but matures earlier in spring. Wheat will provide grazing about three weeks later in spring than rye. The growing season for oats is similar to wheat. Rye is the best choice for land that will be plowed in spring for a summer row crop because it matures in early spring. Wheat and oats are slightly more palatable than rye, and cattle generally gain slightly faster than when grazing pure stands of rye. Rye can mature very rapidly. As a result, the forage quality can decrease very quickly. Triticale (a hybrid of rye and wheat) can also be used, but it is not as grazing-tolerant and offers no substantive advantage over rye or wheat.

Annual Ryegrass – Annual ryegrass is a highly productive cool season annual grass with excellent forage quality. It is widely used in forage programs throughout the Southeast. In Georgia, ryegrass is more productive on heavier soils (those with a high clay or loam content or moist low-lying soils) than on deep well-drained sandy soils. Ryegrass is more productive in late spring than the small grains and will extend the spring grazing season. Ryegrass may be seeded in pure stands. However, it may be necessary to mix ryegrass with rye and/or an annual clover so that high-quality forage can be maintained from late winter through spring (Table 2).

Table 2. The effect of a cool season annual mixture on stocker production.[†]

	ORG[‡]	RG	RRG	TRG	WRG
ADG (lbs/hd/d) [§]					
Winter	1.2	0.7	1.4	1.1	1.2
Spring	2.5	2.6	2.4	2.1	2.4
Gain (lb/acre)	253	239	281	219	256
Cost of Gain ($/lb)	$0.29	$0.28	$0.25	$0.39	$0.28
Net Return ($/acre)	$110	$106	$144	$56	$115

[†] Adapted from Beck et al., 2007. J. Anim. Sci. 85:536-544 (SW Arkansas, Avg. of 2 yrs). Costs and returns based on actual values at the University of Arkansas' Southwest Research and Education Center in 2002 and 2003.
[‡] ORG = oats + ryegrass; RG = ryegrass; RRG = rye + ryegrass; TRG = triticale + ryegrass; WRG = wheat + ryegrass.
[§] Stockers weighed between 500 and 575 lbs. Note that the stocking rate in this study began at 1.5 stockers/acre and additional calves were later added to maintain equal grazing pressure on each treatment (a research method called "put-and-take"). In this study, grazing began in early winter (early January) and continued through early May in each system.

Cool Season Annual Clovers – Arrowleaf and crimson clover are cool season annual legumes adapted to well-drained, fertile soils in the Coastal Plain and Piedmont areas. These clovers are most productive in spring. Crimson matures earlier in spring than arrowleaf and provides less grazing in late spring. In the Piedmont, arrowleaf may provide grazing until early June.

Legumes are generally higher in protein and more digestible than cool season annual grasses, particularly as the grasses mature in late spring. As a result, gains of 2.5 lbs/head/day and 260 lbs/acre can be expected during spring grazing when an annual clover is used. In addition, these legumes may contribute as much as 100 lbs of nitrogen (N)/acre via nitrogen fixation.

Management Considerations for Cool Season Annual Stocker Pastures

Detailed recommendations for managing cool season annual forages are covered more fully in other Extension publications such as "Georgia Forages: Grass Species" and "Georgia Forages: Legume Species." However, there are some slight variations on the recommendations for planting, fertilizing, and managing the grazing of cool season annuals that should be considered when they are to be used in a stocker development enterprise.

Planting – The first priority is to ensure that adequate forage is available when the grazing period needs to begin. The timing of forage availability is primarily affected by the cool season annual species (and, in some cases, variety) that is used, the type of seedbed into which the crops are to be planted, and the planting date. If late fall or early winter grazing is desired, rye or oats should be used (Figure 3). However, if peak forage availability is needed in the spring, annual ryegrass and wheat will generally provide more forage during those months. Crops planted into a prepared seedbed start quickly and provide grazing as early as late November in south Georgia or late December in north Georgia. However, to allow for the earliest possible grazing, the crop will need to be seeded as early as possible (early to mid-September in the Limestone Valley/Mountains region, mid- to late September in the Piedmont region, late September to early October in the Coastal Plain region).

If grazing in mid- to late winter is the goal, then cool season annuals can be planted into an existing warm season perennial grass sod. However, sod-seeded cool season annuals are slow-growing in the fall, and the forage is unlikely to achieve a sufficient height for grazing until late December or the end of January. Planting early may not allow for much earlier grazing when it is sod-seeded, and these early plantings may be slowed by the perennial grass or damaged by disease. When sod-seeding into perennial grass pastures, it is best to wait until growth of the perennial grass has been slowed by cool temperatures (mid-October).

Seeding rates can also affect the timing of forage availability in certain situations. When attempting to graze as early as possible, use a seeding rate that is on the high end of the recommended range, as this will generally provide more grazing earlier in the season (Table 3). Seeding rates higher than the recommended range are unlikely to provide any additional or earlier grazing and may increase the risk of disease. Late winter and spring forage yields are not influenced by seeding rates in the recommended range.

Table 3. Seeding rates and target planting dates for cool season annual forages.

Species	Seeding Rate*	
	Grown Alone	Mixture
	lbs / acre	
Ryegrass	25-30	15-25
Rye	90-120	60-90
Wheat	90-120	60-90
Oats	90-120	60-90
Triticale	90-120	60-90
Arrowleaf Clover	6-8	5-6
Crimson Clover	20-30	10-15

* Use higher seeding rates when broadcasting and lower rates when drilling into a prepared seedbed or existing sod (overseeding pasture).

Fertilization – A good fertilization program is necessary to produce high yields of high quality forage. Obtain a representative soil sample from each pasture and apply the recommended rates of phosphorus (P) and potassium (K) before planting. Amend the soil with lime to maintain soil pH above 6.0.

Small grain and ryegrass pastures can utilize up to 150 lbs of N/acre. Nitrogen fertilization is a key management tool to control forage growth. Adding N at the right time can increase tillering (thickening of the stand) and forage yield. Withholding N at certain times can help prevent the crop from growing too fast. Applying N at planting or soon thereafter is critical, since that initial 50 lbs of N per acre increases initial tillering and provides earlier grazing. A second application of N per acre should be applied in mid-January to early February to increase winter and spring forage production. If there is a great need for forage at that time and the coming weeks, 50 lbs of N per acre should be applied. If the need is less, decrease the N rate accordingly. If cool season annual legumes were used and they contribute 30 to 40 percent or more of the stand, then no more than 25 lbs of N per acre will be necessary in the winter application.

Because ryegrass is longer-lived, a third application of up to 50 lbs of N per acre may be needed in early spring when ryegrass is grown alone or used in a mix for late spring grazing, hay, or silage. If cool season annual legumes constitute 30 to 40 percent or more of the stand, then little if any additional N will be necessary in the spring. The key to remember is that ryegrass is very responsive to N. Take care to only apply enough N to meet the forage yield goal. Excess ryegrass forage, if it cannot be utilized, can be wasteful and pose risks to the grass crop that follows. This is especially problematic if the annual ryegrass is sod-seeded into bermudagrass, as late ryegrass production has been shown to decrease bermudagrass yields by 30 to 50 percent.

Grazing Management – Well-managed stands of cool season annual forages can provide excellent grazing. Grazing management can influence forage growth and utilization and animal performance. Limited grazing can begin in the fall as soon as the plants are well established and have 6 to 8 inches of accumulated growth. This ensures that root development is sufficient to prevent grazers from plucking the plant from the soil. Limited early grazing will improve tillering and increase stand density. However, it is critical that the pastures are not overgrazed during the early grazing period (i.e., maintain at least 2.5 to 3 inches of stubble height). This is also important in late winter when pastures start to recover from extreme cold. Allowing some regrowth to occur before putting significant grazing pressure on the pasture will significantly improve spring forage production.

Achieving the proper balance between cattle stocking rate and the forage growth rate is difficult. Forage growth varies during the growing season with changes in temperature and moisture conditions. The correct number of animals per acre in one week may be far too many the next week. To best utilize the forage that is grown, plan to provide supplemental feed and/or conserved forage during periods of slow pasture growth so that pastures will not be overgrazed.

Another way to prevent damage to late fall and winter pasture is to implement a rotational grazing program. Rotational grazing systems (sometimes called management-intensive grazing or MiG) allow the forage crop to recover more fully before being grazed again. Further, rotational grazing can substantially increase forage utilization efficiency (i.e., more of the forage that is produced ends up being consumed by the grazing animals) and this can increase the stocking rate that the forage system can sustain. More detailed information about the benefits of rotational grazing/MiG and the steps necessary to develop an efficient grazing system can be found on the University of Georgia's Management-Intensive Grazing website (www.caes.uga.edu/topics/sustainag/grazing).

Another strategy to more tightly control grazing is a method called "limit grazing." Limit grazing is a system by which the animals are only allowed a brief opportunity to graze (usually one to two hours). Limit grazing works best when the cattle are allowed access at strategic times during the day. Cattle generally consume large quantities of forage in the morning (~6:00 to 8:30 a.m.) and mid-afternoon (3:00 to 5:00 p.m.) with a smaller bout around the time the sun sets. Timing a limit grazing bout to align with one or more of these natural grazing behaviors during a day can allow the animals to obtain much of their diet from the available pasture while minimizing hoof traffic and other damage to the stand. Of course, this assumes that one has another pasture or lot and enough conserved forage and feed for the animals when they are not present in the limit grazed pasture.

Regardless of the grazing system, it is important to measure how much forage is on offer, monitor the growth rate of the forage, and manage how much forage is allocated to the herd. The forage can easily be measured using a grazing stick or rising plate meter. This data can then be entered into a spreadsheet that can display the total forage in each pasture or paddock and the growth rate. More information on how to measure, monitor, and manage forage growth and allocation can be found on the University of Georgia's Management-Intensive Grazing website on the page titled "Decision Support Tools for the 3 Ms of Grazing Management" (www.caes.uga.edu/topics/sustainag/grazing/3Ms.html).

Cool Season Perennial Forage Programs

The only cool season perennial forage systems recommended for use in stocker development in Georgia are those based on tall fescue. However, a large number of cool season perennial forage species can be used for stocker development in other parts of the U.S.

Tall Fescue as a Forage for Stocker Cattle

Tall fescue is grown throughout the Piedmont and Mountain regions in Georgia. Tall fescue is best adapted to moist soils and is most productive in spring and fall, but it is dormant during July and August in Georgia. When adequate moisture is available, tall fescue will provide excellent grazing in spring, fair to good grazing from June through early July and good grazing in the fall (Figure 4). However, tall fescue productivity in the fall is highly dependent on rainfall. Under conditions of average rainfall and temperature, tall fescue may yield 8,000 to 10,000 lbs of DM/acre/year (Table 1).

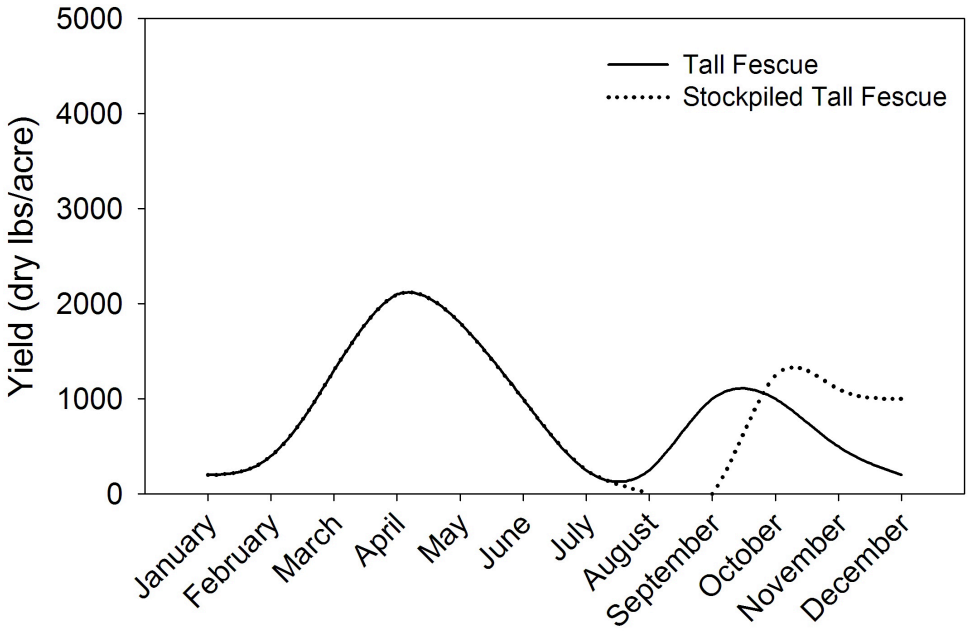

Figure 4. Forage distribution of tall fescue and the typical amount and timing of stockpiled tall fescue.

Tall fescue is also very tolerant of grazing and environmental extremes in Georgia. Much of this versatility is due to an endophytic fungus (*Neotyphodium coenophialum*) that grows within the plant. Unfortunately, this fungus also produces toxic alkaloids that cause several metabolic problems (collectively termed "fescue toxicosis") in animals consuming endophyte-infected varieties. These problems often lead stocker calves to have ADGs of less than 1.0 lbs/head/day (Table 4).

Table 4. The effect of endophyte status on stocker performance on tall fescue in the fall and spring.†				
	ADG (lbs/hd/d)	**Gain** (lb/acre)	**Stocking Rate** (hd/acre)	**Grazing Time** (days)
Fall				
Toxic Endophyte-Infected Jesup	1.5	137	1.5	63
Endophyte-Free Jesup	2.3	211	1.5	63
Jesup MaxQ™	2.1	188	1.5	63
Spring				
Toxic Endophyte-Infected Jesup	0.8	119	1.6	91
Endophyte-Free Jesup	2.2	313	1.6	91
Jesup MaxQ™	1.8	251	1.6	91
† Adapted from Parish (2001).				

In the past, only endophyte-free varieties of tall fescue were recommended for stocker cattle. These varieties can produce ADGs of 1.5 to 2 lbs/head/day during the spring and fall seasons. However, **fungus-free varieties ARE NO LONGER RECOMMENDED** because their reduced drought and heat tolerance, increased susceptibility to insects and nematodes, and propensity to be overgrazed has led to persistence problems.

In the late 1990s, strains of the fungal endophyte that do not produce toxic alkaloids were identified and inserted into tall fescue varieties. The development of these "novel endophytes" (NE) was a joint venture between Dr. Joe Bouton, professor emeritus at the University of Georgia, and Dr. Gary Latch at Ag-Research Limited of New Zealand. Varieties that have been infected with the novel endophyte are now marketed in the U.S. Several researchers have evaluated the productivity and persistence of NE tall fescue varieties throughout the tall fescue-producing areas of the state (Figure). Over these several years of research, NE tall fescue varieties have consistently resulted in ADGs of 1.8 lbs/head/day or greater. Similar studies throughout the Southeast have shown similar results to those listed in Table 4. These studies also indicated the stockers on NE tall fescue pastures had hair coats that were less rough, lower body temperatures, spent more time grazing, and spent less time standing in the shade or in pools of water (Figure 6). The gains and animal performance improvements observed for stockers on NE tall fescue pastures were essentially the same as those on fungus-free pastures, but the NE tall fescue varieties persisted substantially better. More information about novel endophyte-infected tall fescue is available in the UGA Extension bulletin "Novel Endophyte-Infected Tall Fescue."

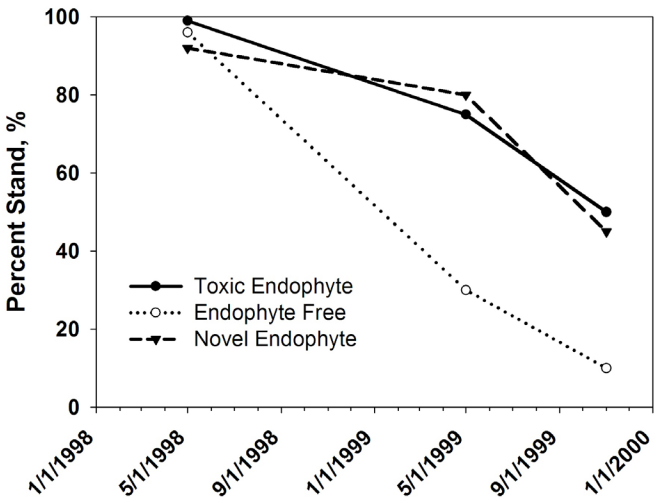

Figure 5. Stand persistence of novel endophyte-infected ('Jesup MaxQ™'), toxic endophyte-infected, and endophyte-free tall fescue in bermudagrass sod after two years of close grazing near Eatonton, Georgia (Bouton et al., 2000).

Figure 6. Cattle grazing toxic tall fescue (foreground) spent less time grazing, while cattle grazing MaxQ™ (background) and endophyte-free tall fescue had higher intakes and performance (Parish, 2001).

Subsequent Feedlot Performance

One of the major problems facing cattle producers in the Southeast is the stigma associated with calves that have been stockered on tall fescue. The perception among many of the cattle buyers is that calves that have been stockered on tall fescue will not gain as well in the feedlot, may have increased morbidity or pull rates, or may not be as efficient as feeder calves that were stockered in other areas or on other forage systems. This perception is based on biases about stockers that had been backgrounded on toxic endophyte-infected tall fescue.

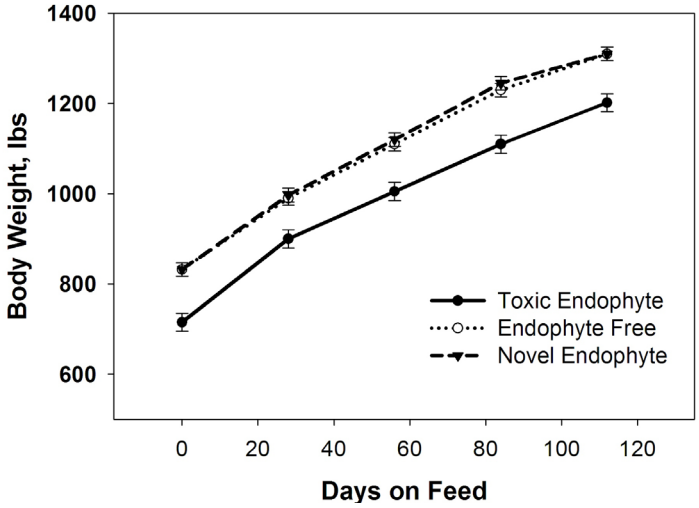

Figure 7. Subsequent feedlot performance of cattle that had grazed toxic, endophyte-free, and novel tall fescue during the stocker phase. Cattle originally grazed pastures in Eatonton and Calhoun, Georgia, and were finished in Stillwater, Oklahoma (Duckett et al., 2001).

Research that followed three of the aforementioned NE tall fescue grazing studies in Georgia examined the legitimacy of these perceptions. The stocker cattle from these studies were finished on high-concentrate diets and their feedlot performance was tracked. No difference in animal performance, feed efficiency, or most carcass quality measurements were found in those calves that had been grazing novel endophyte, endophyte-free, or toxic endophyte tall fescue. However, because of improved stocker performance, the cattle that grazed endophyte-free and novel endophyte tall fescue entered the feedlot heavier and reached targeted harvest weights sooner (Figure 7). While there appeared to be no feedlot performance depression from fescue toxicosis, heavier weights going into the feedlot will either (1) increase finished weights or (2) decrease time-on-feed, either of which translates into more profitable beef production.

Including Legumes in Tall Fescue Pastures

The addition of legumes to tall fescue pastures has only a minimal impact on total forage yield. However, including a legume increases the quality of the pasture and results in the addition of biologically-fixed nitrogen. The effect of these two factors result in increased ADG and gain/acre and a substantial decrease in the total cost of the forage system. As a result, the cost of gain of tall fescue-clover pastures is low and profitability is increased. In fact, research in Alabama has shown that tall fescue-based pastures where legumes were used provided the lowest cost of gain of any forage system. Thus, the practice of adding a legume to tall fescue stands is highly recommended (see the inset titled "Adding Clover to Toxic Endophyte and Novel Endophyte Tall Fescue").

A number of cool season legumes are used in Georgia. However, there are two forage legumes that fit best with tall fescue: white clover and red clover.

White Clover – White clover is a low-growing legume that spreads by stolons and can tolerate close grazing. It furnishes grazing in fall, late winter, and spring. Yields of white clover are usually not sufficient for it to be grown alone or as a hay crop, but it contributes a substantial amount of high quality forage when produced with tall fescue. White clover grows best on moist soils and can die during hot, dry summers. However, some new varieties of white clover are more persistent and will either survive these conditions or return from seed.

There are three basic types of white clover: large (e.g., Ladino clover, 'Patriot,' 'Regal'), intermediate (e.g., 'Durana,' 'Osceola'), and low-growing (e.g., Dutch clover). Large or ladino types are higher yielding than other types, but they do not reseed as well as the other types and are generally more short-lived. The intermediate types are well adapted to most sites, and they are prolific reseeders. Intermediate white clovers are more tolerant of grazing and persist better than red clover (especially in some drought-prone and infertile sites). Consequently, white clover often fits better within tall fescue-based pastures that are continuously stocked or stocked in a way that leaves animals in the pasture while the clover is recovering from grazing.

Red Clover – Red clover is a short-lived perennial legume that is adapted to a fairly wide range of soils. It can be seeded into tall fescue stands along with or instead of white clover. Red clover is taller growing and higher yielding than white clover. It is also more deeply rooted than white clover. Consequently, it is more productive than white clover during periods of drought stress. However, even under the best conditions, red clover stands start to thin in the second year. Moreover, red clover does not tolerate close grazing and will not produce or survive well in continuously stocked pastures. As a result, red clover will need to be replanted every two to three years and should only be used in well-managed, rotationally grazed, tall fescue pastures.

Additional information about establishing and managing white and red clover in tall fescue pastures is available in other UGA Extension publications such as "Georgia Forages: Legume Species," "White Clover Establishment and Management Guide," "Grazing Impacts on Pasture Composition," and "Seeding Methods for Small-Seeded Legumes" (www.caes.uga.edu/commodities/fieldcrops/forages/species/documents/SeedingMethodsforSmall-SeededLegumes.pdf).

Adding Clovers to Toxic Endophyte and Novel Endophyte Tall Fescue

Adding clover to toxic endophyte-infected tall fescue pastures generally increases stocker ADGs to a level that is similar to endophyte-free and NE varieties. However, the effect of the clover addition is not a "dilution effect," as has been previously assumed. When clover is included with the NE tall fescue, an additional improvement in animal performance and gains/acre is observed (Table 5). Thus, the addition of clover is an additive benefit.

Table 5. The effect of tall fescue endophyte status and the use of white clover in the pasture on stocker performance.[†]

	ADG (lbs/hd/d)	**Gain** (lb/acre)
Toxic Endophyte	1.1	126
Novel Endophyte	1.8	186
Toxic + White Clover	1.6	150
NE + White Clover	2.6	252

[†] Bouton, Andrae, and Hill (unpublished data).

Management Considerations for Tall Fescue Pastures for Stockers

Detailed recommendations for establishing and managing tall fescue are available in other UGA Extension publications such as "Georgia Forages: Grass Species" and "Novel Endophyte-Infected Tall Fescue." However, there are some slight variations on the recommendations for fertilizing and managing the grazing of tall fescue that should be considered when it is to be used in a stocker development enterprise.

Fertilization – As with all the other forage systems, it is critical to have a soil fertility program based on representative soil samples from each pasture or management area. Lime and P and K fertilizer should be applied based on soil test recommendations. Pure stands of fescue (no clover) should receive 60 to 80 lbs of N/acre in early spring (March) before rapid growth starts. When a good stand of clover (greater than 30 percent) is present in the pasture, little or no additional N is needed. However, if N is to be applied, avoid using more than 40 lbs of N per acre, as this may cause the clover stand to be reduced. Well-fertilized tall fescue or fescue and clover mixtures typically can carry 1.5 to 2 stockers (~600 lbs/stocker)/acre during the spring.

The amount and duration of the fall grazing season is temperature- and moisture-dependent. Additional N in early fall (40 lbs of N/acre) will allow the forage to take advantage of favorable growing conditions and produce good grazing from late September through November. During this period, well-managed fescue can carry up to 1.5 stockers (~600 lbs/stocker)/acre if growing conditions are favorable. Early fall N applications also can induce tall fescue to produce more tillers and form a denser sod. This will help prevent weed encroachment in the future.

With sufficient rainfall, a late summer application of 40 to 60 lbs of N/acre will produce 2,500 to 3,500 lbs of tall fescue that could be allowed accumulate and stockpiled for later grazing in late fall and early winter. Stockpiled tall fescue can sustain approximately 0.75 stockers (~600 lbs/stocker)/acre and can extend the grazing season well into late fall or early winter (Figure 4). For more information on stockpiling tall fescue, see the UGA Extension publication titled "Stockpiling Tall Fescue for Fall and Winter Grazing."

Grazing Management – Fescue pastures grow rapidly in the spring. Pastures should be stocked heavy enough to maintain high-quality forage. The ADGs of calves in a rotational grazing system may be similar to those in continuously stocked pastures. However, rotational grazing improves forage utilization and has been shown to increase animal gains per acre on tall fescue-based systems.

Rotational grazing also helps keep fescue plants vegetative in the spring. When cattle graze a fescue tiller that has started to produce a seedhead, the growing point is often removed. This prevents that tiller from producing a seedhead. Other tillers will then grow more rapidly, increasing forage production. Having several pastures allows the manager to focus the grazing pressure on smaller areas during periods of rapid pasture growth, keeps the fescue vegetative, and enables greater yields of digestible nutrients. Paddocks not needed for grazing can be set aside and harvested for hay. A stocking rate that is too low in late spring may not apply enough grazing pressure to keep up with the forage growth. As a result, forage quality may decline rapidly, especially once the plants begin to produce seedheads.

Avoid overgrazing in summer by adjusting stocking rates, providing supplemental feed, or transitioning to a warm season annual forage. This is especially important for endophyte-free and NE infected varieties since cattle will continue to graze these crops during the summer.

Warm Season Annual Forage Programs

Some warm season annual grasses can provide high yields of good quality forage for short periods during the summer (Table 1). Warm season annuals can work well in rotation with winter grazing crops and small grains harvested for grain or for use during tall fescue's summer dormancy. However, only a few warm season annual forages have the quality and yield required to sustain adequate stocker gains in Georgia. Furthermore, a 2009 analysis by forage agronomists and livestock economists at Auburn University found that warm season annual forage programs resulted in the second highest cost of gain ($1.35/lb of gain) of 37 forage systems evaluated. Consequently, it is important for stocker developers to ensure that the production costs associated with a warm season annual forage-based stockering program will be such that they can make the system profitable.

Warm Season Annual Forage Crops

Pearl Millet – Pearl millet is a warm season annual grass commonly used in Georgia. Dwarf millets, such as Tifleaf-3, have a higher percentage of leaves (fewer stems) and produce relatively high animal gains. Tifleaf-3 tends to yield well compared to the tall growing varieties and it is resistant to leaf spot diseases, which frequently reduce yield and forage quality in other pearl millets. Pearl millet is well adapted to sandy soils but will perform well throughout the state. Unlike sorghum-sudangrass hybrids and other members of the sorghum family, pearl millet does not cause prussic acid poisoning during periods of drought. Pearl millet yields quite well, even when subjected to drought or low soil pH. However, like all warm season annuals, nitrate accumulation in drought-stressed crops pose a significant risk to the health of ruminant animals that may graze them under such conditions.

Pearl millet can be grazed or harvested at any growth stage. To optimize forage quality, however, grazing of pearl millet should start when plants accumulate 20 to 24 inches of growth and stockers should be removed when 6 to 12 inches of stubble remain. These rotational stocking methods also promote good regrowth.

Research on the use of pearl millet for stocker development is limited. However, a few studies have demonstrated that ADGs of 1.4 to 2 lbs/day are possible. However, gains per acre vary widely with growth conditions, grazing management, condition of the animals, stocking rate, and the number of days in the grazing period. In general, a stocking rate of 2 to 2.5 stockers (~600 lbs/stocker)/acre over an 80- to 100-day grazing period should be anticipated if rotational stocking is used.

Sorghum-Sudangrass Hybrids – Crosses of sorghum and sudangrass have resulted in hybrids that are high yielding and high in forage quality. Sorghum-sudangrass hybrids are available that have the brown-midrib (BMR) trait. Varieties with the BMR trait have lower lignin levels, which can substantially increase the digestibility of

their forage. Sorghum-sudangrass hybrids are commonly used in Georgia, and the BMR hybrids are becoming more popular. However, none of the sorghum-sudangrass hybrids are as tolerant of high grazing pressure, low soil pH, or drought as pearl millet. The latter can pose a significant risk to stocker producers, since drought-stressed sorghum-sudan is not only at risk of toxic levels of nitrates but it may also contain toxic concentrations of prussic acid (cyanogenic compounds). Prussic acid problems are also problematic in the fall when the forage has been subjected to frost.

In general, forage systems based on sorghum-sudangrass will provide similar to slightly better ADGs than pearl millet-based forage systems. However, the maintenance of similar or higher gains/acre will require good growing conditions and excellent grazing management. Like pearl millet, a stocking rate of 2 to 2.5 stockers (~600 lbs/stocker)/acre and an 80- to 100-day grazing period should be anticipated if rotational stocking is used.

Crabgrass – Crabgrass is a warm season annual forage grass that is well adapted to the soils and climatic conditions in the humid Southeast. Though it is most widely known as a weed, it has excellent palatability and produces exceptionally high forage quality relative to other warm season annuals and warm season perennials. Another distinct advantage for crabgrass is that it readily reseeds itself each year as long as it is allowed to produce a seedhead and mature. Crabgrass yields are quite variable, as they are dependent on the selection of a well-drained site, soil fertility, and rainfall. Forage yields for crabgrass generally range between 1 and 5 tons/acre, but one should expect yields to be 3 to 4 tons/acre. These yields are slightly lower than those typical of other warm season annuals; thus, a stocking rate of ~ 1.5 stockers (~600 lbs/stocker)/acre should be expected. In trials in north Florida, stockers grazing crabgrass gained 1.1 to 1.9 lbs/head/day. Research from other states in the Southeast confirms that ADGs of 1.5 to 1.8 lbs/head/day can be expected. The length of the grazing period for crabgrass ranges from 60 to 120 days in the limited research that has been conducted. Additional research into stocker performance on crabgrass in Georgia is needed to determine best management practices and the economic viability of its use. However, it appears to have potential as a warm season annual forage crop for stocker development, especially if rotationally stocked.

Others – A number of other warm season annual forages are grown in Georgia, including forage sorghum, sudangrass, browntop millet, and teff. Either because of poor yields, low quality, a predisposition to nitrate accumulation, or grazing management problems, these forage crops are generally not useful in stocker development programs in Georgia and are not recommended.

Management Considerations for Warm Season Annual Stocker Pastures

Detailed recommendations for establishing and managing warm season annuals are available in other UGA Extension publications such as "Georgia Forages: Grass Species" and the fact sheet titled "Planting Warm Season Annual Grasses" (www.caes.uga.edu/commodities/fieldcrops/forages/documents/PlantingWarmSeasonAnnualGrasses.pdf). There are some slight variations on the recommendations for fertilizing and managing the grazing of warm season annuals that should be considered when they are to be used in a stocker development enterprise.

Planting – Pearl millet and sorghum-sudangrass hybrids should be planted into a moist, well-prepared seedbed to a depth of 1 inch. Seeding these forage crops in rows using a well-calibrated grain drill usually results in better stands than broadcast methods. Wider row spacings (e.g., 30 inches) will reduce damage from hoof traffic. However, narrow row spacings (less than 15 inches) will result in a better coverage of the soil and should be used when the site is prone to erosion. Planting rates when drilled or planted into rows are 10 to 15 lbs/acre for pearl millet and 15 to 20 lbs/acre for sorghum-sudangrass hybrids. Higher seeding rates are often used to increase the proportion of leaves to stems and to increase forage quality. However, this can result in lodging problems in the sorghum-sudangrass hybrids, especially if they contain the BMR trait. Broadcast plantings of these species can also be made, but may result in erratic stands with poor vigor. Since early planted stands will produce more forage than stands planted late, it is recommended that plantings be made in early April in south Georgia, mid-April in the Piedmont region, and late April to early May in the Limestone Valley/Mountains region.

In contrast, crabgrass should be planted at a depth of 0.25 to 0.5 inch in a well-prepared seedbed at a rate of 4 to 6 lbs/acre. It is best to plant crabgrass with a drill (7 to 7.5 inch spacing) or to use a cultipacking seeder (e.g.,

Brillion). Crabgrass seed can be broadcast, but it is best to mix the seed with coarse sand (similar in size to the seed). The sand acts as a carrier to increase the volume being broadcast and to improve the distribution and accuracy of the seeding rate. Crabgrass can be planted in spring after the danger of frost has passed.

Fertilization – Despite their tolerance to low fertility, it is critical to have a soil fertility program for warm season annual forages. For best results, these high-yielding grasses will need high levels of fertility. Soil test and apply the recommended quantities of lime, P, and K before planting. Though these crops are quite responsive to N, high rates of N in combination with dry weather may result in high nitrate levels in the forage. Split applications of N reduce this risk and even out forage production peaks. Apply 40 to 60 lbs of N/acre when these warm season annuals are planted (or soon thereafter) and an additional 40 to 60 lbs of N/acre every four weeks or when cattle are rotated to a fresh pasture. When warm season annual grasses are irrigated, nitrogen rates may need to be increased to 60 to 80 lbs of N/acre at planting and 60 to 80 lbs of N/acre prior to regrowth. Nitrogen applications after early August are not justified, as the forage produced thereafter will generally be low in quality and unpalatable.

Grazing Management – Warm season annual grasses can usually be grazed within 30 to 35 days after planting. Graze when the plants have reached the target height and remove them when the residual height approaches the target stubble height (detailed for individual crops above). Grazing warm season annuals is most efficient when cattle are rotated from paddocks that have been grazed to another paddock that is ready to graze. This allows the forage to regrow before being grazed again. Dividing large pastures into smaller units for rotational grazing will improve control over the utilization. Warm season annual grasses that are not regularly grazed will start reproductive growth (heading). If this occurs, mowing the pasture to the target stubble height (see above) may stimulate vegetative growth.

The most difficult challenge when using pearl millet or sorghum-sudangrass hybrids is that they generally produce forage over a relatively short grazing period (usually less than 120 days), and the majority of this forage is produced in the first 60 to 75 days after planting. This can make grazing management of these stands challenging. Under good growing conditions, these warm season annuals may grow so rapidly that sufficient grazing pressure is difficult to maintain. This is especially problematic in the first 15 to 30 days after grazing begins. The consequence of this is that the forage may mature very quickly and result in poor quality forage. To minimize this effect, be prepared to initiate grazing earlier or stock more heavily.

The rapid growth of these species in the first half of the growing season can also result in poor forage distribution throughout the grazing period. Cattlemen who plan to utilize pearl millet or sorghum-sudangrass hybrids for grazing throughout the summer should plan to make more than one planting. Staggering plantings by two to three weeks can help distribute the forage growth. However, staggering plantings later than mid- to late May is unlikely to substantially improve forage distribution and may severely reduce total forage productivity. Stocking rates may start higher early in the season and may need to be reduced as forage growth and/or quality declines. With irrigation and higher rates of fertilization, stocking rates can be increased.

Warm Season Perennial Forage Programs

Warm season perennial forage crops are widely used throughout Georgia for grazing and hay production. In general, the most common warm season perennials are bermudagrass and bahiagrass. Bermudagrass is productive from spring until fall and responds well to fertilization and harvest (grazing or haying) management. Though the forage quality of bermudagrass is generally lower than cool season species, it can be highly digestible and high in crude protein when kept vegetative (Table 1). Bahiagrass productivity is less tied to fertility and more tolerant of overgrazing, but it is typically less productive and lower in forage quality than bermudagrass. With bahiagrass, the forage quality is not sufficient to attain an ADG of 1.5 or greater (Table 6) without substantial supplemental feed. Some bermudagrass varieties can achieve this goal, but a supplemental feeding program may be necessary to ensure that this goal is consistently achieved while maintaining high stocking rates.

Table 6. Stocker performance on 'Pensacola' bahiagrass and preferred bermudagrass varieties in selected research trials in the Coastal Plain.

	State	ADG (lbs/hd/d)	Gain (lb/acre)	Stocking Rate (hd/acre)	Grazing Period (days)
Pensacola (bahia)	GA[1]	1.0	222	1.5	131
Coastal	GA[1]	1.1	331	2.5	131
Coastal	TX[2]	1.0	279	3.0	92
Coastal	GA[3]	1.5	641	2.5	168
Tifton 44	GA[3]	1.6	681	2.5	168
Tifton 78	GA[4]	1.4	704	3.2	169
Tifton 85	GA[4]	1.5	1032	4.4	169
Tifton 85	TX[2]	1.7	465	3.0	92

[1] Utley et al., 1974. J. Anim. Sci. 38:490-495.
[2] Rouquette et al., 2003. Beef Cattle Research in Tx. pp. 62-66.
[3] Utley et al., 1981. J. Anim. Sci. 52:725-728.
[4] Hill et al., 1993. J. Anim. Sci. 71:3219-3225.

Warm Season Perennial Forage Crops

Hybrid Bermudagrass – Because of their high yield potential and, in some cases, increased digestibility, cattlemen grazing stockers should consider the use of hybrid bermudagrass as their primary basis in their warm season perennial forage system. Many years of selection, breeding, and research have led to the release of several hybrid bermudagrass varieties. However, only a few of these have been shown to consistently provide high yields, increased digestibility, and improved animal gains in university research and on-farm trials (Table 6).

The best of the hybrid bermudagrass varieties for stocker development is 'Tifton 85' (Table 6). Tifton 85 has been shown to produce the highest yield, digestibility, ADG, stocking rate, and gain per acre of any of the forage bermudagrasses. Tifton 85 is clearly the best choice for new pastures for cattlemen in the Coastal Plain. Unfortunately, Tifton 85 lacks the cold tolerance of some hybrid bermudagrasses. Thus, it is not recommended for latitudes in Georgia north of approximately 32° N (roughly south of Interstate 20) until longer-term cold tolerance assessments can be made. Other hybrid bermudagrasses, such as 'Tifton 44,' 'Russell,' 'Tifton 78,' and 'Coastal,' are used in cow-calf production systems in Georgia and can also be used in stocker development systems. However, substantially more supplemental feeding will be necessary (relative to that on Tifton 85 pastures) to attain satisfactory ADG, stocking rate, and gain per acre of stockers grazing these other varieties. More detailed information on bermudagrass varieties can be found in the UGA Extension publication titled "Selecting a Forage Bermudagrass Variety."

Bahiagrass – Since bahiagrass is adapted to a wide range of soils in the Coastal Plain region and persists well under the hot, dry summers of the Southeastern U.S., bahiagrass is a common pasture species in the southern half of Georgia. However, it will not consistently support the stocking rate and live-weight gains per acre that hybrid bermudagrasses can provide. Even improved bahiagrass hybrids produce lower yield, digestibility, ADG, stocking rate, and gain per acre than most bermudagrass varieties. Consequently, the rate of supplemental feed required to attain satisfactory ADG, stocking rate, and gain per acre usually makes stocker development programs on bahiagrass unprofitable. As a result, bahiagrass is not recommended as a forage system for stocker development.

Management Considerations for Warm Season Perennial Stocker Pastures

Since bahiagrass is not recommended for stocker pastures, the following recommendations focus on the management of bermudagrass in the context of a stocker development program. Detailed recommendations for establishing and managing bermudagrass can be found in the UGA Extension publication titled "Georgia Forages: Grass Species." However, there are some slight variations in the best practices for establishing, fertilizing, and managing bermudagrass that should be considered when it is used in a stocker development enterprise.

Planting – New bermudagrass plantings require several months to become well established. Grazing while

attempting to get the bermudagrass to establish will severely reduce the speed at which the stand completely closes. If a new field is to be planted, it should be established for one year before the stocker program begins. Some grazing can be used later in the grow-in period as an alternative to mowing to remove excess forage and encourage thickening of the stand.

If a stocker program is planned, establishment of hybrid bermudagrasses is best accomplished by transplanting freshly-dug sprigs (rhizomes or stolons dug from existing stands) in May or early June. Though bermudagrass can be successfully established at other times, mid-spring plantings generally take advantage of better rainfall distribution and allow the bermudagrass to compete better with summer weeds. The application of diuron immediately after sprigging is recommended, as it provides excellent suppression of summer weeds during the early stages of bermudagrass establishment. However, diuron-treated fields cannot be grazed (or harvested for hay) within 70 days of application.

Fertilization – Soils in individual pastures should be tested every two to three years and recommended rates of lime and fertilizer should be applied. This is essential to maintaining high-yielding, productive stands. Bermudagrass responds well to high rates of N, but 150 to 200 lbs of N/acre is generally sufficient when grazed. Higher rates are appropriate if the stocking rate and the intensity of grazing management are high enough to utilize the forage produced. It is best to apply N in late March or early April (60 to 80 lbs/A) to stimulate new growth, and split the remaining N between two additional applications (one in late spring and one in mid-summer). When pastures are intensively managed, N and K should be applied about every four to five weeks from spring until late summer (March to August). Splitting the N and K fertilizer applications in this way will improve utilization of these important nutrients.

Grazing Management – Some bermudagrass varieties break dormancy and initiate new growth as early as mid-March in south Georgia and early April in north Georgia. However, grazing pressure should be avoided or kept low until the bermudagrass reaches a height of at least 4 inches and the forage is growing rapidly (usually after nighttime temperatures are consistently above 55° F).

Bermudagrass productivity, stand persistence, and forage quality are directly related to the height at which bermudagrass grazing begins and the residual height that remains after grazing. Because of this, it is best to initiate grazing when the forage reaches 8 to 10 inches in height and avoid grazing bermudagrass shorter than 2.5 to 3 inches. Maintaining these initial and residual grazing heights will optimize the amount of high-quality forage that is available and the rate of forage intake. This may require that the bermudagrass be given longer rest periods in periods of slow growth and shorter rest periods during periods of rapid growth.

Since the growth rate is not uniform throughout the season, the correct stocking rate one week may be too heavy or too light the next week. Varying the stocking rate from week to week is a good way to manage pasture growth. This will be difficult unless extra animals are added to the pastures over time. As a result, most cattlemen tend to stock lighter (slightly fewer head/acre) and allow some forage to accumulate in the pasture as a buffer against slow growth due to dry weather. Accumulated forage can also be cut for hay or, later in the season, stockpiled for deferred grazing as an alternative to feeding hay to a brood cow herd once the bermudagrass goes dormant. This is a reasonable approach when a rotational grazing program is used to help improve forage utilization.

Related Publications

Cutting Costs, Not Corners: Managing Cattle in Tough Times. University of Georgia Extension Bulletin 1373.

Fences for the Farm. University of Georgia Extension Circular 774.

Georgia Forages: Grass Species. University of Georgia Extension Bulletin 1351.

Georgia Forages: Legume Species. University of Georgia Extension Bulletin 1347.

Grazing Impacts on Pasture Composition. University of Georgia Extension Bulletin 1243.

Leaf Spot Diagnosis and Management in Bermudagrass Forages. University of Georgia Extension Circular 887.

Planting Guide to Grasses and Legumes for Forage and Wildlife in Georgia. University of Georgia Extension Circular 814.

Selecting a Forage Bermudagrass Variety. University of Georgia Extension Circular 919.

Soil and Fertilizer Management Considerations for Forage Systems in Georgia. University of Georgia Extension Bulletin 1346.

Stockpiling Tall Fescue for Fall and Winter Grazing. University of Georgia Extension Circular 920.

UGA Basic Balancer Instructions. University of Georgia Extension Bulletin 1371.

UGA Feed Cost Analyzer. University of Georgia Extension Bulletin 1377.

White Clover Establishment and Management Guide. University of Georgia Extension Bulletin 1251.

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