Native Grass Forages for the Eastern U.S.

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Director, Center for Native Grasslands Management University of Tennessee Institute of Agriculture

Foreword by Don Ball, Auburn University



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FOREWORD

During the 45 years I have worked as an agronomist, I have observed that no two farms are exactly the same. Development of an exceptional forage program requires creativity and consideration of numerous possible approaches. Often, a viable option is use of native grasses.

Grazing livestock owned by early settlers received most of their nutrition from native plants, the most productive being some key native perennial grasses. However, by the early part of the 20th century, native grasses were no longer prevalent. Most plants grown for forage in the eastern United States had an interesting commonality with the majority of the human inhabitants of the region; they had originated in other parts of the world and were, in essence, immigrants.

In 2006, a development occurred that significantly changed the way native grass forages are viewed. It has created awareness of their attributes, enhanced knowledge of their establishment and management requirements, and greatly increased the scope of their use. I refer to creation by the University of Tennessee of the Center for Native Grasslands Management, for which Pat Keyser was hired to be director.

He proved to be the right person for this job. As a University of Tennessee faculty member, he has an impressive record. This includes authorship of numerous peer-reviewed scientific articles, extension publications, and popular articles — nearly 400 altogether. During his tenure with the Center, he has spoken at well over 100 professional conferences, as well as at over two hundred other events, often as an invited speaker. He has been involved in conducting scores of in-service trainings for university and agency personnel, and well over 100 producer/landowner workshops in numerous states. Under his leadership, the Center has been supported by grants from numerous agencies that have totaled more than 10 million dollars.

This book provides discussions of a broad range of topics pertaining to native forage grasses. This includes their history and the benefits and challenges associated with growing them. Excellent information is provided regarding site selection, establishment and management. The practicality of the book is evidenced by inclusion of insightful discussions of several other important topics including economics, conservation benefits, and soil health. Even seed sources are provided!

Use of native forage grasses can greatly benefit forage-livestock producers in the eastern United States, particularly in areas in which cool-season perennial forages are widely used. The timing of their growth is often instrumental in preventing overgrazing of other forages, they provide a dependable source of nutrition for livestock during periods of extreme heat and drought, enhance wildlife populations, and improve soil health.

I have long been impressed with the accomplishments of my friend and colleague Pat Keyser, but I believe this book is a particularly remarkable achievement, and I think you will as well. In fact, I expect that Native Grass Forages will come to be viewed as a classic agricultural publication! It will be a treasured resource for forage producers, wildlife enthusiasts, conservationists and others who have realized the many attributes these species offer.

Don Ball Professor Emeritus, Auburn University Co-author of *Southern Forages*

PREFACE

In the years that I have been working with native grasses, I have encountered plenty of opinion — some strong, one way or the other — and plenty of conjecture. I have also found that if one is willing to dig through scientific journals, there is a good deal of published research on these grasses. However, the majority of that research has been conducted in the Great Plains, a region with quite different climate and soils than what we have here in the eastern U.S. More recent research has been focused not on forage but on the production of biomass for renewable energy. The remaining research is scattered among numerous journals and is not readily available to the practitioner, farmer, Extension agent or others interested in native grasses forages for the farms of the eastern U.S.

Therefore, I have taken on the task of synthesizing several decades of past research, a number of contemporary studies by numerous scientists and the work that has been conducted at the University of Tennessee over the past 15 years. The book format also provides the flexibility to draw on decades of experience — mine and that of many others — to provide some "mortar" to hold together the "bricks" of science that I have synthesized. It is my hope that by bringing together both science and first-hand experience we can replace some of the conjecture regarding native grasses with evidence-based knowledge. Better still, the book format has allowed me to use laymen's terms, making this information readily available to those interested in learning more about this forage tool.

Speaking of tools, I am reminded of Garry Lacefield, the recently retired forage Extension specialist at the University of Kentucky who often spoke about the "toolbox" for forage management. He reminded us that in that toolbox were various forage species, fertility management, grazing management, herbicides and many other tools. Among those tools are our native grasses. In the early years of modern forage science, native grasses did not receive much attention. However, in more recent years, there has been increasing interest in this often overlooked tool. And this renewed interest in a very old "technology" is not without merit.

The native grasses considered in this book can indeed play a role in eastern forage production by providing solutions to some persistent forage production challenges. The most obvious of these roles are improved drought resiliency, summer forage production and animal health through lessened exposure to toxic tall fescue at particularly critical times of the year. Perhaps less obvious is the ripple effect these summer grasses can have on management of cool-season forages by way of increased flexibility including more summer rest and, thus, longer grazing seasons. Indeed, these heat- and drought-hardy species can serve to restore a better balance in our forage systems between cooland warm-season species, a balance that aligns us more closely with the historical composition of the grasslands of this region. Furthermore, native grasses can address several areas of emerging concern including improvements to soil health, water quality and habitat for at-risk grasslands wildlife and pollinator populations. And all this with low-input, long-lived perennials that, as species native to the entire eastern U.S., are widely adapted and able to be productive on marginal sites. It is also true though, that like all forage tools, native grasses have their strengths and weaknesses. They are challenging to establish, dormant during winter and less forgiving of poor management than many other forage grasses. However, most producers have found that by using sound agronomic and grazing practices, these challenges can be readily met.

The information in this book will enable individuals to make informed decisions about whether and how to use these grasses in each of their unique situations. The ultimate goal though is to contribute to more sustainable farms, those that are profitable, resilient, and improve the stewardship of our pastures, our soil, our water, and the ecosystems that sustain us. As was written many centuries ago, "He causes the grass to grow for the cattle, and herb for the service of man; that he may bring forth food out of the earth."

CONTENTS

FOREWORD	• •	•	• •	•	·	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	III
PREFACE			• •	• •	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	. v
ACKNOWLED	GN	ΛEI	NT	s.	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	.2	хШ

SECTION ONE: ABOUT NATIVE GRASSES

SECTION TWO: NATIVE GRASS ESTABLISHMENT

CHAPTER SIX: PLANNING YOUR PLANTING PROJECT
How Many Acres Should I Plant? • Site Selection • Species and Cultivar Selection • Pre-planting Competition Control
CHAPTER SEVEN: PLANTING NATIVE GRASSES
Fertilization During the Seedling Year • No-till Versus Conventional Seed- beds • Planting Equipment • Planting Timing • Planting Rates, Depth and Seed Treatments • Dormancy in Native Grass Seed
Chapter eight: managing the seedling stand
Seedling Development • Follow-up Competition Control • Imazapic • Nurse Crops During Establishment • What Does Success Look Like? • Second-year Management
CHAPTER NINE: RENOVATING NATIVE GRASS STANDS
REFERENCES, SECTION TWO
SECTION THREE: MANAGING NATIVE GRASSES
Chapter ten: grazing management
with Ray Smith, co-author Basic Principles of Grass Management • When to Initiate Grazing in Spring • Improved Summer Grazing Starts in the Spring • Grazing Strategies • When to Stop Grazing in the Fall - Whatter DaifVey Have Made a Mintake - Cottag
to Stop Grazing in the Fall • What to Do if You Have Made a Mistake — Gotten Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native GrassesCHAPTER ELEVEN: HAY PRODUCTION
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses CHAPTER ELEVEN: HAY PRODUCTION
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses CHAPTER ELEVEN: HAY PRODUCTION
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses CHAPTER ELEVEN: HAY PRODUCTION
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses CHAPTER ELEVEN: HAY PRODUCTION
Behind or Overgrazed? • Balancing Warm- and Cool-season Grass Production During the Spring Flush • Making the Best Use of "Some" Native Grasses CHAPTER ELEVEN: HAY PRODUCTION

SECTION FOUR: OTHER MANAGEMENT ISSUES

CHAPTER FIFTEEN: WEED CONTROL IN ESTABLISHED NATIVE GRASS STANDS
The Best Defense Is a Good Offense • Tools for Weed Control • Herbicides
CHAPTER SIXTEEN: DISEASES AND INSECTS
Fungi • Viruses and Bacteria • Insects • Toxins
CHAPTER SEVENTEEN: PRESCRIBED FIRE
Why Use Fire to Manage Native Grasses? • When to Use Prescribed Fire • How to Use Prescribed Fire
CHAPTER EIGHTEEN: INTERSEEDING LEGUMES AND NATIVE FORBS INTO NATIVE GRASS STANDS
Introduced Legumes • Native Forbs and Legumes • When and How to Interseed • Implications for Weed Control
REFERENCES, SECTION FOUR
SECTION FIVE: OTHER OPPORTUNITIES AND BENEFITS
CHAPTER NINETEEN: NATIVE GRASSES IN SILVOPASTURE SYSTEMS361 Restoring Savannahs and Woodlands • Creating a Silvopasture
CHAPTER TWENTY: INTEGRATION OF FORAGE AND BIOMASS PRODUCTION
CHAPTER TWENTY-ONE: WILDLIFE CONSERVATION
Why the Declines? • Cattle Production – the Solution? • Pollinator Declines
CHAPTER TWENTY-TWO: SOIL HEALTH
What Is "Soil Health?" • Native Grasses and Soil Health • Carbon Sequestration
REFERENCES, SECTION FIVE
APPENDIX A: NATIVE GRASS SEED SOURCES
APPENDIX B: ADDITIONAL RESOURCES
APPENDIX C: NATIVE GRASS SEEDLING IDENTIFICATION

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While a considerable amount of the science and experience that undergirds the information presented in this book was developed at the University of Tennessee, it should be obvious with just a quick glance at the references within each section that numerous scientists have gone before and built the foundation upon which our work could stand: Bruce Anderson, John Blair, John Brejda, Joe Burns, Scott Collins, Chet DeWald, Ron George, Gerry Jung, Allen Knapp, Jerry Matches, Rob Mitchell, Ken Moore, Lowell Moser, Clenton Owensby, Matt Sanderson, Tim Springer, Ken Vogel and John Weaver. There are others too numerous to mention that have also contributed to the accumulating body of knowledge regarding native grass forages.

Finally, I want to thank my wife, Margie, and my children Ben, Krysty, David, Julie, John, Holly and Peter for their encouragement and support throughout this endeavor.

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SECTION ONE

About Native Grasses

with Jimmy C. Henning

Before delving into the practical aspects of using native grasses, you need to know something about these species. Which species are we considering? What are their attributes, where do they grow and to what conditions are they adapted? Are they still common and, if not, why not? Why should these grasses be used in a forage system — and what roles can they play for forage production? And finally, what are some of the challenges to using them? What do you need to be prepared to deal with should you choose to adopt them for your farm? These are all important questions and ones that are addressed in the five chapters in this section.

CHAPTER ONE Introduction

The term "native grasses" means different things to different people. And, to be fair, which grasses are in fact "native" varies depending on the continent on which you find yourself. In this chapter you will be introduced to the native grasses of the eastern half of North America, at least a subset of those species that is important for forage production. Some of their basic characteristics and their adaptations are described.

WHAT ARE "NATIVE GRASSES?"

Let's start by explaining what native grasses are. First, what does the term "native" mean? Simply put, native grasses are those that originate from what is now the U.S., growing here prior to European settlement. In many cases, the species addressed in this book also grew in Canada and Mexico and are considered native to much of North America. Put another way, native grasses are species that have not originated in Europe, Africa, South America or Asia. Such grasses, those originating from outside North America, are considered "introduced" or "exotic" grasses. Whether intentionally or unintentionally, such grasses were brought to North America. Many of these introduced grasses have become quite common and may be considered "naturalized." This means that plants brought in from other regions, such as orchardgrass from Europe, have become well-established, reproduce and, in many cases, continue to spread. Although many non-native species spread readily and can become pests (i.e., "invasive"), others are quite useful in agriculture. Examples of the latter include most of our clovers, orchardgrass, alfalfa and many annuals commonly used for forage such as wheat (Table 1.1).

Native/ Introduced	Common name	Latin name	Origin	Annual/ perennial	Status		
Native	Big bluestem	Andropogon gerardii	North America	perennial			
	Eastern gamagrass	Tripsacum dactyloides	North America	perennial			
	Indiangrass	Sorghastrum nutans	North America	perennial			
	Little bluestem	Schizachyrium scoparium	North America	perennial			
	Sideoats grama	Bouteloua curtipendula	North America	perennial			
	Switchgrass	Panicum virgatum	North America	perennial			
Introduced	Bahiagrass	Paspalum notatum	Southern South America	perennial	naturalized		
	Bermudagrass	Cynodon dactylon	Africa/ Southwest Asia	perennial	naturalized/ invasive		
	Bluegrass, Kentucky	Poa pratensis	Europe	perennial	naturalized		
	Bluegrass, annual	Poa annua	Eurasia	annual	naturalized		
	Crabgrass, smooth	Digitaria ischaemum	Eurasia	annual	naturalized		
	Crabgrass, hairy	Digitaria sanguinalis	Eurasia	annual	naturalized		
	Dallisgrass	Paspalum dilatatum	Southern South America	perennial	naturalized		
	Johnsongrass	Sorghum halepense	North Africa/ Southwest Asia	perennial	invasive ¹		
	Orchardgrass	Dactylis glomerata	West Europe	perennial	naturalized		
	Reed canarygrass	Phalaris arundinacea	Eurasia	perennial	invasive		
	Smooth brome	Bromus inermis	Eurasia	perennial	naturalized/ invasive		
	Tall fescue	Schedonorus arundinaceus	Europe	perennial	naturalized		
	Timothy	Phleum pratense	Europe	perennial	naturalized		

Table 1. Common forage grasses of the eastern United States and their origins.

¹ Considered a noxious weed in many states.

Although there are more than a thousand species of grass native to the U.S. (1,242 based on the authoritative 1935 publication "Manual of the Grasses of the United States", by A.S. Hitchcock), the focus in this book will principally be on five species with demonstrated value to forage production in the eastern U.S. These species are big bluestem, eastern gamagrass, indiangrass, little bluestem and switchgrass. These species have a number of characteristics in common. They are all bunchgrasses (Figure 1.1), but all develop rhizomes (Figure 1.2) to various degrees, or in the case of eastern gamagrass, rhizome-like structures called proaxes (Figure 1.3). Likewise, they all are deep rooted, typically reaching 5 to 8 feet deep and in the case of switchgrass 8 to 12 feet^{49, 37}. These deep roots contribute to their ability to remain productive during drought. These native grasses all also grow well on acidic, low nutrient soils. Each of these species is described in more detail below.



Figure 1.1. The native grasses presented in this book are all bunchgrasses as seen here with little bluestem (a) and big bluestem (b). Note that all of the stems (i.e., tillers) for both plants arise from the same root crown and grow in a bunch. Credit, J. Henning.

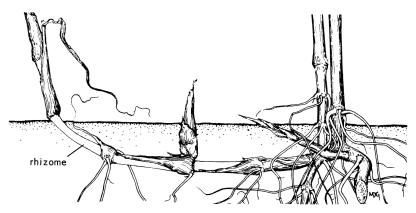


Figure 1.2. Illustration of a grass rhizome representative of those of the native grasses being presented in this book. From 100 Native Forage Grasses in 11 Southern States. Leithead, H. L., L.L. Yarlett, and T.N. Shiflet. 1971. U.S. Department of Agriculture, Soil Conservation Service, Agriculture Handbook No. 389.



Figure 1.3. Illustration of the proaxes, a specialized type of rhizomatous structure common to many wetland plants. Eastern gamagrass, a species very tolerant of extremely wet sites, also has proaxes. These structures contain aerenchyma or air chambers that allow roots within completely saturated soils to continue to grow and effectively respire. Credit, J. Morrison.

Warm-season versus cool-season grasses

In addition to being native to North America and indigenous to the eastern U.S., these five species are all warm-season grasses, meaning they produce most of their growth during the hot part of the year, typically from May-September (Figure 1.4). By contrast, cool-season grasses produce most of their growth from late March-mid-June and again in the fall (October-November) (Figure 1.4). A substantial difference between these two groups of grasses is the metabolic pathway used in photosynthesis. The warm-season species are designated as "C4" and the cool-season as "C3" grasses referring to the number of carbon (C) atoms used to form compounds during photosynthesis. While the underlying biochemical process is quite complex, there are several substantial distinctions between C4 and C3 grasses important to forage growers.

First, C4 grasses, as mentioned above, grow very well in hot weather. For instance, big bluestem maintains photosynthetic rates within 90 percent of its maximum potential with leaf temperatures between 82

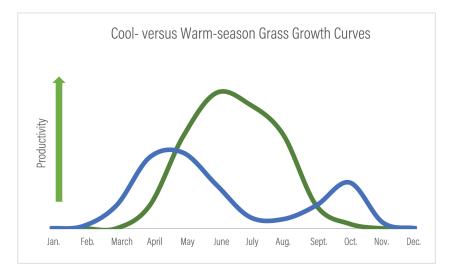


Figure 1.4. Typical growth curves for cool- (blue) and warm-season (green) grasses. Note that the growth seasons of these two types of grasses complement each other and also that the curve for the warm-season species is larger reflecting the greater productivity of these species.

and 105 F and at 118 F still has photosynthetic rates at 70 percent of its maximum potential²⁶. Conversely, at 70 F, big bluestem's photosynthetic rate drops to less than 30 percent of its potential. Clearly, C4 grasses thrive in hot weather and even require such conditions to be productive. In contrast, for C3 grasses, optimal photosynthetic rates occur between 60 and 77 F.

Another strategic advantage of C4 grasses is their ability to endure drought. One way this drought hardiness has been measured is water use efficiency (WUE). In its simplest form, WUE is the amount of biomass produced per unit of water transpired by the plant. The C4 grasses have from 1.5 to nearly 4 times greater WUE than C3 grasses³⁷. Put another way, for each inch of rainfall a C4 grass would produce 1.5-4 times more forage than that produced by a C3 grass. For more on native grasses and drought, see Chapters 3 and 4.

Finally, C4 grasses are more productive than C3 grasses. So, their growth rates, defined as dry matter produced per day per unit leaf area, are from 1.5-10 times greater than that of C3 grasses during the growing season ^{37:157}. For example, tall fescue, a widely used C3 forage grass in the Mid-South U.S., will typically produce 2.5-3.0 tons per acre (dry matter basis) while C4 grasses grown under similar conditions will produce 4-5 tons (dry matter basis) per acre, or about 1.3-2.0 times more. For more information on yields for native grasses, see Chapter 3.

Similarly, C4 grasses use nitrogen (N) more efficiently than C3 grasses⁸. This means that across a range of plant N concentrations, C4 grasses have greater growth rates. They also achieve optimum growth and maintain growth at lower N concentrations than C3 grasses. Another measure of N is N-use efficiency (NUE), a concept identical to WUE — how much forage mass is produced per unit N applied. Data indicate that native C4 grasses can have much greater (up to 2-3 times greater) NUE than C3 species, particularly in low N environments⁸. For more on fertility and native grasses, see Chapter 12.

However, despite these advantages, there are also shortcomings with C4 grasses relative to their C3 counterparts. Perhaps the most obvious

is that C4 grasses, because of their basic physiology, have greater fiber concentrations in the forage including within leaves. Thus, they will always test higher in fiber and lower in energy when compared to C3 species at the same stage of plant maturity. Crude protein levels are also typically lower in C4 grasses. Despite this, the native grasses being considered here have strong animal performance (see Chapters 3 and 10). Another advantage provided by C3 species is that they grow well under cooler conditions. Thus, a forage system that relied on only C4 species would result in a much shorter grazing season. Therefore, both types of forages can — and should — play a role in forage production systems in the eastern U.S.

IMPORTANT NATIVE GRASS SPECIES OF THE EASTERN U.S.

Big bluestem

Big bluestem has extremely wide adaption, occurring across southern Canada and south to Arizona, northern Mexico and Florida⁶. It has been most commonly associated with the Tall Grass Prairie of the Midwest and Great Plains, where it was the dominant grass, accounting for 70-90 percent of the vegetative cover⁴⁹. However, this species, as well as the other native grasses being described here, were thought to have spread to the north and west following the retreat of the last glaciers⁶. Thus, these grasses originated in and have been a key part of the grasslands of the southeastern U.S. for millennia. Indeed, big bluestem was common in places such as Virginia, Alabama and Kentucky before European settlement.

Within its range, big bluestem occupied lower slope positions and areas with damp—but not saturated—soils. On coarser textured soils, shallower soils or soils lower in organic matter, big bluestem was typically replaced by little bluestem. West of about 98 degrees longitude precipitation diminishes, and little bluestem becomes more dominant with big bluestem remaining common in stream bottoms and other areas with greater soil moisture. However, big bluestem will survive more severe drought than little bluestem or indiangrass, another common associate, due, in part at least, to its deeper roots⁴⁹.

Although big bluestem is typically a bunchgrass, it does produce short rhizomes which allow it to thicken stands and contribute to plant regeneration (Figure 1.5). Historically, in the Tall Grass Prairie where soil moisture was not limiting, big bluestem would produce extensive sods ⁴⁹. This, in part, contributed to its dominance of these grasslands. These rhizomes allow big bluestem stands that are not overgrazed to thicken over time.

Like the other native grasses, big bluestem has low demand for N and phosphorous (P). Although the mechanisms are not fully understood, at least part of the explanation is that these species are obligate "mycotrophs." That is, they require a symbiotic relationship with mycorrhizae⁶. The

mycorrhizae, through their ability to extract P from the soil and make it available to the host plant, appear to meet the species' P requirements. The low N demand for this species is more complex and not as well understood. However, there is evidence of associations with N-fixing bacteria, which is a likely part of the explanation^{8, 26, 38}.

Big bluestem is quite productive with yields of up to 5 tons per acre (dry matter basis). However, yield responses are tempered by the genetic origin of the cultivar in question and the location where it is growing. Moving cultivars south of their adaptation tends to force early flowering that, in turn, leads to earlier cessation of



Figure 1.5. Native grasses develop rhizomes that enable them to store energy, produce new growth and spread leading to thicker stands. Note that as is the case with this big bluestem plant, rhizomes (lower right corner of drawing) are not particularly long in native grasses. Source: plants.usda.gov.

vegetative growth and, thus, reduced yield. Conversely, moving cultivars north allows them to be more productive due to longer day lengths that delay flowering and allow the plant to remain vegetative longer. Moving southern source cultivars too far north, however, may lead to winter kill and stand loss. As a rule of thumb, selection of cultivars should be limited to a 200-300 mile movement northward⁴⁸. In addition, ecotypes from more humid environments have adaptations that make them less drought tolerant but more productive^{48:565}. These adaptations include wider, longer leaves, greater total leaf area per tiller and greater plant height³⁵. To date, there are at least ten released cultivars and a number of local ecotypes available (See Appendix A). However, of the cultivars available, only two, 'Niagara' and 'OZ-70', are from genetic material collected in the eastern U.S. A new variety, based on southeastern germplasm, that has been through several cycles of plant breeding to improve seedling vigor is being increased and should be commercially available by 2022.

Among the native grasses described in this book, big bluestem is the most preferred by cattle and native grazers, like bison. It commonly grows with indiangrass and little bluestem and, despite the preference for big bluestem, all three species are readily grazed by cattle. Rate of gain (i.e., average daily gain [ADG]) for cattle grazing big bluestem is as high as or higher than for other native grass forages, typically between 2.0-2.3 pounds per day for steers.

Big bluestem can be identified by its unique "turkey foot" inflorescence (Figure 1.6) which appears in late June to early July in the Mid-South. The stems for the reproductive tillers can be 8-10 feet tall and have a purplish coloration that likely have given this species its name (Figure 1.7). Another diagnostic feature of big bluestem is the fine hairs evident along the leaves (Figure 1.8). Near the base of the leaf, these hairs can be quite dense but are thinner moving towards the tip of the leaf. The outer third of the leaf typically has few if any of these hairs. Also, the lower stems of the plants typically have dense hair and are somewhat flattened (Figure 1.9). An individual plant can have many tillers, 100 or more, giving it a basal diameter that easily fills a square foot.



Figure 1.6. The inflorescence of big bluestem has often been compared to a turkey's foot because of the three characteristic forks of each flower as seen in this image. Credit, J. Henning.



Figure 1.7. Big bluestem grows to heights of 6-8 feet and, on especially productive soils, can reach 10 feet. Late in the growing season, the reproductive stems can develop a purplish hue, likely the source of the species' common name.



Figure 1.8. A diagnostic feature of big bluestem is the growth of fine hairs near the base of the leaf. These hairs gradually thin out moving away from the base and are generally absent towards the leaf tip. Credit, J. Henning.



Figure 1.9. Basal stems of big bluestem typically have dense hairs as seen on this seedling. Stems of big bluestem tend to be flattened in cross section. Credit, J. Henning.

Eastern gamagrass

Eastern gamagrass occurs from Massachusetts to Nebraska and as far south as Texas, Florida and northern Mexico⁴¹. Thus, its distribution covers the southern half of the range of big bluestem. And, like big bluestem, its genetic origins appear to be from the Southeast and its range radiated to the north and west following glaciation. Unlike either of the bluestems though, eastern gamagrass was never a widespread dominant, although it was quite common in the southern Great Plains¹⁵. Rather, it was a common associate within native grasslands and tended to be most prevalent in wetter sites but, like the other native grasses discussed here, is widely adapted. For example, various strains grow on deep sands, sites with claypans, high acidity soils and rocky outcrops⁴¹.

Perhaps more than the other native grasses discussed in this book, eastern gamagrass is a true bunchgrass. It does form rhizome-like structures known as proaxes that grow at or near the surface forming the plants' crown and, like rhizomes, are important for storage of nutrients and energy⁴¹. Another interesting adaptation of eastern gamagrass is that the roots contain structures typically found only in wetland plants. These spongy structures, called aerenchyma, have large air pockets that allow oxygen to enter the roots despite being in completely saturated soils⁴⁷. Thus, eastern gamagrass can grow and remain productive on extremely wet sites (Figure 1.10). Because of their ability to grow and persist in saturated soils, eastern gamagrass roots are very well adapted for penetrating dense claypans⁴⁷.

Another aspect of eastern gamagrass that differs from the other native grasses discussed here is that it can take advantage of very high nitrogen inputs. In one Oklahoma study, yields for eastern gamagrass reached a biological peak at 400 pounds per acre although the economic maximum was reached at 250 pounds per acre¹⁶. On the other hand, it has similar reliance on mycorrhizae and will remain productive with minimal supplemental P. Yields for pure stands of eastern gamagrass range from 4-8 tons per acre (dry matter basis). As with all species, yield varies by cultivar/ecotype. The initial cultivar was released in 1974 as 'PMK-24' and subsequently in 1988 under the name 'Pete'. This cultivar is the most widely available and planted. More recently, two cultivars with eastern origin have been released, 'Bumpers' and 'Highlander.' For additional information on released cultivars and local ecotypes available, see Appendix A.

Cattle preference for eastern gamagrass relative to other native grasses has been described as being above (e.g., "the ice cream grass of the Plains") and below that of the other species. I am unaware of any direct comparisons of animal preference between eastern gamagrass and the other natives. Eastern gamagrass does initiate growth sooner in the spring by about two weeks than the other natives. Consequently, it becomes mature sooner which can negatively affect animal preference. Indeed, I have observed eastern gamagrass growing within a well-grazed pasture dominated by big bluestem and indiangrass where the eastern



Figure 1.10. Eastern gamagrass has a remarkable tolerance of wet sites. Where water frequently inundates the field in winter and early spring, as well as at other times of year, gamagrass can thrive. This poorly drained field has a claypan and water often stands on the site following heavy rains. Despite this poor drainage, the gamagrass has thrived in this field for many years.

gamagrass was already producing seedheads while the other species remained vegetative (Figure 1.11). Animal performance as measured by ADG is lower for eastern gamagrass than the other native forages discussed in this book — about 1.4-1.7 pounds per day for weaned steers.

Eastern gamagrass can be identified by its unique flower, a tall spike with male flowers on the upper portion of the spike and female flowers that produce seed below them on the same spike (Figure 1.12). Seeds of eastern gamagrass have very high dormancy rates (greater than 90 percent at harvest) and typically require stratification or dormant-season planting to obtain successful stands. Leaves arise from the crown (proaxes) and can be quite long, up to 30 inches (Figure 1.13). Leaves are finer on the Great Plains cultivars such as Pete and are coarser and broader on Highlander, a southeastern origin cultivar.

The root crowns of eastern gamagrass are also unique (Figure 1.14). The large proaxes grow at the ground surface and form the initial crown, which then expands outward with the center of the crown dying out leaving a large vacant area in older stands. The growth of the crown at the soil surface can become quite substantial, causing the field to be very bumpy for equipment. For this reason, many growers prefer to use this species for pasture rather than hay production.



Figure 1.11. Because eastern gamagrass starts growing earlier in the season than other natives, it can easily become overmature in mixed stands. Here, the big bluestem and indiangrass have been well grazed while the eastern gamagrass has already developed seedheads and forage quality has declined.



Figure 1.12. The seedhead of eastern gamagrass is unique with male (upper portion of seedhead) and female (lower portion of seedhead) flowers "stacked" along the spike as seen here. Of the native grasses being considered in this book, they are the earliest to flower. Credit, J. Henning.



Figure 1.13. Foliage on eastern gamagrass plants can be quite abundant, in part due to the long leaves this species typically produces. These leaves arise directly from the root crown rather than along a stem as is the case with the other native grasses.



Figure 1.14. Eastern gamagrass can develop very large root crowns as the plant matures, as much as 3 feet across as seen here. While the rhizome-like structures at the crown are critical to energy storage and maintaining robust plants, they also can result in a rough field surface. Credit, J. Henning.

Indiangrass

The range of indiangrass is similar to that of big bluestem, occurring from Canada to Florida and west to the Rockies, including populations as far south as southern Mexico³³. Although never as dominant as either of the bluestems, indiangrass was one of the principal species in the Tall Grass Prairie as well as throughout eastern grasslands. And like eastern gamagrass, indiangrass was more prevalent in the southern Great Plains and southeastern U.S. than it was at more northern latitudes⁴⁹. It is a bunchgrass but, like big bluestem, also expands through the spread of rhizomes.

In terms of site adaptation, indiangrass is quite similar to big bluestem. However, it usually makes up a much smaller portion of the sward than big bluestem. This may be because of less vigorous tillering⁴⁹ and rhizome growth that occurs later in the season, after big bluestem rhizomes have fully developed and become more competitive⁴⁹. Indiangrass also may be slightly more sensitive to extreme drought due to somewhat shallower roots. On the other hand, its seedlings establish more quickly in response to disturbance and, thus, indiangrass can be dominant for a few years following disturbance⁴⁹. It also can respond more vigorously to heavy defoliation than big bluestem³³.

As is the case with the other native grasses, indiangrass is an obligate mycotroph with up to 99 percent colonization rates of roots having been documented ³³. And, like the other native grasses discussed here, indiangrass is very efficient in its use of N. With respect to yield, indiangrass is generally similar to big bluestem, 4-5 tons per acre (dry matter basis), depending on cultivar and test location. Although indiangrass naturally occurs in mixed stands with the bluestems and can be managed together effectively, cattle prefer the bluestems and will graze them somewhat preferentially over indiangrass. Data on ADG for indiangrass in single-species stands is limited but runs from 1.8 to more than 2.0 pounds per day³³.

The earliest cultivar for indiangrass was 'Cheyenne,' released in 1945. Currently, there are 10 additional cultivars with two, 'Rumsey' and 'Americus,' from sources east of the Great Plains. A number of local ecotypes from the eastern U.S. are also available. For additional information on released cultivars and local ecotypes available, see Appendix A.

Indiangrass seedheads are distinct, forming a tawny or yellowish panicle about 8-12 inches tall (Figure 1.15). Indiangrass matures later than the other native forage grasses with rhizome growth, tiller generation and flowering all several weeks later than its associates. The leaves are somewhat broader and coarser than those of big bluestem and are a lighter green in color. The plant also tends to be slightly more robust, developing a somewhat heavier stem that typically lacks the dense hairs of big bluestem and is round rather than flattened. One other useful diagnostic feature is the split ligule that has been likened to a rear gunsight or a pair of feathers (Figure 1.16).



Figure 1.15. The seedheads of indiangrass are a tawny yellow in color and grow as a panicle that commonly becomes nearly a foot tall (a). Among the native grasses, their seedheads are typically the last to appear each summer (b). Credit, J. Henning.



Figure 1.16. Identification of indiangrass is aided by the presence of a split ligule that has been likened to a pair of feathers or a rear gunsight. Credit, J. Henning.

Little bluestem

Little bluestem, as its name implies, is a considerably smaller plant than the other native grasses mentioned here. Despite its smaller stature, it may have been the dominant grass on as many or more acres than its larger associate, big bluestem. In terms of distribution, little bluestem occurs across a range very similar to that of big bluestem. However, it was only a dominant grass where big bluestem was less competitive due to shallower, coarser textured or drier soils. For instance, as precipitation declines moving west across the Great Plains, little bluestem becomes the dominant species in the mid-grass prairies of central and western Oklahoma, north to central and western Nebraska (Figure 1.17). This species was also likely a dominant on poorer soils of southeastern grasslands such as the Cumberland Plateau of Tennessee and Alabama and was also prevalent in the northeastern U.S. where it was a dominant in places such as Long Island and Nantucket Island.

Little bluestem does have rhizomes, but they are small and the species does not typically develop into thicker stands based on the spread of rhizomes. Thus, it is more of a true bunchgrass. However, it has much finer but shallower roots (only about 5 feet deep) that more fully occupy the soil. For example, a study conducted in eastern Nebraska found that

within the top 4 inches of soil of plots measuring just over 5 square feet, there were 12.9 miles of big bluestem roots versus 23.2 miles for little bluestem⁴⁹! Although little bluestem can thrive on poorer sites than big bluestem, it is more susceptible to severe drought, such as the Dust Bowl during the early 1930s, because of the shallower roots.



Figure 1.17. Little bluestem is able to grow and thrive on very poor sites. The deep, droughty sands of the Nebraska Sandhills are typical of the type of marginal soils where little bluestem can be found growing in great abundance (a). On such sites, little bluestem (reddish stems seen across pasture) will outcompete the taller species such as big bluestem (b).

In terms of animal preference, little bluestem ranks similarly, or just below big bluestem. Yield for this species is only about one half of that for big bluestem or indiangrass, or about 2.0-2.5 tons per acre (dry matter basis)⁴³. Data on animal performance for single-species stands of little bluestem are not available but a reasonable assumption is that they will be similar to those with either big bluestem or indiangrass. As a practical matter though, in the eastern U.S. in planted stands, little bluestem will rarely be the dominant species and, therefore, will not drive animal performance.

To date, there are five cultivars for this species all based on collections made from the Great Plains. Perhaps the most widely used in the eastern U.S. is 'Aldous,' a cultivar released in 1966 based on plants collected

in the Kansas Flint Hills. As is the case with the other species though, there are a number of local source ecotypes that are available including some from eastern sources (i.e., Indiana, Michigan, Missouri, North Carolina). For additional information on released cultivars and local ecotypes available, see Appendix A.

Little bluestem bunches grow to a height of about 3 to 4 feet, depending on cultivar and site quality (Figure 1.18). The leaves are much finer than those of the other natives mentioned here and only grow to about 12 inches in total length with a fairly distinct fold along the midrib. The flattened cross-section of the tillers is even more pronounced than that



Figure 1.18. Little bluestem, more so than the other native grasses addressed in this book, is a true bunchgrass as seen in this picture. Unless soils are unusually productive, this species normally only attains heights of 3-4 feet. Also, note that this species has finer leaves than the other natives addressed in this book. Credit, J. Henning.

of big bluestem. Although some hair can occur on the stems and leaves, it is much less pronounced than that of big bluestem. The fertile tillers are stiff, typically reddish in color, almost resembling rusted wire and the seedhead itself has a zigzag pattern producing seeds with long awns giving a fuzzy appearance to the seedhead (Figure 1.19).



Figure 1.19. Little bluestem inflorescences have a very fuzzy appearance, due to the long awns. Credit, C. Coffey.

Switchgrass

Switchgrass shares the wide distribution of the other natives described here, occurring throughout the U.S. and well into both Canada and Mexico²¹. It was most abundant on wetter, poorly drained soils in creek and river bottoms and on lower hillsides⁴⁹. Along the Atlantic and Gulf coasts, it could be found in wet woodlands at the upper margin of tidal influence. In the Great Plains, it was more common in the eastern and central sections, becoming restricted to riparian areas in the High Plains where Short Grass Prairies dominated⁴⁸. It clearly is a widely adapted species but rarely occurred in extensive stands except in particularly wet areas where other grasses were less competitive. More typically, it was a relatively minor associate of upland grasslands accounting for less than 10 percent of the vegetative cover⁴⁹.

Switchgrass roots tend to be the deepest of any of the grasses discussed here, often reaching depths of 10 to 12 feet^{49, 37}. As such, switchgrass is the most drought resilient of these species. It does not produce tillers as robustly as big bluestem⁴⁹, but like that species, it can fill in thin stands through spreading rhizomes. And, like the other native grasses mentioned above, switchgrass has strong associations with mycorrhizae. Associations with free-living and associative nitrogen-fixing bacteria have also been documented for switchgrass⁶. Its nutrient demands and tolerance of acidic soils is similar to that of the previously described species. It is also quite tolerant of saline soils.

In terms of yield, switchgrass can be as productive as big bluestem and indiangrass or more so, depending on the genetics of the material in question, producing 5-8 tons (dry matter basis) per acre⁴⁸. Switchgrass, however, can be stemmier than the other natives addressed in this book. It also has the strongest response to day length for regulating reproduction with seedheads developing by mid-June annually in the Mid-South. As with other native grasses though, the latitude of origin of the cultivar/ ecotype will influence the timing of seedhead emergence.

Cattle preference for switchgrass is below that of the bluestems and indiangrass. Nevertheless, as long as it remains vegetative, cattle readily graze switchgrass. Even with switchgrass that has become reproductive, cattle will selectively graze the leaves, refusing the mature stems. Given the rapid development of seedheads in June, it is important to graze switchgrass aggressively early in the season. Gains for steers grazing switchgrass typically are about 1.75 pounds per day. Switchgrass, like other panic grasses, contain saponins, which can be toxic for horses and small ruminants. It is not known how much switchgrass would have to be consumed to create this problem or at what stage of maturity the switchgrass would be most detrimental. Saponins do not affect cattle.

More work has been done on switchgrass cultivars and breeding than with the other natives because of the focus over the past several decades on this species as a biomass crop. There are well over a dozen cultivars, and likely a number of ecotypes available for switchgrass. It should be noted that switchgrass has two very distinct types, upland and lowland. As these names suggest, the origins of these types correspond to their adaptation to either wet or upland sites. As a rule, lowland switchgrasses are larger, more robust, produce greater biomass and are stemmier than upland types. They also can sustain strong stands longer and under more aggressive grazing pressure than their upland counterparts. Lowland cultivars are less numerous and include 'Kanlow' (northeast Oklahoma) and 'Alamo' (southern Texas). Two upland cultivars developed from eastern U.S. sources are 'Cave-in-Rock' (southern Illinois) and its derivative, 'Shawnee.'

Switchgrass has a heavier stem than big bluestem and, in the case of upland types, is very similar to that of indiangrass. Stems are rounded and have few if any hairs (Figure 1.20). Switchgrass can get quite tall, especially the lowland types, reaching heights of greater than 10 feet at maturity (Figure 1.21). The seedhead is an open panicle typical of the panic grasses (Figure 1.22). A diagnostic feature for many cultivars is a



Figure 1.20. Switchgrass has stems that are round in cross section with little to no hair.



Figure 1.21. The remarkable height lowland switchgrass can sometimes obtain can be seen here (a). The individual in this Alamo switchgrass stand (b) is 6 feet 4 inches tall and easily more than 6 foot 6 inches to the top of his hat. Lowland switchgrass is robust and is capable of producing large volumes of forage. Upland switchgrass cultivars are also tall, but typically only reach heights of 6-8 feet. Credit (a), K. Goddard.



Figure 1.22. Switchgrass seedheads are panicles, open in form with individual seeds growing on separate spikelets. Credit, C. Coffee.



Figure 1.23. Switchgrass can often be identified by the tufts of fine hair that grow at the base of the leaf as seen here. This characteristic is less apparent on lowland cultivars. Credit, J. Henning.

tuft of fine hairs at the base of the leaf near where the sheath joins the stem (Figure 1.23).

Some other native warm-season species

Although less important to forage production in the eastern U.S., there are several other native warm-season grasses worth mentioning. These are species that are common on eastern farms and may influence — or be influenced — by pasture management.

Perhaps the best known of these is broomsedge (also known as sage or sagegrass; Andropogon *virginicus*). This species is about the size of, and superficially resembles, little bluestem (Figure 1.24). However, as most cattle producers know, it is not a desirable forage from either a cattle preference or vield standpoint. It establishes more easily than the other species mentioned here being an earlier successional species. It becomes common in pastures throughout the states east of the Great Plains when dominant pasture grasses are too thin to prevent its establishment.

Nimblewill (*Muhlenbergia* schreberi) is a low-growing species that superficially resembles bermudagrass and spreads by stolons (Figure 1.25). As is the case with broomsedge, it becomes competitive on low fertility soils where the



Figure 1.24. A very common native grass found throughout the eastern U.S. is broomsedge. Although it resembles little bluestem, it lacks the reddish stems and has a seedhead where the seeds are enclosed by a sheath known as a "spathe." More importantly, it is a much less desirable forage species than little bluestem. However, like the other natives, it does quite well on poor sites with low fertility.



Figure 1.25. Nimblewill has a low growth habit not unlike bermudagrass. Like other native warm-season grasses, it does well on poor sites and, like broomsedge, has very limited benefit for forage. Credit, J. Henning.



Figure 1.26. Knotroot foxtail resembles most other foxtails but is a perennial. Because it is not readily grazed by cattle, it can become widespread in pastures. This species can be identified by the distinctive knots formed by the rhizomes on the roots. Credit, B. Muller, J. Via.

existing sward is thin and unpalatable to all classes of livestock. Unlike broomsedge though, it prefers shadier areas although it will grow in full sun. It has limited value as a forage. Its range is similar to that of broomsedge, encompassing most of the U.S. east of the Great Plains.

Knotroot foxtail (*Setaria parviflora*) is a perennial more common from the Atlantic coast and Southeast but can be found as far west as eastern Texas. Except for the small rhizomes on the roots, it resembles most other foxtails (Figure 1.26). And, like most foxtails, it provides limited forage and can be a substantial problem within tall fescue pastures and hayfields where it can take advantage of that cool-season species' reduced summer growth and vigor.

Purpletop or greasegrass (*Tridens flavus*) is another native warm-season grass familiar to many cattle producers. Because of the distinctive reddish-purple hue of the fertile tillers and seedheads, it can be quite obvious in pastures and hayfields during late summer when the dominant cool-season species have limited growth (Figure



Figure 1.27. Purpletop or greasegrass is common throughout much of the eastern U.S. and can be readily recognized in late summer when its purple stems and seedheads develop. Productivity is low and, while readily grazed by cattle, it does not become palatable until after frost. Credit, J. Henning. 1.27). Stems have a dark, greasy coating that comes off when rubbed by hand, hence the name greasegrass. It is widely distributed throughout the eastern U.S. Like the other native warm-season grasses, purpletop does well in low fertility or droughty soils and becomes more prevalent where other grasses are less vigorous. It matures during late summer with seedheads not becoming obvious until mid- to late August in the Mid-South. It has often been considered fair cattle forage but does not produce much volume.

Sideoats grama (*Bouteloua curtipendula*) occurred throughout the Great Plains and into the eastern U.S. with the exception of the south Atlantic states (North Carolina to Florida). A warm-season bunchgrass, it was a common associate of prairie vegetation but has a stature more similar to little bluestem than the tall species. It is exceptionally drought tolerant and as such was more prevalent in the mid-grass prairies of the central Plains, the southern Plains and drier sites throughout the eastern U.S. It also has the advantage of being more shade tolerant than the other warm-season native species. It has a distinct seedhead with the seeds all aligned along one side, hence the species' name (Figure 1.28). Sideoats grama produces less forage than the tall species and is less preferred than little bluestem, but nevertheless, is readily consumed by cattle.



Figure 1.28. The seedheads of sideoats are distinct and are the basis for this species' name. Credit, J. Henning.

What about native cool-season species?

Much of the eastern U.S. was historically dominated by the tall species mentioned above. Although there are many native cool-season species, most either produce small amounts of forage, have brief periods of productive growth or are not particularly good forages. Therefore, from a forage production (and commercial seed availability) standpoint, only the wildryes (*Elymus* spp) will be mentioned here (Figure 1.29). The most widely distributed in the eastern U.S. is Virginia wildrye (E. virginicus) with Canada wildrye (E. canadensis) having a similar distribution except that it is largely absent south of Tennessee and east of Texas. Southeastern wildrye (E. glabriflorus) occurs from Virginia, west through the Corn Belt and then south to east Texas. The wildryes have, like the other natives, wide site adaptability growing well in saturated to sandy soils. They grow best in damp sites and are more shade tolerant than the warm-season natives. They are good forages producing about 3 tons per acre (dry matter basis) and are readily consumed by cattle. Wildryes begin spring growth only about two to three weeks sooner than the warm-season native species. Where other cool-season perennials are already well established, there would be considerable overlap in production with these species.



Figure 1.29. The wildryes are one of the most common native cool-season grasses and produce a substantial amount of good quality forage. Their seedheads are characterized by the long aums on the seeds. Credit, C. Coffey.

SUMMARY

Numerous species of native grasses occur in the eastern U.S. Five of those species as described above have substantial potential as forages for this region of the U.S. All are warm-season, C4, bunchgrasses with remarkable drought tolerance due, in part, to their deep root systems. They produce large volumes of forage, with the exception of little bluestem, and are widely adapted to the region, remaining productive on marginal sites.

CHAPTER TWO Native Grasslands in the Eastern U.S.? A Brief History Lesson

It has been said that before the arrival of European settlers in what is now the eastern U.S., the forests were so extensive and dense that a squirrel could have traveled from the Atlantic Coast to the Mississippi River without having to ever touch the ground. This concept, really, this myth, has long been assumed to be true. And believing this myth leads many to assume that there were no grasslands in the eastern U.S. prior to European settlement. And if there were no grasslands, perhaps there were very few grasses that naturally grew in the eastern third of the continent. It should be apparent though from the preceding descriptions of native grass species that the historic range of all 13 species mentioned included Virginia as well as Kansas. In fact, the ranges of all 13 species included virtually every state east of the Rocky Mountains. And, as mentioned above, most of the native grasses that dominated the vast grasslands of the Great Plains had their origins in what is now the southeastern U.S.

Furthermore, early explorers and settlers described extensive treeless grasslands, savannahs (grasslands with scattered trees) and woodlands (open-canopied forests with grass and numerous other herbaceous plants dominating the ground layer) across the eastern U.S. These various forms of grasslands covered the landscape in a variable mosaic, all mixed to one degree or another with the dense, closed-canopy forests needed by that mythical squirrel.

For example, early explorers reported extensive savannahs on the Piedmont Plateau of the Carolinas and that bison were plentiful in the Piedmont of Georgia. Others reported widespread burning by Native Americans and the presence of large herds of bison in the Great Valley of the Appalachians (within Virginia known as the Shenandoah Valley, further south, the Tennessee Valley). Further west, travelers crossing the Cumberland Plateau described extensive grasslands grazed by bison and elk. In Alabama, an early explorer wrote of traveling through wide expanses of prairie along the Alabama River (the Black Belt Prairie). In Western Tennessee and Kentucky early settlers tired of eating the ubiquitous prairie chickens (a grassland obligate bird). Numerous places, creeks and rivers in the Mid-South include "barren" in their names. This was the 19th century term for areas with no or only a few trees, what we would now call a savannah. All described native grasses (often big bluestem) that were taller than a man on horseback.

And I would be remiss not to mention the once more than 100 million-acre longleaf pine ecosystem, stretching from southeastern Virginia to eastern Texas along the Coastal Plain and lower Piedmont. This vast savannah, burned annually by Native Americans and, until the 1920s and 1930s, by the descendants of European settlers, had a grassy understory. In fact, the earliest Spanish explorers of the region reported bison in what is now Florida. Furthermore, the first cowboys in what is now the U.S. got their start here herding wild cattle left behind by the Spanish in the mid-1500s. These became known as "pineywoods cattle" and the cowboys as "crackers" (Figure 2.1).

As was the case for most grasslands on the planet, those in the eastern U.S. were maintained by periodic fires, either caused by Native Americans or by lightning. Lightning was an especially important ignition source in the southeastern U.S. For example, Florida has some of the highest lightning strike frequencies recorded anywhere on earth. Early European settlers also regularly used fire to improve forage for livestock as well as game. In drier climates, such as the Great Plains, grasses could persist with fewer and less frequent fires because droughts and low rainfall limited the encroachment of woody species. In the eastern U.S. though, where precipitation is much greater, the battle between trees and grasslands was always more vigorous and savannahs and woodlands persisted amongst areas of denser forest.

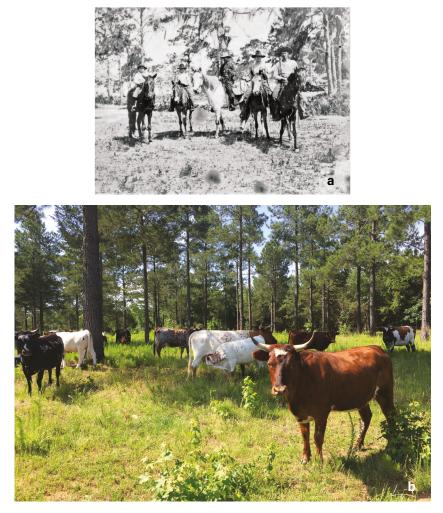


Figure 2.1. The native grasslands of Florida, especially the extensive pine savannahs, provided range for feral cattle that had escaped from 16th century Spanish settlements. Many believe that it was here that the legacy of the American cowboy was born as these wild cattle were rounded up and brought to market (a). Today a fine breed of tough, productive cattle known as "pineywoods cattle" are descended from these early animals (b). Source (a), thecrackerhistorian.weebly.com. Credit (b), Grove Creek Farm, Crawford, GA.

Extent of C4 grasslands in eastern U.S.

The original ranges of the species described in the preceding chapter make it clear that the grasslands that historically occurred in the eastern U.S. were all dominated by C4 grasses. From the longleaf pine savannahs of Florida to the prairies of northern Ohio and from the plains of southern Wisconsin to the valleys of the Appalachians, big bluestem, indiangrass, little bluestem, switchgrass and eastern gamagrass were the major species (Figure 2.2). Indeed, intact native grasslands surveyed during 1930 as far north as central Iowa were comprised of 72-97 percent C4 grasses^{49:29}. Similarly, C4 grasses were prevalent in native grasslands in North Carolina⁴⁶, Tennessee¹⁴, and Ohio^{49:6-7}. More contemporary assessments indicate C4 grass compositions of 35 percent (West Virginia), 46 percent (southern Illinois), 50 percent (Missouri), and 54 percent (Alabama)⁴² and dominance of C4 grasses as far north as

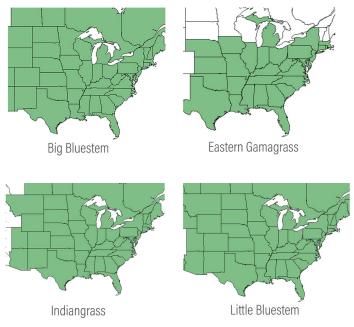


Figure 2.2. Range of several common native warm-season grasses. It becomes apparent that these species were not restricted to only the prairies of the Great Plains. Indeed, they dominated the grass-lands throughout what is now the eastern U.S. Source, plants.usda.gov.

the Dakotas⁴⁵. Given the historic distribution of C4 grasses in the eastern U.S. and their adaptation to the region's soils, climate and conditions, use of these species in forage programs throughout this extensive area continues to make sense today.

Where are they now?

Given the wide distribution and historical prevalence of these grasslands, I am often asked, "Where have they gone?" There are several reasons that these native grasses, once so common in the region, are hard to find. First, early settlers tended to clear and/or plow areas first where there were fewer or no trees. With as many as two centuries - and more – of cultivation on such sites, the grasses were eliminated. Where the ground was not plowed, reductions in burning frequency due to more restrictive fire policies led to natural succession and, in time, development of closed-canopy forests. Under the dense shade of these full canopies, the grasses died out. Where neither plowing nor fire exclusion were issues, grazing played a role. These grasses all tolerate grazing, but year-round, continuous grazing, especially with high stocking rates, eventually took their toll. Range managers use the terms "increasers" and "decreasers" to refer to plants that, under heavy grazing pressure, either decrease (preferred forages) or increase (undesirable forages). The grasses of value for forage mentioned in this book are all preferred by cattle and are thus decreasers. After a century and more of unmanaged grazing, native grasses were severely reduced or eliminated from the degraded pastures. It is also worth noting that many of our pastures today have not always been pastures, they have been tilled at some point in the past. However, even today, in areas where there is not unmanaged grazing, a history of tillage, or closed forest canopies, one can see native grasses still growing. Railroad rights-ofway, roadside ditches, power line rights-of-way and even cemeteries are all places where these native grasses are still present (Figure 2.3). Many local ecotypes and released cultivars, particularly those of eastern origin, have been developed from such relict populations.



Figure 2.3. Native grasses continue to persist in the absence of long-term cultivation, where forest canopies are not closed, and where unrestricted, year-round grazing is not a factor. This eastern gamagrass continues to thrive along this roadside where there is ample sunlight and mowing only occurs periodically for maintenance of the right-of-way (a). A vigorous patch of big bluestem along the edge of the road within the city limits of Crossville, Tennessee. Credit (b), C. Coffey.

SUMMARY

Native grasses that still occur today in small, scattered populations are the remnants of once extensive grasslands that were prevalent throughout the eastern U.S. The dominant grasses are the very same species that still dominate the Tallgrass Prairies of the Great Plains. Interestingly, these grasses are thought to have originated in the Southeast, following the retreat of the last glaciers to the north and west. Clearly, these native grasses are very much a part of the natural heritage and legacy of the eastern U.S. The remainder of this book addresses their potential role in forage production systems of this region.

CHAPTER THREE Why Use Native Grasses in Your Forage Program?

Knowing something about the grasses native to the eastern U.S. and the legacy of the region's grasslands may be interesting, but why should these grasses be used as part of a forage program in this region? Given that most of the native grasses beneficial for forage production are warm-season species, maybe a better place to start is by asking, "Why include any warm-season grass in a forage program?"

THE SUMMER SLUMP

Across a substantial part of the eastern U.S., producers currently rely on cool-season perennials for much of their annual forage production. However, cool-season species do not remain productive through summer. Thus, from about mid-June through late September each year there is a "summer slump" in forage production (see Figure 1.4). Not only do cool-season grasses produce less volume of forage at this time of year, but the forage they do produce has reduced quality as a result of advanced plant maturity. In turn, this leads to reduced animal intake and, ultimately, reduced animal performance (Table 3.1). And in the case of tall fescue, toxins associated with endophyte infection increase starting in late spring and negatively impact cattle that may already be experiencing reduced forage intake and nutrition.

Table 3.1. During summer, tall fescue, like other cool-season perennials, has limited productivity. Reduced grazing days and animal performance are the result. Warm-season species can provide a good complement to cool-season species and, thus, offset the summer slump.

Season	Forage produced (ton/acre)	ADG (lbs./day)	Gain (Ibs./acre)	Reference
Spring		1.56		1
Summer		1.16		
Spring	1.11	1.89	245	2
Summer	0.66	0.18	41	
Spring		1.40		3
Summer		0.82		

Table References

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Summer not only stresses livestock grazing cool-season pastures, it also increases stress on the pasture itself. Continued grazing pressure during summer on species that are already semi-dormant compounds the stress on these plants and will quickly weaken them. Weakened stands thin out and allow for encroachment of broadleaf weeds as well as less desirable grasses, many of which will be perennials that create problems for years to come (Figure 3.1). Summer stress on cool-season grasses is further increased in the face of drought and/or excessive heat, particularly when grazing pressure is not reduced. Taken all together, pasture vigor and longevity, weed control costs and forage quantity and quality will all be improved where cool-season pastures receive adequate rest during summer. Such rest can be provided by moving livestock to pastures planted to a grass adapted to summer, a C4 grass.



Figure 3.1. Without appropriate rest, cool-season pastures that are grazed throughout summer can be weakened allowing weed pressure to increase. This starts a downward cycle that leads to degraded pastures and reduced productivity.

It is worth noting that the severity of the summer slump will vary with latitude (and in the Appalachians, elevation). To the north of the Fescue Belt, certainly at the latitude of southern Wisconsin, Michigan and southern New York, the need for summer forages diminishes. To the south of the Fescue Belt, from northern Mississippi east to Upstate South Carolina and southward, tall fescue gives way to bermudagrass as the dominant forage grass. While the marginal benefit of a different summer perennial is lower where one is already available, there remains a premium on cost-effective forages that produce strong animal gains (see Chapter 4 for more on pros and cons of native grasses versus bermudagrass).

IMPROVED DROUGHT RESILIENCY

In normal summers, cool-season species have a difficult time keeping up. But, of course, not all summers are normal! And as we have seen repeatedly in recent years, severe summer droughts can come in waves. For example, based on USDA's drought monitor, 2007, 2008, 2011, 2012 and 2016 had "extreme" (D3) or "exceptional" (D4) droughts across large portions of the Fescue Belt — five such droughts within a decade!



Figure 3.2. Productivity of cool-season pastures, such as this one in northern Missouri, can be severely reduced during prolonged droughts. Expensive alternative feeds required during such periods lead to increased costs of production and reduced profits.

Any single severe drought can be hard on pastures. When there is no relief following drought and pastures get hit by a second dry summer, the impact to cool-season species can be devastating. Regardless of pasture condition, animals still need to be fed. And in the northern portions of the eastern U.S. where the normal summer slump may not be as pronounced, severe droughts can still be an issue (Figure 3.2). Therefore, having a forage option that provides a buffer against severe droughts can be a huge advantage anywhere in the eastern U.S.

As described in Chapter 1, the native warm-season species being considered in this book are all highly drought tolerant, deep-rooted, C4 grasses. They are much more drought tolerant than any of the cool-season species (Figure 3.3). It is worth noting that native warm-season grasses have persisted for eons in areas with much lower rainfall than what we have in the eastern U.S. For instance, the Kansas Flint Hills average only 38 inches of rain per year, the Rolling Red Plains of southwestern Oklahoma only 26 inches, and the Nebraska Sandhills only 20 inches and all are dominated by native C4 species.



Figure 3.3. In contrast to cool-season perennials, the warm-season native grasses can remain productive and provide grazing during summer drought as seen in these pastures. In the foreground is suitchgrass that has been hayed once. Note the contrast between this field and the one in the background, a cool-season pasture under considerable drought stress. Credit, B. McCord.

In addition to the testimony of eons of history in the semi-arid portions of the U.S., recent research also confirms the drought resiliency of these native grasses. A study in the Texas Panhandle compared switchgrass and bermudagrass and found that under dryland conditions switchgrass had greater WUE (about 29 percent greater). Sideoats grama was also tested and although it was not statistically different than bermudagrass, its WUE was about 20 percent greater numerically. Other researchers have reported greater WUE for both switchgrass and indian-

grass than bermudagrass. A testament to switchgrass' drought resilience came unexpectedly during a trial being conducted in West Tennessee from 2006-2009. During this 4-year period, Alamo switchgrass produced an average of 7.6 tons of biomass per acre each year. During 2007, one of the driest summers recorded in Tennessee, the Alamo switchgrass produced 5.1 tons per acre, 67 percent of the 4-year average! As a frame of reference, keep in mind that tall fescue normally produces only about one-half that amount in an average year, one with normal precipitation.

HISTORICAL LEGACY OF WARM-SEASON GRASSES IN THE EASTERN U.S.

Although mentioned in preceding chapters, it bears repeating that for much of the eastern U.S., as far north as southern Michigan and

Minnesota, native grasslands were dominated by C4 species (see Figure 3.4). If these grasses made sense that far north then, why would they not still make sense today, especially in the middle and southern parts of this region? The whole issue of climate change is beyond the scope of this book and there are as many opinions on that subject as there are people discussing it. However, if we are moving at all towards hotter, drier conditions, then the need for warm-season grasses, especially those that are remarkably drought resilient, will be greater going forward. Regardless, within the Fescue Belt, we have been asking a cool-season species to do the work of a warm-season species for much of the past 70 years since tall fescue began to be widely planted. The wisdom of innovation for this production model, one so heavily dependent on a C₃ grass, through incorporation of a C4 component is borne out by the legacy of the grasslands that grew here for millennia. Indeed, such an innovation is simply a correction, one that aligns our forage production more closely to the region's climate. Like putting a round peg in a round hole!

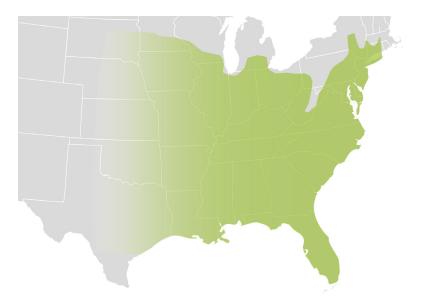


Figure 3.4. Prior to the last century, grasslands of the eastern U.S. were dominated by C4 grasses (area shaded in green) as far north as the Great Lakes and southern New England.

POSITIVE IMPACT ON COOL-SEASON FORAGES

Inclusion of some warm-season grasses is likely to have another major effect on forage production — better management of existing cool-season species. By reducing the stress on our cool-season pastures during summer, we provide them with critical rest that produces stronger, more productive stands (Figure 3.5). This means less pasture degradation, more grass, fewer weeds and less money spent on correcting weed problems and/or reseeding pastures. Not to mention the reduced grazing days associated with weaker stands (lower stocking, shorter grazing intervals) and idle periods during renovation.

Having more vigorous pastures, regardless of whether they are coolor warm-season, guarantees stronger root systems and, in turn, less vulnerability to drought. Furthermore, rested pastures, with their greater root volume, improve soil health. Keep in mind, roots are the foundation of just about every measure of soil health—organic matter, substrate for soil microbes and arthropods, aggregation and water infiltration. Also, more grass cover during summer means protection from extreme soil temperatures, which improves the environment for growth and



Figure 3.5. This vigorous cool-season pasture benefits from the native warm-season grass pastures on the same farm. By grazing the warm-season species during summer, the cool-season pastures receive ample rest during stressful summer months. Credit, F. Walker.

respiration of soil microbial communities. The combination of improved ground cover and root volumes also means reduced soil erosion.

Benefits from these rested cool-season pastures can also improve our ability to effectively stockpile cool-season species, particularly tall fescue. Weakened, thin stands will not be as effective in producing a fall stockpile as vigorous, well rested stands — stands with healthy roots. Thus, a vigorous cool-season stand can provide more grazing days by extending the grazing season well into the fall, in some cases into early winter. More days grazing translates into fewer days feeding hay and that means additional savings (Figure 3.6). And where stockpiling is not going to be used, that rested pasture can provide more fall and/or spring grazing. All these benefits come from not grazing pastures that are already at a

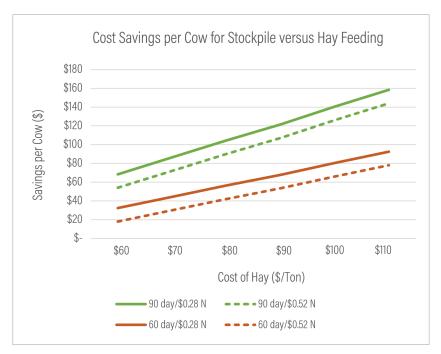


Figure 3.6. Stockpiling provides a clear economic advantage over hay feeding whether a 60- (red lines) or 90-day (green lines) stockpile grazing period is assumed. Costs per cow were based on hay prices ranging from \$60-110 per ton and N at \$0.28 or \$0.52 per pound for N applied with an \$8 per acre spreading cost. Costs based on University of Kentucky Extension's Grazing and Hay Cost Calculator (https://agecon.ca.uky.edu/budgets#Livestock_Forages).

low point in their productivity. So, by pushing a cool-season pasture at the time when it may be most vulnerable, we lose the opportunity for much better use of its strengths — and penalize pasture condition and soil health in the meantime. It would be much better to use the right tool for the job, a summer (C4) grass for summer forage production!

The take-home message

It should be clear that warm-season grasses can make critical contributions to eastern forage programs by improving the quantity and quality of summer forage, creating a buffer against drought, improving management of cool-season forages, extending grazing seasons, increasing operation resiliency, productivity and prospectively, profitability. Collectively, these benefits all serve to reduce a forage operation's exposure to risk. Furthermore, based on both our historic and current climate, warm-season grasses belong here. Trying to manage without them is definitely paddling upstream. So, taken all together, maybe a better question than "Why would you incorporate a warm-season species into your program" is, "Why wouldn't you?" **After all, we have been given two very good tools – warm-season and cool-season grasses – so why not use both? Why fight with one hand tied behind your back?**

All of these benefits apply, more or less, to any warm-season grass, not just natives. Which leaves us with a very appropriate question, why, among all of the warm-season options that are available, would someone want to use natives? Put another way, are they a good choice? The following sections are an attempt to answer that question.

WHY NATIVE WARM-SEASON GRASSES?

All of the foregoing emphasizes the importance of including a warm-season component within eastern forage production programs. But why *native* warm-season species? Are they a good choice? Below, a number of their attributes, those important for any forage production tool, are described.

Perennials

Each of the key forage species being considered here (big bluestem, eastern gamagrass, indiangrass, little bluestem and switchgrass) is a long-lived perennial. Planted stands that are not abused have lasted for 20-30 years (Figure 3.7). Perennials are inherently more cost effective than annuals (see Chapters 4 and 14 for additional information on this subject), have less risk (no annual planting), require less soil disturbance (and, therefore, less impact on soil health), have longer grazing seasons and are always available — at least within the appropriate growing season. While annuals will always be a valuable tool, perennials are a much better choice for the foundation of a forage program.





Figure 3.7. With proper management, native grass stands can remain productive for decades as demonstrated by the eastern gamagrass (a), switchgrass (b), and eastern gamagrass (c) stands seen here, all of which are 20-25 years old. Credits, C. Benhoff, J. Daniel, D. Dulworth, for images a, b, and c, respectively.

Productivity

The native warm-season species included here produce large volumes of forage. Various studies have documented yields for these species ranging from 2-3 tons per acre (little bluestem and sideoats grama) up to 4-5 tons per acre (big bluestem, indiangrass and upland switchgrasses) and, in the case of lowland switchgrass and eastern gamagrass, greater than 5 tons per acre (Table 3.2). Of course, these yields will be reduced on marginal soils or during extreme droughts. Also, longer term studies have documented a great deal of annual variability in native grass yields that cannot be readily explained by rainfall patterns (Figure 3.8).

The yields mentioned here are greater than what has often been reported for the same species on native range. There are three reasons for this apparent discrepancy. First, land remaining in range is generally restricted to sites that are steeper and/or have thinner soils and, consequently, were less likely to have been converted to row crop production. A prime example of this is the Kansas Flint Hills, a four million-acre

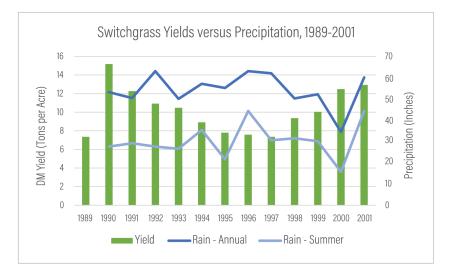


Figure 3.8. Native grass yields can vary a good deal through the years. While there is no doubt that exceptional droughts can reduce yield, the range of precipitation during the 13-year period captured by a study at Auburn University was not enough to affect annual yields of switchgrass. Adapted from McLaughlin, S.B., and L.A. Kszos. 2005. Development of switchgrass (Panicum virgatum) as a bioenergy feedstock in the United States. Biomass and Bioenergy 28:515-535.

grassland that has never been plowed. Yields reported for this area with its thin, shale-derived soils are only about 1-2 tons per acre^{24, 32}. A second reason for lower yields from studies on rangeland is that planted stands have used plant materials that come from releases that have either been selected or improved for yield and are thus more productive than wild strains⁸. Finally, lower yields from rangeland could be explained by the generally drier conditions where range occurs relative to the eastern forage growing region.

Species	DM Yield (tons/ac)	N input (Ibs./ac)	Location	Duration	Reference
Big bluestem					
mean for 7 cultivars/ ecotypes ^a	5.95	60	Knoxville, TN	2015-2018	5
mean for 7 cultivars/ ecotypes ^b	4.62	60	Knoxville, TN	2015-2018	5
mean for 5 cultivars/ ecotypes	3.88	60	Lexington, KY	2002-2009	4
mean for 5 cultivars/ ecotypes	3.83	0	Poplarville, MS	2015-2016	7
Eastern gamagrass					
mean for 6 cultivars/ ecotypes	4.9	60	Lexington, KY	2002-2009	4
Pete cultivar, mean from 2 sites	3.1	0	north Missouri	1991-1993	1
Pete cultivar, mean from 2 sites	4.8	150	north Missouri	1991-1993	1
Highlander cultivar, mean from 5 sites	7.4	ns	southeastern U.S.	1996-1998	2
Indiangrass					
mean for 6 cultivars/ ecotypes ^a	4.7	60	Knoxville, TN	2015-2018	5
mean for 6 cultivars/ ecotypes ^b	3.7	60	Knoxville, TN	2015-2018	5
mean for 6 cultivars/ ecotypes	5.2	60	Lexington, KY	2002-2009	4
mean for 2 cultivars/ ecotypes	2.0	0	Poplarville, MS	2015-2016	7

Table 3.2. Native grass yields in the eastern U.S. can be quite high as demonstrated by the data in this table (continued on next page).

NATIVE GRASS	5 FORAGES	FOR THE	EASTERN	U.S.
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Species	DM Yield (tons/ac)	N input (Ibs./ac)	Location	Duration	Reference
Little bluestem					
OK ecotype	2.5	30	Knox City, TX	2013-2015	6
Switchgrass					
mean for 5 upland cultivars/ecotypes	4.5	60	Lexington, KY	2001-2009	4
mean for 3 upland cultivars/ecotypes	2.5	0	Poplarville, MS	2015-2016	7
Alamo (lowland)	5.3	60	Lexington, KY	2001-2009	4
Alamo (lowland), early boot harvest ^c	3.5	90	Knoxville, TN	2010-2012	3
Alamo (lowland), early seedhead harvest ^c	5.5	90	Knoxville, TN	2010-2012	3
mean for 3 lowland cultivars/ecotypes	3.3	0	Poplarville, MS	2015-2016	7

^a includes December harvests for years with only one growing-season harvest, 2015 and 2017.

^b does not include December harvests for years with only one growing-season harvest, 2015 and 2017.

^c single annual harvest at stated stage of maturity.

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Quality

Animal performance while grazing natives can be very strong, with ADGs from 1.3-2.4 pounds depending on the species (Table 3.3). As with any forage, performance will depend on grazing management with more mature grass (i.e., reproductive rather than vegetative) and high stocking rates (reduced selectivity) typically reducing rates of gain. In an

^{7.} White, J., B. Rushing, R. Lemus, J.R. Saunders, and D. Rivera. 2017. Mississippi native grass variety trials, 2016. Bulletin 523. Mississippi State Univ., Mississippi Agricultural and Forestry Experiment Station, Starkville. 14 pp.

Iowa study, weaned calves grazing switchgrass only gained an average of 1.26 pounds per day, quite a bit lower than what has been reported from other studies³⁴. Why the reduced rate of gain? The switchgrass was not stocked until, on average, June 26 each year, a point at which plant maturity was well advanced. Stand quality can influence gain as well with thinner stands typically having greater cover of undesirable species that may lower animal performance. For example, in a recent study conducted at Mississippi State University, rates of gain for a mixed native grass stand (1.06 pounds per day during the second year of that study) were reduced by large amounts of volunteer common bermudagrass (a forage that rarely produces ADGs above 1.0 pound per day) that had begun to dominate the stand by the second year of the study.

Species	ADG (lbs./day)	N input (Ibs./ac)	Location	Years	Duration (days)	Reference
Big bluestem/ indiangrass blend						
weaned steers (6 cwt)	1.81	60	West TN	2010-2012	84	3
weaned steers (6 cwt)	2.12	60	Middle TN	2010-2012	108	3
bred dairy heifers (10 cwt)	2.01	60ª	Middle TN	2010-2012	71	8
weaned steers (6 cwt)	2.06	0	East TN	2015-2017	105	4
weaned heifers (5 cwt)	1.87	0	East TN	2015-2017	105	4
Big bluestem						
weaned steers (6 cwt)	2.38	278-320	central NC	three years	137	6
Eastern gamagrass						
weaned steers (6 cwt)	1.06	60	West TN	2010-2012	96	3
bred beef heifers (9 cwt)	1.25	0	East TN	2013-2015	112	9
weaned steers (6 cwt)	1.92	278-320	central NC	five years	137	6

Table 3.3. Numerous studies have confirmed high average daily gains (ADG) for cattle grazing native grasses (continued on next page).

Species	ADG (lbs./day)	N input (Ibs./ac)	Location	Years	Duration (days)	Reference
weaned steers (6 cwt)	1.46	75	western AR	1993-1995	114	1
weaned steers (5 cwt)	1.68	210	central NC	1991-1995	146	5
Indiangrass						
weaned steers (6 cwt)	2.38	40	South Dakota	1973-1975	31	10
ns	1.85	ns	Texas	1963-1965	ns	7
Switchgrass						
weaned steers (6 cwt)	1.23	60	West TN	2010-2012	86	3
weaned steers (6 cwt)	1.74	60	Middle TN	2010-2012	108	3
bred dairy heifers (10 cwt)	1.46	60ª	Middle TN	2010-2012	71	8
weaned steers (6 cwt)	2.01	278-320	central NC	six years	137	6
weaned steers (7 cwt)	1.69	100	eastern NE	two years	55	2

^a mean of pastures receiving 60 units N and overseeded with red clover (did not differ, p = 0.18).

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Low input

As described in Chapter 1, native grasses are well adapted to grow on poor sites where acidity is high. They are also very efficient in their use of N. That, combined with their mycorrhizal relationships, means that they do not need much lime or supplemental fertilizer to remain productive. Of course, these grasses are responsive to N, but how much is actually applied will depend on production needs. See Chapter 12 for more information regarding managing fertility for native grass forages.

Wide adaptation

The native grasses being considered here can, depending on the species in question, grow well on a wide variety of sites. Recall, most of their natural ranges encompass an area from the High Plains to the Atlantic, from Canada to Mexico, indicating a very wide degree of ecological adaptability. They can grow in poorly drained soils (lowland switchgrass and eastern gamagrass; Figure 3.9) as well as thin, coarse-textured and droughty soils (little bluestem and sideoats grama; Figure 3.10). They can grow in remarkably acidic soils to deep, fertile, well drained loams. Switchgrass can survive up to 60 days of growing-season inundation²⁰. The roots of



Figure 3.9. Among the native grasses, there are species and/or cultivars that are extremely welladapted to wet sites, notably lowland switchgrass and eastern gamagrass. Seedling lowland switchgrass competing with sedges on a very wet site with poor internal drainage (a). These seedlings produced a strong stand that provides excellent summer grazing (b), a good example of the ability of this species to thrive on sites too wet for many other forages.

eastern gamagrass can penetrate claypans⁴⁷. In short, you can likely grow a native grass productively on about any site where you could practically manage forages so long as you appropriately match the species to the site.



Figure 3.10. Native grasses are adapted to very poor sites, those with thin or coarse-textured soils. The stand of big bluestem and indiangrass (a) is providing excellent forage on this reclaimed surface mine in eastern Kentucky where soils (foreground) are of very low quality. Little bluestem growing in a thin, shaley, acidic soil on a ridgetop (note rocky soil in path and on far side of path) in the Appalachian Mountains provides a good example of the extreme sites where it can persist — and provide forage.

Non-toxic

With a few exceptions, native grasses are not plagued with toxicity issues. As mentioned in Chapter 1, switchgrass can be a problem for both horses and small ruminants. Indiangrass does produce a cyanide compound, but it is only concentrated enough to be a potential problem early in the spring when the grasses are just emerging (less than 8 inches tall). But, because this species is not normally grazed when that small and rarely occurs in pure stands, the risk is very low. In fact, there has never been a case of documented loss of cattle associated with indiangrass. Problems with prussic acid and nitrates have not been documented either. No toxic endophytes occur and there is no evidence of negative impacts on reproduction as occurs with tall fescue.

Not invasive

Because the species being considered here are native, they will not be invasive; they are adapted to the conditions of this region. Also, because the species considered here are all late successional — they are not early successional or pioneer species — they are not aggressive in their establishment. I have known producers who have had native grass pastures for many years, even decades, and have not had a problem with spread.

Conservation friendly

For years, conservationists have promoted native grasses as a tool to improve soil health, water quality and wildlife habitat. Studies have confirmed the benefits of these strategies.

With respect to soil health, a number of studies through the years have demonstrated the tremendous amount of below ground organic matter that native grasses produce (Figure 3.11). For example, in a long-term study on a Kansas prairie, it was found that the amount of below-ground biomass produced was more than three times greater than that produced above ground ^{36:246}. The belowground root mass within the top 24 inches of the soil was more than eight tons per acre. Across four other prairie study sites, belowground biomass within the top 36 inches of soil

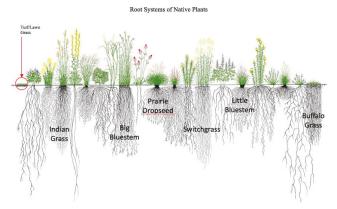


Figure 3.11. Soil health depends heavily on extensive root systems and the organic matter, exudates, and structure they produce. Because of their deep and extensive root systems, native grasses can be particularly beneficial for promoting healthy soils. Credit, Conservation Research Institute.

was more than six tons per acre^{37: 174}. In the eastern U.S., more than five tons per acre of root biomass accumulated (within the top 12 inches of soil) — within five years of stand establishment³¹. These results are from eight study sites across the southeastern U.S. where soils were often considered marginal and yet the accumulation of belowground biomass appears to be comparable to the sites in the prairies of the Great Plains. This tremendous root mass, along with all of the exudates and associated relationships with microbes, creates the life that is essential to a productive soil. This organic matter also holds nutrients, retains soil moisture and creates healthy aggregation. In addition to the root mass, the rooting depth — and ability to penetrate claypans — allows the nutrient mixing upward and water penetration downward that further enriches soil health. The large amount of root mass also provides exceptional capacity for carbon sequestration.

In terms of water quality, several studies have demonstrated that the strong root systems increase water infiltration (Figure 3.12), presumably through the channels they create, some reaching down as far as 8-12 feet. Furthermore, native grasses, because of their stiff stems, can slow water velocities and, therefore, serve as barriers to off-site movement of

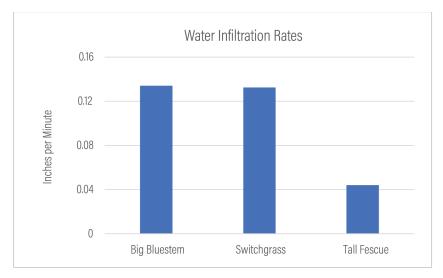


Figure 3.12. Improved water infiltration is made possible by the deep roots of native grasses and the channels that they create. Such infiltration allows more water to be stored within the soil profile and less to runoff into streams carrying away valuable soil and nutrients. Source, A. Nouri, University of Tennessee, unpublished data.

surface flow, associated sediments and adsorbed nutrients and chemicals^{28, 17}. By contrast, low-growing sod-forming species such as bermudagrass and tall fescue may prove inadequate in trapping sediments where water velocities are high¹³. Finally, the dense root mats, rhizomes and surface litter produced in native grass stands serve to reduce erosion. As was the case with the improved grazing on cool-season acres mentioned earlier in this chapter, the presence of a warm-season grass component can have a ripple effect onto cool-season pastures. By allowing cool-season pastures to rest, they can develop larger, more robust root systems and greater above ground cover (including litter). These improvements will allow for more water infiltration and less surface flow, along with the associated erosion. Thus, improving conditions on warm-season pastures.

Grassland bird populations have declined for more than a halfcentury and, for most of these species, the declines have occurred across most of their breeding range. Among all guilds of breeding birds in the

Percent Change in Population, 1970 - 2017 GRASSLAND HABITAT GENERALIST FOREST GENERALIST EASTERN FOREST WETLANDS -60 -50 -40 -30 -20 -10 0 10 20 Percent Change а

NATIVE GRASS FORAGES FOR THE EASTERN U.S.

Grasshopper Sparrow

Figure 3.13. Grassland birds have experienced long-term population declines, more so than any other guild of birds (a). Despite conservation efforts, these species continue to experience steep population declines. Typical of such declines is that of the grasshopper sparrow, a species that nests only in grasslands and has experienced an 81 percent loss in population during this period (b). Adapted (a) from: Rosenberg, K.V., A.M. Dokter, P.J. Blancher, J.R. Sauer, A.C. Smith, P.A. Smith, J.C. Stanton, A. Panjabi, L. Helft, M. Parr, and P.P. Marra. 2019. Decline of the North American avifauna. Science 336:120-124; source (b), https://www.mbr-purc.usgs.gov/.

U.S., those adapted to grasslands have experienced the most substantial declines (Figure 3.13). For instance, the northern bobwhite, a species once common throughout the eastern U.S. from what is now the Corn Belt southward to Mexico, has declined by 84 percent across its range since the late 1960s (Figure 3.14). This species has persisted, however, on rangeland where native grasses continue to be the dominant grass. Two recent studies, one in southwestern Missouri and one in central Kentucky, have confirmed that northern bobwhite do well in grazed native grasses. In fact, it turns out that such areas are the most readily used and productive habitat for this species (Figure 3.15). By contrast, these and other studies have demonstrated that grazing lands dominated by tall fescue and other introduced grasses are avoided by quail and, in many cases, other grassland birds^{50, 4, 2, 3, 9}.

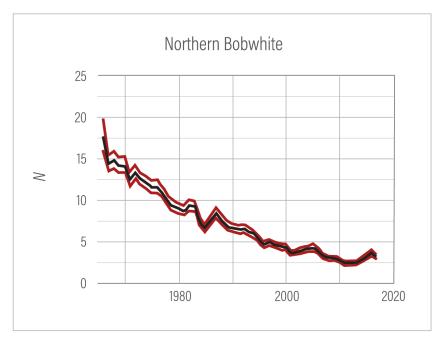


Figure 3.14. The northern bobwhite, once abundant throughout the eastern U.S. has lost 86 percent of its population over the past five decades. This species is well-adapted to the structure provided by native grasses but not that of species such as bermudagrass or tall fescue. https://www.mbr-pwrc. usgs.gov/.

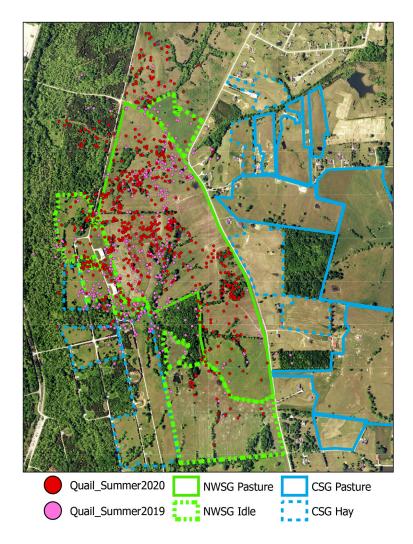


Figure 3.15. Northern bobwhite are adapted to native grasses and the conditions they provide, but recent research has demonstrated that grazed native grasses are even more valuable to this species. Here, it can be seen based on the breeding-season radio telemetry locations (red and pink dots) depicted on this map, that northern bobwhite used actively grazed native grass pastures readily while entirely avoiding tall fescue-dominated hay and pasture. Idle native grass fields, with their heavier, ranker cover were used less frequently than those that were being grazed. D. Mitchell, University of Tennessee, unpublished data.

SUMMARY

Native grasses have many attributes that make them attractive as a tool for forage production. As warm-season plants, they are well-poised to complement the cool-season grasses that dominate the forage systems of the eastern U.S. Benefits include improved yield and quality of summer forage, improved drought resiliency and, where tall fescue is the primary cool-season forage, relief from fescue toxicosis. Furthermore, grasslands of the eastern U.S. as far north as southern Michigan have historically been dominated by C4 grasses. Restoring a balance between C4 and C3 species is simply an adjustment to more closely match the historical baseline of the region, one that may be even more critical if the frequency and severity of extreme heat and drought episodes become more pronounced in the future. In addition to being warm-season grasses, these natives have a number of other attributes important for forage production: they are perennial, highly productive, produce strong animal performance, have low input requirements, have broad adaptation, produce few toxins, are non-invasive and conservation friendly (in terms of improving soil health, increasing water quality and serving as habitat for wildlife such as the northern bobwhite).

CHAPTER FOUR Roles for Native Grasses

Based on the attributes of native grasses presented in the preceding chapters, there are some obvious roles that they can play in eastern forage systems. Three particular areas are where higher rates of gain are important, as a buffer against drought and to avoid toxic tall fescue during summer. Native grasses will also be compared to two other warm-season forage tools, bermudagrass and summer annuals.

GROWING CLASSES OF ANIMALS

As mentioned in the previous chapter, native grasses can produce high rates of gain. For backgrounding, stockering, heifer development and grass finishing, high rates of gain are important. Weaned calves that are backgrounded on native grass for 30-60 days could gain 75-150 pounds, increasing their value substantially. This presumes that calves are being weaned at a time of year that they can take advantage of these forages. Thus, the value here will be largely for fall-calving herds. In such herds though, the increase in value of these backgrounded calves comes at a very modest price (approximately \$0.30 per pound of gain) as described further in Chapter 14.

As is the case with backgrounding, native grasses can provide stocker operators substantial amounts of gain at very low cost (Figure 4.1). Over a three-year study conducted at the University of Tennessee, 6 cwt steers gained, on average, 216 pounds per head grazing a big bluestem/indiangrass blend. In a second Tennessee study, also conducted for three years and with the same forage, similar sized steers gained an average of 229 pounds each. Both projects achieved these gains during a



Figure 4.1. Steers grazing a native grass pasture planted to big bluestem and indiangrass. Research has consistently indicated these growing animals perform very well on native grass forages gaining about 225 pounds per head during a 15-week summer grazing season.

15-week grazing season extending from mid-May to late August. Cost of gain was calculated in the first of those two studies and was only \$0.31 per pound. Other studies have documented similar gains from grazing native grasses. For instance, a study in North Carolina reported steers grazing big bluestem over a 19-week summer season gained approximately 300 pounds each and those grazing switchgrass gained about 290 pounds each¹¹.

For heifer development, gaining weight at a rate high enough to ensure puberty is not delayed is important. Given a target of 65 percent of mature body weight by breeding, ADGs of 1.4-1.8 pounds per day will be required. This is well within the rates documented for weaned heifers grazing native grasses. Maintaining adequate rates of gain, 1.5-1.7 pounds per day, continues to be important for bred heifers. Again, studies have shown that heifers grazing native grass forages typically gain at those rates. In a two-year trial conducted in Tennessee, Holstein heifers (10 cwt starting weight) gained an average of 1.64 pounds per day over the summer (14-week grazing season) on a big bluestem/indiangrass blend (Figure 4.2). Beef heifers grazing the same pastures in subsequent years have experienced similar rates of gain. Given the lack of revenue associated with heifer development for approximately 30 months, having inexpensive forage is obviously important. In a threeyear grazing trial with eastern gamagrass, cost of gain for beef heifers (9 cwt starting weight) was \$0.40 per pound²⁵ (Figure 4.3). In another Tennessee study, cost of gain for dairy heifers grazing native grasses was \$0.39 (big bluestem) and \$0.31 (switchgrass) per pound²⁵, values well below those for silage-based diets or those based on commodity feeds²⁹.

Grass finishing requires high rates of gain to achieve target carcass weights, achieve those by target ages that maximize meat tenderness and ensure appropriate meat quality through intramuscular fat deposition (marbling). For instance, to end up with a 1,300-pound steer by 24 months of age requires an average rate of gain of 1.6-1.7 pounds per day. As mentioned above, rates of gain on native grasses meet this target.



Figure 4.2. Yearling heifers maintain desirable rates of growth on summer pasture planted to big bluestem and indiangrass. Native grasses have proven to be a useful—and inexpensive—tool for heifer development. These black-hided heifers are grazing a big bluestem/indiangrass blend at 4 p.m. in mid-July despite temperatures well above 90 F.

Clearly, other forages will have to provide those gains during the balance of the production cycle, but at least for summer grazing, natives can be a part of the solution. And depending on the calving date (i.e., fall calving), native grasses could be grazed for two summers during the production cycle. To the extent that perennial natives can replace more expensive summer annuals, the native grasses can also contribute to cost reductions and improved profitability. These higher rates of gain are also important for quality grade and marbling, especially during the final phase of finishing.

In a study conducted at Mississippi State University, meat quality was compared for animals grazed on native grasses and other species (in this case bermudagrass). Animals that grazed indiangrass during the stocker phase had better quality grade²⁷. There was also a preference expressed in taste panels for the meat from animals that had grazed



Figure 4.3. Although rates of gain for beef heifers grazing eastern gamagrass during summer are lower than those for other native grasses, this grass supports high stock density while maintaining good growth and calving rates. The picture was taken on August 13.

indiangrass. Some reports have indicated that finishing on tall fescue imparted an off-flavor, an assertion that seems to have been confirmed in a recent study conducted in South Carolina¹⁹. However, that study did not compare animals finished on tall fescue with those on native grasses. Further research will be required to determine if there is an advantage in taste from finishing on native grasses.

IMPROVED DROUGHT RESILIENCE

Native grasses can play an important role in any operation – stocker, cow-calf, fall calving, spring calving, dairy-by providing a buffer against substantial droughts. The greater an operation's reliance on cool-season grasses, the greater the need for a drought-resilient alternative. Summer annuals can be helpful in this regard as well but are more expensive (see Chapter 14), have higher risk given their annual establishment and, depending on the timing of drought, will be less reliable than perennials. By contrast, warm-season perennials, once established, can be available each spring regardless of the timing or intensity of drought. A University of Tennessee study comparing five summer forage options found that the financial risk associated with annuals was greater than that for perennials. For the annual, the probability of negative net returns was twice that of bermudagrass and four times greater than that for a big bluestem/indiangrass blend⁷. This was largely the result of delayed establishment of the annual and, thus, shorter grazing seasons and/or weaker stands due to poor establishment conditions. Thus, a warm-season perennial can be a risk management tool that not only avoids issues with annuals but also can reduce or eliminate the need for purchased feed. A model that simulated long-term drought patterns and associated hay feeding demonstrated that where only cool-season forages were used net returns could frequently be negative⁵ (Figure 4.4). On the other hand, where a warm-season perennial was a component of the forage system, net returns remained positive even under more extreme assumptions regarding summer drought duration.

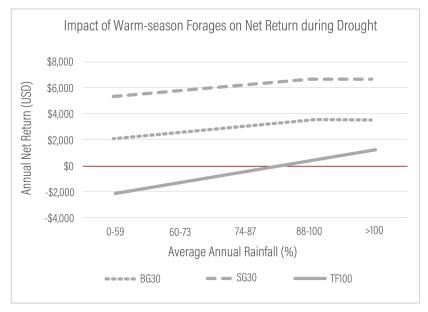


Figure 4.4. Having a perennial warm-season grass as a component of a forage program can help reduce risk. Based on an economic model that simulated net present value for operations with either 30 percent bermudagrass (BG30) or 30 percent switchgrass (SG30) and without a perennial warm-season grass (TF100), the negative impact of hay feeding on profitability becomes apparent. Note the net present values for the cool-season grass-only production scenario (TF100) became negative once rainfall dropped below about 80 percent of the annual average. This was due to the cost of increased hay purchases. (K. Brazil, Ph.D. dissertation, University of Tennessee, 2019)

MITIGATION OF FESCUE TOXICOSIS

We have known about problems with tall fescue toxicosis for many years. Research continues to show depressed calving rates, weaning weights and rates of gain where animals are on toxic-endophyte infected tall fescue during summer (Figure 4.5). Toxicosis has been estimated to cost U.S. beef producers more than \$2 billion annually, primarily as a result of reduced calving rates and weaning weights. The impact has been estimated to be about \$160 per cow per year²³. In a South Carolina study, cows moved off of infected tall fescue-dominated pastures following timed AI breeding had considerably greater pregnancy retention (92 percent) than those that remained on "hot" fescue (60 percent) following breeding¹⁰. Thus, removing animals following



Figure 4.5. Toxicosis caused by an endophyte in tall fescue leads to numerous health problems for grazing cattle, particularly during summer. Elevated body temperatures of cattle grazing toxicendophyte infected tall fescue cause cattle to seek relief by standing in stock ponds such as seen here. Note several animals standing in the shade of the small tree to the right of the pond. None of the animals in the pond or under the small shade tree are grazing.

breeding can substantially improve calving rates. A study in Arkansas also demonstrated a benefit from reducing exposure to hot tall fescue during spring breeding. In that study, spring-calving cows with no exposure to hot fescue had an 80 percent calving rate while those with heavy exposure had a calving rate of 44 percent¹². In that same study, weaning weights for spring calves on non-toxic fescue were 18 percent greater than those on hot fescue. Returns from grazing based on that study were 26 percent greater for spring herds with non-toxic forage versus those on toxic fescue⁴⁰. Clearly, avoiding summer effects of toxicosis can have beneficial outcomes for cow-calf operations. Based on rates of gain associated with infected tall fescue (0.82 pounds per day for steers based on a metanalysis of 12 studies conducted across seven states)⁴⁴, avoiding exposure in summer can also benefit backgrounding, stockering and grass finishing operations. With respect to heifer development, rate of gain is reduced (by about one-third of that on non-infected pastures, based on a North Carolina study¹⁸), as are calving rates, even more so than with mature cows. Summer forages that reduce exposure to fescue toxicosis are valuable for any cattle operation.

FORAGE SYSTEMS --- USING WARM- AND COOL-SEASON GRASSES TOGETHER

Based on the benefits of native grasses described in the preceding chapter, another obvious way to take advantage of these species is to incorporate them into a balanced forage system, one that uses warm-season perennials to complement cool-season forages. Studies documenting the impact of both together are limited because of the challenging logistics of conducting such research. There are, however, a few examples that we can look to that give us some insight into the likely benefits of such a complementary system. First, there have been several studies with steers or heifers that included sequential grazing, going from a coolseason pasture in spring to a warm-season pasture in summer, then back to a cool-season pasture in fall. These studies have generally shown a benefit from the system. A study in Nebraska reported a 38 percent improvement in ADG for the full grazing season for the complementary system versus the cool-season only system¹. Studies in Missouri and Pennsylvania both reported carrying capacity increased during summer by 2-4 times compared to cool-season pasture at that time^{39; 22}. In a Tennessee study, the combination of tall fescue and bermudagrass resulted in an 84 percent increase in per acre beef production, driven by increased grazing days per acre rather than ADG³⁰. In a cow-calf study, ADG for both cows and calves improved versus a cool-season only system¹.

Based on these studies, it would seem that a complementary system can offer a number of advantages over a system that relies only on cool-season grasses. One obvious benefit is greater rates of gain during summer that add up to better season-long gain. Another benefit is more grazing days through greater summer carrying capacity and, potentially, a lengthened grazing season as a result of rested coolseason species that can be more effectively stockpiled for fall and winter grazing. Together, these two improvements should translate into more gain per acre. In addition, the improved cool-season pasture condition resulting from greater summer rest will translate into more productive, vigorous swards that require less maintenance and have longer stand life. And of course, as mentioned above, the improved ability to deal with drought and avoidance of fescue toxicosis are also advantages of a complementary system. Additional research with cow-calf pairs needs to be conducted to validate how complementary systems work in practice.

SOME COMPARISONS BETWEEN NATIVE GRASSES AND OTHER WARM-SEASON FORAGES

Much of the preceding information may be as applicable to other warm-season forages as it is to native grasses. Again, the question can be asked, "Are natives an appropriate tool for the job?" Below, some comparisons are drawn between natives and two other widely used summer forages, summer annuals and bermudagrass, in an attempt to address that question.

Summer annuals

There are a number of high-quality summer annuals that can play an important role in a forage program. How do they compare then to native grasses? In terms of rate of gain, they generally perform below big bluestem and big bluestem/indiangrass blends, but similarly to switchgrass and similar to or better than eastern gamagrass. However, in terms of grazing days, the perennials generally are preferable. For example, in a study comparing eastern gamagrass to a sorghum × sudangrass hybrid, starting date for grazing the eastern gamagrass was, on average over the three years of the study, 37 days sooner than that for the annual (May 7 versus June 13). Although planting dates and grazing initiation may vary by location across the eastern U.S., it is typical for perennials to be available earlier in the season than annuals. In this case, the perennial provided a 112-day grazing season versus 65 days for the sorghum × sudangrass. In addition, eastern gamagrass allowed for heavier stocking during the active grazing period (1,600 versus 1,240 pounds per acre) and, consequently, offered twice as many grazing days per acre as the annual over the course of the study²⁵. In another study, crabgrass provided comparable stock density to eastern gamagrass and switchgrass but produced fewer grazing days per acre than these perennials because they had longer grazing seasons due to earlier initiation dates. Although the crabgrass carried greater stock density than a big bluestem/indiangrass blend, the advantage was negated when it came to grazing days per acre because of the longer grazing season for the perennial blend. All three natives in this study produced greater total gains per acre than the crabgrass, in part because of more grazing days, but also, in the case of the big bluestem/indiangrass blend, because of greater rates of gain⁵¹.

Regardless, the high rates of gain and flexibility of annuals make them a valuable tool. The major drawback for annuals is their greater cost (see Chapter 14) and the risks each year associated with establishment. Thus, they can always make an important contribution to a forage program but should not be the warm-season foundation for it. Another consideration regarding annuals is the risk of toxins including nitrates (millets, sorghums, sudangrass, sorghum × sudangrass hybrids) and prussic acid (sorghums, sudangrass, sorghum × sudangrass). Although these problems arise only infrequently, they can be quite serious when they do occur. Death loss of only a few animals under such conditions can quickly reinforce the benefits of a non-toxic perennial for summer forage production. With native grasses, these toxins are not an issue, allowing greater flexibility in management during drought or other situations that promote nitrate or prussic acid toxicity.

Bermudagrass

A very common summer perennial that is widely used for forage in the southern part of the eastern U.S. is bermudagrass. Bermudagrass has many attributes that make it attractive for forage production. Like the native species being addressed in this book, it is a long-lived perennial. It also provides much greater drought resiliency than cool-season grasses and, like the natives, provides relief from fescue toxicity. It also avoids most of the issues with annuals regarding the toxins mentioned above. Bermudagrass enjoys one substantial advantage over native grasses and that is its resiliency to mismanagement. As a species that grows close to the ground through stolons, it is much less vulnerable to overgrazing than the tall-growing natives. Consequently, mistakes in management are more easily corrected with bermudagrass than with natives and there is greater room for error.

On the other hand, native grasses enjoy a number of advantages over bermudagrass. Because they are native to the eastern U.S., these grasses are well adapted to a much wider range of sites, including those we often think of as marginal (i.e., poorly drained, thin, sandy or gravely; Figure 4.6). This adaptation allows for a great deal of flexibility in establishing and growing native grasses on most sites (see Chapter 6). Native grasses also are much more cold-tolerant than bermudagrass and can be grown in the northern half of the eastern U.S. (Figure 4.7) By contrast, bermudagrasses, even those with some cold-tolerance, can readily winterkill as far south as Tennessee. Although bermudagrass is much more drought tolerant than cool-season species, it is less so than the



Figure 4.6. Because species such as big bluestem and indiangrass are native, they are well adapted to the conditions of the region and can be grown on a wide variety of sites, including those with thin, rocky soils. This stony ridgetop field had been growing briars and broomsedge prior to establishing the native grasses seen emerging here. This became a fine stand and a productive pasture.

native grasses. During a prolonged, severe drought in Texas, 2011-2015, many bermudagrass pastures died and had to be replaced but native range persisted. Another advantage of native species is that they do not spread into areas where they are not wanted. Bermudagrass can spread into other pastures impacting management and limiting alternatives. To maintain desirable levels of bermudagrass productivity fertility and pH must be maintained. Although native grasses are more productive with N amendment (see Chapter 12), they are much more tolerant of low P, K and pH, maintaining most of their productive potential under these conditions. Based on these higher input requirements, bermudagrass becomes more costly to grow, produces gain/hay at greater cost and has lower net returns. In a recent study, net returns from grazing bermudagrass were only 44 percent of those from the poorest and only 26 percent of the best performing native grass in the study. Not all of the difference in returns can be attributed to cost of production though.



Figure 4.7. Native grasses have much greater cold hardiness than bermudagrass. However, some care must be used when selecting native grass cultivars with southern origins when planting in northern locations. Nevertheless, there are native grass cultivars that thrive across the northern U.S.

Natives have higher rates of gain and provide similar (big bluestem) or greater grazing days (eastern gamagrass and switchgrass) per acre, thus producing more beef per acre (Figure 4.8). And as described earlier in this chapter, the higher rates of gain make natives attractive for enterprises that require strong animal growth including heifer development, stockering or grass finishing. Another advantage of native species is the limited problem with diseases and pests. Recent issues with bermudagrass stem maggot and bipolaris leafspot fungus highlight some of the challenges that often occur with non-native species.

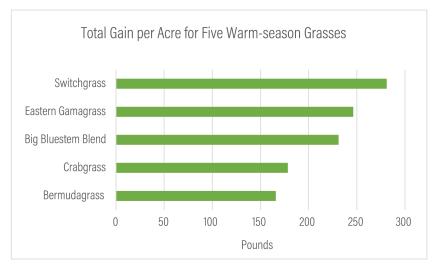


Figure 4.8. In a recent side-by-side trial, native grasses produced more beef per acre than bermudagrass. K. Zechiel, MS thesis, University of Tennessee, 2017.

SUMMARY

It should be clear that native grasses can play a number of roles in forage production in the eastern U.S. This may be especially true where higher rates of gain are required. But it is also true where the predominant cool-season forage is endophyte-infected tall fescue. And regardless of any endophyte issues or the rate of gain sought for any given production enterprise, drought is an inevitable challenge. Attempting to prosper in the face of summer drought with only a cool-season forage guarantees increased costs and reduced productivity. Some warm-season species should be incorporated into the forage production system. Although annuals are high quality and flexible forages, they are expensive relative to perennials, are not always reliable and face challenges with prussic acid and nitrate toxins. Other perennial warm-season grasses such as bermudagrass are a better long-term solution to summer forage production. However, despite a high tolerance for overgrazing, bermudagrass has a number of disadvantages when compared to natives. It is not as widely adapted, is not cold-hardy, is somewhat less drought tolerant, is more costly to produce and has considerably lower rates of gain. Depending on each producer's needs, the advantages of native grasses may outweigh those of bermudagrass or other introduced warm-season perennials.

CHAPTER FIVE Challenges to Using Native Grasses for Forage Production

Despite the many positive attributes of native grasses described in the three preceding chapters, these grasses, like all forages, have their drawbacks. There are four such issues that present challenges to their use for forage production: difficulty in establishment, lost forage production during the establishment year, more attention required for proper management and a shorter production season than some of the dominant cool-season perennials. Each of these challenges is addressed below.

CHALLENGING ESTABLISHMENT

The native grasses most commonly used for forage production in the eastern U.S. (big bluestem, eastern gamagrass, indiangrass, little bluestem and switchgrass) are all considered late-successional species within grassland ecosystems. Thus, they are not adapted to rapid exploitation of disturbed sites. Put another way, they are all slow to establish; they are distance runners not sprinters. Keep in mind though, this is generally true of all of our perennial forage grasses. None of these species are as easy to establish as the annuals commonly used in forage production such as sorghum × sudangrass hybrids, millets, rye or wheat. And with any perennial, there are some basic challenges to establishment — all require high quality seedbeds with excellent competition control and shallow seeding depths. All of these are things that farmers can, more or less, control. And, of course, establishment success for all of these species, including the annuals, requires adequate and timely rain, something none of us can control.

Native grasses present an additional challenge though, at least compared to the cool-season perennials, because they germinate slowly. Much like seeded bermudagrass, native grasses require 20-24 days to begin to germinate in appreciable numbers (Figure 5.1). Thus, even where competition control has been excellent, the long interval until seedlings emerge can allow weeds to germinate and once again become competitive. Furthermore, the native grass seedlings prioritize root growth over

top growth leaving them vulnerable to developing canopies of rapidly growing annual weeds. Where good agronomic practices are not implemented, these factors can contribute to high stand failure rates. On the other hand, with good, pre-planting competition control, high quality seedbeds and diligent post-planting weed control, establishment success rates are high – 85-95 percent on the initial attempt. Where failures do occur despite good practices, it is usually a result of drought or excessive rain, which fosters rapid development of weeds. Nevertheless, the limited margin of error when establishing these small-seeded species (eastern gamagrass is an exception having large seeds) makes native grass



Figure 5.1. Because of slow germination and their small seedlings, which are vulnerable to competition from weeds, native grasses can be challenging to establish. Note numerous indiangrass seedlings, foreground and top. Also note crabgrass seedling at bottom center and bottom right, and broadleaf weeds. Because of their more rapid growth, these weeds will present substantial competition for the native grasses during the seedling year.

establishment challenging. One promising development are the recent advances in plant breeding that have led to cultivars with substantially improved seedling vigor. These cultivars are expected to be commercially available by 2023. Chapters 6-8 provide further information for successful establishment of native grasses.

Planting native grasses also requires an outlay of the producer's time and labor for implementing the good agronomic practices mentioned above. And that clock starts running well before planting season when pre-planting weed control is initiated. There are also inescapable costs associated with a new planting. These may include herbicides, application of those herbicides, seed, drill rental and follow-up spraying/ herbicides. A reasonable estimate of typical out-of-pocket costs would be \$225-\$315 per acre. Of course, actual costs for any particular planting project will vary based on specific circumstances. For instance, the \$315 figure just mentioned was based on seed costs of \$150 per acre whereas the \$225 figure was based on seed costs of \$57 per acre. Both figures include custom application and/or equipment rental as well. Regardless of the actual cost, this investment presents a risk – as do all planting exercises regardless of the species in question. Furthermore, costs and risks associated with establishing native grasses should not be compared to doing nothing, assuming the site needed to be planted or renovated regardless of the species to be planted. Rather, the appropriate framework for comparing the costs and risks of planting native grasses should be the other forage option being considered, such as a novel-endophyte tall fescue, seeded bermudagrass, etc. In that framework, the costs and risks of establishing native grasses may not be much greater than that for the alternatives, and in some cases may be lower.

LOST FORAGE PRODUCTION DURING ESTABLISHMENT

Because of the need for newly emerged seedlings to develop their deep root systems and produce enough above ground growth to be competitive, use of seedling stands for grazing or hay production is not recommended. Even in a best-case scenario, with initial competition control not being implemented until late March and, therefore, forage still available up until that point, there would not be any forage produced until early May of the second year, about 13 months later. For many producers this is a serious challenge, especially where existing herd size and grass availability leave little management flexibility.

However, keep in mind that for any perennial forage establishment project there is a period during which seedlings are developing and forage is not being produced. In addition, depending on the latitude where the planting is being undertaken, there are already three months (December-February) or more during which even established grasses are not productive. As an example, fall-planted tall fescue would not be expected to produce useable forage until after the first winter, a 7-month (September through March) gap in production. For spring planted bermudagrass, forage production that summer would be limited at best and, because this is also a warm-season species, no production could be expected that fall or subsequent winter. Thus, the gap in production would be similar to that for native grasses. Regardless of how one accounts for this gap in production though, producers do need to recognize it and plan accordingly. Current research is exploring the potential for using a warm-season annual nurse crop that could provide some forage production during the seedling year (see Chapter 8 for further information). At the time of this writing, it is too early to draw conclusions about how successful this approach will be.

CHALLENGING MANAGEMENT

Compared to other commonly used forages such as tall fescue, bermudagrass and bahiagrass, native grasses require more management to maintain vigorous, productive stands. This is largely because of their tall growth habit and how they store energy (see Chapter 10 for additional details). Their rapid early summer growth also contributes to the challenge. Because of their height, the optimum range in which to maintain canopies is considerably taller than what we are accustomed to with other forages that have shorter growth habits. It is important for managers to recognize and become accustomed to these taller canopy height targets. Attempting to graze native grasses as closely as more conventional forages will, over time, result in weakened, less productive stands and greater weed pressure. Collectively, these factors mean that more timely adjustments to stocking are required for native grasses to ensure appropriate canopy targets are maintained.

However, if some care is taken in monitoring canopies and making appropriate adjustments in stocking, native grasses are not difficult to manage (Figure 5.2). It is also important to recognize that native grasses are much more resilient to mismanagement than is commonly recognized. Severe overgrazing can be accommodated by simply providing longer rest periods. What is critical, though, is to avoid repeated and/ or prolonged overgrazing. Maintaining short canopies for a full season or repeated bouts of excessive canopy reduction over a period of a few years is what leads to more serious problems. Even then, extended rest periods (up to season long) and perhaps some weed control can be effective in restoring the stand (see Chapter 9 for more on renovating degraded stands). In situations where the stand has become too tall,



Figure 5.2. A well-managed native grass pasture with a vigorous canopy 16-18 inches tall on July 10th. By simply maintaining canopies of native grasses within a reasonable height range, one appropriate to their taller growth habit, proper grazing management is easily achieved. In this case, the pasture was stocked in mid-May and a single adjustment to stocking was implemented in late June, 16 days before this picture was taken. While these grasses will require more attention than what is needed with other common perennials, with a bit of experience one can quickly develop the skill to successfully manage these species.

either mob grazing (high stock densities for short intervals) or a hay harvest can easily correct this problem. Although rotational grazing has been commonly recommended for natives, they can be readily managed under other approaches including various continuous grazing strategies, management intensive grazing, patch-burn grazing or some combination of hay harvest and aftermath grazing. The point is that as long as appropriate canopy heights are maintained, grazing management can be quite flexible and stands can remain productive for decades.

SHORT SEASON LENGTH

Native grasses, depending on the species in question, can be grazed from as early as late April (eastern gamagrass) through mid-September (indiangrass) in the Mid-South, a period of approximately 130 days¹¹. That period will be somewhat longer at lower latitudes and several weeks shorter further north. However, toward the end of this period (after midto late August), the quantity and quality of forage will be diminished. But even with the assumption of a 130-day grazing season, that still leaves 235 days during which no forage is produced. In comparison with tall fescue, this is a considerably shorter grazing season. For some producers, this can be a concern. However, for others the benefit of having a productive warm-season forage within the operation outweighs the shorter grazing season. It is worth noting that the grazing season for bermudagrass in the Mid-South is generally similar to that for natives, about 130 days but with the window shifted a week or two later in the spring¹¹. Thus, the same question has to be answered regarding use of any warm-season perennial within a forage program, not just native grasses.

While it is true that there is a long period each year during which native grasses are not actively growing, there are some other factors that should be considered when evaluating this gap in production. First, it is really not fair to consider all 235 days that native grasses are not actively growing as lost to forage production. Even with cool-season perennials, productivity during winter is limited. In three multi-year studies

that included tall fescue, one in southwest Tennessee, one in southern Missouri and the third in central North Carolina, the average dates that fescue grazing was initiated were April 1, 4 and 7, respectively. Thus, there are approximately 120 days (December 1-March 31) during which tall fescue growth is likewise unable to support grazing. If that period is discounted, the penalty for warm-season perennials could be more accurately considered to be 115 (235 days minus 120 days) rather than 235 days. While this can still be an issue, it is not as large a gap in production as it first appears (Figure 5.3). Secondly, there are strategies that can reduce the impact of this gap including grazing the native grasses once they are dormant and overseeding the natives with winter annuals (see Chapter 13 for more information on dormant-season management). Finally, I have spoken to many producers who have found that the benefit of having the four-month summer slump period filled with a productive forage is a worthwhile trade-off for having those same warm-season pastures remaining unproductive for what amounts to 3-4 months. Indeed, the greater gains provided by these natives through the summer can provide a substantial net increase in pounds of beef produced per acre across the operation.



Figure 5.3. Cool-season perennials can provide extended periods of productive grazing during spring and fall but have limited production during winter. Comparisons between grazing season lengths for species such as tall fescue and native grasses should take into account the winter dormancy of cool-season grasses. Credit, J.B. Daniel.

SUMMARY

Producers should evaluate each of the issues addressed above as they consider adopting warm-season native grasses into their program. However, each should be weighed in context. There is no doubt that these species present challenges in establishment. It is also true that success rates with good agronomic practices are above 85 percent and that any perennial grass has many of the same issues. Lost forage production during the seedling year is a serious concern for many producers, but, again, there is such a period for any perennial, albeit a notably shorter one for cool-season species. Much has been said about the difficulty in managing native grasses once established. However, with some attention to canopies (something we should be doing with any forage) and an appreciation for their taller growth habit, good management can be readily achieved (Figure 5.4). The trade-off between a productive summer forage and several months where these same stands are dormant must also be weighed. Together, all of these challenges must be considered in making the decision to adopt these grasses.



Figure 5.4. Many producers are not familiar with native grass forages and as a result are under the impression that they are too difficult to establish or manage. While there is no doubt that establishment can be a challenge and that management requires more attention than with other common forages, the level of difficulty has been over-emphasized through the years. Indeed, stands such as the one here are commonly established and have produced high-quality summer forage, in many cases for decades. Credit, K. Brazil.

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